LITHUANIAN INFORMATIVE INVENTORY REPORT 2015

Lithuanian Pollutant Emission Inventory for Period 1990-2015 Reported to the Secretariat of the UN/ECE Convention on Long-range Transboundary Air Pollution

Lithuanian Environmental Protection Agency

Legal Disclaimer

Abbreviations

BC – black carbon;
CEIP – Centre on Emission Inventories and Projections;
CPST – Centre for Physical Sciences and Technology in Lithuania;
CLRTAP – Convention on long Range Transboundary Air Pollutants (ECE/EB.AIR/97);
CORINAIR – The Core Inventory of Air Emissions in Europe;
DSGRL – Department of Statistics to the Government of the Republic of Lithuania;
DSI – dry sorbent injection;

EMEP/EEA – European Monitoring and Evaluation Program / European Environmental Agency;

EMEP/EEA 2013 or 2016 guidebook - The EMEP/EEA air pollutant emission inventory guidebook, where 2013 or 2016 is the year when guidebook was approved;
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 Emissions in Europe;
E-PRTR – European Pollutant Release and Transfer Register;
ESP – electrostatic precipitation;
FF – fabric filter;
FRD – Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania;
GHG – Green-house Gas;
HCB – hexachlorobenzene;
IIR – Informative Inventory Report;
IPCC GPG 2000 – IPCC Good Practice Guidance and Uncertainty management in national Greenhouse Gas Inventories (2000);
KCA – key category analysis;
LEPA – Environmental Protection Agency under the Ministry of Environmental Protection (Lithuanian Environmental Protection Agency);
MoE - Ministry of the Environmental Protection;
NEC – National Emission Ceilings (directive 2001/81/EC);
NFR – Nomenclature for Reporting;
NMVOC – non-methylated volatile organic compounds;
PAH – Polycyclic aromatic hydrocarbons;
PCB – polychlorinated biphenyl;
PCDD/PCDF – polychlorinated dibenzodioxins / polychlorinated dibenzofurans;
PM – particulate matter;
POP – persistent organic pollutants.

SD – spray drying;

SNCR – selective non-catalytic reduction;

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;

TFEIP – Task Force on Emission Inventories and Projections;

TSP – total suspended particles;

UN – United Nations;

UNFCCC – United Nations Framework Convention on Climate Change;

UNECE – the United Nations Economic Commission for Europe.

The Lithuanian Environmental Protection Agency (LEPA) was established on the 1st of January, 2003, by the Order of the Minister of the Environment of the Republic of Lithuania No. 466 which was released on the 30th of August, 2002. The LEPA performs functions of former Joint Research Centre, Water Resources Department of the Ministry of Environment and undertakes Chemical Substances Management previously managed by State Non-food Products Inspectorate under the Ministry of Economy.

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Authors of the report greatly appreciate input of the following individuals and institutions:

- Centre for Physical Sciences and Technology Institute of Physics, for estimating pollutant emissions via *Tier 1* and *Tier 3* (transport) approach, analyzing and presenting results and much more;
- Climate Change Division specialists (LEPA) for providing activity data;
- Laima Kulviciene and Mindaugas Simanskas from Water condition assessment division in LEPA for providing information on waste water treatment and use in agriculture;
- Laimute Bazyte from Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania for providing statistics on forest and other natural habitats fires; Inga Latveliene from waste licensing division in LEPA for providing information and statistics on waste burning companies.

Executive Summary

The Republic of Lithuania, as a party of the United Nations Economic Commission for Europe (UNECE), under the Convention on Long-range Transboundary Air Pollution (CLRTAP, ECE/EB.AIR/97) is required to annually report pollutant emission data. In compliance with the CLRTAP and its protocols Lithuania submits statistics on the following pollutant emissions: SOx, NOx, NMVOC, NH3, BC, heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, and Zn), particulate matter (TSP, PM10, and PM2.5), and POPs (dioxins, furans, PAHs, and HCB).

The Centre for Physical Sciences and Technology (CPST) in Lithuania has a role of inventory preparation using *Tier 1* approach (and *Tier 3* for Road transport). The Air Division specialists from the Lithuanian Environment Protection Agency, Under Ministry of Environment (LEPA) perform the assessment on the transparency, quality and completeness of the inventories, improve inventory by recalculating emissions in higher tier approaches. LEPA is responsible for the submission of the results to the Centre on Emission Inventories and Projections (CEIP) under the CLRTAP.

The current report includes information (background information, activity data, methodologies, QA/QC, recalculations and future projections and improvements) on emission inventory for the period 1990-2015. The commitments under the National Emission Ceilings (NEC) directive 2001/81/EC and reduction of the pollutant emissions are discussed in this report.

This report is Lithuanian's Annual Informative Inventory Report due March 15, 2017. The report contains information on Lithuanian's inventories for all years from the base years of the protocols to 2015. The inventory is submitted to the European Commission and EEA via EIONET CDR http://cdr.eionet.europa.eu/ annually. This report (IIR) is available for public and can be accessed via Lithuanian Environmental Protection Agency's website: http://oras.gamta.lt/cms/index?rubricId=aaa6bf9f-634d-49e5-9189-47e5f4def4d7 and Convention on Long-range Transboundary Air Pollution webpage: http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2016_submissions/

The report shows how Lithuania complies to and follows the Guidelines for Reporting Emission Data for inventory preparation, how attempts to ensure transparency, accuracy, consistency, comparability and completeness (TACCC) of the reporting. The submission of results was closely followed according to the template provided by the CLRTAP's Task Force on Emission Inventories and Protections (TFEIP) Secretariat.

Main differences from the last submission are:

1) Improved IIR by including more details on calculation methodologies, activity data uncertainties, removing excessive repetition of information on emission factors available on Guidebook;
2) Recalculation of large part of the inventory using the latest 2016 EMEP/EEA guidebook.
3) Evaluation of previously not estimated categories, e.g., NFR 3Df *Use of pesticides*, 3F *Field burning of agricultural residues*, 5C2 *Open waste burning*, 5E *Other waste* and other.

4) Improved methodologies and activity data in multiple categories, for instance, NFR 1A1a *Public electricity and heat production*, all NFR 5C1b categories (i.e., cremation, hazardous waste incineration, medical waste incineration and other) and other.

There is a necessity for inventory improvement in the future. One of the main priorities is to estimate KCA categories using *Tier 2* or higher approach.

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1. INTRODUCTION

1.1. National Inventory Background

The Convention on Long-range Transboundary Air Pollution (CLRTAP) was signed in Geneva in 1979 by 34 Governments and the European Community. It was the first international document addressing problems of transboundary air pollution.

In January of 1994 the Republic of Lithuania ratified the 1979 Geneva Convention on Long-Range Transboundary Air Pollution and became a party to the Convention and its protocols. One of the obligations to the Convention on LRTAP is to submit an annual pollution emission inventory. According to the Reporting Instruction of Reporting Guidelines under the CLRTAP (ECE/EB.AIR.125) time series of emissions under nomenclature for reporting (NFR) and informative inventory reports (IIR) have to be submitted every year, including recalculated emissions for the period from 1990. Projection reports, gridded data and large point sources (LPS) information (Annex III - V) have to be reported every 4 years [1].

The Convention entered into force in 1983 and has been extended by eight protocols, which specify financing aspects of the cooperative monitoring and evaluation programme, address groups or individual pollutants' reduction and control issues, and other issues, such as eutrophication, acidification and ground level ozone formation. The following classes of pollutants are addressed in the inventory:

- Main pollutants (SO_x, NO_x, NMVOC, NH_3 and CO);
- Particulate matter (TSP, PM_{10}, $PM_{2.5}$ and BC);
- Heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se and Zn);
- Persistent organic pollutants (PCBs, Dioxins, Furans, PAHs and HCB).

The trend of national emissions of the main pollutants (except CO) and reduction commitments under revised Gothenburg Protocol for 2020-2029 are shown in the figure 1.1 below.

The 2017 Lithuanian IIR contains information on the national inventory for 2015 including descriptions of methodologies and NFR categories, input parameters, improvement, QA/QC, recalculations, analysis and interpretation of results, assessment for TACCC and other sections as formulated in ECE.EB.AIR.125 revised guidelines. Changed parameters are applied retrospectively for previous submissions and recalculated values are changed accordingly for annual submissions.

Emission estimates are mainly based on official publically available Lithuanian Statistics Yearbooks: energy, production, agricultural, transport and other statistical data, which is available on the main website http://www.stat.gov.lt/en/. EMEP/EEA 2016 guidebook is often referred to when calculating category-specific emissions as almost no country specific data emission factors and methodologies are available.

Figure 1.1-1. National emissions of 5 pollutants (darker shade curves) for period 1990-2015 as a percentage of base year 1990. Straight lines indicate emission reduction commitments for 2020 as set out in the Gothenburg protocol [1].

1.2. 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: 2.8 million

Currency: Euro (Eur)

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.

1.3. Institutional Arrangements

The Lithuanian Environmental Protection Agency (LEPA) under the Ministry of Environment in 2011 was nominated to be responsible for the inventory communication by the Order No. D1-85. Air Division specialists in the LEPA have made a legal arrangement with Center of Physical Sciences to estimate inventory using *Tier 1* approach. Such inventory report is delivered annually and is firstly estimated and compiled by experts of Center of Physical Sciences and Technology (CPST). Air Division specialist then recalculate, improve, check, archive and approve final inventory version. The LEPA has a legal responsibility for submission of the inventory under Convention on LRTAP.

For the years 1990-2015 primary estimation via *Tier 1* EMEP/EEA approach was performed by the experts of Center of Physical Sciences and analyzed, improved and communicated by the EPA (Environmental Quality Department under the Ministry of Environment before 2011) Air division specialists. No other institutional arrangements are made.

There is no clearly defined documentation and archiving system. Information needed to compile inventory reports is saved in the LEPA database and retrieved if needed.

Inventory improvements are prioritized based on the following factors:

1) Stages 1, 2 and 3 inventory reviews, which can be accessed on ceip.at website;
2) KCA categories, which are not estimated using *Tier 2* approach yet;
3) Other experts' reviews and suggestions

1.4. Inventory Preparation Process

Inventory preparation is carried out with the help of experts of the Centre of Physical Sciences and Technology as described in 1.2. The activity data is mainly gathered from publically available databases. The major and most accurate database is the National Statistical Yearbook managed by the Lithuanian Statistics Department. A few yearbooks are used to collect needed activity data. All activity data sources are available in Table 1.5-1.
The brief process of inventory preparation is shown in Figure 1.4-2. Every year entire time series (period from 1990 to 2015 for 2017 inventory submission) are checked and revised, recalculations performed for changes made (error corrections, data improvement or methodology enhancement). The milestones for preparation and submission of National Inventory under the Convention of LRTAP are shown in Figure 1.4-2.

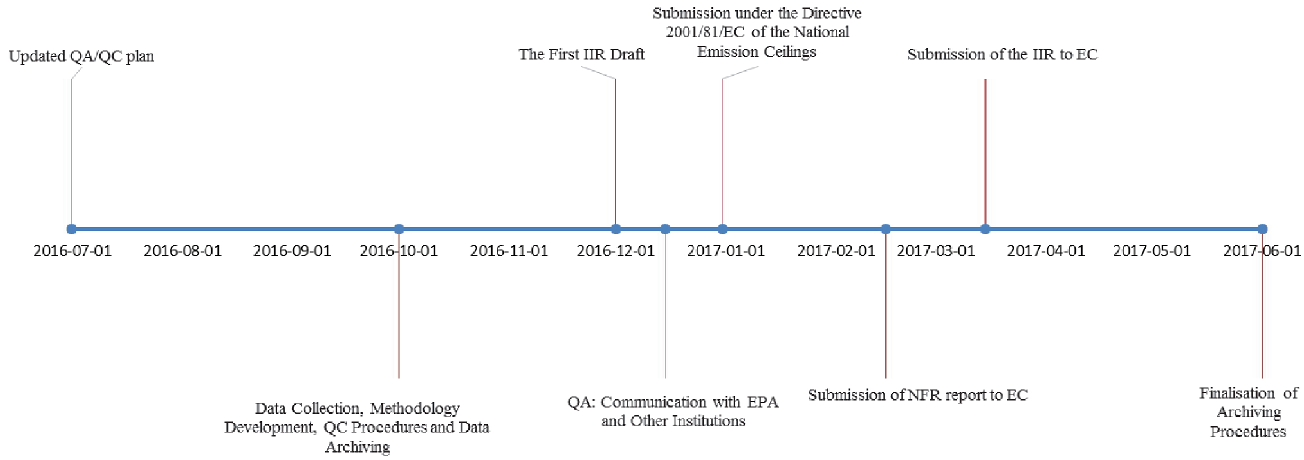

Figure 1.4-1 The milestones for preparation and submission of National Inventory

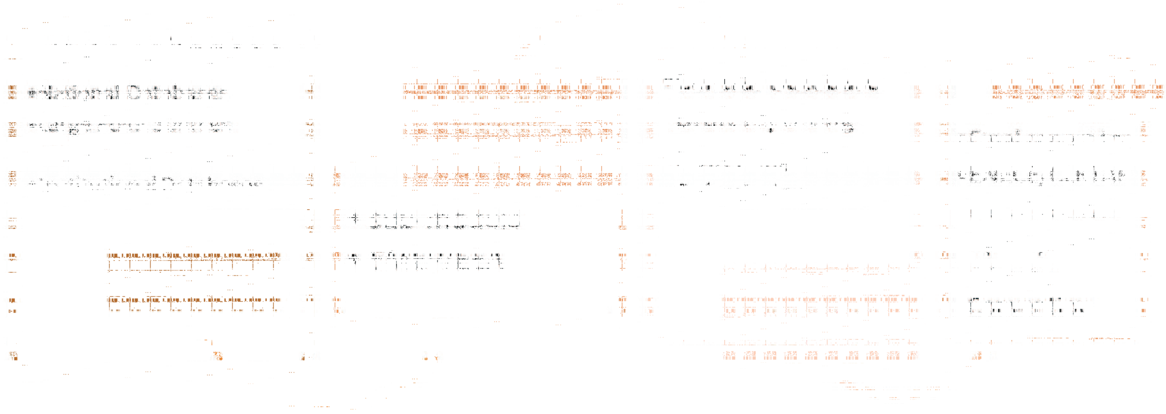

Figure 1.4-2 Schematic diagram of the process of inventory preparation

The Figure illustrates the process of inventory preparation from the first step of collecting external data to the last step, where the reporting schemes are generated for the UNFCCC and

EU (in the CRF format (Common Reporting Format)) and to the United Nations Economic Commission for Europe/Cooperative Programme for Monitoring and Evaluation of the Longrange

Transmission of Air Pollutants in Europe (UNECE/EMEP) (in the NFR format (Nomenclature For Reporting)). Data files and programme files used in the inventory preparation process are listed in Table 1-1.

1.5. Methods and Data Sources

Mainly national or international statistics have been used for the estimation of the 1990-2015 inventory. Also, for major part of the NFR categories 2016 EMEP/EEA methodology with provided emission factors was applied. All methodologies which were utilized are described for each NFR category. The most frequently used approach was default Tier 1. Please see Table 1.5-1 for description of what activity data and from where it was gathered.

Table 1.5-1 Summary of the main sources from which activity data

Category	*Activity Data*	*Source*
Energy (NFR 1)		
Energy Industries (NFR 1.A.1)	Fuel Consumption	National Statistical Yearbook (Lithnuanian Statistics Department's Database) Companies: 'PLLC Fortum Klaipeda'
Residential, public and Commercial Machinery (NFR 1.A.4)	Fuel Consumption	National Statistical Yearbook (Lithnuanian Statistics Department's Database)
Oil and Gas Exploration, Transportation, Production (NFR 1.B.2)	Fuel Production	National Statistical Yearbook (Lithnuanian Statistics Department's Database)
Industrial Processes (NFR 2)		
Mineral Products (NFR 2.A)	Production Information	National Statistical Yearbook (Lithnuanian Statistics Department's Database)
		Source-specific Information from Production Plants: "UAB Akmenes Cementas", "AB Panevezio Stiklas", "UAB Kauno Stiklas"
Solvent and Other Products Use (NFR 2.D)	Solvent Consumption	European Asphalt Pavement Association Yearbook
		National Statistical Yearbook (Lithnuanian Statistics Department's Database)
		Green-house Gases Inventory Report 2016
		The Customs Database of the Republic of Lithuania
Agriculture (NFR 3)		
Manure Management (3.B)	Number of animals	National Statistical Yearbook (Lithnuanian Statistics Department's Database)
Crop Production and Agricultural Soils (3.D)	Fertilizers usage, waste usage beneficial for agriculture, crop areas,	International Fertilizer Industry Association Database
		Food and Agriculture Organization of the UN, Statistics Division

	pesticide usage	National Statistical Yearbook (Lithnuanian Statistics Department's Database)
		Environmental Protection Agencies' Waste Registry Database
Field Burning of Agricultural Residues (3.F)	Area Burnt	Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania Database
Waste (NFR 5)		
Waste Treatments (NFR 5)	Amount of Waste	Green-house Gases Inventory Report 2016
		Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania Database
		National Statistical Yearbook (Lithnuanian Statistics Department's Database)
		Environmental Protection Agencies' Waste Registry Database

1.6. Key Categories

Key categories are the smallest number of categories from which emissions sum contribute 80% of total national emissions. According to 2016 EMEP/EEA guidebook, a key category is pollutant emission category which has a significant influence on the country's inventory as it forms a considerable amount of the total emissions.

Key categories for certain pollutant were identified in terms of their contribution to the total emission of that specific pollutant. The key categories were not more disintegrated as it is expressed in the NFR. Methodological approach 1 was used to identify key categories. For more detailed methodological explanation, please see Appendix 1.

Level assessment was performed for 2005 and the latest year, 2015 (see Tables Table 1.6-1and Table 1.6-2). This was done to show contribution of categories to the total emission of specific pollutant and how distribution has changed

Trend assessment was performed in order to find categories which trend changed significantly in any direction and that have had the most significant impact on the average trend. Declining trends could be associated with improved abatement measure in particular process or activity decrease in specific category, while increasing trend usually indicates increased activity/ production.

Table 1.6-1. Categories obtained from level assessment for the year 2005.

Component	Key categories (Sorted from high to low from left to right)												Total (%)
SOx	1A1a 32.2%	1A1b 26.2%	1B2aiv 14.7%	1A4ai 8.8%									81.9
NOx	1A3biii 26.8%	1A3bi 19.6%	3Da1 11.6%	1A1a 9.7%	1A3c 6.4%	1A1b 5.1%	1A4bi 4.0%						83.1
NH3	3Da2a (21.7%)	3Da1 (18.3%)	3B3 (18.2%)	3B1a (13.4%)	3B1b (5.5%)	1A4bi (5.1%)							82.2
NMVOC	1A4bi (16.1%)	1B2aiv (13.5%)	1A3bi (10.3%)	2D3d (8.9%)	3B1a (7.3%)	2H2 (5.6%)	2D3a (5.3%)	3B1b (3.2%)	1A3bv (3.2%)	2D3e (3.1%)	1B2av (3.0%)	2D3g (2.8%)	82.5
CO	1A4bi (50.9%)	1A3bi (34.9%)											85.9
TSP	1A4bi (47.7%)	2A5b (13.7%)	3Dc (7.9%)	2A5a (3.4%)	2D3b (2.9%)	3B3 (2.3%)	1A3biii (1.7%)	3B1a (1.7%)					81.3
PM10	1A4bi (57.0%)	3Dc (9.9%)	2A5b (5.2%)	1A3biii (2.2%)	5E (2.1%)	2A5a (2.1%)	3B4gi (1.9%)						80.4
PM2.5	1A4bi (74.6%)	1A3biii (2.9%)	5E (2.8%)										80.4
Pb	1A3bi (35.5%)	1A4bi (18.7%)	2G (8.0%)	1A4ai (7.2%)	1A3bvi (7.1%)	1A1a (5.9%)							82.5
Hg	1A2f (19.2%)	2K (15.7%)	1A4bi (11.9%)	2D3a (8.9%)	2D3f (8.9%)	1A4ai (8.9%)	1A1a (7.5%)						80.9
Cd	1A4bi (53.9%)	1A1a (16.4%)	1A2gviii (7.8%)	2G (3.9%)									82.0
DIOX	1A4bi (62.9%)	5E (21.2%)											84.1
PAH	1A4bi (78.2%)	3F (12.3%)											90.5
HCB	3Df (85.3%)												

Table 1.6-2. Categories obtained from level assessment for the year 2015

Component	Key categories (Sorted from high to low from left to right)											Total (%)
SOx	1B2aiv (35.9%)	1A1a (22.2%)	1A4bi (12.6%)	1A4ai (8.2%)	1A1b (7.3%)							86.2
NOx	1A3biii (32.6%)	3Da1 (17.2%)	1A3bi (13.3%)	1A1a (7.6%)	1A2f (5.3%)	1A3c (5.0%)						80.9
NH3	3Da1 (28.0%)	3Da2a (18.4%)	3B3 (12.5%)	3B1a (10.8%)	3B1b (6.8%)	1A4bi (5.0%)						81.5
NMVOC	1A4bi (18.4%)	1B2aiv (16.1%)	2D3d (9.8%)	3B1a (6.7%)	2H2 (6.6%)	2D3a (5.9%)	3B1b (4.5%)	1B2av (4.2%)	2D3e (3.4%)	2D3g (3.2%)	1A3bi (2.6%)	81.2
CO	1A4bi (70.3%)	1A3bi (9.1%)	1A1a (6.0%)									85.3
TSP	1A4bi (45.3%)	2A5b (14.1%)	3Dc (10.7%)	2A5a (3.7%)	2D3b (3.7%)	1A1a (2.1%)	2A2 (1.8%)					81.4
PM10	1A4bi (54.9%)	3Dc (13.6%)	2A5b (5.4%)	1A1a (2.4%)	2A5a (2.3%)	1A3biii (1.9%)						80.6
PM2.5	1A4bi (75.1%)	1A1a (3.2%)	1A3biii (2.6%)									80.9
Pb	1A4bi (19.8%)	1A1a (17.0%)	1A3bi (13.0%)	2G (11.6%)	1A3bvi (10.8%)	1A3biii (8.3%)						80.5
Hg	1A3bi (49.8%)	1A3biii (42.1%)										91.9
Cd	1A1a (36.8%)	1A4bi (33.9%)	1A3bi (7.6%)	1A3biii (4.3%)								82.6
DIOX	1A4bi (65.2%)	5E (15.8%)										80.9
PAH	1A4bi (77.7%)	3F (8.9%)										86.6
HCB	1A1a (33.5%)	1A4bi (28.5%)	3Df (15.2%)	5C1biii (10.4%)								87.6

1.7. QA/QC and Verification Methods and General Uncertainty Evaluation

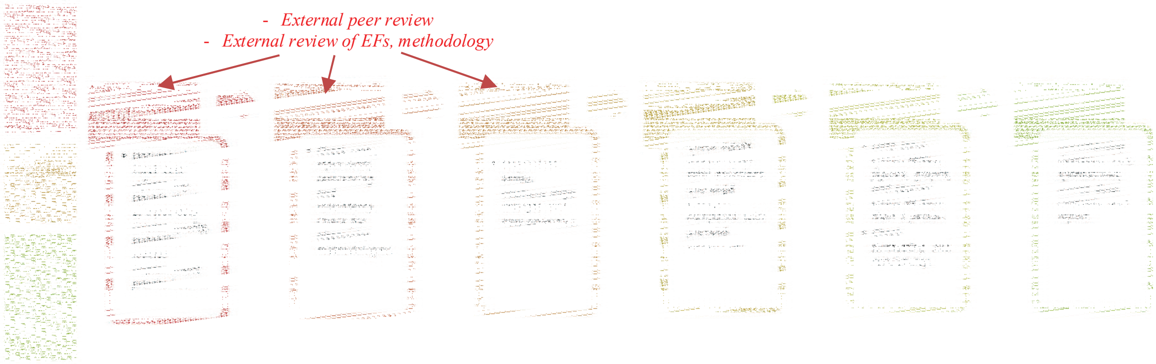

Figure 1.7-1 Quality assurance and quality control methods used to ensure quality and data consistency of the inventory.

Simple combination of uncertainties (see 2016 EMEP/EEA guidebook) was use to estimate uncertainties for all categories. The following general equation was applied for the most categories:

$$U_{Total} = \sqrt{U(activity\ data)^2 + U(emission\ factor)^2};$$

Where:

U_{Total} is overall uncertainty;

$U_{Activity\ data}$ is uncertainty from activity data;

$U_{Emission\ factor}$ is uncertainty from emission factor.

1.8. General Assessment of Completeness

The NFR Report is completed using following notation keys if numerical pollutant emission value is not provided (Table 1.8-1):

- NO (not occurring) is used for processes that do not occur in the country;
- NE (not estimated) appears for emissions that do happen but are not estimated due to data unavailability or negligibility of emissions;
- NA (not applicable) is used for activities that do not emit specific pollutant;
- IE (included elsewhere) for pollutant emissions which are estimated but included in another category;
- C (confidential) appears for processes which are not reported as reporting at disaggregated level would lead to confidential information disclosure.

Table 1.8-1. NFR cells filled.

NFR cells filled	Number
NE	477
NO	782
IE	62
NA	1117
Value	864

DDT, Aldrin, chlordane, chlordecone, dieldrin, endrin, HCB, HCH, heptachlor, mirex, pentachlorophenol (PCP) and toxaphene production, import and use are forbidden according to regulation (EC) No. 850/2004 of the European Parliament and of the Council [1].

Table 1.8-2 List of sources and reasons why categories were not estimated.

Category Code	*Category Name*	*Pollutant*	*Reason(s) why not estimated (NE)*
3.D.a.4	Crop Residues Applied to Soils	All	No activity data available
3.D.b	Indirect Emissions from Managed Soils	All	No activity data available
3.D.c	Farm-level Agricultural Operations	All	No activity data available
3.D.e	Cultivated Crops	All	No activity data available
3.I	Agriculture Other: Ammonia-treated Straw	All	No activity data available
5.E, SNAP: 091003	Sludge Spreading	All	No activity data available

Table 1.8-3 Importance of the sources labelled as (NE) in table 1.6 and future plans for calculation.

Category Code	Category Name	Relative importance now (future)	Future plans for estimation
3.D.a.4	Crop Residues Applied to Soils	High (high) for PM emissions, average (average) for NH3 and Nox	Undergoing researches should provide detailed description on details how to estimate pollution from these categories: methodologies, CS EFs, activity data and etc. This information will be available between 2017 and 2020.
3.D.b	Indirect Emissions from Managed Soils		
3.D.c	Farm-level Agricultural Operations		
3.D.e	Cultivated Crops		
3.I	Agriculture Other: Ammonia-treated Straw	Small (small)	
5.B.2	Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities	Low (low)	
5.C.2	Open Burning of Waste	Negligible (negligible)	
5.E, SNAP: 091003	Sludge Spreading	Negligible (negligible)	

The following Table 1.8-4 and Table 1.8-5 provide information on what categories have been included elsewhere, reasons for that and how IE categories will be disaggregated in the future inventory reports.

Table 1.8-4 List of categories included elsewhere (IE) and reasons for such aggregation

Category Code	Category Name	Pollutant	Where Included	Reason(s) why included elsewhere (IE)
3.D.a.2.a; 3.D.a.3	Livestock Manure Applied to Soils; Urine and Dung Deposited by Grazing Livestock	NH3	3.B	Tier 1 approach was used to calculate emissions from 3.B category. Tier 1 emission factors include both 3.D.a.2.a and 3.D.a.3 categories.

There are future intention to disaggregate categories included in Table 1.8-5.

Table 1.8-5 List of categories included elsewhere (IE) and how they will be disaggregated in the future submissions

Category Code	Category Name	Pollutant	How they will be disaggregated
3.D.a.2.a; 3.D.a.3	Livestock Manure Applied to Soils; Urine and Dung Deposited by Grazing Livestock	NH3	Emissions from these categories will be estimated using the latest 2016 EMEP/EEA guidebook, tier 1 approach.

2. TRENDS IN EMISSIONS

2.1. Pollutant Emission Trends

The emissions trends of nitrogen oxides, carbon monoxide, non-methane volatile organic compounds and sulphur oxide (calculated as sulphur dioxide) emissions are presented in Figure 2.1-1. Development of emissions 1990-2015 (source: LRTAP submission 2017 and NEC submission).

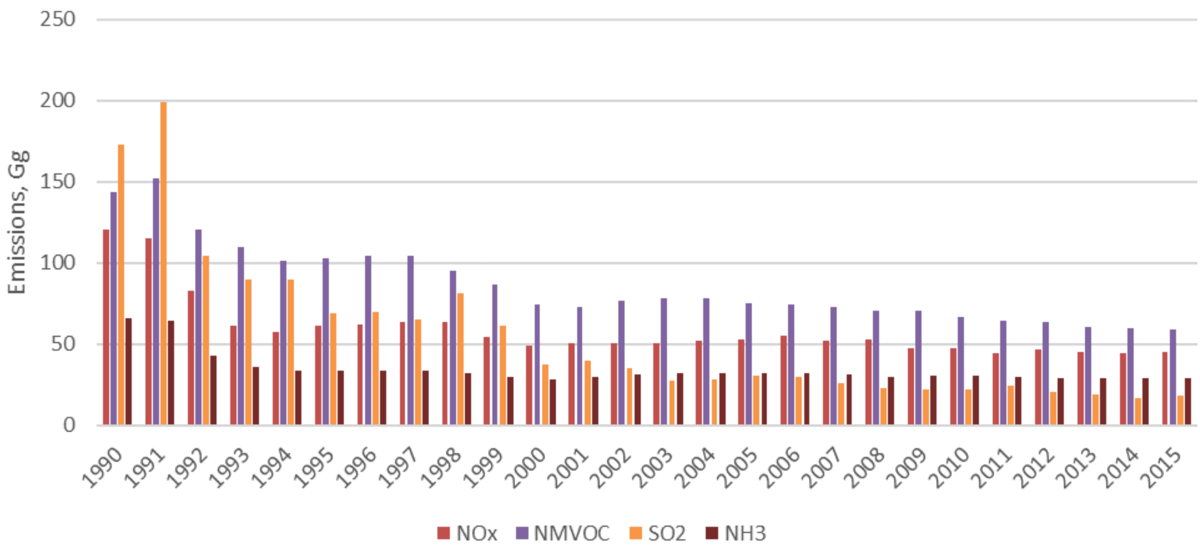

Figure 2.1-1. Development of emissions 1990-2015 (source: LRTAP submission 2017 and NEC submission)

A rapid decrease of emissions followed the decline of the country economy in the 1990s. Since 2000, the GDP has been growing continuously. Table 1.6-1and Table 1.6-2Table 2.1-1 present results from the Level Assessment of the key source for 2005 and 2015. The sources that add up to at least 80% of the national total in 2005 and 2015 are defined as being a key source for each pollutant.

Lithuania has been reporting data regarding national total and sectoral emissions under The LRTAP convention since 2000 (Table 2.1-1).

Table 2.1-1. Main pollutant emissions in the period 1990-2015, Gg

	NOx	NMVOC	SO2	NH3	PM2.5
1990	120,4	118,6	173,3	65,9	22,4
1991	115,3	128,2	198,9	64,9	23,5
1992	83,2	102,2	104,7	43,2	16,4
1993	61,8	93,6	90,3	35,9	17,8
1994	57,6	86,9	89,6	34,1	17,1

1995	61,4	89,9	69,4	33,7	16,9
1996	62,2	91,2	70,1	33,8	17,7
1997	63,7	91,9	65,1	33,9	18,3
1998	63,9	83,5	81,4	32,1	18,5
1999	54,9	76,0	61,5	30,2	18,8
2000	49,0	64,6	37,6	28,1	18,3
2001	50,3	63,2	40,3	29,9	18,9
2002	50,4	66,6	35,3	31,3	19,3
2003	50,7	67,5	27,6	31,9	19,4
2004	52,0	68,1	28,4	31,9	19,7
2005	53,1	64,3	30,9	32,4	20,2
2006	55,5	63,7	29,7	32,6	21,0
2007	52,2	62,6	25,9	31,1	20,5
2008	53,3	60,7	22,9	30,2	21,2
2009	46,6	57,0	22,3	30,9	20,5
2010	48,0	57,1	22,4	30,8	20,4
2011	44,7	54,9	24,2	29,7	19,9
2012	46,6	54,3	20,6	29,5	19,9
2013	45,4	51,2	18,8	28,8	19,5
2014	44,7	50,7	16,9	29,2	18,5
2015	45,3	49,9	18,2	28,9	17,9
Trend 1990-2015, % / Pokytis 2015/1990, %	-62,4%	-57,9%	-89,5%	-56,2%	-20,3%
Trend 2005-2015, % / Pokytis 2015/2005, %	-14,6%	-22,4%	-41,0%	-11,1%	-11,5%
Reduction commitments 2020 vs 2005 (NECD) / Sumažinimo įpareigojimas 2020/2005 (NECD)	-48%	-32%	-55%	-10%	-20%

2.2. Nitrogen Oxides (NO_x)

Total (excluding agriculture) nitrogen oxides emissions have decreased 62% from 120.4 Gg in 1990 to 45.3 Gg in 2015 (Figure 2.2-1. National total emission trend for NOx, 1990 – 2015.).

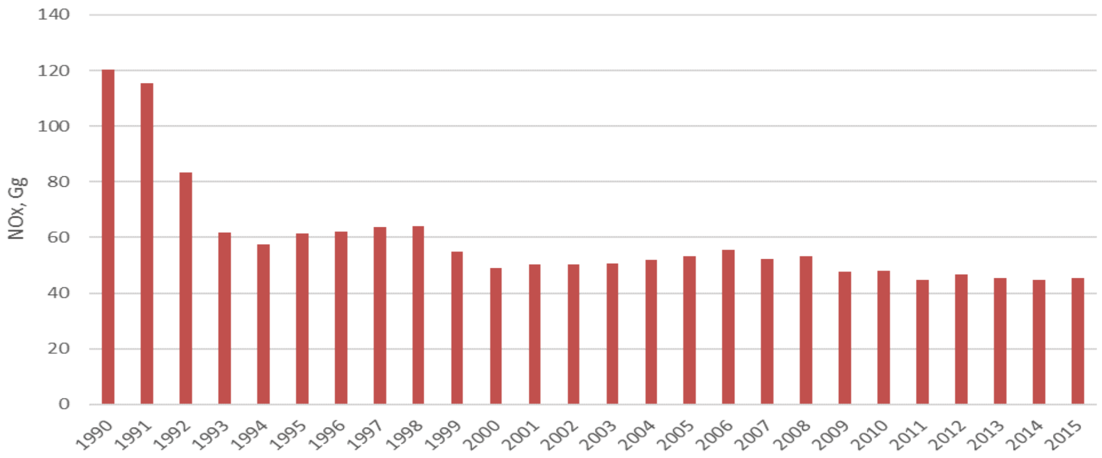

Figure 2.2-1. National total emission trend for NOx, 1990 – 2015.

Road Transport (1.A.3) is the principal source of NOx emissions, contributing ~33 per cent (and 26 Gg) of the total in 2015 (Figure 2.2-1. National total emission trend for NOx, 1990 – 2015.). 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 9.7 %, decreased to 4.2 Gg in 2015 as a result of the decreases in fuel consumption due to the economic crisis impacting upon the sector (Figure 2.2-2). The Small Combustion (Commercial/Institutional (1A4a) and Residential Stationary Plants (1A4b)) sectors are another main source of NOx emissions, accounting for 4 % of emissions in 2015. Emissions from this sector have decreased between 1990 (3.2 Gg) and 2015 (2.2 Gg). The remainder of the NOx emissions arise from combustion sources in the 3 D a 1 Inorganic N-fertilizers per cent of the total in 2015 (17 %).

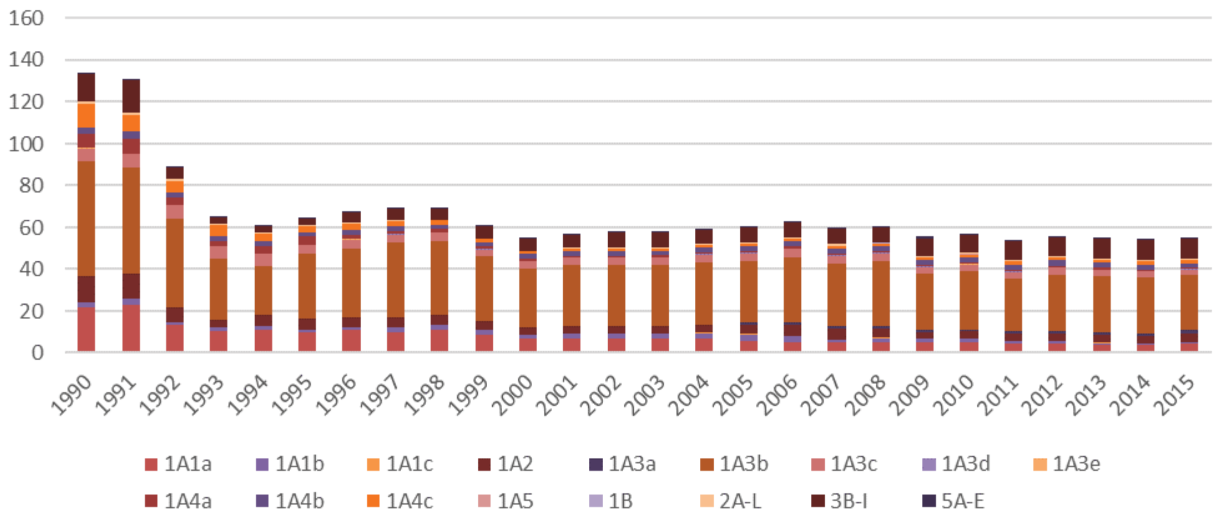

Figure 2.2-2. Emission trend for NOx by sectors, 1990 – 2015.

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.

2.3. Non-Methane Volatile Organic Compounds (NMVOC)

Total (excluding agriculture) non-methane volatile organic compound emissions have decreased by 58 %, from 118.6 Gg in 1990 to 49.9 Gg in 2015 (Figure 2.3-1). The emissions of NMVOC can be divided into main groups: solvents and incomplete combustion. The main contributor of NMVOC in the year 2015 is Residential: Stationary plants (1.A.4.b, 18.4 %), followed by Fugitive emissions oil: Refining / storage small combustion (1.B.2.a iv, 16.1 %).

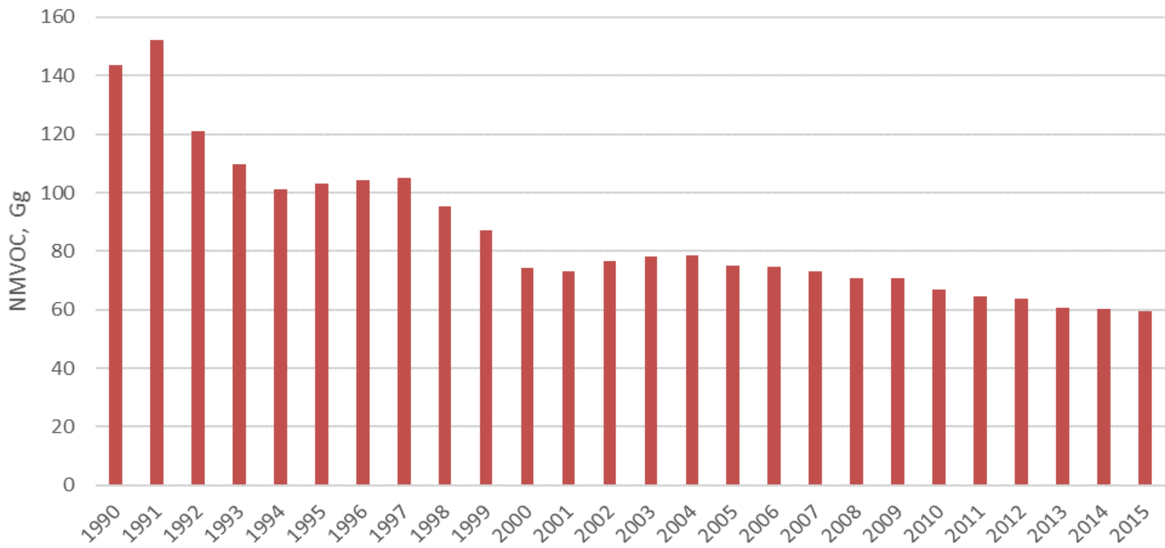

Figure 2.3-1 National total emission trend for NMVOC, 1990-2015.

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 Residential: Stationary plants and Road Transport. The combined solvents produced 9.8 % of the 2015 total of NMVOC emissions in Lithuania having decreased between 1990 (16.6 Gg) and 2015 (5.7 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 (10.3 %) and 2015 (2.6 %) (Figure 2.3-2).

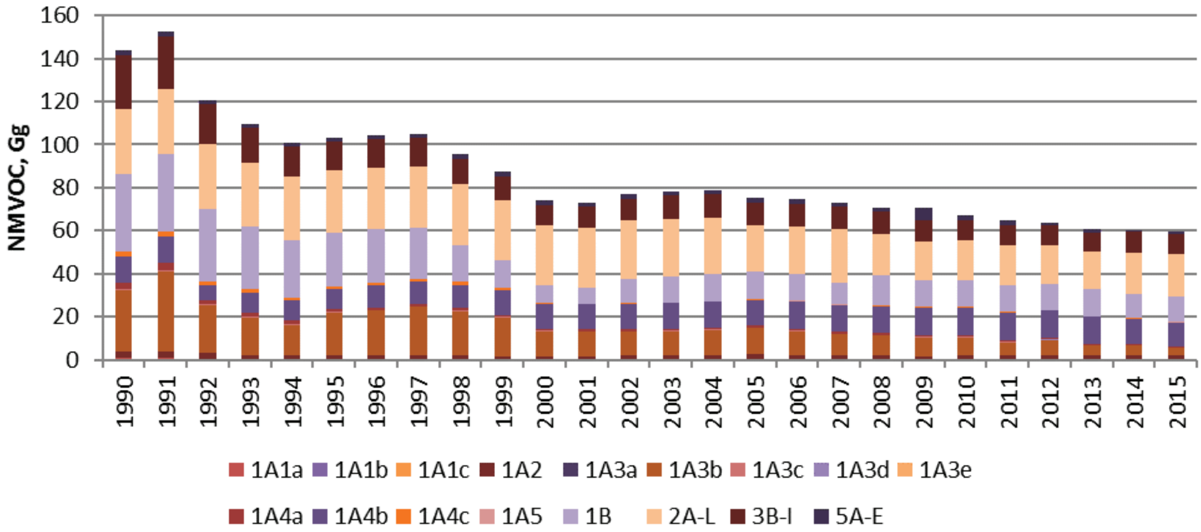

Figure 2.3-2. Emission trend for NMVOC by sectors, 1990-2015.

Combustion sources in the Residential (1.A.4.b) sector is another important source, accounting for 18.4 per cent of national total NMVOC emissions in 2015.

2.4. 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 89.5 %, from 173 Gg in 1990 to 18 Gg in 2015 (Figure 2.4-1). The Public electricity and heat production and Fugitive emissions oil: Refining / storage (1.B.1.a and 1.A.1.b) sectors remain the principal source of SO_2 emissions, contributing 58 % of the total in 2015.

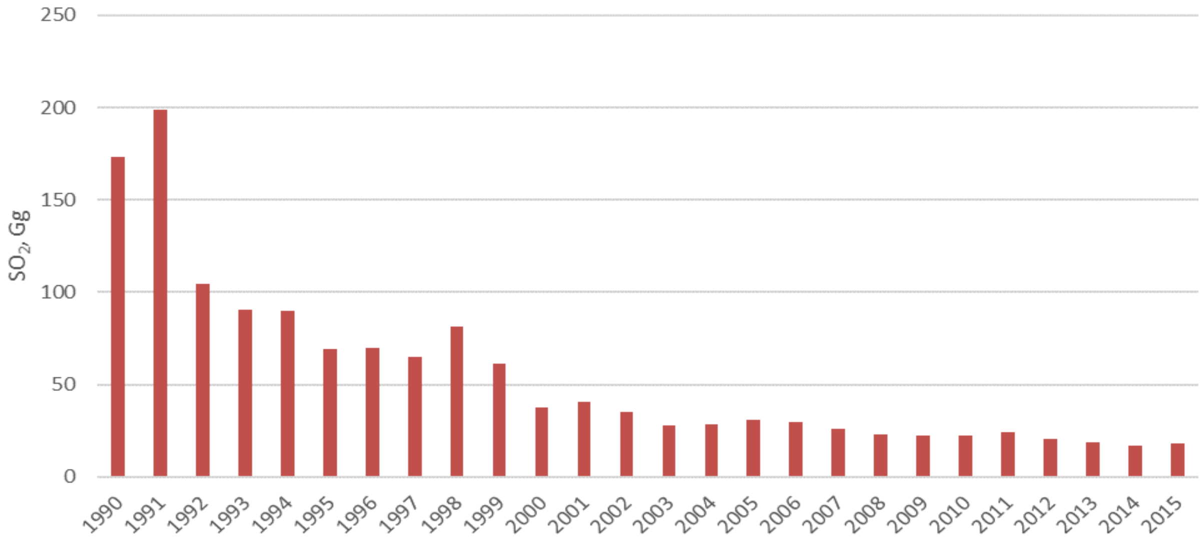

Figure 2.4-1. National total emission trend for SO_2, 1990-2015.

Public Electricity and Heat Production (1.A.1.a) sector accounts for 22.2 % of the total in 2015 and Commercial/institutional: Stationary and Mobile sectors largely account for the remainder of the emissions, with contribution of 8.2 % in 2015. Chemical industry: Othere (1.A.1.ba) sector account for 7.3 % of national total emissions of SO_2 in 2015 (Figure 2.4-2).

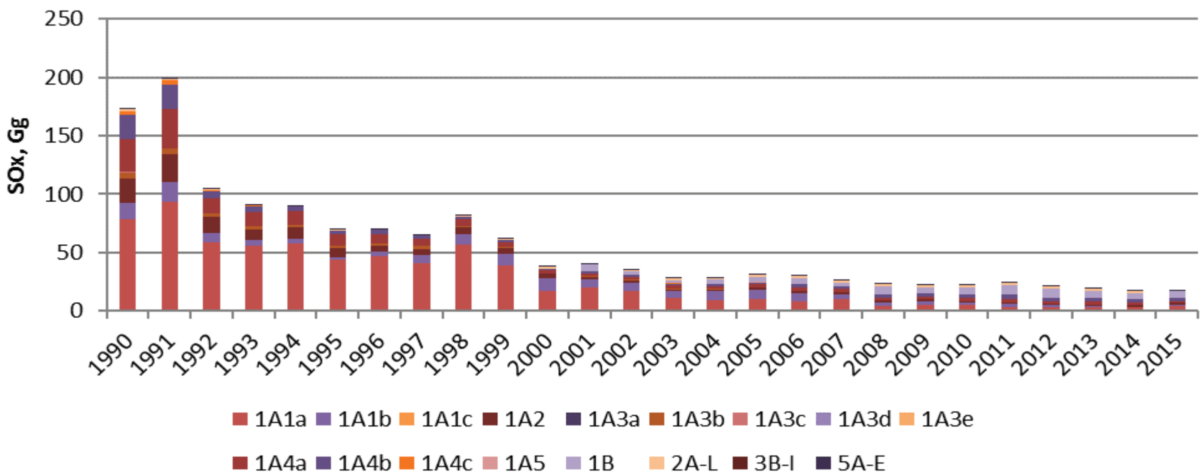

Figure 2.4-2. Emission trend for SOx by sectors, 1990-2015.

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 % of the total emission.

2.5. Ammonia (NH_3)

Almost all atmospheric emissions of NH_3 result from agricultural activities (94 % in the year 2015). Animal manure applied to soils for 28 % and Residential: Stationary sector accounted for 5 % of the total in 2015. Only a minor part originates from other combustion sectors. The total ammonia emission decreased from 65.9 Gg in 1990 to 28.9 Gg in 2015. This is due to decreasing livestock population (Figure 2.5-1).

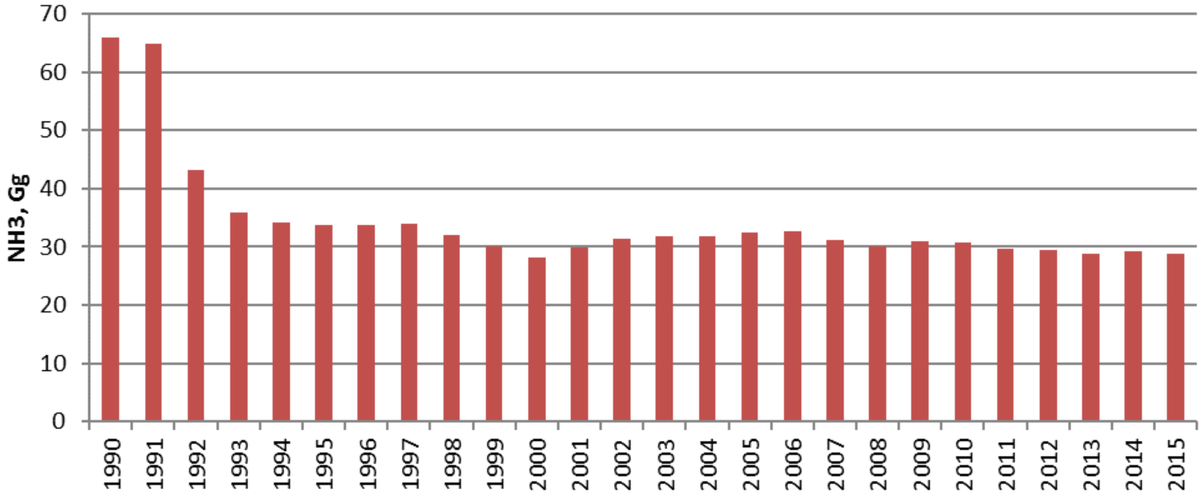

Figure 2.5-1. National total emission trend for NH3, 1990-2015.

Throughout the 1990–2015 time series, the small contribution by Transport (1.A.3) sources has increased. Emissions from Sector 1.A.3.b have increased from 0.03 Gg in 1990 to 0.2 Gg in 2015 (Figure 2.5-2).

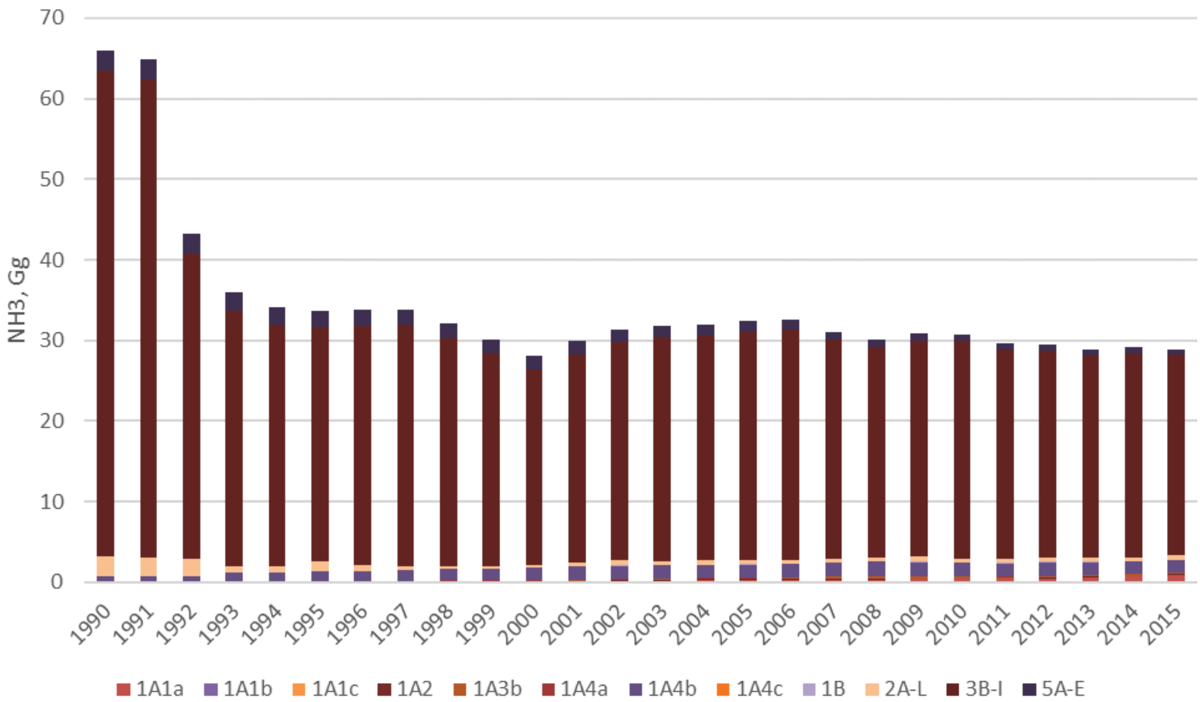

Figure 2.5-2. Emission trend for NH_3 by sectors, 1990-2015.

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.

3. ENERGY

3.1. 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 2.5-1. Planned power reactors in Lithuania

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

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 2015. 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.

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.

3.1.1. PUBLIC ELECTRICITY AND HEAT PRODUCTION (1.A.1.a)

Public electricity and heat production sector includes public CHP plants, autoproducer CHP plants, public heat plants, autoproducer heat plants and geothermal plants.

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 1990–2015 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.

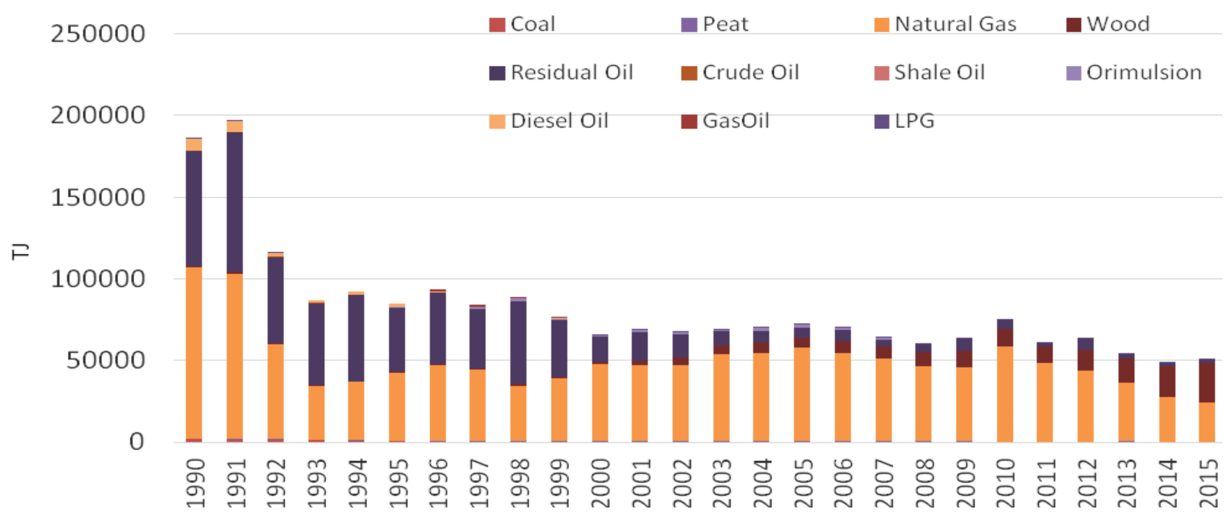

Figure 3.1.1-1. Tendencies of fuel consumption in 1A1a.

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.

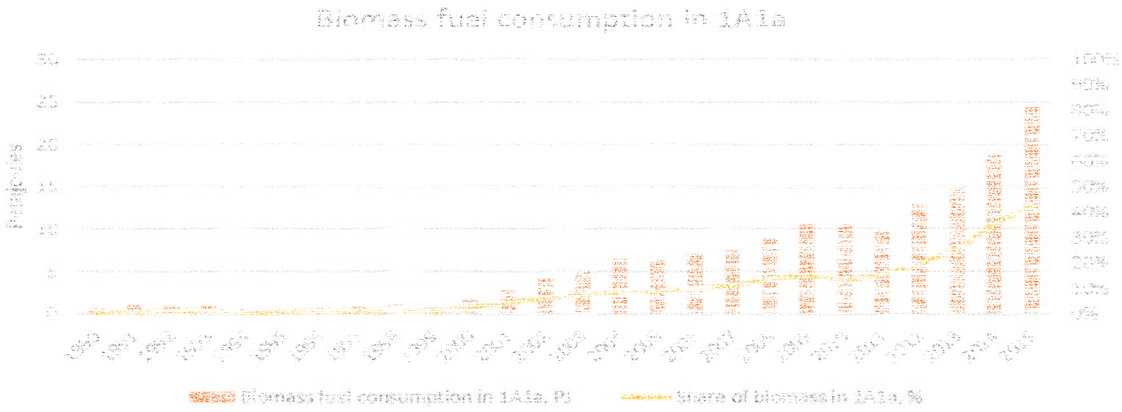

Figure 3.1.1-2. Tendencies of biomass fuel consumption in 1A1a.

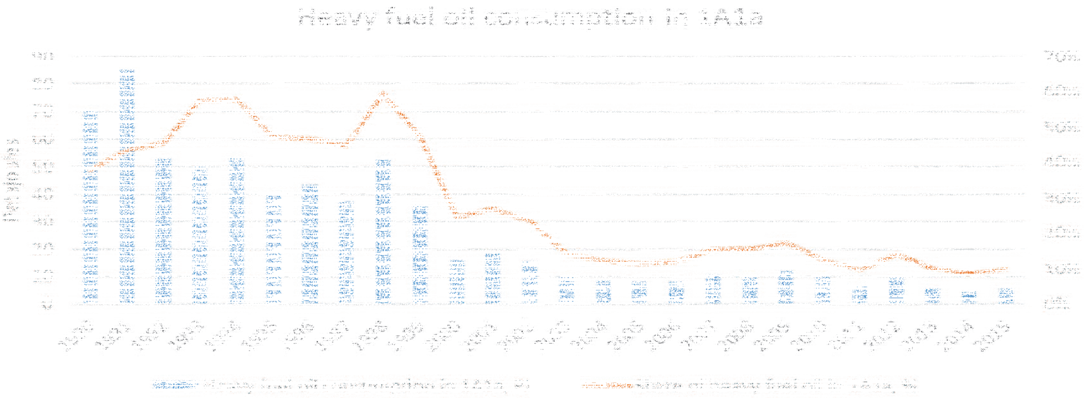

Figure 3.1.1-3. Tendencies of heavy fuel oil consumption in 1A1a.

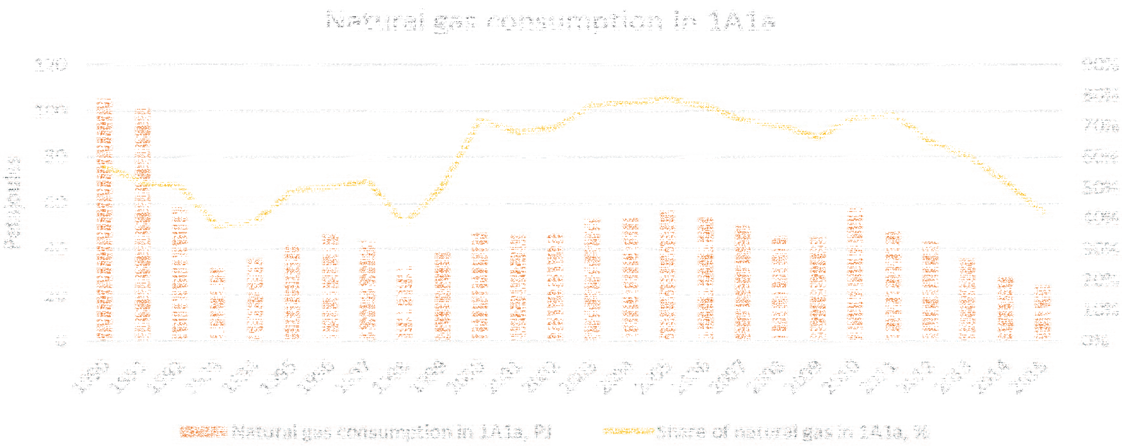

Figure 3.1.1-4. Tendencies of natural gas fuel consumption in 1A1a.

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.
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 3.1.1-1 Pollutant emissions from the 1.a.1.a in the period 1990-2015.

	Nox	NMVOC	Sox	NH3	PM2.5	PM10	TSP	BC	CO
1990	21.69	0.79	78.22	0.02	1.76	2.19	2.91	0.14	8.54
1991	23.18	0.79	93.77	0.04	2.01	2.53	3.40	0.15	8.69
1992	13.44	0.49	58.35	0.03	1.27	1.60	2.14	0.09	5.58
1993	10.70	0.41	55.45	0.03	1.19	1.50	2.01	0.08	4.43
1994	11.30	0.36	58.09	0.02	1.18	1.50	2.05	0.08	3.87
1995	10.05	0.31	43.74	0.02	0.89	1.13	1.54	0.06	3.49
1996	10.99	0.32	47.19	0.02	0.97	1.23	1.68	0.07	3.59
1997	9.63	0.29	40.45	0.03	0.82	1.04	1.40	0.06	3.34
1998	10.75	0.29	56.72	0.04	1.10	1.40	1.92	0.07	3.18
1999	8.70	0.25	38.82	0.02	0.79	1.00	1.36	0.05	2.89
2000	6.70	0.22	17.21	0.06	0.43	0.53	0.69	0.03	3.18
2001	7.09	0.24	19.86	0.11	0.51	0.62	0.81	0.04	3.66
2002	6.83	0.25	17.17	0.15	0.50	0.59	0.75	0.04	4.10
2003	6.64	0.26	10.83	0.19	0.44	0.50	0.60	0.04	4.58
2004	6.63	0.27	9.46	0.24	0.44	0.49	0.58	0.05	4.90
2005	5.83	0.28	9.97	0.23	0.40	0.42	0.48	0.04	3.69
2006	5.28	0.28	8.45	0.27	0.40	0.42	0.49	0.05	3.61
2007	5.24	0.28	10.22	0.28	0.41	0.44	0.51	0.05	3.48
2008	4.94	0.27	4.38	0.33	0.42	0.45	0.51	0.06	3.67
2009	4.87	0.28	5.26	0.39	0.39	0.42	0.48	0.06	3.79
2010	4.95	0.31	4.84	0.39	0.40	0.42	0.48	0.06	3.93
2011	4.37	0.27	3.45	0.37	0.31	0.32	0.36	0.05	3.51
2012	4.52	0.30	3.26	0.48	0.35	0.37	0.42	0.06	4.72

2013	3.90	0.33	2.83	0.55	0.37	0.41	0.45	0.07	5.10
2014	3.64	0.33	2.77	0.69	0.43	0.46	0.50	0.08	6.02
2015	4.17	0.38	4.04	0.90	0.57	0.60	0.66	0.10	7.56
Trend 1990-2015	**-80.79**	**-51.94**	**-94.83**	**4529.98**	**-67.72**	**-72.62**	**-77.47**	**-29.93**	**-11.41**
Trend 2005-2015	**-28.56**	**35.17**	**-59.41**	**287.98**	**41.78**	**44.35**	**36.82**	**124.38**	**105.15**

3.1.2. Source category description

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).

3.1.3. 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.

3.1.4. 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.

Emission factors from Guidebook 2016, chapter 1A1a, Table 3-7 (Tier 1 EFs for biomass combustion) were applied for biomass combustion in boilers with capacity 50MW or greater and emission factors from chapter 1A4, Table 3-33 (Tier 2 emission factors for non-residential sources, medium sized (>1 MWth to ≤ 50 MWth) boilers wood) were applied for biomass combustion in boilers with capacity less than 50MW:

Table 3.1.4-1. Tier 1 emission factors for source category 1.A.1.a using biomass.

Tier 1 default emission factors				
Code		Name		
NFR Source Category	1.A.1.a		Public electricity and heat production	
Fuel		Biomass		
Not applicable				
Not estimated		NH3		
Pollutant	**Value**	**Unit**	**95% confidence interval**	**Reference**
Lower		**Upper**		

NOx	81	g/GJ	40	160	Nielsen et al., 2010
CO	90	g/GJ	45	180	Nielsen et al., 2010
NMVOC	10.8	g/GJ	6.45	15.1	US EPA (2003), chapter 1.6
TSP	172	g/GJ	86	344	US EPA (2003), chapter 1.6
PM10	155	g/GJ	77	310	US EPA (2003), chapter 1.6
PM2.5	133	g/GJ	66	266	US EPA (2003), chapter 1.6
BC	3.3	% of $PM_{2.5}$	1.6	6.6	See Note
Pb	20.6	mg/GJ	12.4	28.9	US EPA (2003), chapter 1.6
Cd	1.76	mg/GJ	1.06	2.47	US EPA (2003), chapter 1.6
Hg	1.51	mg/GJ	0.903	2.11	US EPA (2003), chapter 1.6
As	9.46	mg/GJ	5.68	13.2	US EPA (2003), chapter 1.6
Cr	9.03	mg/GJ	5.42	12.6	US EPA (2003), chapter 1.6
Cu	21.1	mg/GJ	12.6	29.5	US EPA (2003), chapter 1.6
Ni	14.2	mg/GJ	8.51	19.9	US EPA (2003), chapter 1.6
Se	1.2	mg/GJ	0.722	1.69	US EPA (2003), chapter 1.6
Zn	181	mg/GJ	108	253	US EPA (2003), chapter 1.6
PCB	3.5	µg/GJ	0.35	35	US EPA (2003), chapter 1.6
PCDD/F	50	ng I-TEQ/GJ	25	75	UNEP (2005) (for clean wood)
Benzo(a)pyrene	1.12	mg/GJ	0.671	1.57	US EPA (2003), chapter 1.6
Benzo(b)fluoranthene	0.043	mg/GJ	0.0215	0.0645	US EPA (2003), chapter 1.6
Benzo(k)fluoranthene	0.0155	mg/GJ	0.00774	0.0232	US EPA (2003), chapter 1.6
Indeno(1,2,3-cd)pyrene	0.0374	mg/GJ	0.0187	0.0561	US EPA (2003), chapter 1.6
HCB	5	µg/GJ	0.5	50	Bailey, 2001

Table 3.1.4-2. Tier 2 emission factors for non-residential sources, medium sized (>1 MWth to ≤ 50 MWth) boilers wood Tier 2 emission factors.

Code			Name		
NFR source category		1.A.4.a.i		Commercial / institutional: stationary	
1.A.4.c.i			Stationary		
1.A.5.a			Other, stationary (including military)		
Fuel			Wood		
SNAP (if applicable)		20100		Commercial and institutional plants	
20300			Plants in agriculture, forestry and aquaculture		
Technologies/Practices			Wood combustion >1MW - Boilers		
Region or regional conditions			NA		
Abatement technologies			NA		
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	300	g/GJ	50	4000	German test standard for 500 kW-1MW boilers;
Danish legislation (Luftvejledningen)					
NMVOC	12	g/GJ	5	300	Johansson et al. (2004) 1)
SOX	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	36	g/GJ	18	72	Johansson et al. (2004)
PM10	34	g/GJ	17	68	Johansson et al. (2004) 3)
PM2.5	33	g/GJ	17	67	Johansson et al. (2004) 3)
BC	15	% of $PM_{2.5}$	6	39	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)
PCB	0.007	□g/GJ□	0.0007	0.07	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) Assumed equal to low emitting wood stoves

2) 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.

3) Assumed equal to advanced/ecolabelled residential boilers

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.

5) The TSP, PM10 and PM2.5 emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions

Table 3.1.4-3 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 3.1.4-4 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 3.1.4-5 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 3.1.4-6 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),

3.1.5. Uncertainty

Uncertainty of pollutant emmisions is not estimated so far.

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

3.2.1.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.

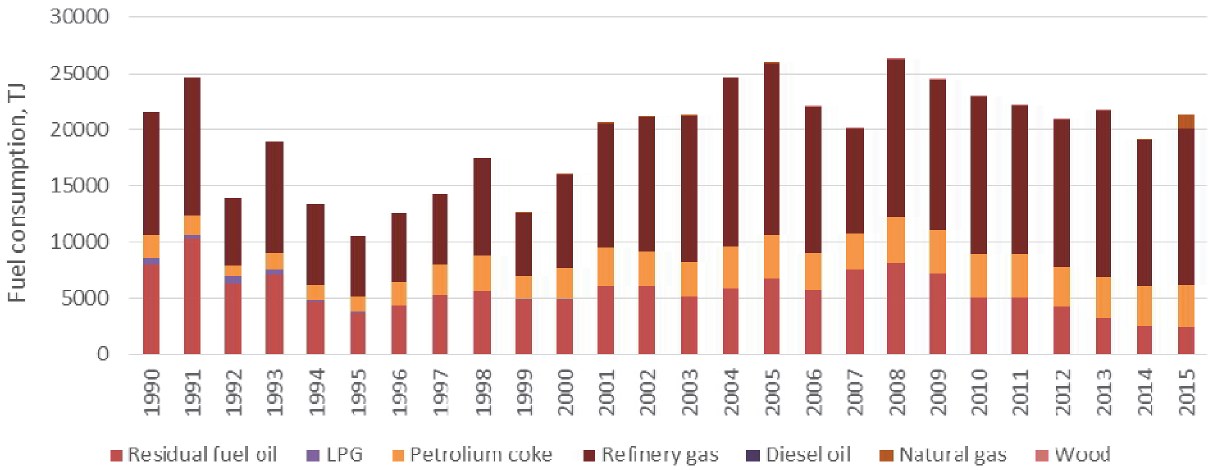

Figure 3.2.1-1. Tendencies of fuel consumption 1A1b in 1990-2015.

This chapter presents the entire consumption of fuels in oil industry (Fig. 3.2.1-1). 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

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

petroleum refining company operating in the Baltic States. Oil refinery processes approximately 10 million tons of crude oil a year. The company is the most important supplier of petrol and diesel fuel in Lithuania, Latvia and Estonia.
Motor gasoline, jet 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 (Figure 3.2.1-1).

3.2.2. 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, 2016, Energy industries Tables 2.3-1-3.

Table 3.2.2-1. 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 3.2.2-2. 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	See 1.A.1.a Tier 1

	feedstock, petroleum coke	
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

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

3.3.1. 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 (Figure 3.3.1-1).

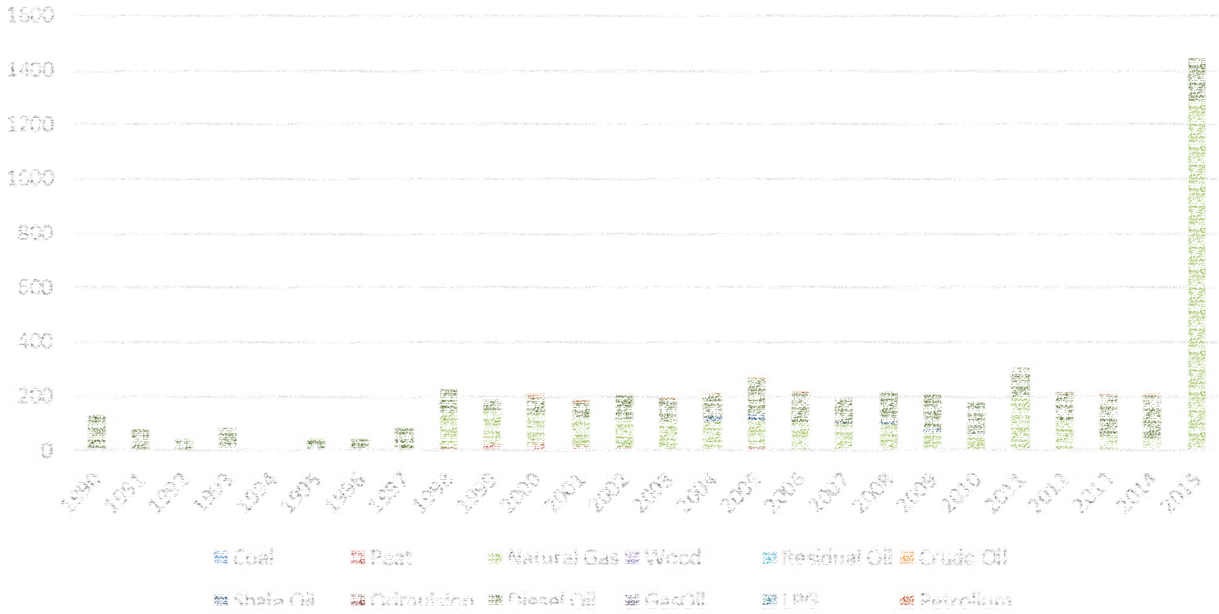

Figure 3.3.1-1 Fuel consumption in 1.A.1.C in 1990-2015

Fuel consumption in Other Energy Industries increased significantly due to start of LNG terminal operation since January 2015. In 2015, 1220 TJ of natural gas was combusted at LNG terminal for operational needs. The total fuel consumption in Other Energy Industries amounted 1305 TJ in 2015. With reference to data of 2015, natural gas accounted 98.3%, liquid fuels – 1.5% and biomass – 0.2% of structure.

Most of the heavy metals considered (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) are normally released as compounds (e.g. oxides, chlorides) in association with particulates. Only Hg and Se are at least partly present in the vapour phase. Less volatile elements tend to condense onto the surface of smaller particles in the flue gas stream. Therefore, enrichment in the finest particle fractions is observed.

The content of heavy metals in coal is normally several orders of magnitude higher than in oil (except occasionally for Ni in heavy fuel oil) and in natural gas. For natural gas only emissions of mercury are relevant. During the combustion of coal, particles undergo complex changes, which lead to evaporation of volatile elements. The rate of volatility of heavy metal compounds depends on fuel characteristics (e.g. concentrations in coal, fraction of inorganic components, such as calcium) and on technology characteristics (e.g. type of boiler, operation mode).

3.3.2. 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, 2016.

3.4. 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. 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.

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

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

3.4.2. 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 (Figure 3.4.2-1).

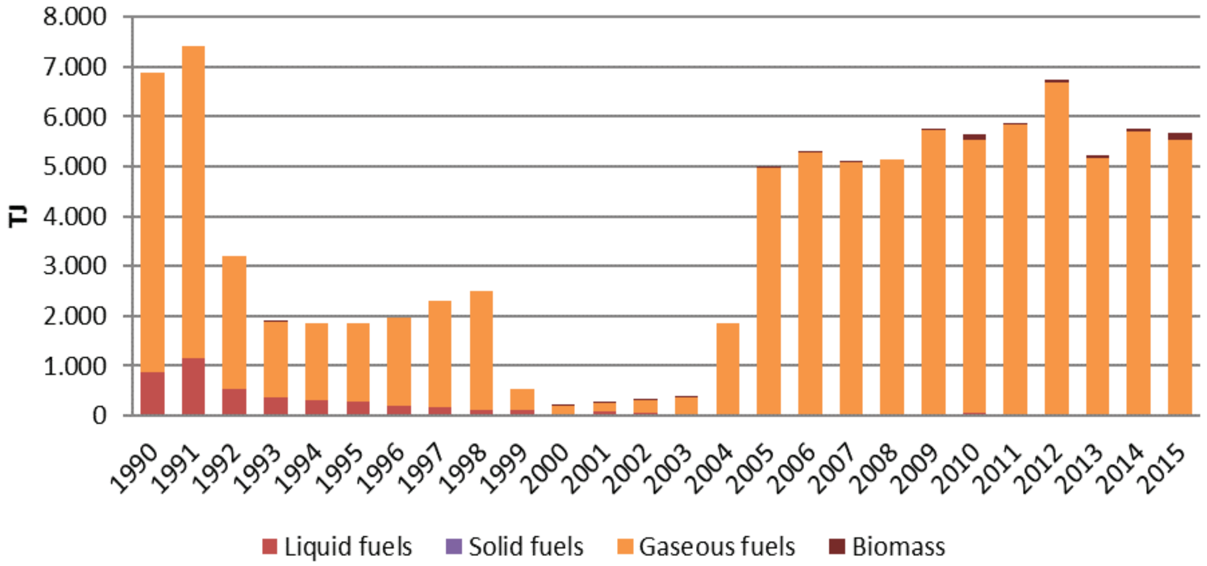

Figure 3.4.2-1. Tendencies of fuel consumption in chemical industries during 1990-2015, TJ

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). A gas turbine is installed in the largest chemical plant "Achema". Tier 2 emission factors were applied for evaluating emissions from this gas turbine.

Table 3.4.2-1 Pollutant emissions from the 1.a.2.c sector in the period 1990-2015

	NOx	NMVOC	SOx	PM2,5	PM10	CO
1990	0.53	0.15	0.98	0.03	0.04	0.35
1991	0.58	0.16	1.28	0.04	0.05	0.41
1992	0.25	0.07	0.58	0.02	0.02	0.18
1993	0.15	0.04	0.40	0.01	0.02	0.12
1994	0.15	0.04	0.35	0.01	0.01	0.11
1995	0.14	0.04	0.31	0.01	0.01	0.10
1996	0.15	0.04	0.22	0.01	0.01	0.09
1997	0.18	0.05	0.18	0.01	0.01	0.09
1998	0.19	0.06	0.13	0.01	0.01	0.09
1999	0.04	0.01	0.13	0.00	0.01	0.04
2000	0.02	0.01	0.02	0.00	0.00	0.01
2001	0.02	0.01	0.08	0.00	0.00	0.02
2002	0.03	0.01	0.08	0.00	0.00	0.02
2003	0.03	0.01	0.02	0.00	0.00	0.01
2004	0.14	0.04	0.01	0.00	0.00	0.05
2005	0.15	0.05	0.00	0.00	0.00	0.06
2006	0.21	0.04	0.03	0.00	0.00	0.06
2007	0.16	0.04	0.00	0.00	0.00	0.05
2008	0.18	0.06	0.00	0.00	0.00	0.07
2009	0.23	0.06	0.00	0.00	0.00	0.08
2010	0.23	0.06	0.05	0.00	0.00	0.09
2011	0.17	0.04	0.00	0.00	0.00	0.05

2012	0.20	0.02	0.00	0.00	0.00	0.04
2013	0.17	0.03	0.00	0.00	0.00	0.04
2014	0.17	0.02	0.00	0.00	0.00	0.03
2015	0.15	0.03	0.00	0.01	0.01	0.06
Trend 1990-2015, %	**-71.48%**	**-81.32%**	**-99.77%**	**-68.14%**	**-74.68%**	**-84.03%**
Trend 2005-2015, %	**1.18%**	**-39.56%**	**22.04%**	**492.79%**	**502.95%**	**-5.65%**

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 3.4.2-2 Tier 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 3.4.2-3 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)

3.4.3. 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 (Figure 3.4.3-1).

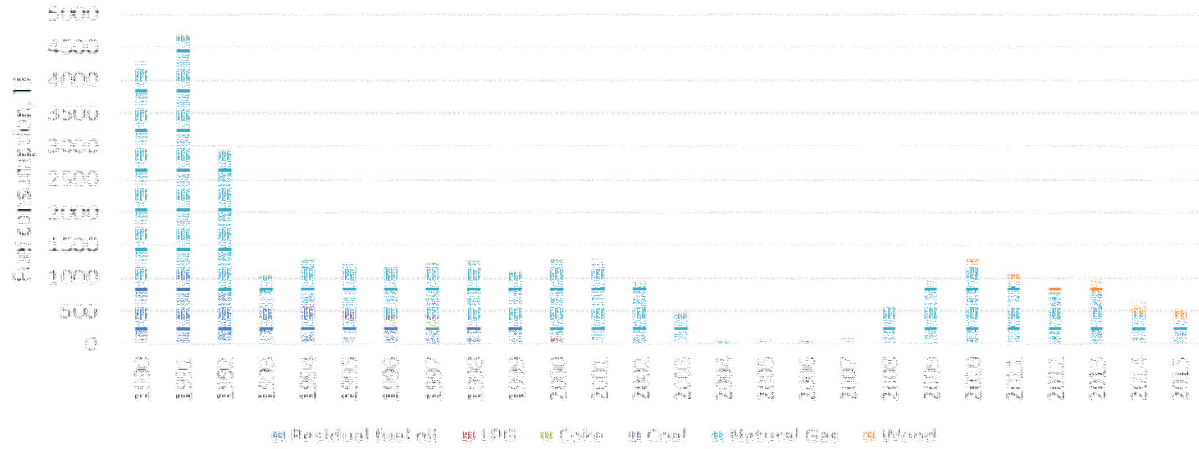

Figure 3.4.3-1. Tendencies of fuel consumption in Pulp, Paper and Print industries during 1990-2015, TJ

3.4.4. 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) (**Error! Reference source not found.**).

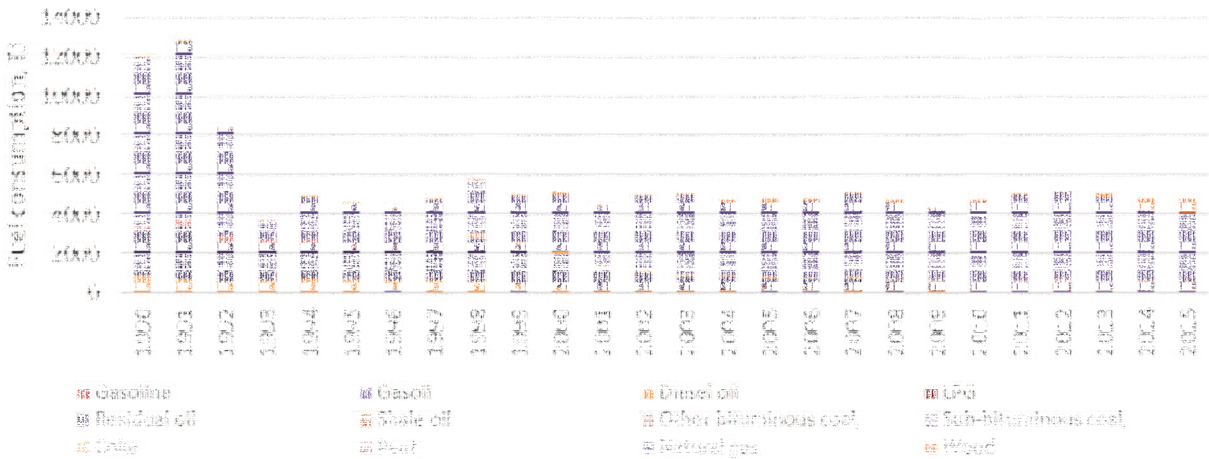

Figure 3.4.4-1. Tendencies of fuel consumption in Food processing, Beverages and Tobacco industries during 1990-2015, TJ

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.

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

3.5.1. 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 1990-2015. The share of residual fuel oil has decreased from 67% (1990) till 1% (2015). 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 2008-2015 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 2005-2015.

3.5.2. 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 2016.
Emissions of SO_2 are dependent on fuel consumption and fuel type. SO2 emissions are calculated by multiplying statistical fuel use by emission factors (Table 3.5.2-1and Table 3.5.2-2). 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 3.5.2-1 Pb 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 3.5.2-2 Pb Emission factors for other mobile sources.

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

3.5.3. Source-specific planned improvements

No source-specific improvements have been planned.

3.6. TRANSPORT (NFR 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

Estimation of emissions in 1.A.3 *Transport* are carried out for each fuel in sub-categories listed below:

- *Civil and International Aviation* 1.A.3.a
- *Road Transportation* 1.A.3.b
- *Railways* 1.A.3.c
- *Navigation* 1.A.3.d
- *Other Transportation* 1.A.3.e

3.6.1. Civil aviation (NFR 1.A.3.a i-ii)

3.6.1.1. Overview of the Sector

This category includes activities related to air traffic within or in the surroundings of airports (landing and take-off cycles, LTO). International traffic includes all flights whose origin or final destination is a foreign airport. In Lithuania, there are four international airports (Figure 3.6.1.1-1):

- Vilnius International Airport
- Kaunas Airport
- Palanga International Airport
- Šiauliai International Airport

Figure 3.6.1.1-1 Map of air ports and aerodromes in lithuania.

Lithuania reports its air pollutants emissions according to the requirements of the CLRTAP as well as greenhouse gas according to the requirements of the UNFCCC. The nomenclature for both reportings is (almost) the same (NFR), but there are differences concerning the system boundaries. Emissions from civil aviation are accounted for differently under the CLRTAP and the UNFCCC: Only emissions from domestic flights are accounted for in the GHG inventory, while emissions from international flights are reported as memo items. For the reporting under the CLRTAP, landing and takeoff (LTO) emissions of domestic and international flights are accounted for, while emissions of international and domestic cruise flights are reported under memo items only.

Table 3.6.1.1-1. Accounting rules for emissions from 1A3a Civil aviation transportation for CLRTAP and UNFCCC.

Differences between reporting under CLRTAP and UNFCCC concerning the accounting to the national total			CLRTAP / NFR-Templates			UNFCCC/CRTables	
			National total	National total for compliance	Memo item	National total	Bunker 1D
Aviation 1.A.3.a	Civil/Domestic aviation	Landing and Take-off (LTO)	Yes	Yes	No	Yes	No
		Cruise	No	No	Yes	Yes	No
	International aviation	Landing and Take-off (LTO)	Yes	No	No	No	Yes
		Cruise	No	No	Yes	No	Yes

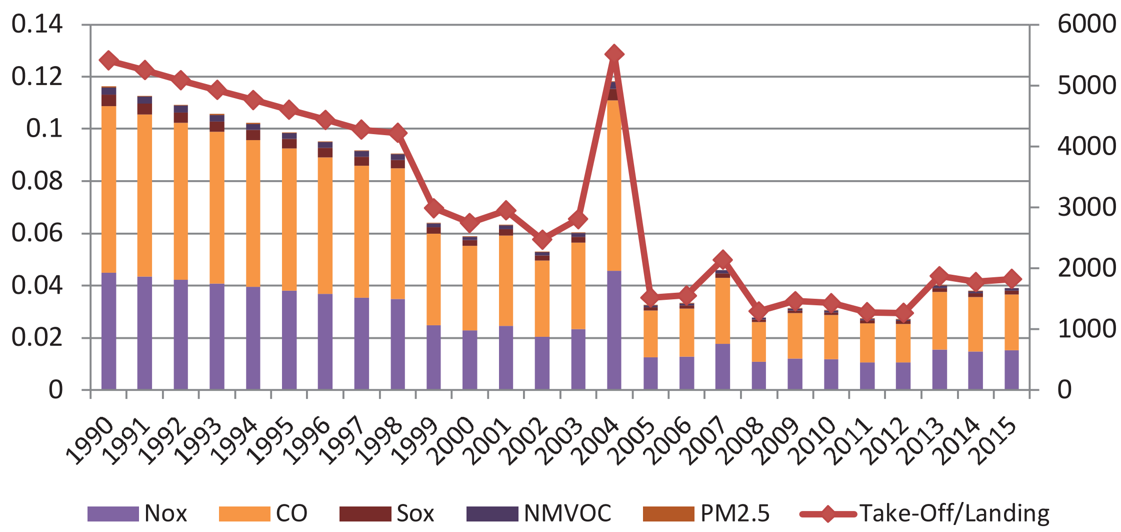

Figure 3.6.1.1-2 air pollutants emissions and number of take-off/landing from the 1.A.3.a.ii category

3.6.1.2. Methodological issues

For the years 1990-2015 data related to aviation gasoline and jet kerosene are those of the Statistics Lithuania database splited on international and domestic jet kerosene use, the amounts of domestic fuels use in years 1990 – 2004 were calculated based on extrapolation data on fuel share of jet kerosene used for international aviation in Lithuania.

Aviation gasoline is more common as fuel for private aircraft, while the jet fuel used in aircraft, airlines, military aircraft and other large aircraft. Net calorific values (NCVs) used to convert fuel consumption in natural units into energy units are provided in the Table 3.6.1.2-1.

Table 3.6.1.2-1 Specific net calorific values (conversion factors).

Type of fuel	Tonne	Tonne of oil equivalent (TOE)	TJ/tonne
Gasoline type jet fuel	1.0	1.070	0.04479
Kerosene type jet fuel	1.0	1.031	0.04316

The aviation gasoline consumption and air pollutants emissions were based on *Tier 1* approach as this method should be used to estimate emissions from aircraft that use aviation gasoline which is only used in small aircraft and generally represents less than 1% of fuel consumption from aviation.

The *Tier 1* approach for aviation is based on fuel consumption data for aviation divided by LTO and for domestic and international flights separately. The method uses a simple approach to estimate the division of fuel use between CCD and LTO, as shown schematically in Figure 3.6.1.2-1 Estimation of aircraft emissions using the Tier 1 and Tier 2 methodologiesFigure 3.6.1.2-1.
The *Tier 1* approach for aviation emissions uses the following general equation:

$$E_{pollutant} = AR_{fuel\ consumption} \times EF_{pollutant},$$

where
$E_{pollutant}$ is the annual emission of pollutant for each of the LTO and CCD phases of domestic and international flights;
$AR_{fuel\ consumption}$ is the activity rate by fuel consumption for each of the flight phases and flight types;
$EF_{pollutant}$ is the emission factor of pollutant for the corresponding flight phase and flight type.

This equation is applied at the national level, using annual national total fuel use data disaggregated for domestic and international flights.

The jet kerosene fuel consumption and emissions within Lithuania associated with sub-category 1.A.3.a Civil Aviation was estimated using a *Tier 2* approach based on aircraft type and LTO data for domestic and international air travel, the fuel consumption rates given by the EMEP/EEA emission inventory guidebook (2016) appropriate to the type of aircraft. This approach was used for all years from 2005 to 2015 where data is available. For the purpose of these guidelines, operations of aircraft were divided into *Landing/Take-Off (LTO) cycle* and *Cruise*.

Generally, about 10 percent of aircraft emissions of all types (except hydrocarbons and CO) are produced during airport ground level operations and during the LTO cycle[2]. The bulk of aircraft emissions (90 %) occur at higher altitudes.

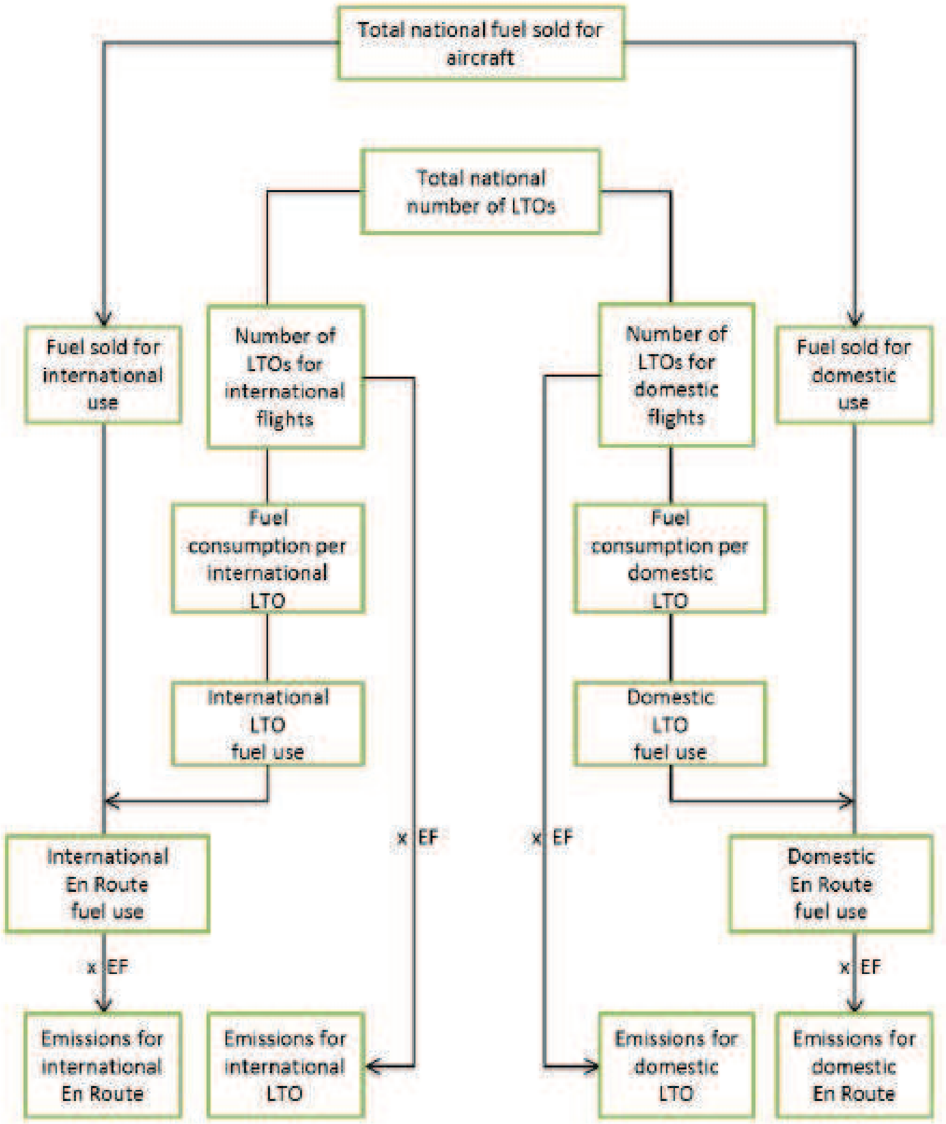

Figure 3.6.1.2-1 Estimation of aircraft emissions using the Tier 1 and Tier 2 methodologies

Default emission factors for Civil aviation are taken from EMEP/EEA 2016 methodology and are presented in Table 3.6.1.2-2.

Table 3.6.1.2-2 Emission factors used in the calculation of emissions from Civil aviation (g/kg fuel)

	NO_x	CO	NMVOC	SO_2	PM
Aviation petrol	8.3	11.8	0.5	0.08	0.07

[2] LTO cycle is defined in ICAO, 1993. If countries have more specific data on times in mode these can be used to refine computations in higher tier methods.

3.6.1.3. Uncertainties

Uncertainty in activity data 2005-2015 of fuel consumption is ±2%. For the 1990-2004 period uncertainty in activity data of fuel consumption is ±20%. Taking into account that it is used representative emission factors for LTO and cruise activities the uncertainty of EF lies between 20-45%.

3.6.1.4. Source-specific QA/QC and verification

Assessment of trends have been performed.

3.6.1.5. Source-specific recalculations

Recalculations have been carried out 1990-2015 for domestic and international civil aviation due to corrected jet fuel consumption and EF.

3.6.1.6. Source-specific planned improvements

No improvements are planned for the next submission.

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

3.6.2.1. Overview of the Sector

Road transport is the largest and most important emission source in the transport sector. This sector includes all types of vehicles on the roads (passenger cars, light duty vehicles, heavy duty trucks, buses, motorcycles). The source category does not cover farm and forest tractors that drive occasionally on the roads because they are included in other sectors, such as off-roads (agricultural and industrial machinery, etc.). The road transport sector includes emissions from fuel combustion, road abrasion, tyre and brake wear and NMVOC emissions from gasoline evaporation.

At the end of 2015, the length of roads amounted to 84.9 thousand kilometres; the length of E-roads amounted to 1 639 kilometres, that of motorways – 309 km. In 2015, 1244.1 thousand passenger cars, 6.9 thousand buses, 26.7 thousand motorcycles, 11.1 thousand mopeds, 78.1 thousand lorries and 24.8 thousand road tractors were registered in the country. In 2015, compared to 2014, the number of motorcycles increased by 14, mopeds – 13.4, road tractors – 5.5, passenger cars – 3.2, lorries – 2.6 %, while the number of buses decreased by 1.2 %. 63.9 % of mopeds, 29.2 % of motorcycles, 21 % of passenger cars, 30.2 % of buses, 39.2 % of lorries, and 73.3 % of road tractors were produced up to 10 years ago. In 2015, goods transport by road amounted to 58.6 million tonnes, which is by 1.8 % more than in 2014. The major part of goods transport (59 %) was made up of national road transport (by 1 % less than in 2014). In 2015, national road transport mainly consisted of the carriage of the following goods: metal ores and other mining and quarrying products (27.2%), products of agriculture, hunting, and forestry, fish and other fishing products(21.6 %), food products, beverages and tobacco (11.5 %). In 2015, international goods transport amounted to 24 million tonnes, which is by 6 % more than in 2014. The amount of goods loaded in the country totalled 5.3 million tonnes and, compared to 2014, decreased by 16.3 %, while that of goods unloaded in the country totalled 4 million tonnes and, compared to 2014, decreased by 9.9 %. Road transport amounted to 12.2 million tonnes and, compared to 2014, increased by 11.7 %. A significant part of international road transport fell within the carriage of food products, beverages and tobacco (19.3 %), products of agriculture, hunting, and forestry, fish and other fishing products (12.2 %), wood and products of wood and cork (except furniture) , articles of straw and plaiting materials, pulp, paper and paper products, printed matter and recorded media (7.4 %).

Activity data for mobile sources (Figure 3.6.2.1-2) are based on official energy balance of the Lithuania prepared by the Statistics Lithuania (2016). The parameters necessary for distribution of sold fuels are transport mode, fuel type, weight of vehicle and equipment with more or less effective catalytic system. The appropriate distribution is necessary for assigning of the relevant emission factor. Sector 1A3b Road Transportation is split into five subsectors:

- 1.A.3.b i Passenger Cars
- A.3.b ii Light Duty Vehicles
- 1.A.3.b iii Heavy Duty Vehicles
- 1.A.3.b iv Mopeds & Motorcycles
- 1.A.3.b v Gasoline Evaporation
- 1.A.3.b vi Automobile tyre and brake wear

- 1.A.3.b vii Automobile road abrasion

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 NH_3 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.

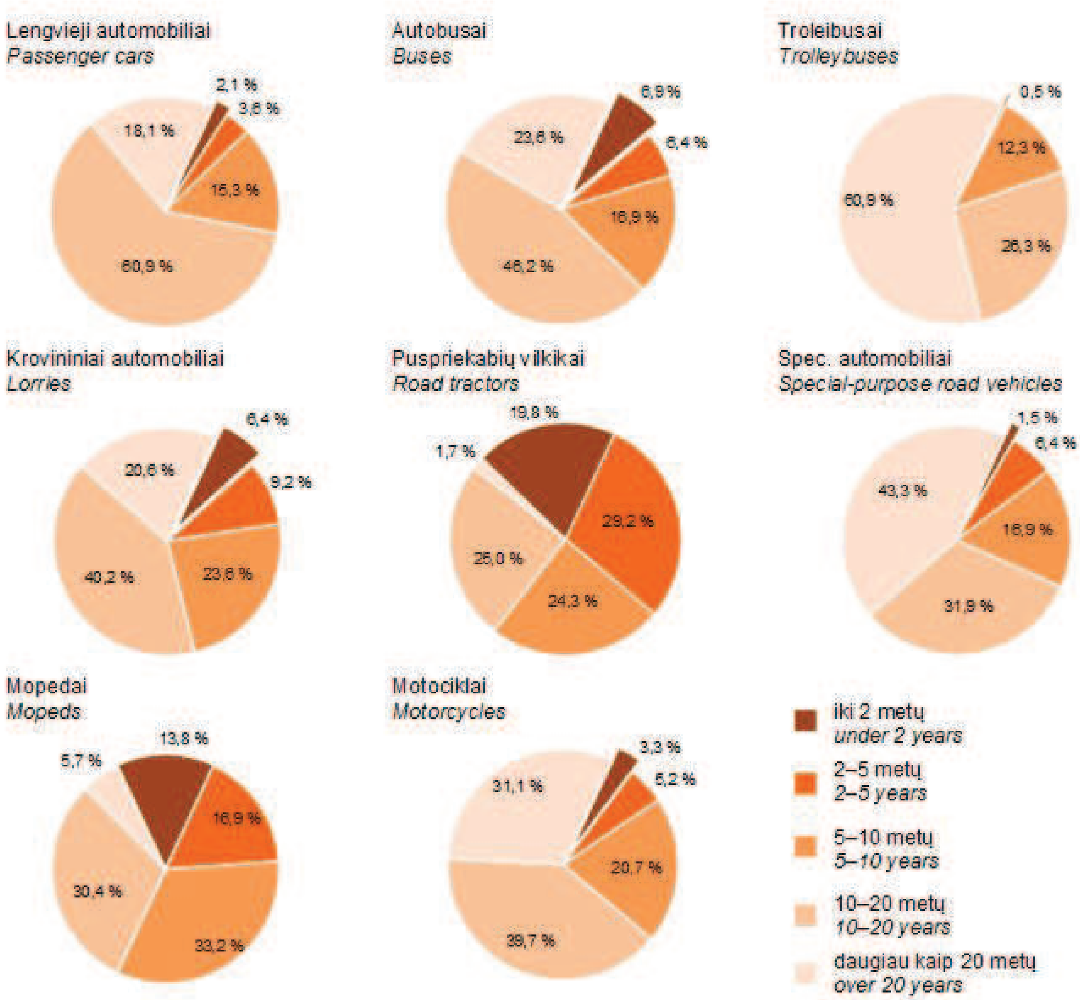

Figure 3.6.2.1-1Road vehicles by age, 2015.

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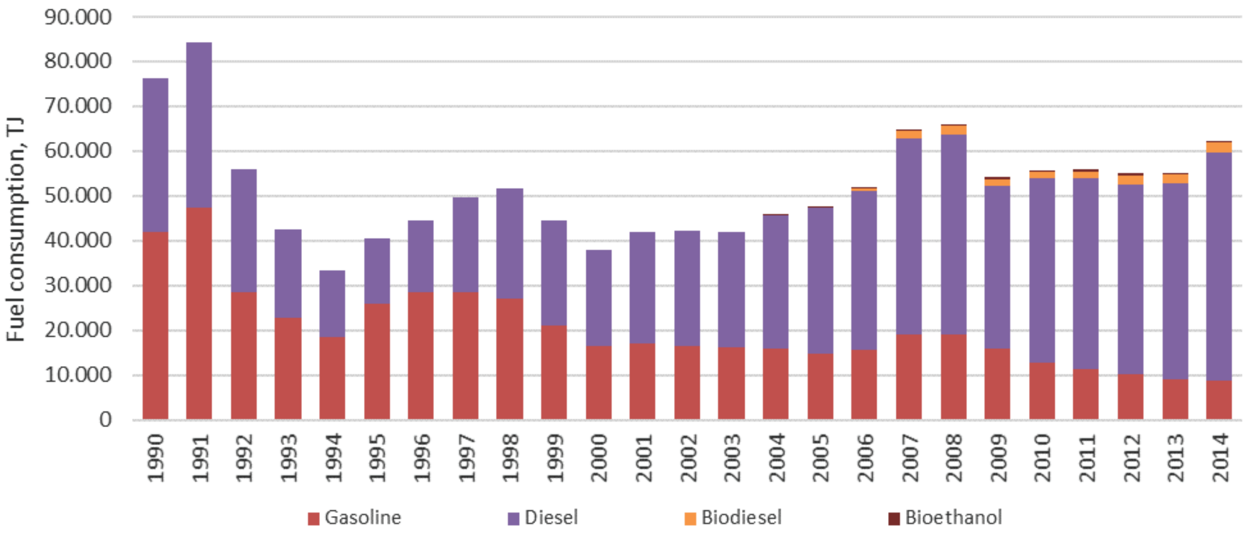


Figure 3.6.2.1-2 Fuel consumption in road transport in 1990-2015, TJ

Diesel and petrol fuels are mainly used in transport sector with a slow and steady increase in electromobiles. According to "Regitra" there were 222 registered electromobiles in April, 2016 with an estimation of 450-600 in 2017. 4243 hybrid automobiles were registered in April, 2016.

There is a marked switch from petrol engines to diesel. The number of petrol engines (all vehicles) and as a result petrol fuel consumption has dropped between 1990 and 2015, while the number of diesel engines increased significantly from ~116 to 790 thousand for the same period. Passenger cars represent the most fuel-consuming vehicle category, followed by heavy-duty vehicles, light duty vehicles and 2-wheelers, in decreasing order (Figure 3.6.2.1-3).

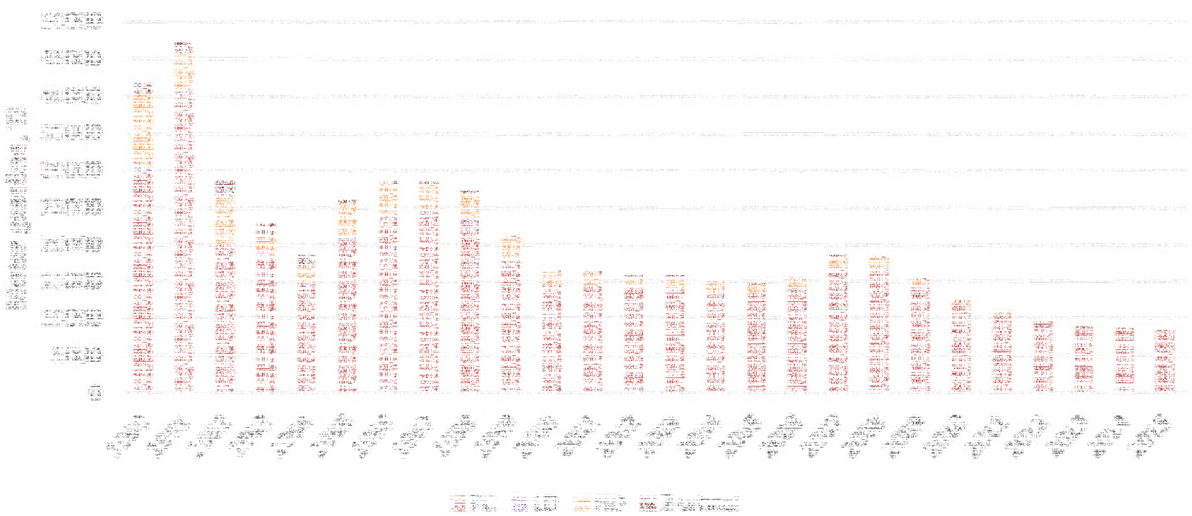


Figure 3.6.2.1-3 Gasoline fuel consumption per vehicle type for road transport 1990-2015

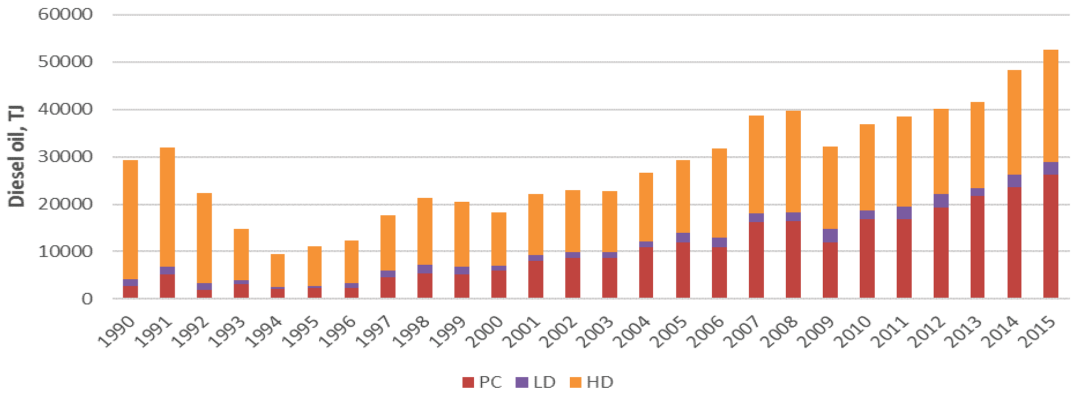


Figure 3.6.2.1-4 Diesel oil consumption per vehicle type for road transport 1990-2015

In 2015, fuel consumption shares for diesel passenger cars, diesel heavy-duty vehicles, gasoline passenger cars, diesel light duty vehicles were 39 %, 36%, 12%, 4%, respectively (Figure 3.6.2.1-4 and
Figure 3.6.2.1-5).

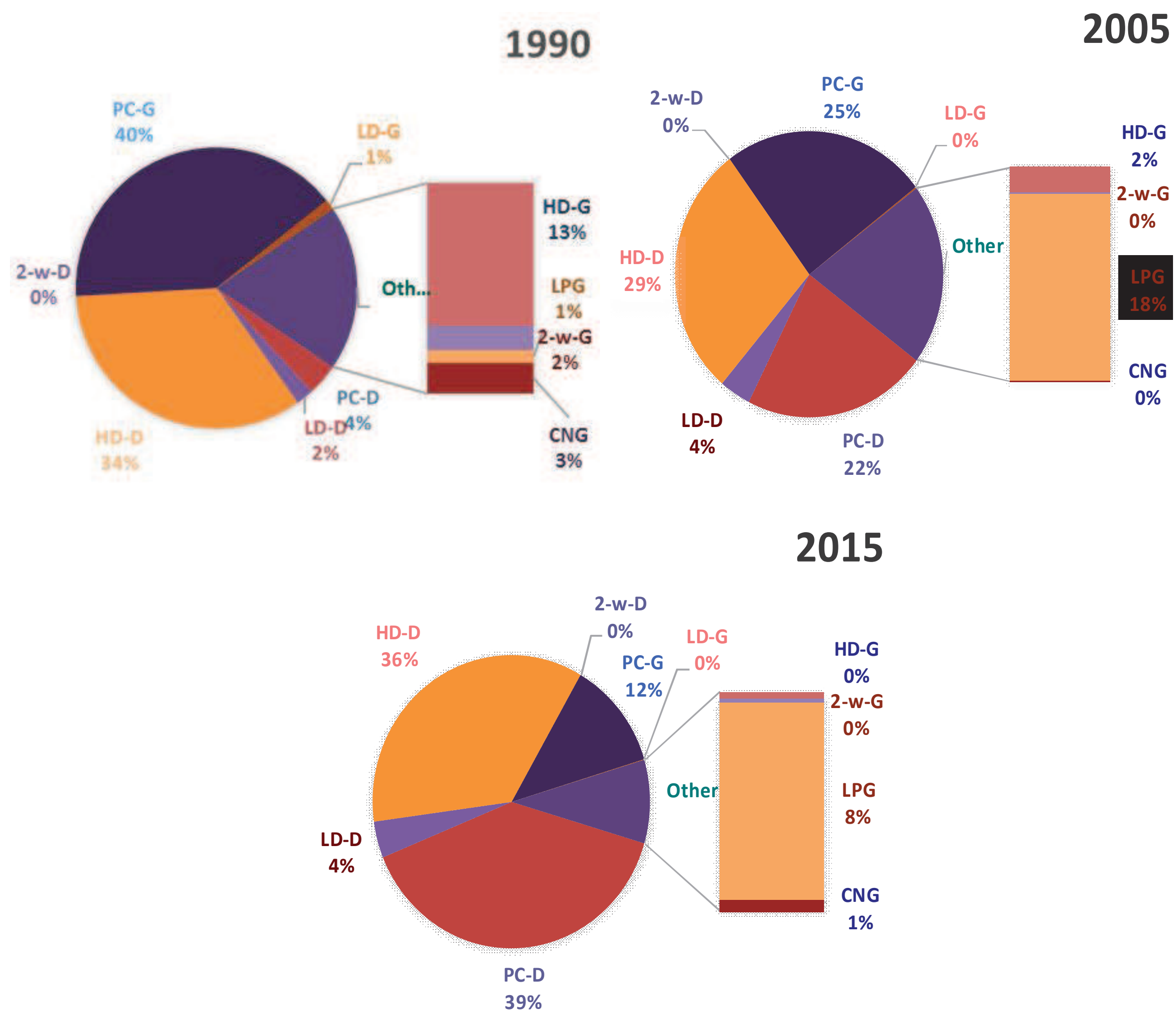


Figure 3.6.2.1-5 Fuel consumption share (TJ) per vehicle type and fuel type for road transport in 1990, 2005 and 2015

Table 3.6.2.1-1. Emission trend in road transport sector 1990-2015.

	Nox	NMVOC	Sox	NH3	PM2.5	PM10	TSP	BC	CO
1990	55.03	28.21	5.61	0.03	1.80	1.96	1.62	0.73	282.73
1991	50.82	37.01	5.15	0.04	2.16	2.35	1.95	0.75	356.98
1992	42.90	22.21	3.48	0.02	1.30	1.42	1.17	0.52	226.70
1993	28.73	17.54	2.60	0.02	1.01	1.09	0.91	0.00	170.84
1994	23.23	13.92	2.02	0.01	0.81	0.88	0.74	0.30	127.80
1995	30.97	19.79	2.23	0.02	0.79	0.88	0.69	0.29	176.87
1996	32.96	20.76	2.46	0.02	0.85	0.94	0.74	0.31	183.20
1997	35.37	22.70	2.31	0.07	1.20	1.31	1.07	0.35	199.69
1998	35.37	20.76	1.12	0.08	1.41	1.52	1.28	0.43	181.67
1999	30.97	17.83	0.96	0.08	1.45	1.55	1.33	0.36	155.50
2000	28.15	11.66	0.80	0.07	0.99	1.08	0.89	0.41	88.70
2001	29.75	11.49	0.73	0.07	1.13	1.22	1.02	0.45	91.10
2002	28.89	11.14	0.74	0.08	1.16	1.25	1.06	0.45	88.64
2003	28.83	11.19	0.62	0.09	1.17	1.26	1.06	0.44	89.77
2004	29.53	11.66	0.54	0.09	1.27	1.37	1.16	0.45	71.85
2005	29.35	12.34	0.10	0.09	1.31	1.42	1.19	0.47	74.46
2006	31.45	10.96	0.07	0.12	1.29	1.41	1.15	0.48	66.21
2007	29.88	9.67	0.13	0.29	1.51	1.65	1.35	0.55	56.52
2008	30.75	9.18	0.13	0.32	1.65	1.79	1.48	0.61	53.40
2009	27.31	8.70	0.02	0.22	1.27	1.39	1.13	0.50	50.31
2010	27.77	8.42	0.02	0.17	1.39	1.52	1.25	0.55	52.47
2011	25.05	6.14	0.02	0.16	1.26	1.38	1.11	0.47	36.97
2012	27.11	7.11	0.02	0.14	1.19	1.31	1.05	0.45	39.61
2013	27.02	4.67	0.02	0.16	1.15	1.27	1.02	0.45	23.04
2014	26.97	4.64	0.02	0.16	1.16	1.28	1.02	0.45	23.08
2015	26.34	3.36	0.02	0.17	1.18	1.34	1.46	0.35	17.23
Trend 1990-2015, %	-52.13	-88.11	-99.59	463.82	-34.61	-31.46	-9.58	-51.89	-93.90
Trend 2005-2015, %	-7.93	-62.21	-77.71	79.60	-12.38	-10.58	-14.48	-3.53	-76.86

3.6.2.2. Methodological issues

In the *Tier 3* method, emissions are calculated using a combination of firm technical data and activity data. The activity data of road transport was split and filled in for a range of parameters including:

- Fuel consumed, quality of each fuel type;
- Emission controls fitted to vehicle in the fleet;
- Operating characteristics (e.g. average speed per vehicle type and per road)
- Types of roads;
- Maintenance;
- Fleet age distribution;
- Distance driven (mean trip distance), and
- Climate

The program calculates vehicle mileages, fuel consumption, exhaust gas emissions, evaporative emissions of the road traffic. The balances use the vehicle stock and functions of the km driven per vehicle and year to assess the total traffic volume of each vehicle category. The production year of vehicles in this category has been taken into account by introducing different classes, which either reflects legislative steps ('ECE', 'Euro') applicable to vehicles registered in each Member State. The technology mix in each particular year depends on the vehicle category and the activity dataset considered.

For the period between 1990 and 2006, it was necessary to estimate the figures with the aid of numerous assumptions. The total emissions were calculated by summing emissions from different sources, namely the thermally stabilized engine operation (hot) and the warming-up phase (cold start) (EEA 2000; MEET, 1999). For *Tier 3* approaches cold start emissions were estimated:

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

Where:

$E_{COLD;i,k}$ - *cold start emissions of pollutant i(for the reference year), produced by vehicle technology k,*

$\beta_{i,k}$ - *fraction of mileage driven with a cold engine or the catalyst operated below the light-off temperature for pollutant i and vehicle [veh] technology k,*

N_k - *number of vehicle of technology k in circulation,*

M_k - *total mileage per vehicle [km veh^{-1}] in vehicle technology k,*

e_{COLD}/e_{HOT} - *cold/hot emission quotient for pollutant i and vehicle of k technology.*

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

where,

E_{TOTAL} - *total emissions (g) of compound for the spatial and temporal resolution of the application,*

E_{HOT} - *emissions (g) during stabilized (hot) engine operation,*

E_{COLD} - *emissions (g) during transient thermal engine operation (cold start).*

The *β*-parameter depends upon ambient temperature *ta* (for practical reasons the average monthly temperature was used). Since information on average trip length is not available for all vehicle classes, simplifications have been introduced for some vehicle categories. According to the available statistical data (André *et al.*, 1998), a European value of 12.4 km has been established for the l_{trip} value and used in estimations in Lithuania.

Due to the fact that concentrations of some pollutants during the warming-up period are many times higher than during hot operation. In this respect, a distinction is made between urban, rural and highway driving modes. Cold-start emissions are attributed mainly to urban driving (and secondarily to rural driving), as it is expected that a limited number of trips start at highway conditions. Therefore, as far as driving conditions are concerned, total emissions were calculated by means of the equation:

$$E_{TOTAL} = E_{URBAN} + E_{RURAL} + E_{HIGHWAY}\,. \qquad (3)$$

where:

E_{URBAN}, E_{RURAL} and $E_{HIGHWAY}$ - the total emissions (g) of any pollutant for the respective driving situations.

Fuel was distributed to transport categories, types, ecology standards and driving modes according to data taken from State Enterprise Transport and Road Research Institute under the Ministry of Transport and Communications of the Republic of Lithuania.
Emissions was estimated from the fuel consumed (represented by fuel sold) and the distance travelled by the vehicles. The first approach (fuel sold) was applied.

Emission factor assumes full oxidation of the fuel. Emission equation for air pollutants for *Tier 3* is:

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

where:

Emission - *emission of air pollutants;*

$EF_{a,b,c,d}$ - *emission factor, kg/km;*

$Distance_{a,b,c,d}$ - *distance travelled during thermally stabilized engine operation phase, km;*

$C_{a,b,c,d}$ - *emission during (g) during transient thermal engine operation (cold start), kg;*

b – vehicle type;

c – emission control technology;

d – driving situation (urban, rural, highway).

The annual mileage driven by the stock of vehicle per year is an important parameter in emission calculation as it affects both the total emissions calculated but also the relative contributions of the vehicle types considered. Calculations demand annual mileage per vehicle technology and the number of vehicles was supplied by the Lithuanian Road Administration and study funded by the European Commission – DG Environment and executed in collaboration with, KTI, Renault, E3M-Lab/NTUA, Oekopol, and EnviCon. The source for these data is various European measurement programmes. Fuel consumption was calculated on the basis of appropriate assumptions for annual mileage of the different vehicle categories can be balanced with available fuel statistics (Ntziachristos et al., 2008). In general the COPERT IV v.11 data are transformed into trip-speed dependent fuel consumption and emission factors for all vehicle categories and layers. The calculated fuel consumption in COPERT IV must equal the statistical fuel sale totals according to the UNFCCC and UNECE emissions reporting format. The statistical fuel sales for road transport are derived from the Statistics Lithuania.
For example, if a country has bulk fuel sold but does not have fuel use by vehicle type, they may allocate total fuel consumption across vehicle types based on the consumption patterns of their fleet (TRB's National Cooperative Highway Research Program (NCHRP) project report, Greenhouse Gas Emission Inventory Methodologies for State Transportation Departments). By applying a trial-and-error approach, it was possible to reach acceptable estimates of mileage. For each group, the emissions were estimated by combining vehicle type and annual mileage with hot emission factors, cold/hot ratios and evaporation factors.
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 below.

Table 3.6.2.2-1 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		PRE ECE	9508.97	496.65	828.67	0.58	0	0	0

l		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 3.6.2.2-2 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 3.6.2.2-3 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 3.6.2.2-4 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 3.6.2.2-5 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

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. Then the equation is:

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

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.

Table 3.6.2.2-6 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. LPG doesn't contain heavy metal; therefore there are no heavy metals emissions from road transport using LPG.

Table 3.6.2.2-7 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

PAH's and other POP's emissions

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

Table 3.6.2.2-8 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

Gasoline evaporation (1.A.3.b.v)

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 3.6.2.2-9).

Table 3.6.2.2-9 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

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 3.6.2.2-10) is used as activity rates for estimating tyre, brake wear and road abrasion emissions.

Table 3.6.2.2-10 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 Table 3.6.2.2-11. $PM_{2.5}$ and PM_{10} emission factors were taken from [7] reference and reported in Table 3.6.2.2-12-Table 3.6.2.2-13.

Table 3.6.2.2-11 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 3.6.2.2-12 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 3.6.2.2-13 PM2.5 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 3.6.2.2-14. 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

3.6.2.3. Uncertainties and time-series consistency

Expert judgement suggests that the uncertainty of the activity data is approximately ±5%. The primary source of uncertainty is the activity data rather than emission factors.

3.6.2.4. Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.6.2.5. Source-specific recalculations

No source specific recalculations.

3.6.2.6. Source-specific planned improvements

No source-specific improvements.

3.6.3. Railways (NFR 1.A.3.c)

3.6.3.1. Overview of the Sector

In 2014, the operational length of railways amounted to 1767.6 km. The length of electrified lines remained unchanged (122 km) (Figure 3.6.3.1-1 Map of lithuanian railways). In 2015, compared to 2014, the number of railway vehicles decreased: that of locomotives – by 4.2, wagons – 2.4, coaches (including diesel and electric railcars) – 7.3 %. 52 per cent of locomotives, 71 per cent of coaches (including diesel and electric railcars) and 86 % of wagons were produced 15 and more years ago. In 2015, goods transport by rail amounted to 48.1 million tonnes, which is by 1.9 % less than in 2014. National goods transport by rail amounted to 14.4 million tonnes, which is by 0.4 % less than in 2014; international goods transport by rail amounted to 33.6 million tonnes, which is by 2.6 % less than in 2014. In 2015, 31.4 % of all the goods carried by rail (15.1 million tonnes) were chemicals, chemical products and manmade fibres, rubber and plastic products, nuclear fuel; compared to 2014, their carriage increased by 2.2 %. Coke and refined petroleum products carried by rail amounted to 13.9 million tonnes, or 29 % of all the goods carried; compared to 2014, their carriage increased by 6.7 %. Metal ores and other mining and quarrying products, peat, uranium and thorium amounted to 4.4 million tonnes, or 9.2 per cent of all the goods carried by rail; compared to 2014, their carriage decreased by 23.9 %. The major proportion of goods was carried from Belarus (73.9 %) and Russia (19.5 %). Most goods from Lithuania were carried to Latvia (24.9 %), Ukraine (21.5 %), Estonia (15.7 %), and Belarus (13 %). Tonne-kilometres amounted to 14 036 million, and, compared to 2014, decreased by 1.9 %. In 2015, the number of passengers carried by rail totalled 4.2 million, which is by 7.7 % less than in 2014. In 2015, passenger-kilometres amounted to 361 million, which is by 3.2 % less than in 2014.

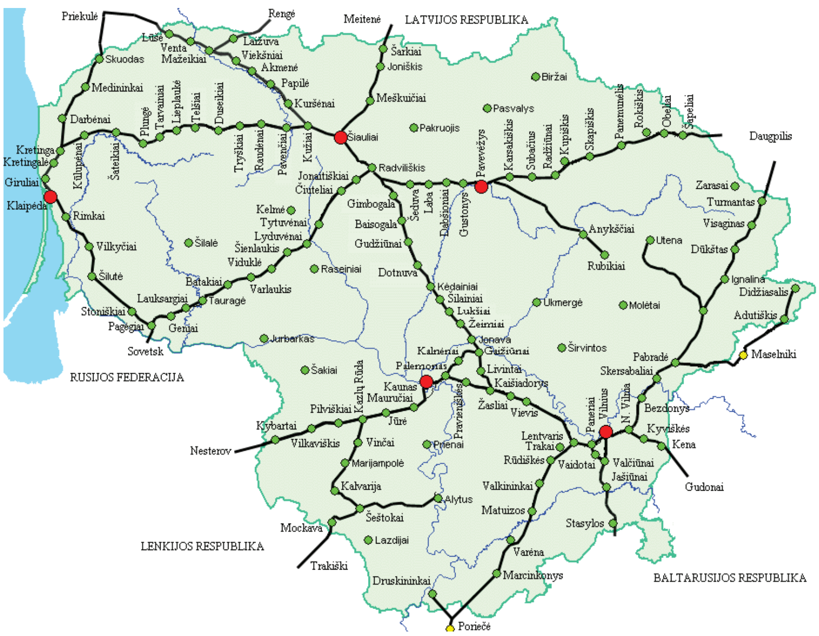


Figure 3.6.3.1-1 Map of lithuanian railways

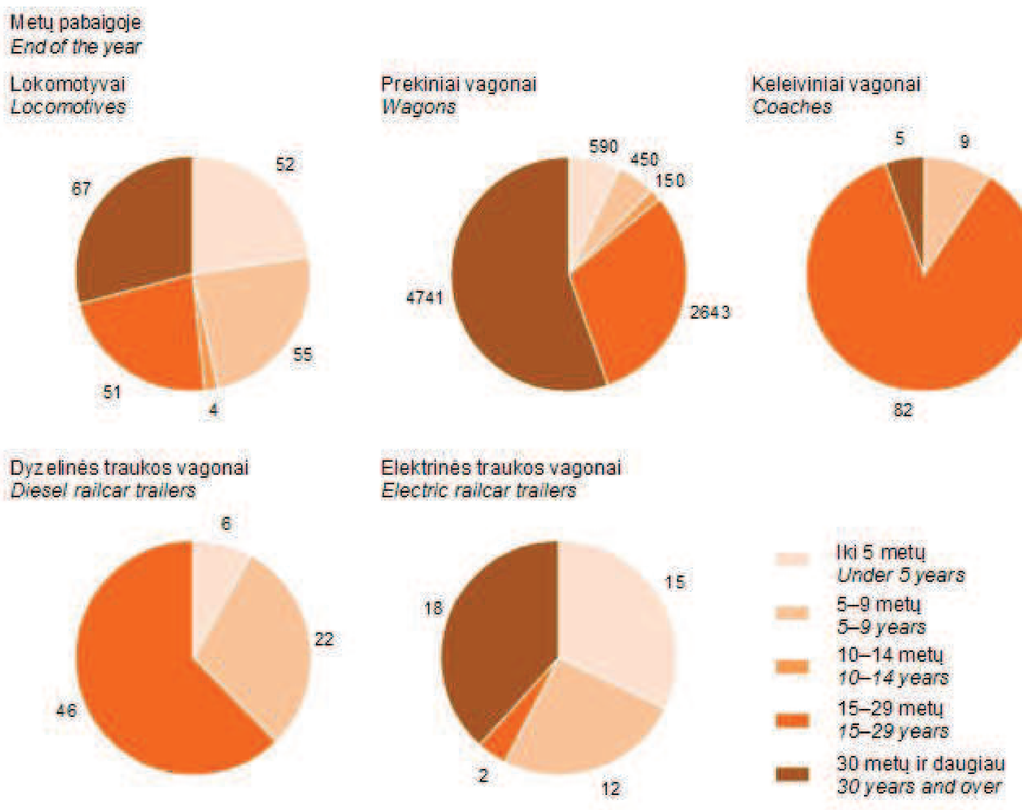


Figure 3.6.3.1-2 Railway vehicles by age, 2015

Table 3.6.3.1-1 Emissions in Railways

	Nox	NMVOC	Sox	NH3	PM2.5	PM10	TSP	BC	CO
1990	5.88	0.52	0.04	0.00	0.15	0.16	0.17	0.00	1.20
1991	6.24	0.55	0.05	0.00	0.16	0.17	0.18	0.00	1.27
1992	6.03	0.54	0.05	0.00	0.16	0.17	0.17	0.00	1.23
1993	5.93	0.53	0.05	0.00	0.16	0.16	0.17	0.00	1.21
1994	6.29	0.56	0.05	0.00	0.16	0.17	0.18	0.00	1.29
1995	4.06	0.36	0.03	0.00	0.11	0.11	0.12	0.00	0.83
1996	4.22	0.37	0.03	0.00	0.11	0.12	0.12	0.00	0.86
1997	4.07	0.36	0.03	0.00	0.11	0.11	0.12	0.00	0.83
1998	3.95	0.35	0.03	0.00	0.10	0.11	0.11	0.00	0.81
1999	3.50	0.31	0.03	0.00	0.09	0.10	0.10	0.00	0.71
2000	3.66	0.32	0.02	0.00	0.10	0.10	0.11	0.00	0.75
2001	3.22	0.29	0.02	0.00	0.08	0.09	0.09	0.00	0.66
2002	3.47	0.31	0.02	0.00	0.09	0.10	0.10	0.00	0.71
2003	3.81	0.34	0.02	0.00	0.10	0.10	0.11	0.00	0.78
2004	3.79	0.34	0.02	0.00	0.10	0.10	0.11	0.00	0.77
2005	3.84	0.34	0.00	0.00	0.10	0.11	0.11	0.00	0.78
2006	3.66	0.32	0.00	0.00	0.10	0.10	0.11	0.00	0.75
2007	3.77	0.33	0.00	0.00	0.10	0.10	0.11	0.00	0.77
2008	3.81	0.34	0.00	0.00	0.10	0.10	0.11	0.00	0.78
2009	2.92	0.26	0.00	0.00	0.08	0.08	0.08	0.00	0.60
2010	3.09	0.27	0.00	0.00	0.08	0.08	0.09	0.00	0.63
2011	3.22	0.29	0.00	0.00	0.08	0.09	0.09	0.00	0.66

2012	3.03	0.27	0.00	0.00	0.08	0.08	0.09	0.00	0.62
2013	2.79	0.25	0.00	0.00	0.07	0.08	0.08	0.00	0.57
2014	2.92	0.26	0.00	0.00	0.08	0.08	0.08	0.00	0.60
2015	2.74	0.24	0.00	0.00	0.07	0.08	0.08	0.00	0.56
Trend 1990-2015, %	-53.45	-53.45	-99.07	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45
Trend 2005-2015, %	-27.29	-27.29	-85.46	-27.29	-27.29	-27.29	-27.29	-27.29	-28.79

3.6.3.2. Methodological issues

Emissions were estimated using fuel statistics from Statistics Lithuania. Tier 1 emission factors were taken from 2016 EMEP/EEA Guidebook 1.A.3.c category. Tier 1 EFs from 1A3biii category for heavy duty vehicles were used to find BC and SO_2 emissions. EF for BC equal to 0.53% of $PM_{2.5}$ was applied, while several EFs based on sulphur content in the fuel were used: for the 1990-2000 period 400 g Sulphur/Mg of fuel consumed, 2000-2005 – 300 g/Mg, 2005-2009 – 40 g/Mg and 8 g/Mg for every year from 2009. The following Guidebook-provided equation was used to estimate SO_x emissions:

Emission $_{SO(x)}$ = 2 x Fuel consumed (Gg) $_{Diesel}$ x Sulphur content (Gg of S per Gg of diesel)

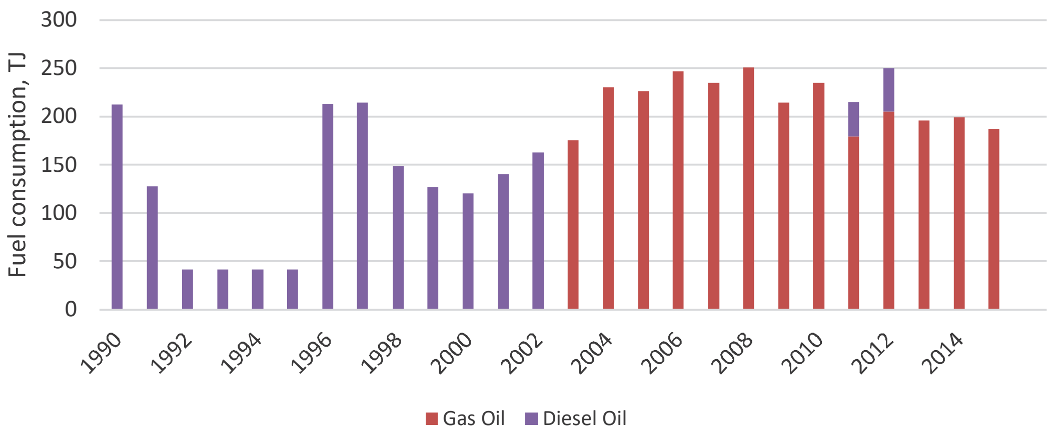


Figure 3.6.3.2-11FUEL CONSUMPTION IN SMALL COMBUSTION 1.A.4.A SECTOR

Fuel consumption in the railways transport decreased more than twice from 1990 to 2015 (Figure 3.6.3.2-11). Similar change occurred in the amounts of emissions. 1990/2015 emissions dropped by 53.5%, while 2005/2015 emissions decreased by 28.8%. SO_x emissions decreased by 99.0% and 85.8% from 1990 to 2015 and from 2005 to 2015, respectively.

Table 3.6.3.2-1 Emissions 1990-2015, Gg

	NOx	SOx	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$	BC	CO
1990	5.877	0.045	0.521	0.001	0.170	0.161	0.154	0.001	1.200
1995	4.056	0.031	0.360	0.001	0.118	0.111	0.106	0.001	0.828
2000	3.660	0.021	0.325	0.000	0.106	0.101	0.096	0.001	0.747

2005	3.841	0.003	0.341	0.001	0.111	0.106	0.100	0.001	0.784
2010	3.092	0.000	0.274	0.000	0.090	0.085	0.081	0.000	0.631
2013	2.793	0.000	0.248	0.000	0.081	0.077	0.073	0.000	0.570
2014	2.924	0.000	0.259	0.000	0.085	0.080	0.076	0.000	0.597
2015	2.735	0.000	0.243	0.000	0.079	0.075	0.072	0.000	0.56
Trend, 1990-2015, %	-53.45	-99.07	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45

Table 3.6.3.2-2 Metal EMISSIONS 1990-2015, GG

	Cd	Cr	Cu	Ni	Se	Zn	B(a)p	B(b)f
1990	0.001	0.006	0.191	0.008	0.001	0.112	0.003	0.006
1995	0.001	0.004	0.132	0.005	0.001	0.077	0.002	0.004
2000	0.001	0.003	0.119	0.005	0.001	0.070	0.002	0.003
2005	0.001	0.004	0.125	0.005	0.001	0.073	0.002	0.004
2010	0.001	0.003	0.100	0.004	0.001	0.059	0.002	0.003
2013	0.001	0.003	0.091	0.004	0.001	0.053	0.002	0.003
2014	0.001	0.003	0.095	0.004	0.001	0.056	0.002	0.003
2015	0.001	0.003	0.089	0.004	0.001	0.052	0.002	0.003
Trend, 1990-2015, %	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45	-53.45

The major proportion of goods was carried from Belarus (70 %) and Russia (18.9 per ent). Most goods from Lithuania were carried to Ukraine (26.1 %), Latvia (20.7 %), Belarus (15.9 %) and Russia (11.3 %).

3.6.3.3. 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:

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

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.

Table 3.6.3.3-1 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 3.2/2016
NMVOC	4.65	g/GJ	6	19	EMEP CORINAIR Gdbk 3.2/2016
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 3.2/2016
Cr	0.05	mg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2016
Cu	1.7	mg/GJ	0.5	4.9	EMEP CORINAIR Gdbk 3.2/2016
Ni	0.07	mg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2016
Se	0.01	mg/GJ	0.003	37.3	EMEP CORINAIR Gdbk 3.2/2016
Zn	19	mg/GJ	7.75	0.025	EMEP CORINAIR Gdbk 3.2/2016
Benzo(a)pyrene	0.03	µg/GJ	0.01	0.1	EMEP CORINAIR Gdbk 3.2/2016
Benzo(b)fluoranthene	0.05	µg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2016

B(k)f & Indeno (1,2,3-cd) pyrene and dioxins emission factor values are not available for railway emissions. It is therefore recommended to use values corresponding to old technology heavy duty vehicles from the Exhaust Emissions from Road Transport chapter (1.A.3.b.iii).
BC fraction of PM (f-BC): 0.65.

3.6.3.4. Uncertainty analysis for the railway transport sector.

The uncertainty in activity data is 2%. The EF in Table above provide ranges indicating the uncertainties associated with diesel fuel. In the absence of specific information, the percentage relationship between the upper and lower limiting values and the central estimate may be used to derive default uncertainty ranges associated with emission factors for additives.

3.6.3.5. Source-specific planned improvements

No source-specific improvements.

3.6.4. National navigation (shipping) (NFR 1.A.3.d)

3.6.4.1. Overview of the Sector

Lithuania has ~900 km of inland waterways. Inland waterways are navigable rivers, canals, lakes, man-made water bodies, and part of the Curonian Lagoon belonging to the Republic of Lithuania. Length of inland waterways regularly used for transport in Lithuania equalled 452 km in 2015. In 2015, transport of goods by inland waterways amounted to 1.1 million thousand tonnes, the number of passengers carries – 2.0 million. In 2015 compared to 2014, transport of goods increased by 1.7%, passenger transport decreased by 1.8 %.

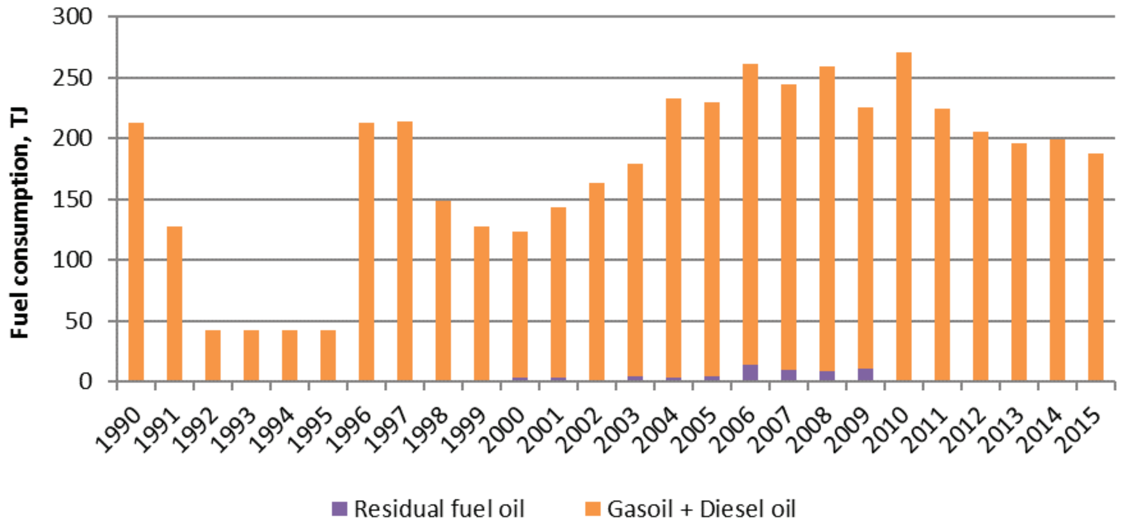


Figure 3.6.4.1-1. Trend of fuel consumption in Water navigation sector

As seen in Figure above fuel consumption decreased by 17.2% between 2005 and 2015. This decrease is obviously due to the impact of the decreased fuel consumption in inland waterways.

Table 3.6.4.1-1 Emissions 1990-2015, Gg

	NOX	NMLOJ	Sox	NH3	PM2,5	PM10	TSP	BC	CO
1990	0,39	0,01	0,02	0,00	0,01	0,01	0,01	0,00	0,04
1991	0,16	0,01	0,01	0,00	0,00	0,00	0,00	0,00	1,71
1992	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56
1993	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56
1994	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56
1995	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56
1996	0,26	0,01	0,02	0,00	0,01	0,01	0,01	0,00	2,85
1997	0,26	0,01	0,02	0,00	0,01	0,01	0,01	0,00	2,87
1998	0,18	0,01	0,02	0,00	0,01	0,00	0,01	0,00	2,00
1999	0,16	0,01	0,01	0,00	0,00	0,00	0,00	0,00	1,70
2000	0,15	0,01	0,01	0,00	0,00	0,00	0,00	0,00	1,65
2001	0,17	0,01	0,02	0,00	0,01	0,00	0,01	0,00	1,91
2002	0,20	0,01	0,02	0,00	0,01	0,01	0,01	0,00	2,18
2003	0,33	0,01	0,02	0,00	0,01	0,01	0,01	0,00	0,03
2004	0,43	0,02	0,03	0,00	0,01	0,01	0,01	0,00	0,04
2005	0,43	0,02	0,03	0,00	0,01	0,01	0,01	0,00	0,04
2006	0,48	0,02	0,01	0,00	0,01	0,01	0,01	0,00	0,05
2007	0,45	0,02	0,01	0,00	0,01	0,01	0,01	0,00	0,04
2008	0,48	0,02	0,01	0,00	0,01	0,01	0,01	0,00	0,04
2009	0,42	0,01	0,01	0,00	0,01	0,01	0,01	0,00	0,04
2010	0,50	0,02	0,01	0,00	0,01	0,01	0,01	0,00	0,05
2011	0,41	0,01	0,01	0,00	0,01	0,01	0,01	0,00	0,04
2012	0,38	0,01	0,00	0,00	0,01	0,01	0,01	0,00	0,04
2013	0,36	0,01	0,00	0,00	0,01	0,01	0,01	0,00	0,03
2014	0,37	0,01	0,00	0,00	0,01	0,01	0,01	0,00	0,03

2015	0,35	0,01	0,00	0,00	0,01	0,01	0,01	0,00	0,03
Trend, 1990-2015, %	**-13,61%**	**-13,61%**	**-468,1%**	**-13,61%**	**-13,61%**	**-13,61%**	**-13,61%**	**-13,61%**	**-13,61%**

3.6.4.2. Methodological issues

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

Table 3.6.4.2-1Tier 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 3.6.4.2-2 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 3.6.4.2-3Tier 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

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:

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

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.

3.6.4.3. Uncertainty

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

Table 3.6.4.3-1 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%

This sector was not estimated. Inaccurate emissions were changed to not estimated.

3.6.5. Pipelines (NFR 1.A.3.e)

3.6.5.1. Overview of the Sector

In Lithuania, natural gas is transported via gas transmission and distribution systems (Figure 3.6.5.1-1). Statistics Lithuania started collecting data on consumption of natural gas used for gas transportation in pipeline compressor stations from 2001.

JSC "Lietuvos Dujos" is the operator of Lithuania's natural gas transmission system in charge of the safe operation, maintenance and development of the system. The transmission system is comprised of gas transmission pipelines, gas compressor stations, gas metering and distribution stations (Table 3.6.5.1-1).

Table 3.6.5.1-1 Lithuanian natural gas transmission system

Gas transmission pipelines	Gas distribution stations	Gas metering stations	Gas compressor stations
1.9 thous. km	65 stations	3 stations	2 stations

Figure 3.6.5.1-1. Gas distribution network in Lithuania

Transport via pipelines includes transport of gases via pipelines.

Table 3.6.5.1-2. Emission in pipeline, Gg.

	Nox	CO	NMVOC	SO2
1990	1,2384	0,0774	0,0062	0,0005
1995	0,4888	0,0306	0,0024	0,0002
2000	0,5552	0,0347	0,0028	0,0002
2010	0,8224	0,0514	0,0041	0,0003
2011	0,6896	0,0431	0,0034	0,0003

2012	1,0640	0,0665	0,0053	0,0004
2013	1,0000	0,0625	0,0050	0,0004
2014	0,9856	0,0616	0,0049	0,0004
2015	1,0000	0,0625	0,0050	0,0004

3.6.5.2. Methodological issues

Statistics Lithuania has started collecting data on consumption of natural gas used for gas transportation in pipeline compressor stations from 2001. For the period prior to 2001 data on use of natural gas for transmission are not available.
The surrogate method to estimate unavailable data during 1990-2000 was used since the extrapolation approaches should not be done to long periods and inconsistent trend. To evaluate more accurate relationships the regression analysis was developed by relating emissions to more than one statistical parameter. The relationship between gas pipeline emissions and surrogate data was developed on the basis of underlying activity data during multiple years.

3.6.5.3. Uncertainties and time-series consistency

The uncertainty in activity data (fuel use) is 5%.

3.6.5.4. Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.6.5.5. Source-specific recalculations

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

3.7.1. 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

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.

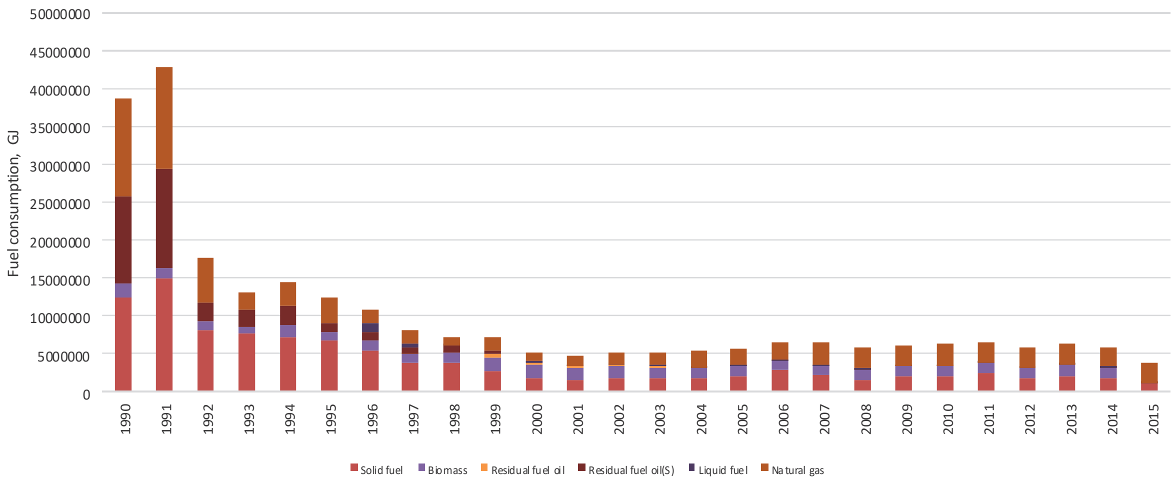


Figure 3.7.1-1Fuel consumption in Small Combustion 1.A.4.A sector

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.

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%).

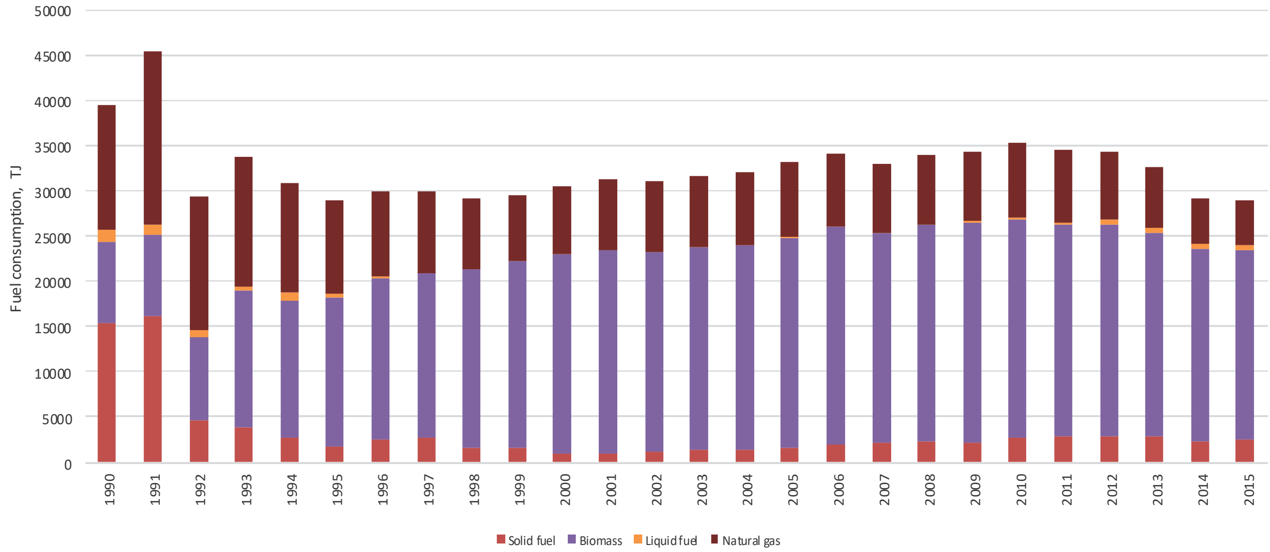


Figure 3.7.1-2Fuel consumption in Small Combustion 1.A.4.B sector

CO, PM2.5, NMVOC, PAH (polycyclic aromatic hydrocarbons) and dioxins/furans emissions from the category 1A4bi contribute a large part to the total inventory.

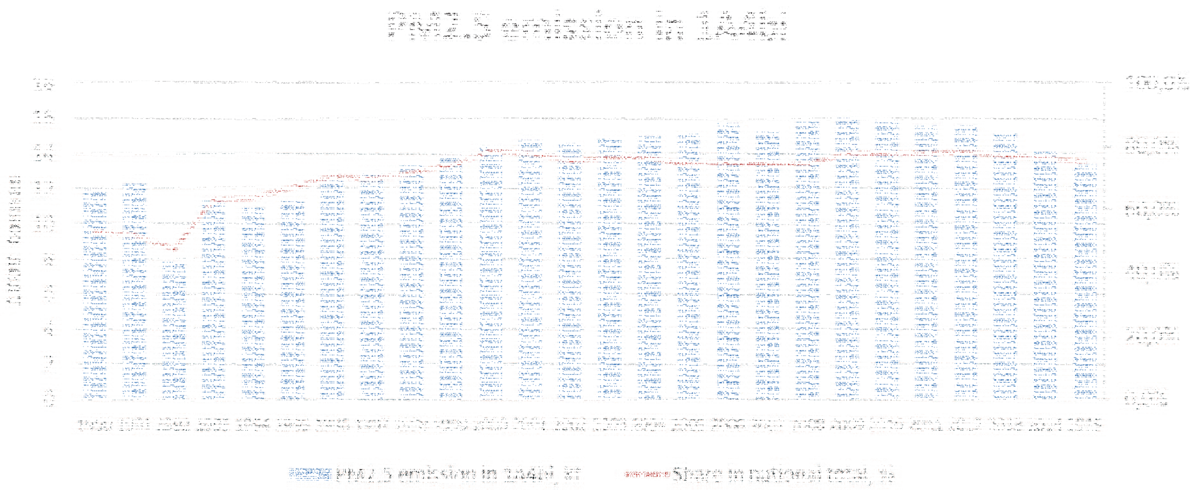


Figure 3.7.1-3 PM2.5 emission in 1.A.4.bi

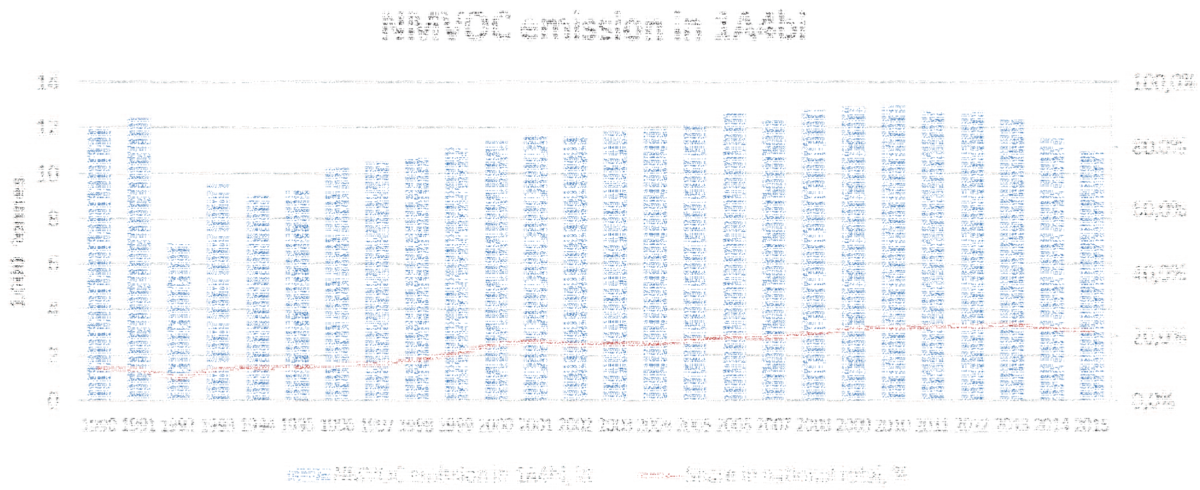


Figure 3.7.1-4 NMVOC emission in 1.A.4.bi

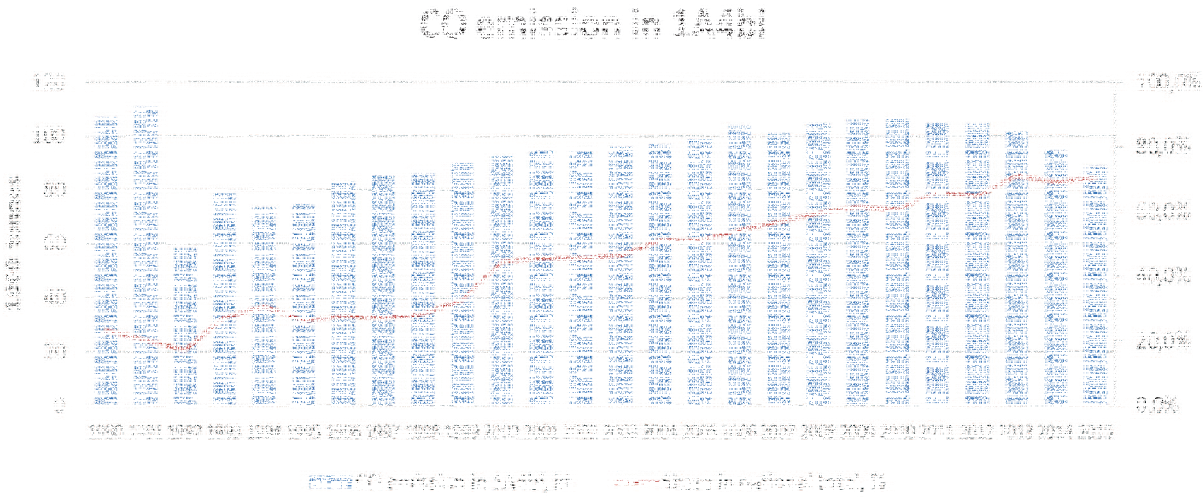


Figure 3.7.1-5 CO emission in 1.A.4.bi

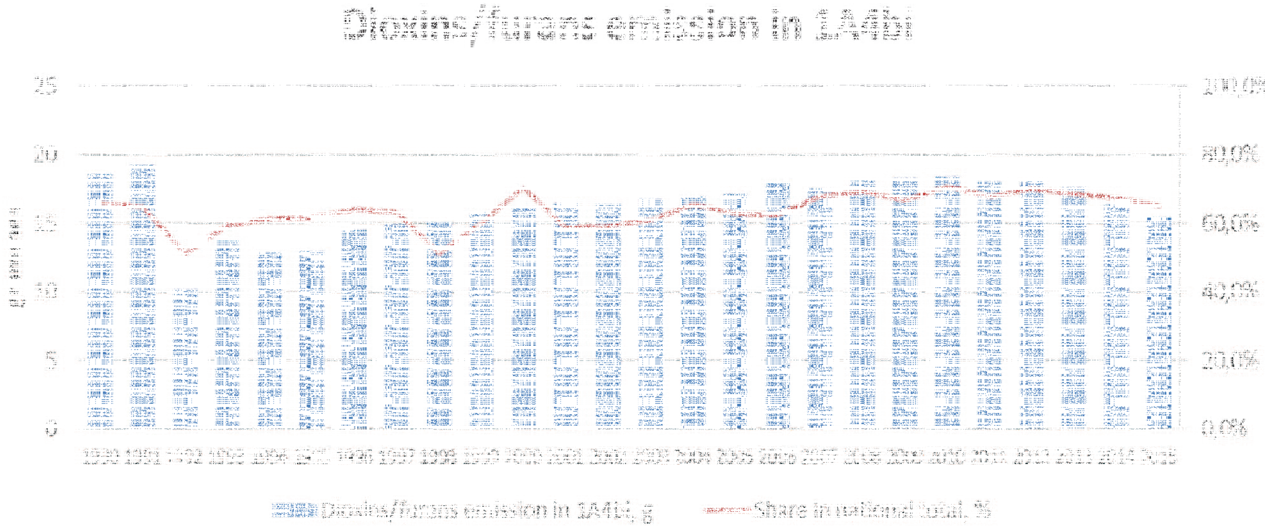


Figure 3.7.1-6 DIOX/furans emission in 1.A.4.bi

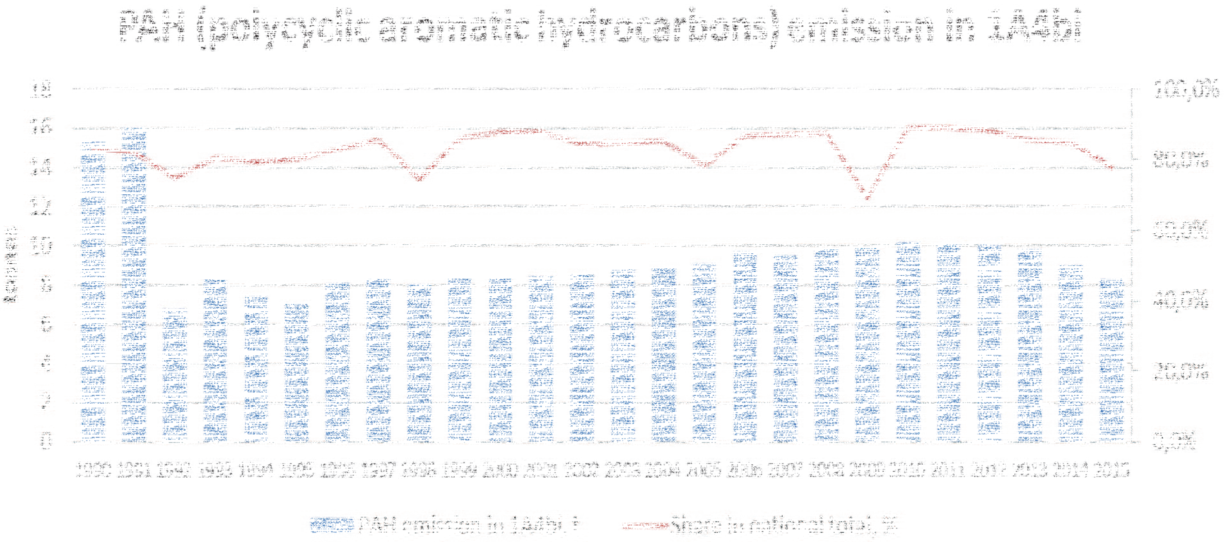


Figure 3.7.1-7 PAH emission in 1.A.4.bi

3.7.2. Methodological issues

Residential: Stationary combustion (NFR 1.A.4.b.i)

The source of emission factors was 2013 EMEP/ EEA guidebook, chapter “1.A.4 Small combustion”, paragraphs *3.2.2.1 Residential combustion (1.A.4.b)(Tier 1 EFs)* and *3.3.2.1 Residential heating technologies (1.A.4.b) (Tier 2 EFs)*
Emissions from wood were calculated using tier 2 emission factors. Information on the combustion of wood in specific residential plants was taken from IIASA GAINS model.

Table 3.7.2-1 Distribution of fuelwood combustion devices by type in Lithuania's residential sector

Type of combustion device / Years	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Fireplaces	6,94	7,69	8,47	7	7	6	5	4	4	4	4
Single house boilers (<50 kW) - automatic	0	0	0	2	3	4	6	8	10	10	10
Single house boilers (<50 kW) - manual	37,5	38,46	40,68	41	40	38	35	30	25	25	25
Heating stoves	55,56	53,85	50,85	50	50	52	54	58	61	61	61
Source: IIASA											

Emissions from LPG were calculated using tier 2 emission factors from Table 3-13 for Natural gas combustion in cooking. This was done on the basis of results of households survey performed by Statistics Lithuania (*more than 90 per cent of LPG is used food preparation*)
Emissions from other fuels were estimated using tier 1 emission factors.
Activity data was gathered from the fuel balance compiled by the Statistics Lithuania.

Table 3.7.2-2. Tier 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**	**Reference**

			interval		
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 3.7.2-3 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 3.7.2-4Tier 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 3.7.2-5Tier 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) PM10 estimated as 95 % of TSP, PM2.5 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 3.7.2-6Tier 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 3.7.2-7Tier 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 3.7.2-8Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using liquid fuel

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 3.7.2-9. Tier 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.

3.7.3. 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%	

3.7.4. Source-specific planned improvements

No source-specific improvements have been planned.

3.8. 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).

3.9. Fugitive emissions from fuels (1.B)

3.9.1. 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 Latvia (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.

3.9.2. Exploration, Production and Transport of Oil (1.B.2.a.i)

Activity data of crude oil consumption (*Production + Import – Export)* was gathered from Lithuanian Statistics Department (LTSTD) for the period 1990 – 2015. Taking into account that there is only onshore oil-refining company and mainly onshore oil-distributing pipelines, tire 2 default emission factor has been used, equal to 0.1 kg NMVOC per Mg of oil. Emissions have been determined using the following equation:

Equation 3.2 $E_{Pollutant} = EF_{Pollutant} \times Activity\ Data_{Consumption} \times Conversion\ Factor;$

where $Activity\ Data_{Consumption}$ is consumption (Mg) of crude oil per year; *Conversion Factor is equal to* 10^{-6} *necessary to convert units to Gg.*

3.9.3. Exploration, Production and Transport of Natural Gas (1.B.2.b)

Information on the natural gas consumption was collected from LTSTD and NMVOC emissions have been determined using equation Equation 3.2. Emission factor for onshore natural gas-related activities (tier 2) has been used.

3.9.4. Fugitive Emissions from Oil Refining (1.B.2.a.iv)

Due to the fact that there is only one crude oil refining company in Lithuania (ORLEN Lietuva), calculation of NMVOC emissions for this category have been based on company's "Air Pollution Annual Report", which is available on AIVIKS database [1]. In the company's report VOC emissions are included. The NMVOC numbers have been obtained assuming that 10% of VOC is methane, while 90% - NMVOC [2]. Other substances (i.e. methanol, benzene, toluene, xylene, etc.) which were reported separately, have been included into the total NMVOC emission.

3.9.5. Fugitive Emissions from Distribution of Oil Products (1.B.2.a.v)

Gasoline consumption data was gathered from LTSTD and tire 1 approach has been used with EF value equal to 2 kg of NMVOC per Mg of oil (various types gasoline: used in aviation, distillate oil, gas oil, fuel oil, etc.). 3.5.4.1 equation has been used to find emissions.

3.9.6. Fugitive Emissions from Venting and Flaring (1.B.2.c)

Emissions from venting and flaring are included into 1B2ai, 1B2aiv and 1B2b categories.

3.9.7. Fugitive Emissions from Energy Production (1.B.2.d)

Emission from the extraction of geothermal energy (in MWh) has been obtained using tire 1 approach, Equation 3.5.4.1 equation and default emission factors. Energy production statistics were provided by LTSTD, see Figure 3.5.6.

3.10. Time Series and Key Categories

3.10.1. Exploration, Production and Transport of Oil (1.B.2.a.i)

Table 3.10.1-1 Exploration, Production and Transport of Oil

	1990	*1995*	*2000*	*2005*	*2010*	*2012*	*2013*	*2014*
Extraction, Gg	12000	128000	316300	216200	114700	102300	83200	82200
NMVOC emissions, Gg	**0.954**	**0.314**	**0.466**	**0.920**	**0.899**	**0.901**	**0.750**	**0.008**

3.10.2. Exploration, Production and Transport of Natural Gas (1.B.2.b)

Table 3.10.2-1 Natural gas consumption (mln. m3) and corresponding NMVOC emissions, Gg.

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*
Total Consumption, mln. m^3	5810	2519	2580	3096	3115	2706	2581
Total NMVOC Emissions, Gg	**0.581**	**0.252**	**0.258**	**0.310**	**0.312**	**0.271**	**0.258**

3.10.3. Fugitive Emissions from Oil Refining (1.B.2.a.iv)

Table 3.10.3-1 ORLEN Lietuva total NMVOC emissions (Gg).

Year	*1991*	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
NMVOC emission, Gg	**29.86**	**21.31**	**5.14**	**9.16**	**8.84**	**9.23**	**8.25**	**8.62**

3.10.4. Fugitive Emissions from Distribution of Oil Products (1.B.2.a.v)

Table 3.10.4-1 Total consumption of gasoline and oil products, and total NMVOC emissions from distribution (Gg).

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*
Total Consumption, Gg	6216	2755	1671	1882	1879	1789	1918
Total NMVOC Emissions, Gg	**12.43**	**5.51**	**3.34**	**3.76**	**3.76**	**3.58**	**3.84**

3.10.5. Fugitive Emissions from Energy Production (1.B.2.d)

Table 3.10.5-1 NH_3, Hg and As emissions (Gg) from geothermal energy production

	2002	2005	2010	2011	2012	2013	2014
Production, GWh	55,1	16,9	26,4	18,7	21,9	9,7	10,8
Emissions, Gg							
NH_3	0,116	0,035	0,055	0,039	0,046	0,020	0,023
Hg	2,4E-05	7,4E-06	1,2E-05	8,2E-06	9,6E-06	4,3E-06	4,8E-06
As	1,4E-06	4,2E-07	6,6E-07	4,7E-07	5,5E-07	2,4E-07	2,7E-07

References:

[1] ORLEN Lietuva "Annual Air Pollution Report", available on http://aplinka.lt, last accessed on 07/06/2016;
[2] Hjerrild & Rasmussen, 2014: Fugitive VOC from refineries, taken from Danish Inventory Report.

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. Cement production (2.A.1)

4.3.1. 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.

4.3.2. 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 4.3-1 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)

4.3.3. Uncertainty

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

4.4. Lime production (2.A.2)

4.4.1. 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.

Data on lime (both hydrated ($Ca(OH)_2$) and anhydrous (CaO)) production for years after 2004 is available on the Lithuanian Statistics database [1], while production information of lime for years before 2005 was provided by Lithuania Statistics. There is no information available on the amounts of anhydrous lime manufactured before 2002, thus it was assumed that none had been produced.
Lime is also produced and then used in sugar industry, necessary for sugar purification. Sugar companies were inquired to provide information on the amounts of lime manufactured as this sub-category is not covered in Lithuania Statistics database.
Lime production amounts (Gg) in the sugar and other than sugar industries for 1990-2015 period.

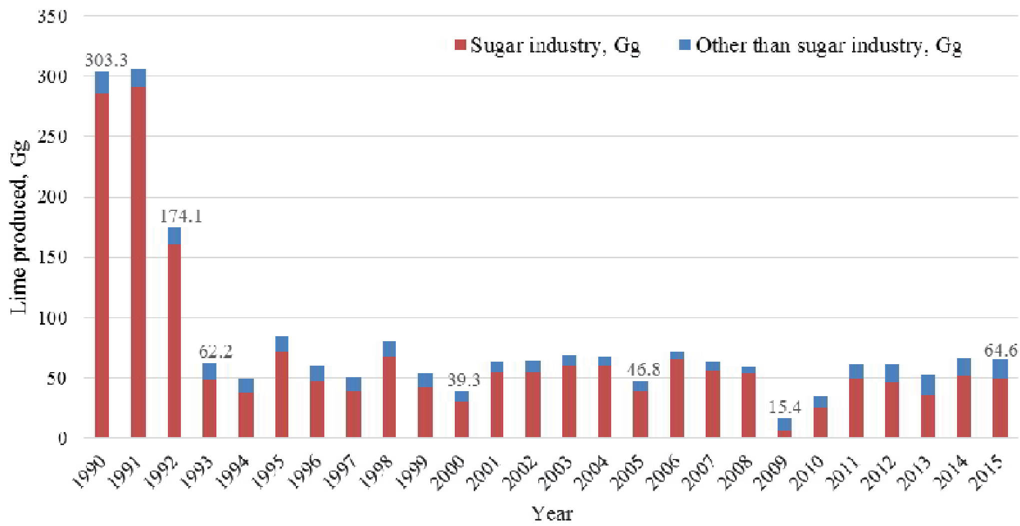


Figure 4.4-1 Sugar and other industry production 1990-2015

Lime production decreased by 78.7% from 1990 to 2015, while increased by 38.0% from 2005 to 2015.

4.4.2. 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)
-

Table 4.4-1 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)

Table 4.4-2 Emissions from industrial process

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
	Emissions, Gg							
Lime produced, Gg	303.3	84.1	39.3	46.8	34.6	52.0	66.6	64.6
TSP	2.730	0.757	0.354	0.421	0.311	0.468	0.599	0.582
PM_{10}	1.062	0.294	0.138	0.164	0.121	0.182	0.233	0.226
$PM_{2.5}$	0.212	0.059	0.028	0.033	0.024	0.036	0.047	0.045
BC	0.0010	0.0003	0.0001	0.0002	0.0001	0.0002	0.0002	0.0002

4.5. Glass production (2.A.3)

Total glass production quantities are shown in the figure below.

Figure 4.5-1 Glass production for the 1990-2015 period, Gg

4.5.1. Methodology

Table 4.5-1 Estimated pollutant emissions (Gg) from glass production

	1990	1995	2000	2005	2010	2013	2014	2015
Emissions, Gg								
TSP	0.035	0.042	0.045	0.035	0.019	0.031	0.033	0.029
PM_{10}	0.032	0.038	0.041	0.032	0.018	0.028	0.029	0.026
$PM_{2.5}$	0.028	0.034	0.036	0.028	0.016	0.025	0.026	0.023
BC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Emissions, Mg								
Pb	0.199	0.240	0.256	0.201	0.110	0.177	0.185	0.164
Cd	0.015	0.018	0.020	0.015	0.008	0.014	0.014	0.013
Hg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
As	0.022	0.027	0.029	0.022	0.012	0.020	0.021	0.018
Cr	0.027	0.033	0.035	0.027	0.015	0.024	0.025	0.022
Cu	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001
Ni	0.057	0.069	0.074	0.058	0.032	0.051	0.053	0.047
Se	0.093	0.113	0.120	0.095	0.052	0.083	0.087	0.077
Zn	0.043	0.052	0.056	0.044	0.024	0.039	0.040	0.036

From the Table 4.5-1 it is seen that 1990/2015 emissions decreased by 17.4%, while 2005/2015 emissions dropped by 18.4%. Pollutants emissions from this category contribute only a small part to the total inventory.

4.6. Quarrying and Mining of Minerals Other than Coal (2.A.5.a);

4.6.1. Overview of the Section

Activity data for this category was gathered from Lithuania Statistics database. Information of the following commodities was obtained:

- Silica sand;
- Construction sand;
- Gravel pebbles, shingle and silica;
- Crushed dolomite;
- Crushed granite;
- Extraction of peat.

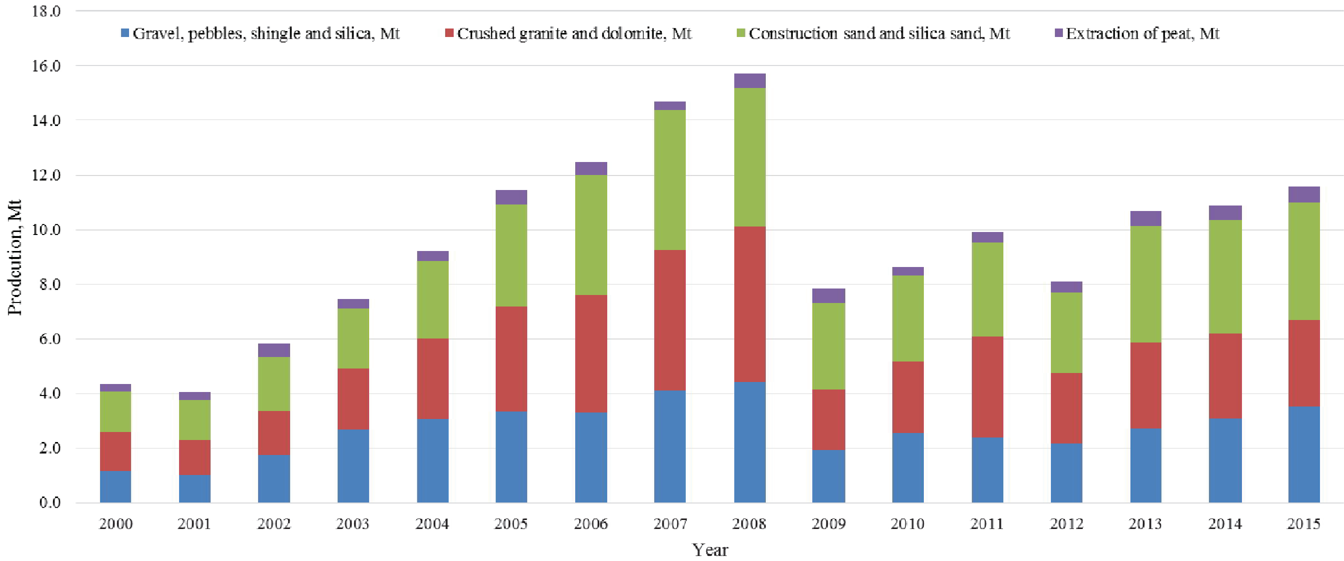


Figure 4.6-1 Activity data for the 2000-2015 period, Mt

Default tier 1 approach was applied using emission factors from 2016 EMEP/EEA Guidebook. Table 4.4: activity data (minerals mined, Tg) and estimated pollutant emissions (Gg).

	2000	***2005***	***2010***	***2012***	***2013***	***2014***	***2015***
Activity Data, Tg	4.3	11.4	8.6	8.1	10.7	10.9	11.6
Emissions, Gg							
TSP	0.44	1.17	0.88	0.83	1.09	1.11	1.18
PM_{10}	0.22	0.57	0.43	0.41	0.53	0.54	0.58
$PM_{2.5}$	0.02	0.06	0.04	0.04	0.05	0.05	0.06

2005/2015 emissions increased by 167% due to increased amount of mined minerals.

4.7. Construction and Demolition (2.A.5.b);

4.7.1. Overview of the Section

Data on the construction of residential and non-residential buildings is available on Lithuanian Statistics database. Area of buildings which were demolished is not available and it can be omitted due to relatively negligible pollution compared with that from construction activities.

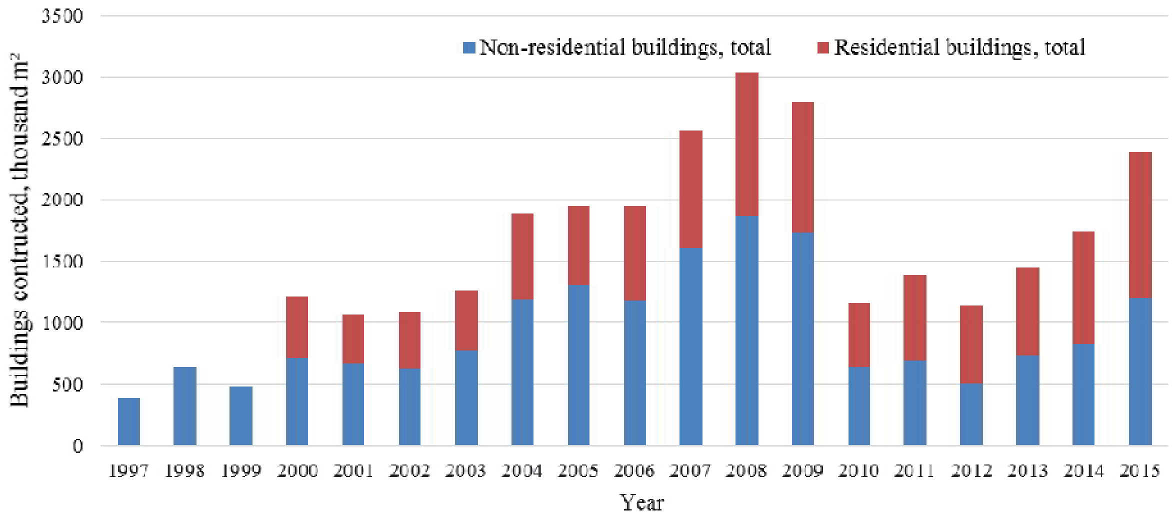


Figure 4.7-1 Area of residential and non-residential buildings constructed, thousang m².

Area of residential buildings constructed increased by 81.0% from 2005 to 2015, while non-residential decreased by 7.4%.

4.7.2. Methodology

Default emission factors from 2016 EMEP/EEA Guidebook with eq. 4.1. were used.

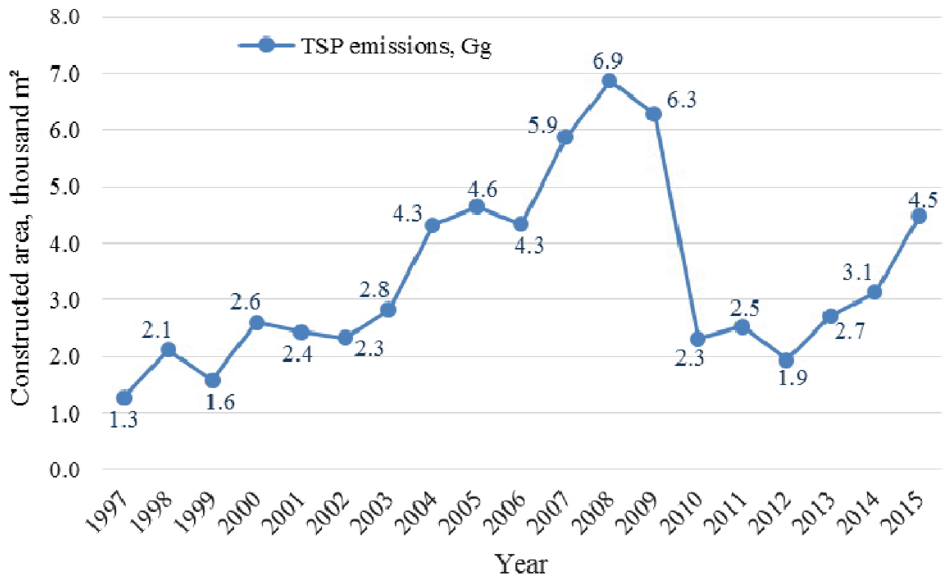


Figure 4.7-2 Activity data (residential and non-residential buildings constructed, thous. square meters) and estimated pollutant emissions (Gg).

TSP, PM_{10} and $PM_{2.5}$ emissions decreased by 3.3% from 2005 to 2015. See figure above for TSP emissions. PM emissions exhibit identical trends.

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

No emissions were calculated.

4.9. ther mineral products (2.A.6)

No emissions were calculated

4.10. Chemical Industry (2.B)

4.11. Ammonia production (2.B.1)

4.11.1. 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.).

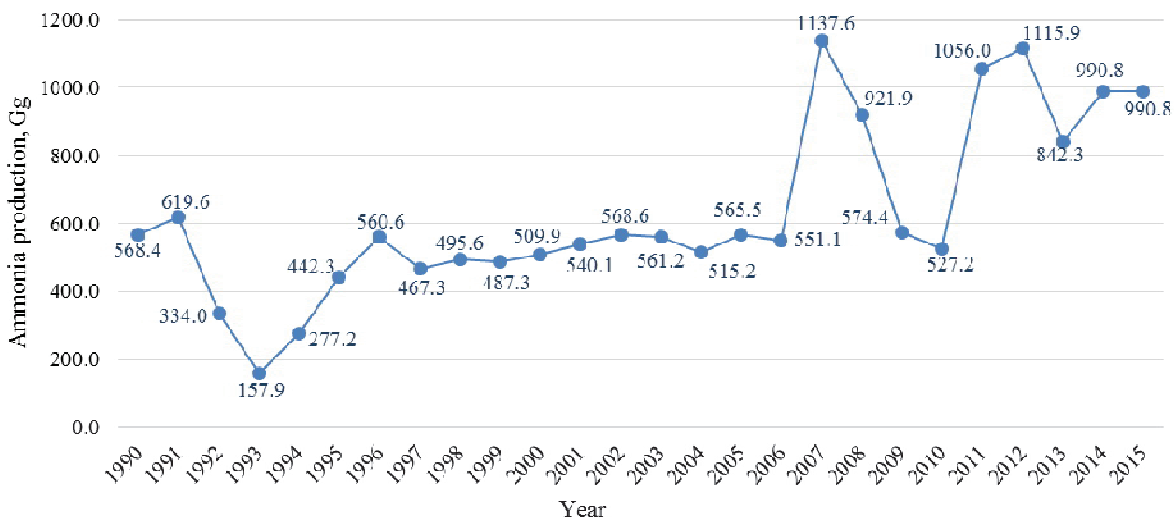


Figure 4.11-1 Ammonia production quantities (Gg) from 1990 to 2015

4.11.2. Methodology

NO_x, CO, NH_3 and SO_x emissions for 2006-2015 period were collected from CLRTAP reports provided by the company, while previous years' emissions were included elsewhere (under NFR 2B10a category) as emissions were not separated by different processes.

4.11.3. Time Series

2006/2015 NO_x emissions increased by 118.6%, while CO emissions dropped by 32.7%, please see figure below. NO_x and CO emissions (Gg) reported by AB Achema from ammonia production, 2006-2015.

4.12. 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).

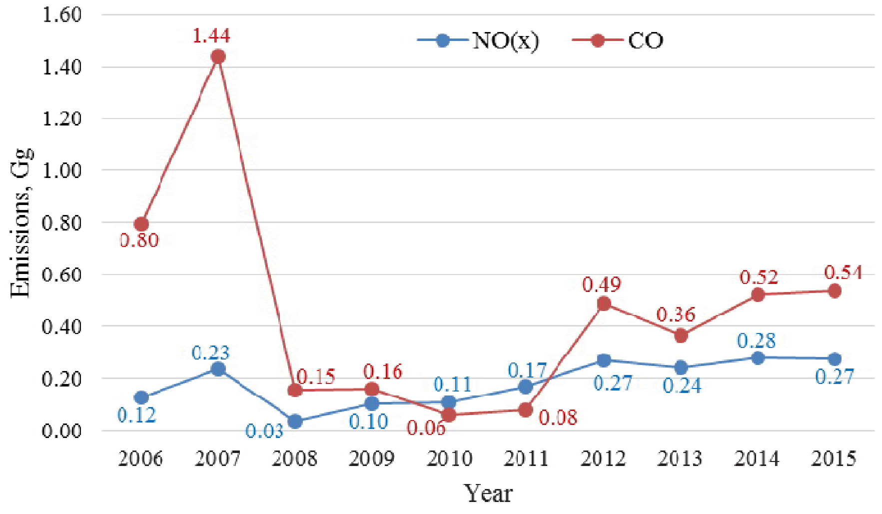


Figure 4.12-1 NOx and CO emissions

Gaseous emissions from GP are cleaned from NOx in the reactor using a DeNOx technology.

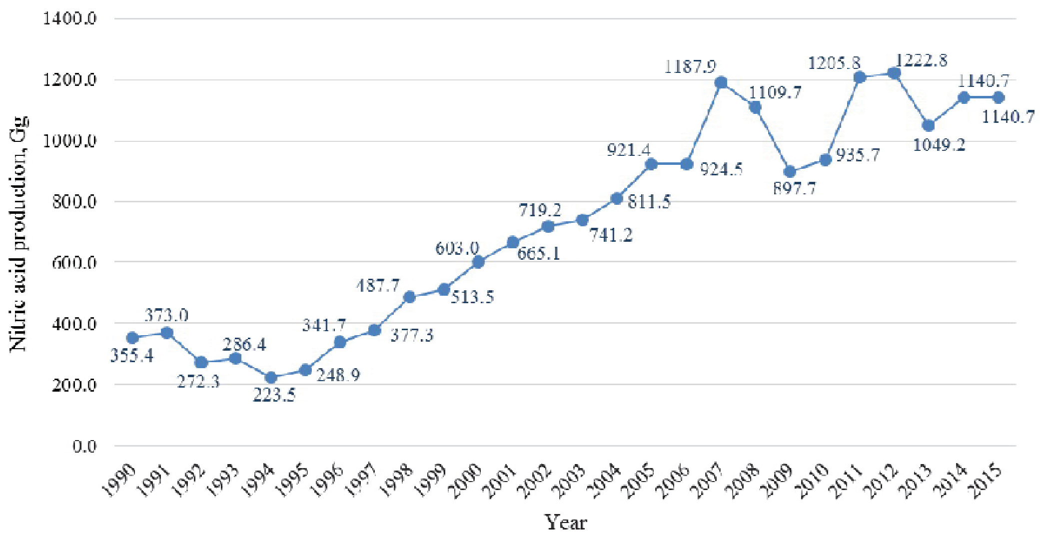


Figure 4.12-2 Nitric acid production in Gg for the 1990-2015 period

4.13.1. Methodology

2006-2015 CO, NO_x and NH_3 emissions were taken from CLRTAP reports submitted by AB Achema. 1990-2005 emissions were included under 2B10a category *Other chemical industry* as no information on the emissions from nitric acid production was available.

4.13.2. Time Series

2006/2015 NO_x emissions increased by 84.2%, while CO emissions dropped by 87.9%. See figure below.

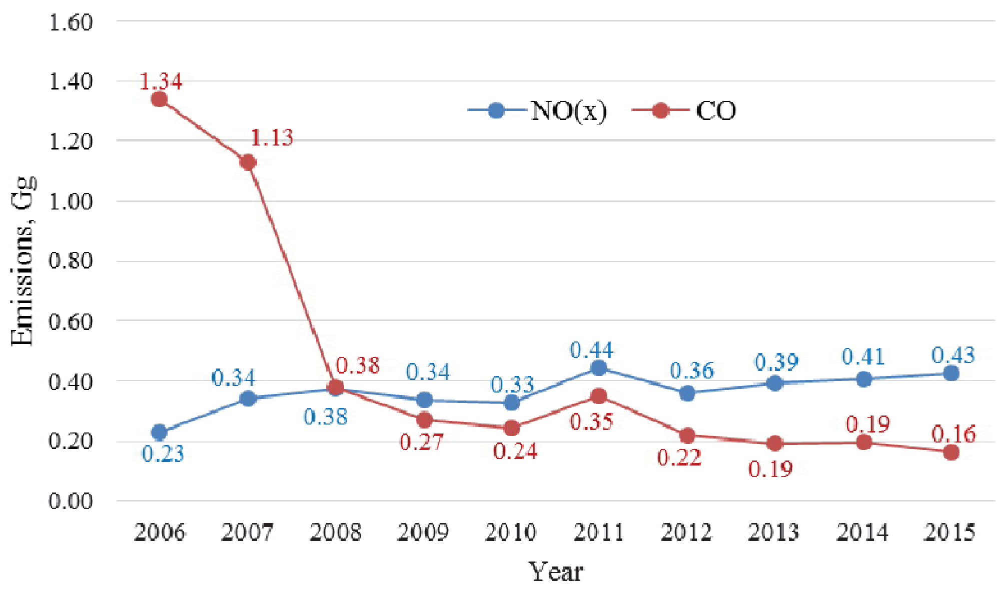


Figure 0-1 NOx and CO emissions (Gg) from nitric acid production

4.13. Chemical industry: other (NFR 2.B.10.a)

4.13.1. Overview of the Sector

This category includes emissions from the production of other chemical species in two major companies AB Achema and AB Lifosa. Processes which fall under this category are:

- Sulfuric acid production *SNAP 040401* (AB Lifosa);
- Ammonium nitrate production, *SNAP 040405* (AB Achema);
- Urea production, *SNAP 040408* (AB Achema);
- Phosphate fertilizers production, *SNAP 040414* (AB Lifosa);
- Other chemical species production, including production of CAN, *SNAP 040416* (both AB Lifosa and AB Achema).

4.13.2. Methodology

2006-2015 emissions from the processes mentioned above were taken from AB Achema and AB Lifosa CLRTAP reports. For years 1990-2006 no details on the emissions according to different production sources were available, thus all production-related emissions were reported under NFR 2B10a category. NFR 2B1 and 2B2 categories were labelled as 'IE' for the 1990-2006 period.

14.13.3. Time Series

1990/2015 emissions show down trend, which is mainly due to the fact that emissions from NFR 2B1 and 2B2 categories are included under this category for 1990-2006 years. Please see figure in the beginning of the sector for overall pollutants emissions trends for the 19902015 period.

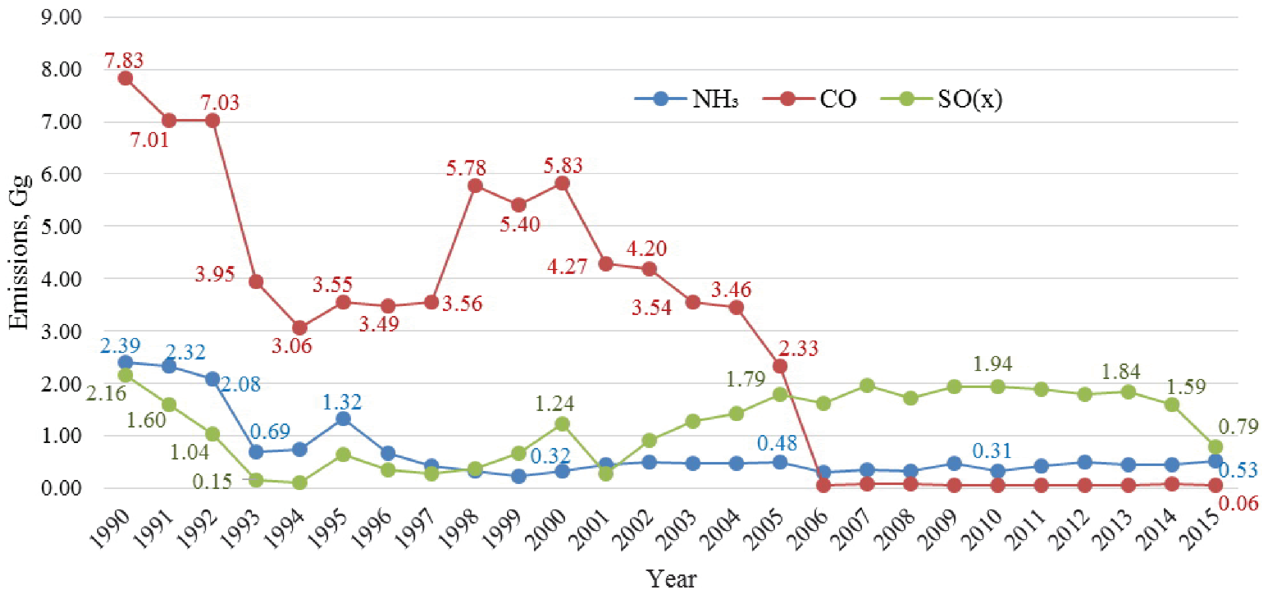


Figure 4.13-1 NH3, CO and SOx emissions for the 1990-2015 period

4.14. Metal production (2.C)

4.14.1. Iron and Steel Production (NFR 2.C.1)

4.14.1.1. Overview of the Sector

Three companies were producing cast iron before 2009. After the closure of one factory the other two have been operating in the sector. One of the facilities has been producing cast iron in the blast furnace, while the other has been manufacturing cast iron in the induction furnace since 2011.

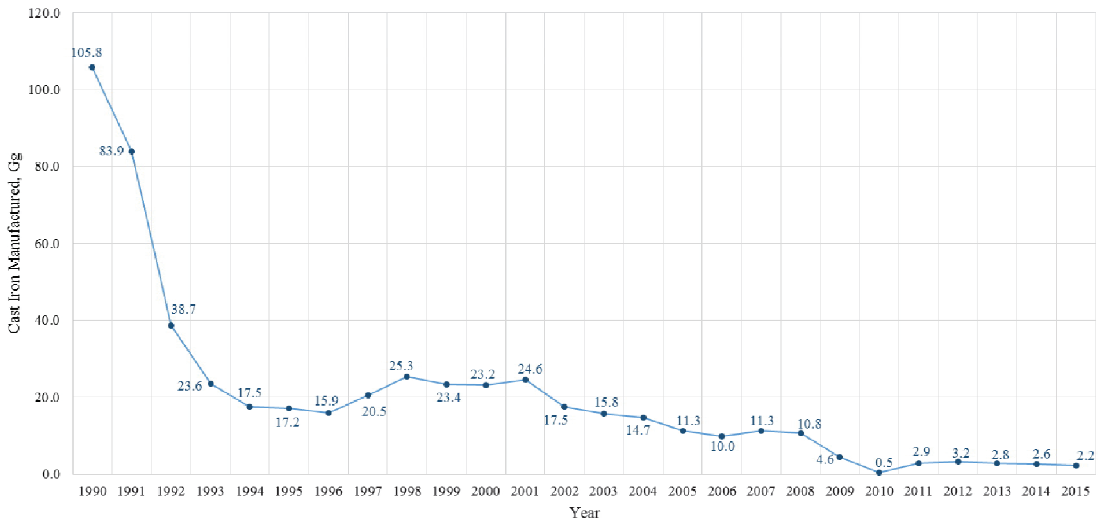


Figure 4.14.1-1 Cast iron production in the Republic of Lithuania from 1990 to 2015.

4.14.1.2. Methodology

The 2016 EMEP/ EEA guidebook tier 1 emission factors were used to estimate pollutants emissions from the category. Activity data was gathered from Statistics Lithuania. Three types of commodities produced were included into the estimation of emissions:

- Grey iron castings for machinery and mechanical appliances excluding for piston engines (PRODCOM 2451135000);
- Grey iron castings for locomotives/rolling stock/parts, use other than in land vehicles, bearing housings, plain shaft, bearings, piston engines, gearing, pulleys, clutches, machinery (PRODCOM 2451139000);
- Parts for other utilization (malleable iron casting) (PRODCOM 2451119000).

4.14.1.3. Time Series

1990/2015 emissions decreased by 97.9%, while 2005/2015 emissions dropped by 80.2%. Please see precise emissions in table below.

Table 4.14.1-1 Pollutants emissions from the category for the 1990-2015 period.

	1990	1995	2000	2005	2010	2013	2014	2015
				Gg				
NMVOC	0.016	0.003	0.003	0.002	0.000	0.000	0.000	0.000
TSP	0.032	0.005	0.007	0.003	0.000	0.001	0.001	0.001
PM_{10}	0.019	0.003	0.004	0.002	0.000	0.001	0.000	0.000
$PM_{2.5}$	0.015	0.002	0.003	0.002	0.000	0.000	0.000	0.000
BC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				Mg				
Pb	0.487	0.079	0.107	0.052	0.002	0.013	0.012	0.010
Cd	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hg	0.011	0.002	0.002	0.001	0.000	0.000	0.000	0.000
As	0.042	0.007	0.009	0.005	0.000	0.001	0.001	0.001
Cr	0.476	0.077	0.104	0.051	0.002	0.013	0.012	0.010
Cu	0.007	0.001	0.002	0.001	0.000	0.000	0.000	0.000
Ni	0.015	0.002	0.003	0.002	0.000	0.000	0.000	0.000
Se	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Zn	0.423	0.069	0.093	0.045	0.002	0.011	0.010	0.009
PAHs	0.051	0.008	0.011	0.005	0.000	0.001	0.001	0.001
				kg				
PCB	0.265	0.043	0.058	0.028	0.001	0.007	0.007	0.006
HCB	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000
				g				
PCDD/F	0.317	0.052	0.070	0.034	0.001	0.009	0.008	0.007

4.15. 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).

- 4.15.1. Domestic solvent use including fungicides (2.D.3.a)
- 4.15.2. Road paving with asphalt (2.D.3.b)
- 4.15.3. Asphalt roofing (2.D.3.c)
- 4.15.4. Coating applications (2.D.3.d)
- 4.15.5. Degreasing (2.D.3.e)
- 4.15.6. Dry cleaning (2.D.3.f)
- 4.15.7. Chemical products (2.D.3.g)
- 4.15.8. Printing (2.D.3.h)
- 4.15.9. Other solvent and product use (2.D.3.i, 2.G)

4.15.1.1-9. Source category description

NMVOCs are used in a large number of products Products for the maintenance or improvement

sold for use by the public. These can be divided into a number of categories:	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 2014. 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%).

4.15.1.11. 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 (Figures 4.13 1-4.13 2).

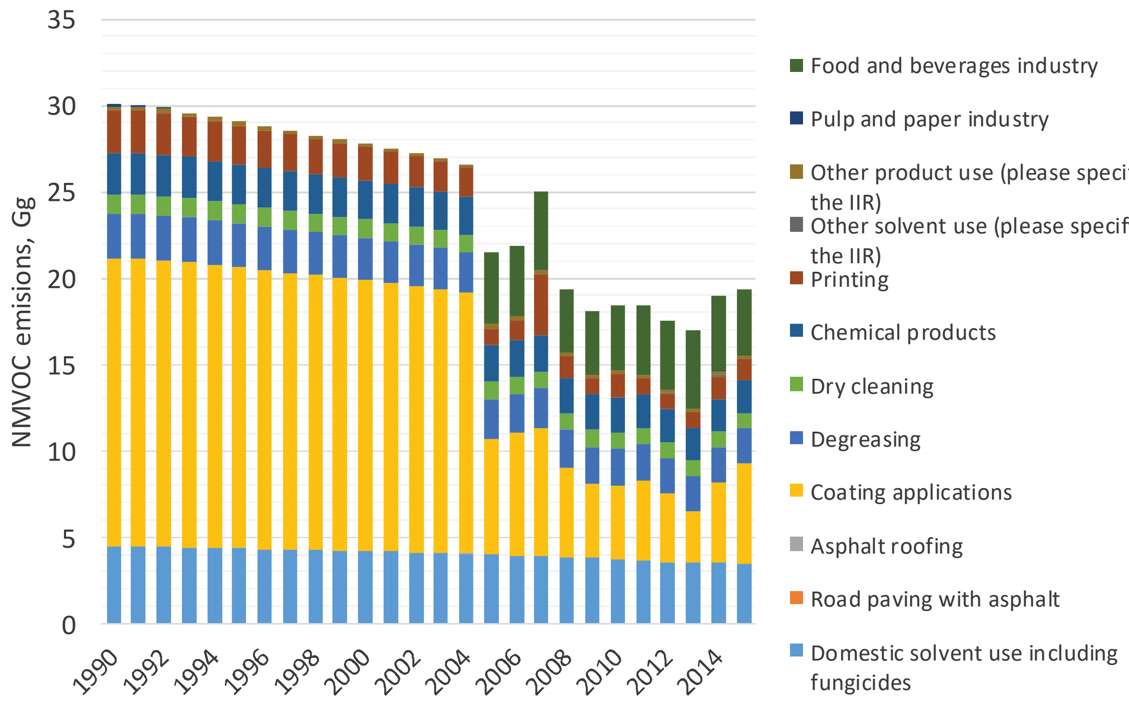


Figure 4.13 0-1 NMVOC emissions 1990-2015

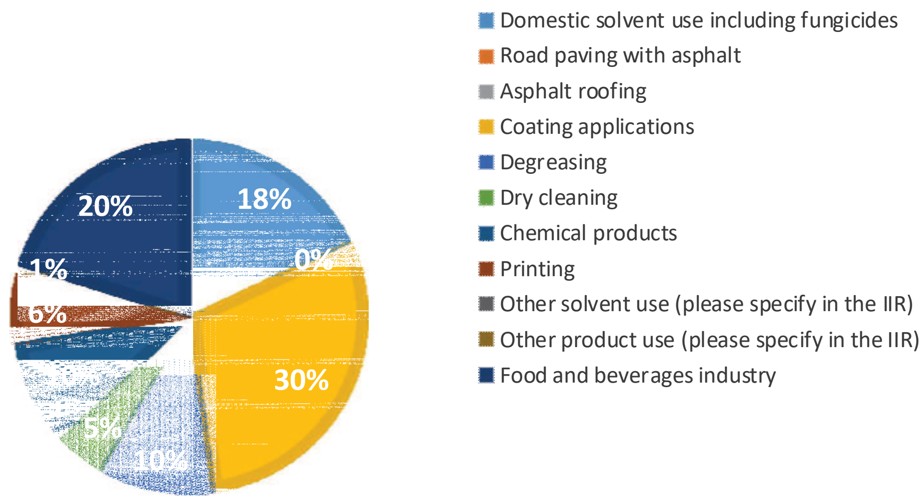


Figure 4.13 2. Distribution of NMVOC emissions in other solvent and product use sector for 2015 (Gg).

Emission from solvent and other product use were estimated according to number of population and NMVOC emission factor in [g/inhabitant] units during 1990-2015 given in Statistics Lithuania (2016). Derived and used in estimation NMVOC emission factors are listed in Table 0-1 and Table 0-2. Emissions from Coating application were calculated for 2005-2015 Tier 2 method using activity data of production.

Table 0-1 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)	1200	g/person	100	900	N=5 (Norwegian IIR, 2012; Swiss IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
Car care products					
NMVOC (all)	464	g/person	20	900	N=4 (Norwegian IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
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)
DIY/buildings					
NMVOC (all)	522	g/person	220	820	N=2 (Norwegian IIR, 2012; Greece, 1996-2006)
Pharmaceutical products					
NMVOC (all)	48	g/person	16	100	FOEN (2012), ISPRA (2012)

Table 0-2 Solvent and other product use NMVOC 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.a Household (cleaning) products	1.2
2.D.3.f Dry cleaning	0.3
2.D.3.e Metal degreasing	0.7
2.D.3.g Chemical products	0.65
2.D.3.c Asphalt roofing	0.130

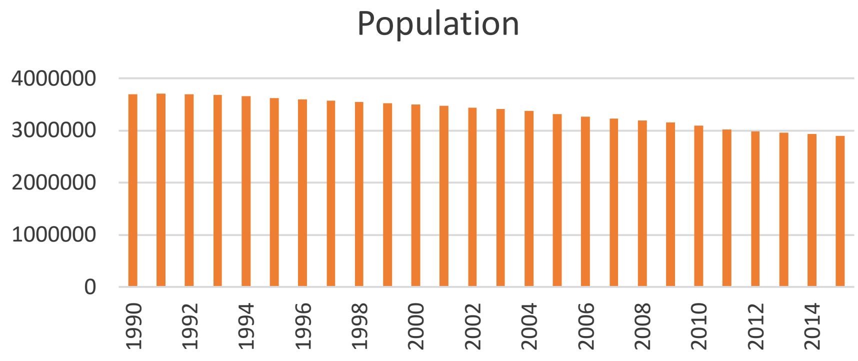


Figure 0-2. Population and population density, [inhabitant]

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

4.16.1. Overview of the Sector

2005-2015 emissions from *Printing* category were estimated based on the production and trade amounts of black and other than black printing paint. Emissions for the period 1990-2005 were obtained by extrapolating paint consumption figures for the 2005-2015 period. There is a decreasing trend observed for the period 2005-2015, please see figure below.

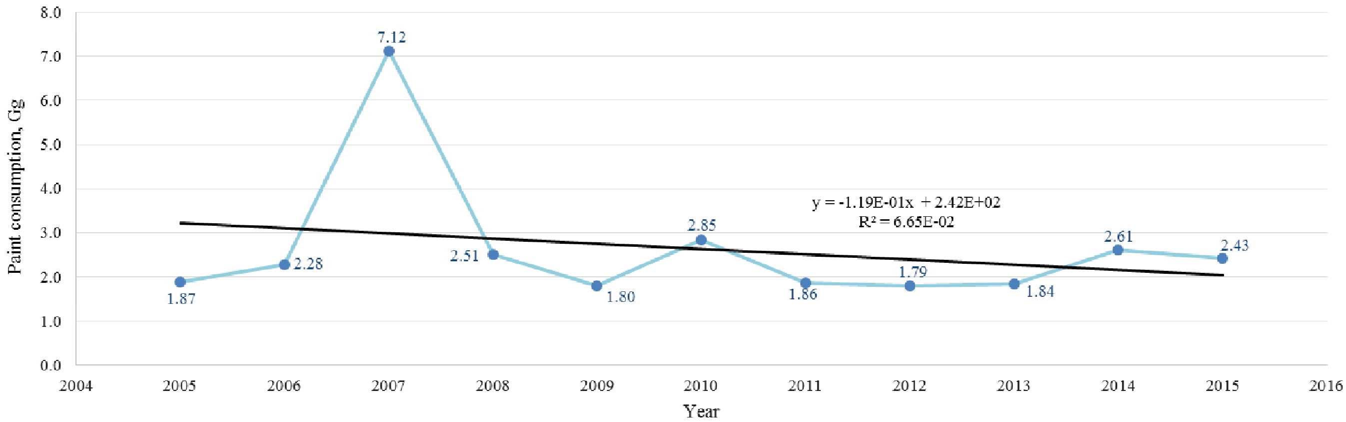


Figure 4.16.1-1 Estimated paint consumption for 2005-2015 and the fitted trend line.

4.16.2. Methodology

Raw data on production, import and export for years 2005 – 2015 was obtained from the Lithuania Statistics database. From this data set $AR_{Consumption}$ was estimated:
Equation……: $AR_{Consumption}$ = *Production – Export + Import*, expressed in kilograms.
Tier 1 EF equal to 500 grams of NMVOC per kilogram of paint from 2016 EMEP/ EEA guidebook was applied.

The activity data was used in the following equation to estimate NMVOC emissions for years 2005 – 2015:
Equation 4.6: $E_{NMVOC} = AR_{Production} \times EF_{Average} \times \text{Conversion Factor}$,

The 1990 – 2005 emission were estimated using extrapolation of obtained 2005-2015 data points. The equation used is shown in the figure above.

Figure below shows NMVOC emissions from the *Printing* category. Estimated 2005-2015 NMVOC emissions form a declining trend, which was the basis for the 1990-2015 emissions estimation. On the other hand, the 2005/2015 emissions increased by 29.6%. Please see figure below.

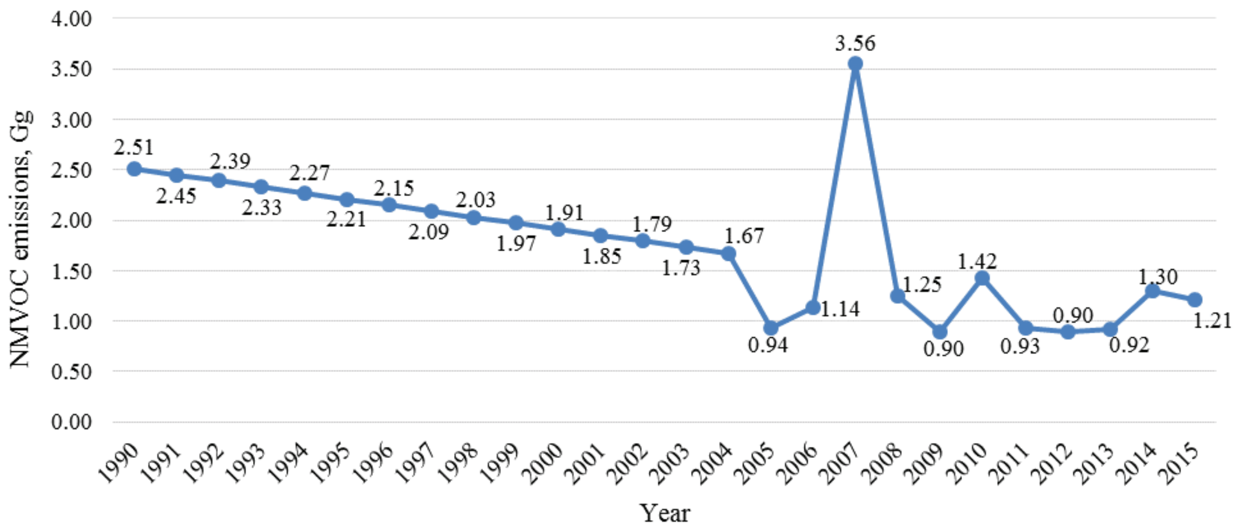
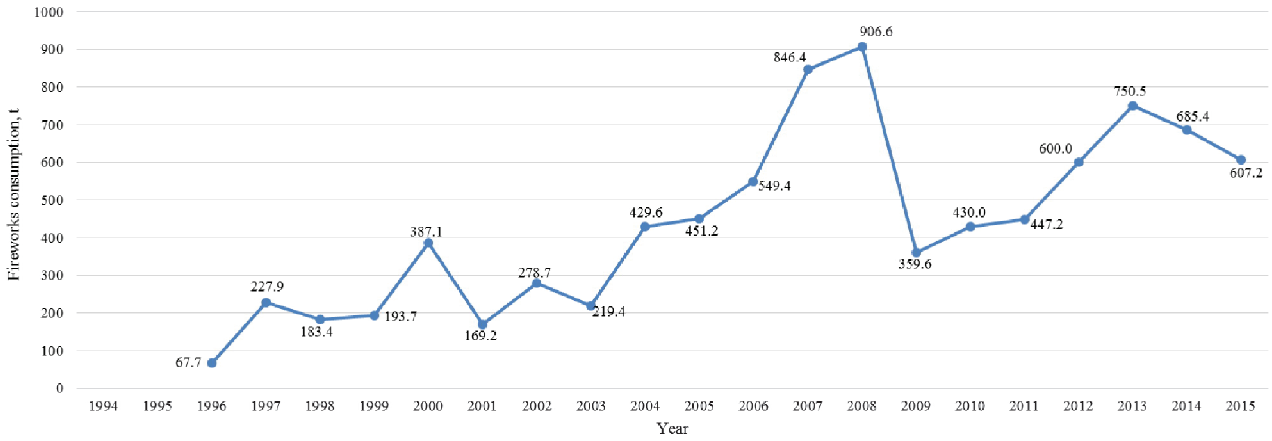


Figure 4.16.2-1 Estimated NMVOC emissions (Gg) from *Printing* category for 1990-2015 period

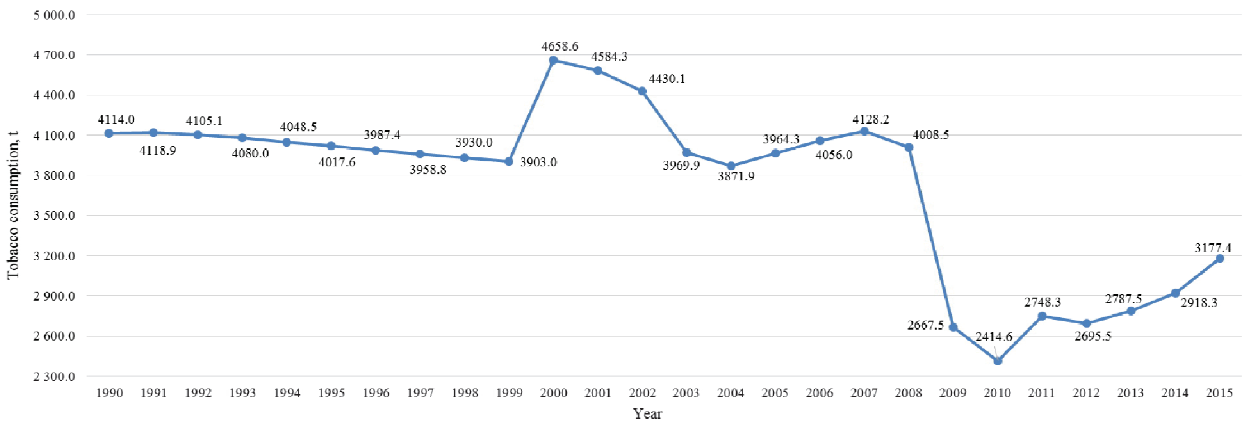
4.16.3. Overview of the Sector

NFR 2G Other Product Use category has been estimated and included into the inventory for the first time. Emissions from *Use of fireworks (SNAP 060601), Tobacco combustion (SNAP 060602)* and *Use of shoes (SNAP 060603)*. This category is a minor contributor to the national inventory. Please see figures below for activity data from different categories.

Firework use (t) trend in Lithuania for 1990-2015. Information obtained from Statistics Lithuania and Comext Eurostat.



Tobacco consumption (t) in Lithuania for 1990-2015. Information taken from Statistics Lithuania.



4.16.4. Methodology

Information on cigarette consumption (cigarettes per inhabitant per year) from 2000 to 2015 is available from Statistics Lithuania database. Averaged 2000 – 2015 (i.e. 1112.07 cigarettes/ inhabitant/ year) value was used to estimate tobacco consumption for years before 2000. See figures for estimated tobacco consumption for 1990-2015. Emissions from tobacco consumption were estimated using emission factors from 2016 EMEP/EEA guidebook.

Statistical data on *Use of fireworks (SNAP 060601)* was based on import and export of fireworks (*CN 36041000*) and signal flares, fog signals and other firework related (*CN 36049000*) goods. In order to obtain consumption in the country, exported quantity was subtracted from imported amount. Statistics for 1999 – 2015 were gathered from EUROSTAT reference database for

external trade COMEXT. Information was compared with 1996 – 2015 data obtained from Statistics Lithuania. Statistical data for 1999 – 2015 years was found to be identical.
No information on 1990 – 1995 was available, thus emissions were not estimated for that period. Please see figure 4.6.12 for firework consumption trend in Lithuania for 1990 – 2015. Emissions from firework use were estimated using emission factors from 2016 EMEP/EEA guidebook.
Use of shoes (SNAP 060603) category was estimated based on assumption that one inhabitant uses one pair of shoes per year. 2016 EMEP/EEA Guidebook emission factors were applied.

Table 4.16.4-2 pollutants emissions from tobacco smoking category for 1990-2015

Pollutants	*1996*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Emissions, Gg							
SO(x)	2.05E-04	1.17E-03	1.36E-03	1.30E-03	2.27E-03	2.07E-03	1.83E-03
CO	4.84E-04	2.77E-03	3.23E-03	3.07E-03	5.37E-03	4.90E-03	4.34E-03
NO(x)	1.76E-05	1.01E-04	1.17E-04	1.12E-04	1.95E-04	1.78E-04	1.58E-04
TSP	7.44E-03	4.25E-02	4.96E-02	4.72E-02	8.24E-02	7.53E-02	6.67E-02
PM_{10}	6.77E-03	3.87E-02	4.51E-02	4.30E-02	7.50E-02	6.85E-02	6.07E-02
$PM_{2.5}$	3.52E-03	2.01E-02	2.34E-02	2.23E-02	3.90E-02	3.56E-02	3.15E-02
Emissions, Mg							
As	9.01E-05	5.15E-04	5.71E-04	5.72E-04	9.98E-04	9.12E-04	8.08E-04
Cd	1.00E-04	5.73E-04	6.36E-04	6.36E-04	1.11E-03	1.01E-03	8.99E-04
Cr	1.06E-03	6.04E-03	6.70E-03	6.71E-03	1.17E-02	1.07E-02	9.47E-03
Cu	3.01E-02	1.72E-01	1.91E-01	1.91E-01	3.33E-01	3.04E-01	2.70E-01
Hg	3.86E-06	2.21E-05	2.45E-05	2.45E-05	4.28E-05	3.91E-05	3.46E-05
Ni	2.03E-03	1.16E-02	1.29E-02	1.29E-02	2.25E-02	2.06E-02	1.82E-02
Pb	5.31E-02	3.03E-01	3.37E-01	3.37E-01	5.88E-01	5.37E-01	4.76E-01
Zn	1.76E-02	1.01E-01	1.12E-01	1.12E-01	1.95E-01	1.78E-01	1.58E-01

Emissions from the use of fireworks (*SNAP 060601*) increased by 797% from 1996 to 2015, while decreased by 29.3% from 2005 to 2015.

Pollutants	*1990*	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Emissions, Gg								
Nox	7.41E-03	7.23E-03	8.39E-03	7.14E-03	4.35E-03	5.02E-03	5.25E-03	5.72E-03
CO	2.27E-01	2.21E-01	2.57E-01	2.18E-01	1.33E-01	1.54E-01	1.61E-01	1.75E-01
NMVOC	1.99E-02	1.94E-02	2.25E-02	1.92E-02	1.17E-02	1.35E-02	1.41E-02	1.54E-02
NH_3	1.71E-02	1.67E-02	1.93E-02	1.65E-02	1.00E-02	1.16E-02	1.21E-02	1.32E-02
TSP	1.11E-01	1.08E-01	1.26E-01	1.07E-01	6.52E-02	7.53E-02	7.88E-02	8.58E-02
PM_{10}	1.11E-01	1.08E-01	1.26E-01	1.07E-01	6.52E-02	7.53E-02	7.88E-02	8.58E-02
$PM_{2.5}$	1.11E-01	1.08E-01	1.26E-01	1.07E-01	6.52E-02	7.53E-02	7.88E-02	8.58E-02
BC	5.00E-04	4.88E-04	5.66E-04	4.82E-04	2.93E-04	3.39E-04	3.55E-04	3.86E-04
Emissions, Mg								
Cd	2.22E-02	2.17E-02	2.52E-02	2.14E-02	1.30E-02	1.51E-02	1.58E-02	1.72E-02
Ni	1.11E-02	1.08E-02	1.26E-02	1.07E-02	6.52E-03	7.53E-03	7.88E-03	8.58E-03
Zn	1.11E-02	1.08E-02	1.26E-02	1.07E-02	6.52E-03	7.53E-03	7.88E-03	8.58E-03
Cu	2.22E-02	2.17E-02	2.52E-02	2.14E-02	1.30E-02	1.51E-02	1.58E-02	1.72E-02
Emissions, g I-TEQ								
PCDD/PCDF	4.11E-04	4.02E-04	4.66E-04	3.96E-04	2.41E-04	2.79E-04	2.92E-04	3.18E-04
Emissions, Mg								
Bezno(a)pyrene	4.57E-04	4.46E-04	5.17E-04	4.40E-04	2.68E-04	3.09E-04	3.24E-04	3.53E-04
Benzo(b)pyrene	1.85E-04	1.81E-04	2.10E-04	1.78E-04	1.09E-04	1.25E-04	1.31E-04	1.43E-04
Benzo(k)pyrene	1.85E-04	1.81E-04	2.10E-04	1.78E-04	1.09E-04	1.25E-04	1.31E-04	1.43E-04
Indeno(1,2,3-dc)pyrene	1.85E-04	1.81E-04	2.10E-04	1.78E-04	1.09E-04	1.25E-04	1.31E-04	1.43E-04
4 PAH	1.01E-03	9.88E-04	1.15E-03	9.75E-04	5.94E-04	6.86E-04	7.18E-04	7.82E-04

Emissions from tobacco smoking decreased by 22.8% from 1990 to 2015 and by 19.8% from 2005 to 2015.

Table 4.16.4-3 NMVOC emissions (Gg) from *Use of shoes (SNAP 060603)*

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
NMVOC emissions, Gg	0.222	0.217	0.209	0.197	0.183	0.177	0.175	0.173

Emissions from use of shoes dropped by 22.0% and by 12.2% from 1990 to 2015 and from 2005 to 2015, respectively.

4.17. Other Industrial Processes (NFR 2.H – 2.K);

4.17.1. Pulp and paper industry (NFR 2.H.1)

4.17.1.1. Overview of the Category

There is no pulp industry in Lithuania. However, there are couple paper-producing companies in Lithuania.

4.17.2. Methodology

2016 EMEP/EEA Guidebook tier 1 emission factors were used to estimate emissions from this category. 1990-1994 estimates were calculated and included to the inventory.

Table 4.17-1 Pulp production (Gg) and corresponding emissions (Gg) for the 1990-1993 period.

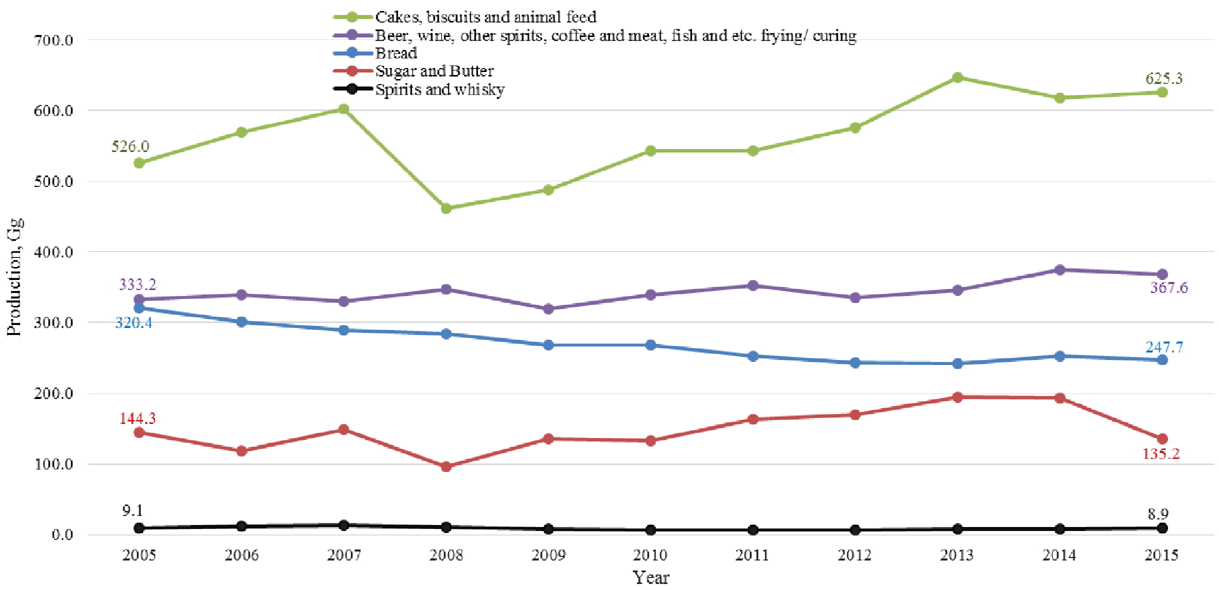
	1990	***1991***	***1992***	***1993***
Pulp production, Gg	51	51	51	5
Emissions, Gg				
NOx	0.0510	0.0510	0.0510	0.0050
CO	0.2805	0.2805	0.2805	0.0275
NMVOC	0.1020	0.1020	0.1020	0.0100
SOx	0.1020	0.1020	0.1020	0.0100
TSP	0.0510	0.0510	0.0510	0.0050
PM_{10}	0.0408	0.0408	0.0408	0.0040
$PM_{2.5}$	0.0306	0.0306	0.0306	0.0030
BC	0.0008	0.0008	0.0008	0.0001

4.18. Food and Beverages Industry (NFR 2.H.2)

4.18.1. Overview of the Category

Information on the production and processes described under this category was gathered from Statistics Lithuania. Please see figure below for changes in production quantities from 2005 to 2015.

2005-2015 production of different goods. Products are combined in groups according to the NMVOC emission factors: cakes biscuits and animal feed (1 kg/Mg), beer, wine, other spirits, coffee, and meat and fish curing/frying (below 1 kg/Mg or 1 kg/hl), bread (EF = 4.5 kg/Mg), sugar and butter (10 kg/Mg) and spirits and whisky (15 kg/hl).



Production of biscuits, cakes and other goods increased by 56.9% from 2005 to 2015, while bread production decreased by 22.7%. Alcoholic drinks production remained almost constant.

4.18.2. Methodology

Activity data on the production of the following goods was collected from Statistics Lithuania in (numbers in brackets are PGPK 2013 (Products, Manufactured Goods and Services Classification System) codes):

- Sugar (1062139000, 1081123000, 1081129000, 1081130000);
- Bread (1071110000, 1071110010, 1071110080);
- Beer (1105100000, 1105101000);
- Spirits and whisky (1101105000, 1101104000, 1101106300, 101107000, 1101102000, 1101108000, 1101103000);
- Wine (1102119000, 1102121500, 1102122000, 1103100010);
- Coffee (1083115000, 1083117000);

- Animal feed (1091101000, 1091103300, 1091103500, 1091103700, 1091103900, 1092103000, 1092106000);
- Meat, fish curing/ frying (1013118000, 1013120000, 1013130000, 1020248000, 1020248500, 1020242000, 1020242500, 1020245000, 1020245500);
- Margarine and butter (1051303000, 1051305000, 1082120000, 1089194060, 1042103000);
- Biscuits, cakes and other (1072113000, 1072115000, 1072123000, 1072125300, 1072125500, 1072125700, 1072125900, 1072194000, 1072199000, 1071120000).

Emission factors from 2016 EMEP/EEA Guidebook were used to estimate NMVOC emissions from the category.
The figure below shows NMVOC emissions from the food and beverages industry. 2005/2015 emissions decreased by 8.2%.
Recalculated values are lower than submitted on 2016. For instance, 2014 NMVOC emission after reevaluation is equal to 4.50 Gg, which is 9.5% lower than in the previous submission (i.e., 4.97 Gg).

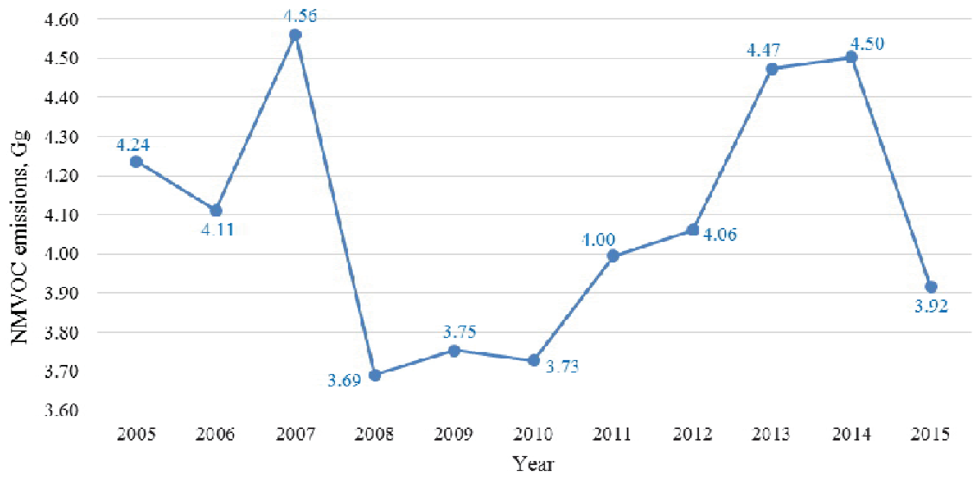


Figure 4.18.2 NMVOC emissions (Gg) from the food and beverages industry.

4.19. Other industrial production including production, consumption, storage, transportation or handling of bulk products (NFR 2.H.3, 2.L)

Not occurring.

4.20. Wood processing (NFR 2.I)

Not estimated.

4.21. Production of POPs (NFR 2.J)

Not estimated.

4.22. Consumption of POPs and heavy metals (e.g. electrical and scientific equipment) (NFR 2.K)

4.22.1. Overview of the Category

According to the requirements of the Rules on PCB/PCT Management, adopted on 26 September 2003 by Order No 473 of the Minister of Environment (as amended in 2004), holders of equipment containing PCBs shall compile inventory of equipment where PCB content exceeds 5 dm^3 and equipment containing PCBs from 0.05% to 0.005% by fluid weight. The Rules on PCB/PCT Management are aimed at implementing the PCB Directive – Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT). The updated inventory reports are submitted to the Regional Environmental Protection Departments annually.

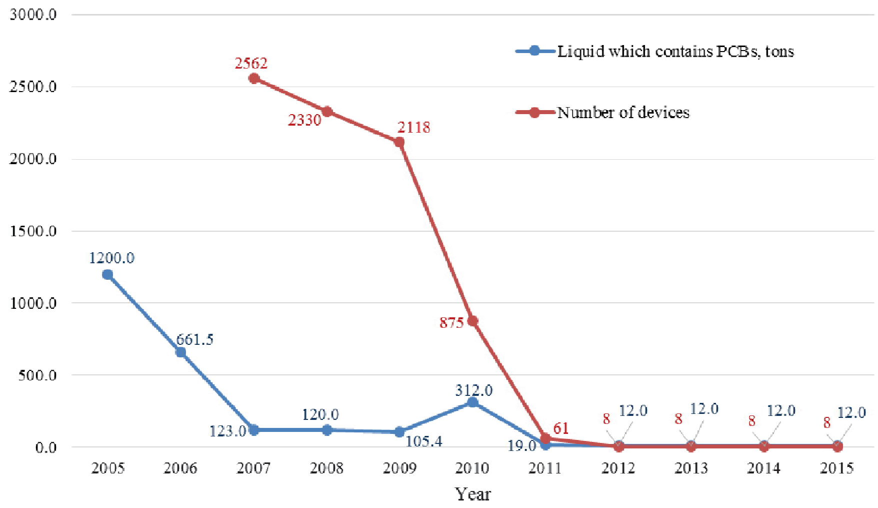
According to the Rules on PCB/PCT Management, PCB-containing equipment was to be decontaminated and/or disposed by the end of 2010 at the latest. The major part of the equipment inventoried before the end of 2010 in Lithuania has been disposed by this deadline. It should be noted that not all companies holding PCB–containing equipment managed to comply with this deadline. The Regional Environmental Departments are observing such companies concerning their situation, actions and plans for disposal/decontamination of PCB equipment no longer permitted. However, transformers the fluids in which contain between 0.05% and 0.005% of PCBs by weight are to be either decontaminated or disposed of at the end of their useful lives.

4.22.2. Methodology

Data on electrical equipment containing liquids with PCBs was provided by the specialists of waste licensing division in Lithuanian EPA. No information on the amount of liquid containing PCBs was available for year 2006, thus average of 2005 and 2007 was taken.

Only one company (UAB Domus Altera equipment is used by UAB Dirbtinis Pluostas) in Lithuania is still using such equipment. From 2012 to 2016 the number of devices with fluid containing PCBs did not change and remained to be 8 with 12 tons of liquid containing PCBs. See figure below for more details.

Number of devices which contain liquid with PCBs, 2005-2015.



No information on the quantity of PCBs in the liquid was provided, thus it was assumed that PCBs contain exactly 0.05% of the liquid mass. Tier 3 emission factors from 2016 EMEP/EEA Guidebook were taken. The most of the equipment used are transformers left from Soviet era, thus emission factor for transformers emissions to air in CIS countries was used (equal to 0.06 kg PCBs/ ton of PCBs).

Mercury emissions were estimated using tier 1 approach and population in Lithuania.
PCBs emissions for period 2005-2015.

Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
PCBs emissions, kg	36.0	19.8	3.7	3.6	3.2	9.4	0.6	0.4	0.4	0.4	0.4

2005/2015 emissions decreased by 99% (see table above). A lot of liquid containing PCBs is being stored in Lithuania in long-term storage facilities (188.5 tons in 2014), which might be a possible key source of PCBs emissions. However, more information on storage facilities is necessary.

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.

5.2. Manure Management (NFR 3.B)

5.2.1 Overview of the Category

Livestock, poultry and other animals population sizes significantly dropped with the re-establishment of private ownership after the Soviet Union had collapsed. Change in animal population caused a significant decrease in pollutant emissions from agriculture sector. Cattle and swine population size has remarkably decreased, which was the reason for significant change in emissions as cattle and poultry subcategories' emission factors are the largest (cattle 1990/2015 population decrease by 68.9%, swine population by 71.8%). On the other hand, 2005/2015 population changes were not that remarkable, with the largest 38% decrease in swine population size.

Please see table below for numbers of animals on the 1st of January of each year starting from 1990 to 2015.

Table 5.1 Animal numbers from 1990 to 2015. Statistics were gathered from LTSTD [1] and checked with activity data reported in GHG NIR [2].

	Animal Categories											
	Dairy Cattle	***Non-dairy Cattle***	***Sheep***	***Swine (fattening)***	***Swine (sows and piglets)***	***Goats***	***Horses***	***Other Chicken***	***Geese***	***Ducks***	***Turkeys***	***Fur-bearing animals (minks, foxes and polar foxes and rabbits)***
Year	*Number of animals, heads*											
1990	842,000	1,479,600	56,500	2,209,800	226,100	5,200	79,900	11,329,486	39,931	63,032	9,179	231,600
1991	831,900	1,364,700	58,100	1,977,500	202,300	6,300	82,600	11,118,256	22,875	75,270	7,264	229,600
1992	737,800	963,100	51,700	1,233,500	126,300	8,800	79,700	5,044,561	26,174	0	7,823	229,600
1993	678,104	706,100	45,000	1,085,200	110,906	10,417	81,300	5,403,364	41,831	0	0	192,300
1994	614,871	537,500	40,000	1,142,900	116,950	12,359	78,200	5,454,527	35,000	2,100	0	182,700
1995	586,049	478,900	32,300	1,152,000	117,963	14,618	77,600	4,846,251	13,726	0	0	174,200
1996	589,885	464,200	28,200	1,023,100	104,525	16,903	81,400	4,258,520	40,863	30,950	21,750	187,300
1997	582,819	433,300	24,000	1,074,700	125,385	18,499	78,500	3,987,390	68,000	61,900	43,500	209,800
1998	537,695	390,100	15,800	1,057,700	101,326	23,700	74,300	3,626,535	65,100	53,700	36,800	148,100
1999	494,325	403,500	13,800	851,300	84,846	24,654	74,900	2,980,080	64,800	56,400	42,900	127,200
2000	438,353	309,600	11,500	787,900	79,681	23,064	68,400	1,948,200	48,400	47,900	31,600	127,100
2001	441,757	309,100	12,300	914,900	95,898	23,738	64,500	2,770,400	52,700	51,100	43,400	125,700
2002	443,291	334,900	13,600	962,400	98,623	21,947	60,700	3,058,100	59,000	47,400	46,000	135,100
2003	448,084	362,300	16,900	963,200	94,158	27,172	63,600	3,903,100	52,400	46,800	98,400	190,600
2004	433,937	358,029	22,149	977,606	95,742	26,904	63,628	4,008,532	52,126	46,056	93,453	228,120
2005	416,500	383,786	29,208	1,015,831	98,816	21,984	62,605	4,823,889	49,847	42,945	103,000	272,050
2006	398,968	439,806	36,591	1,029,626	97,498	20,789	60,851	4,848,259	48,958	40,605	116,537	276,154
2007	404,490	383,425	43,298	841,578	81,620	19,678	55,907	5,383,186	40,117	37,471	104,424	263,081
2008	394,711	376,206	47,516	819,007	78,105	16,580	54,421	5,181,799	35,788	36,723	194,024	278,699
2009	374,648	384,724	52,463	844,832	83,355	14,717	48,980	5,202,290	34,023	35,935	213,312	227,558
2010	359,780	388,202	58,548	847,338	82,058	16,048	44,676	4,894,026	27,839	37,301	206,152	279,153
2011	349,545	402,806	60,400	721,995	68,346	14,958	36,361	4,624,030	21,807	33,593	207,666	291,176
2012	331,036	398,136	82,752	743,954	63,526	13,598	29,464	5,424,721	20,444	46,378	205,881	404,555
2013	315,681	397,808	99,637	695,585	59,048	13,832	22,178	6,541,599	15,481	39,592	85,673	444,268
2014	314,044	422,568	123,909	657,781	56,376	12,991	18,193	6,706,327	15,567	24,219	85,524	554,141
2015	300,489	422,113	147,073	634,706	53,116	13,526	17,321	5,936,887	22,485	15,825	183,219	590,772

5.2.2. Methodology

Methodology for estimation of NH_3, NMVOC, NO_X, PM_{10}, $PM_{2.5}$ and TSP emissions was taken from 2016 EMEP/EEA Guidebook. Detailed information on the method applied, emission factors and activity data is given in table 5.2.

Table 5.2: Emission factors and methods used for each pollutant. Activity data sources are given below.

NFR code	Animal category	Method applied	Emission factor	Activity data
3B1a, 3B1b	Dairy and other cattle	**T1** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	**DV** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	LTST
3B2, 3B4d, 3B4e	Sheep, goats, horses	**T1** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	**DV** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	LTST
3B3	Swine (fattening pigs and sows)	**T1** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	**DV** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	LTST, LGHGNIR
3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h	Laying hens, other chickens, turkeys, ducks, geese, fur bearing animals	**T1** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	**DV** (NH_3, NOx, NMVOC, PM_{10}, $PM_{2.5}$, TSP)	LTST, LGHGNIR

LGHGNIR – Lithuania's Green House Gas National Inventory Report 2016, LTSTD – Lithuania Statistics, DV – default value taken from 2016 EMEP/EEA Inventory Guidebook.

Tier 1 approach was used to calculate pollutant emissions:

Equation 5.1: $E_{Pollutant} = AAP_{Animal\_category} \times EF_{Pollutant\_Animal\ category} \times Unit\ Conversion\ Factor;$

where $AAP_{Animal\_category}$ is annual average population of animal category (animals per annum); and $EF_{Pollutant\_Animal\ category}$ represents emission factors for different animal categories (kg of pollutant per AAP per year).

AAP values were not estimated, therefore animal numbers on the 1st day of the year were taken and assumed to represent population present over the year before.

For NO and NH_3 emission calculations information on the manure type and percentage amount of manure per management system was used, modifying equation 5.1 to:

Equation 5.2: $E_{Pollutant} = AAP_{Animal\_category} \times EF_{Pollutant\_Animal\ category}, \times \%\ Manure\ of\ specific\ type\ per\ total\ manure \times Unit\ Conversion\ Factor;$

NMVOC emissions were calculated based on the animal diet, i.e. percentage of silage in animal feed [3]. The correlation of silage feeding and grazing/ confinement periods were taken into account [4] to estimate percentage of silage in animals diet. For 3B2, 3B4d and 3B4e identical amount of silage feed was assumed as for the cattle categories.

Table 5.3: 2015 NH_3 (Gg) emissions from the manure management (Gg).

	Category	1990	1995	2000	2005	2010	2013	2014	2015
Manure Management	3B1a - Dairy cattle	8.77	6.10	4.57	4.34	3.75	3.29	3.27	3.13
	3B1b - Other cattle	6.91	2.24	1.45	1.79	1.81	1.86	1.97	1.97
	3B2 - Sheep	0.02	0.01	0.00	0.01	0.02	0.04	0.05	0.06
	3B3 - Swine	13.01	6.78	4.60	5.92	4.93	3.95	3.74	3.60
	3B4d - Goats	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3B4e - Horses	0.56	0.54	0.48	0.44	0.31	0.16	0.13	0.12
	3B4gi - Laying hens	1.72	1.15	1.12	1.40	1.38	0.99	1.08	1.03
	3B4gii - Broilers	1.70	0.73	0.29	0.72	0.73	0.98	1.01	0.89
	3B4giii - Turkeys	0.01	0.00	0.02	0.06	0.12	0.05	0.05	0.10
	3B4giv - Other poultry	0.04	0.00	0.04	0.03	0.03	0.02	0.02	0.01
	3B4h - Fur-bearing animals	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	Total	**32.75**	**17.57**	**12.58**	**14.73**	**13.09**	**11.34**	**11.33**	**10.93**

Tables 5.4 and 5.5 below show emissions in 1990 and 2015, respectively. The reduction of 1990/2015 emissions is remarkable. The change is 60% or more. The ammonia emissions dropped by more than 21.8 Gg. The steady decrease in NH_3 emissions can be correlated with the decline in animal numbers and improved manure management system in the recent years.

Table 5.4: Emissions of different pollutants in Gg, year 1990.

Category	*NOx*	*NH_3*	*NMVOC*	*PM_{10}*	*$PM_{2.5}$*	*TSP*
3B1a	0.21	8.77	11.09	0.53	0.35	1.16
3B1b	0.24	6.91	9.40	0.32	0.21	0.70
3B2	0.00	0.02	0.01	0.00	0.00	0.01
3B3	0.25	13.01	1.60	0.80	0.14	1.76
3B4d	0.00	0.00	0.00	0.00	0.00	0.00
3B4e	0.02	0.56	0.49	0.02	0.01	0.04
3B4gi	0.04	1.72	0.89	0.64	0.12	0.64
3B4gii	0.03	1.70	1.22	0.78	0.10	0.78
3B4giii	0.00	0.01	0.00	0.00	0.00	0.00
3B4giv	0.00	0.04	0.05	0.02	0.00	0.02
3B4h	0.00	0.00	0.31	0.00	0.00	0.00
Total	*0.80*	*32.75*	*25.07*	*3.12*	*0.94*	*5.12*

Table 5.5 Emissions of different pollutants in Gg, year 2015.

Category	*NOx*	*NH_3*	*NMVOC*	*PM_{10}*	*$PM_{2.5}$*	*TSP*
3B1a	0.07	3.13	3.96	0.19	0.12	0.41
3B1b	0.06	1.97	2.68	0.09	0.06	0.20
3B2	0.00	0.06	0.03	0.00	0.00	0.02
3B3	0.07	3.60	0.44	0.22	0.04	0.49
3B4d	0.00	0.01	0.01	0.00	0.00	0.00
3B4e	0.01	0.12	0.11	0.00	0.00	0.01
3B4gi	0.02	1.03	0.53	0.38	0.07	0.38
3B4gii	0.02	0.89	0.64	0.41	0.05	0.41
3B4giii	0.00	0.10	0.09	0.10	0.01	0.10
3B4giv	0.00	0.01	0.02	0.01	0.00	0.01
3B4h	0.00	0.01	0.91	0.00	0.00	0.01
Total	*0.25*	*10.93*	*9.42*	*1.41*	*0.37*	*2.05*

Total pollutant reduction commitments for Lithuania for year 2020 under the NEC directive 2001/81/EC (2020 – 2005 emissions change) are -48% for NO_x, -32% for NMVOC and -10% for NH_3. As it is shown in the Figure 5.2 below only NH_3 emission reduction obligation is fulfilled when 3.B category is considered. Please note that pollutants' emissions may change with improved methodology.

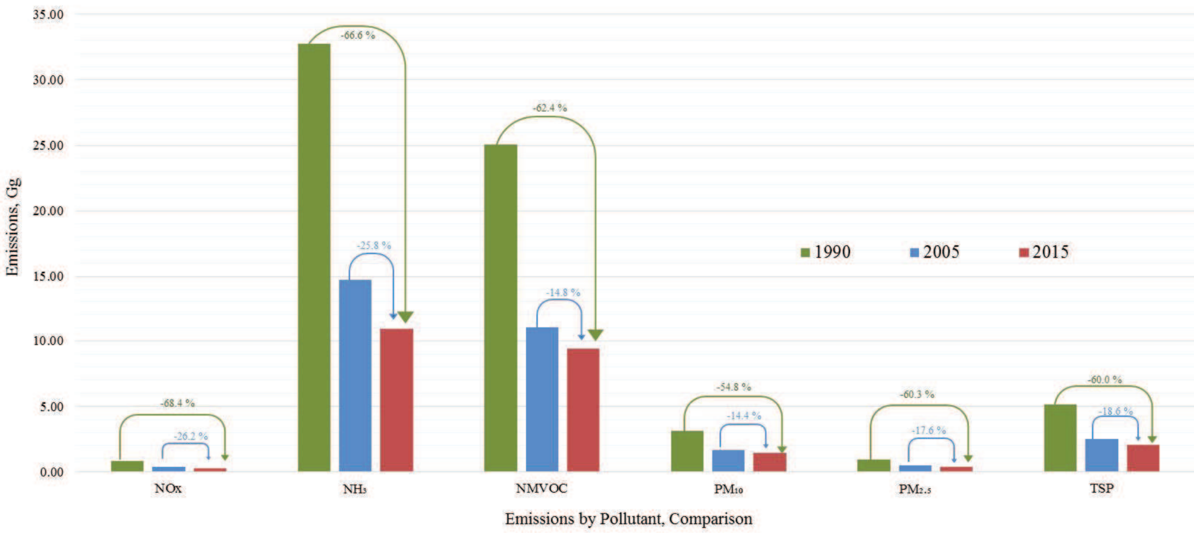


Figure 5.2-1 Total pollutant emissions in Gg for years 1990, 2005 and 2015, and corresponding percentage changes

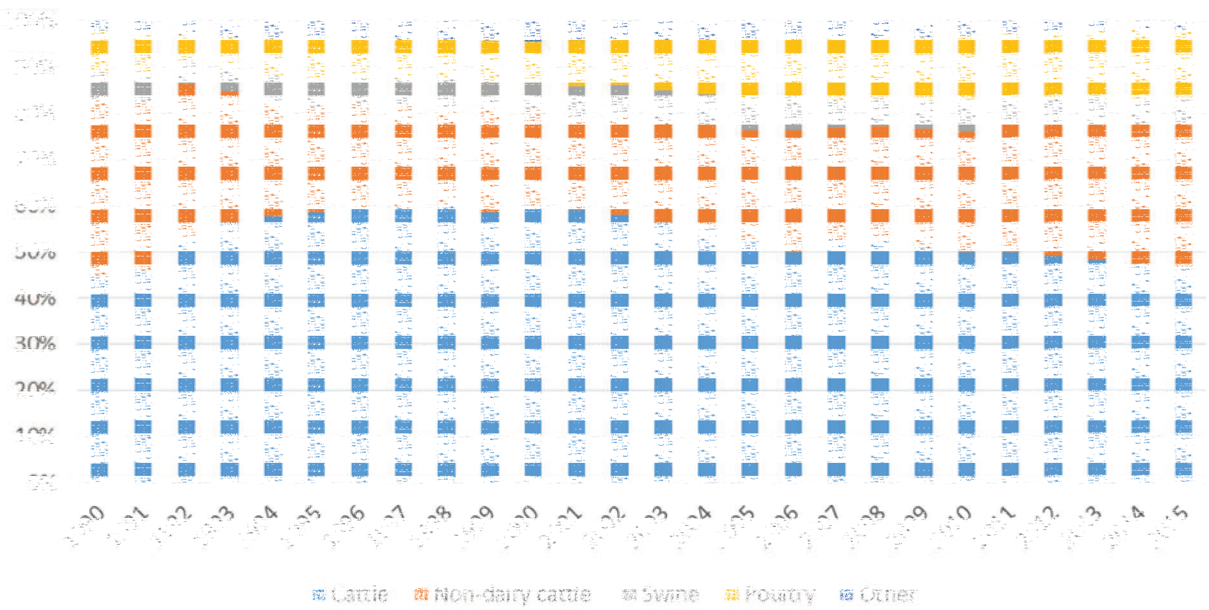


Figure 5.2-2 Ammonia emissions from Manure Management in 1990-2015.

In Figure 5.2-2 are shown emissions from Manure Management distributed on different livestock categories in 2015. It is seen that the majority of the emissions is related to the cattle (diary and non-diary) – 78%, poultry – 15 % and swine - 5 %.

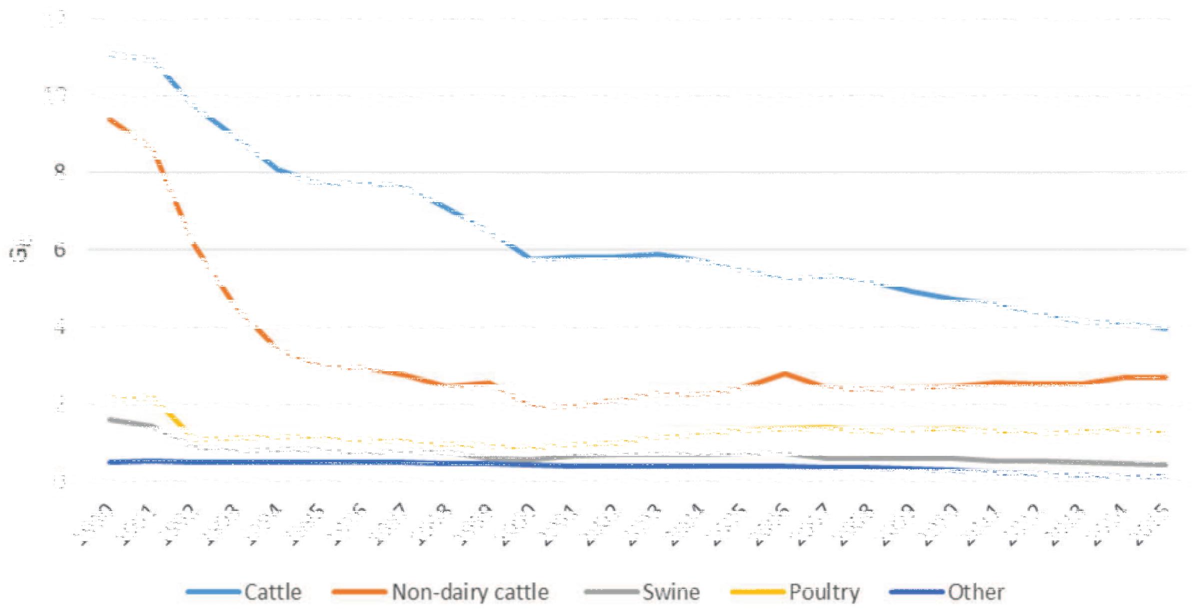


Figure 5.2-3 Trend of NH3 Emissions (NFR 3.B-L).

NH_3 emissions in Manure management decreased from 25.1 Gg in 1990 to 8.5 Gg in 2015.

5.3. Crop Production and Agricultural Soils (3.D)

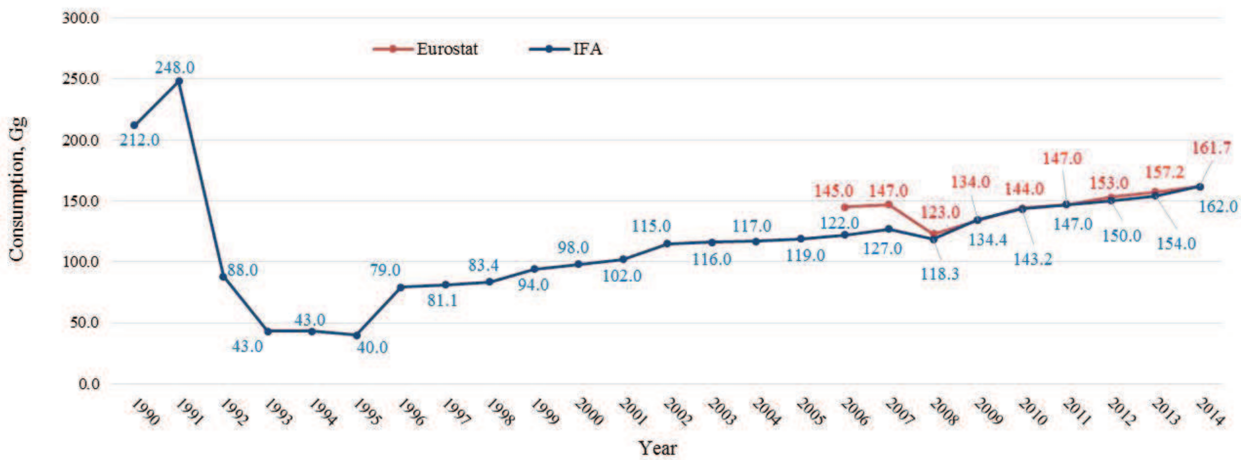
5.3.1. Application of Inorganic N-fertilizers (3.D.a.1)

5.3.1.1. Overview of the Category

Inorganic-N fertilizers is one of the major NO_x and NH_3 contributors, thus higher tier methodology is necessary for better estimation of emissions arising from processes described under this category. As it is seen from figure below the consumption of N-fertilizers has been increasing steadily for over the past 20 years.

Consumption data was gathered from international databases IFA [6] and Eurostat. Both IFA and Eurostat provide similar or identical values for 2008 – 2014. For the period 1990 – 2014 IFA dataset was used. 2015 value was chosen to be average of the two values (161.85 Gg) reported by the Eurostat and IFA for 2014.

Figure 5.3: Consumption statistics of inorganic N-fertilizers (Gg) provided by Eurostat and IFA.



5.3.1.2. Methodology

Methodology for estimation of pollutant emissions was taken from 2016 EMEP/EEA guidebook. NO and NH_3 tier 1 emission factors were used to estimate NO_x and NH_3 emissions, respectively. The following equation was used:

Equation 5.3: $E_{Pollutant} = AR_{Consumption} \times EF_{Pollutant} \times \textit{Unit Conversion Factor} \times \textit{Other CF};$
Where *Other CF* is only applicable for conversion of NO to NO_2. The factor is equal to 44/30.

Table 5.6: NH_3 and NO_x (expressed in NO_2) emissions in Gg.

	1990	*1995*	*2000*	*2005*	*2010*	*2012*	*2013*	*2014*	*2015*
NH_3 Emissions, Gg	10.60	2.00	4.90	5.95	7.16	7.50	7.70	8.08	8.08
NO_2 Emissions, Gg	12.44	2.35	5.75	6.98	8.40	8.80	9.03	9.49	9.49

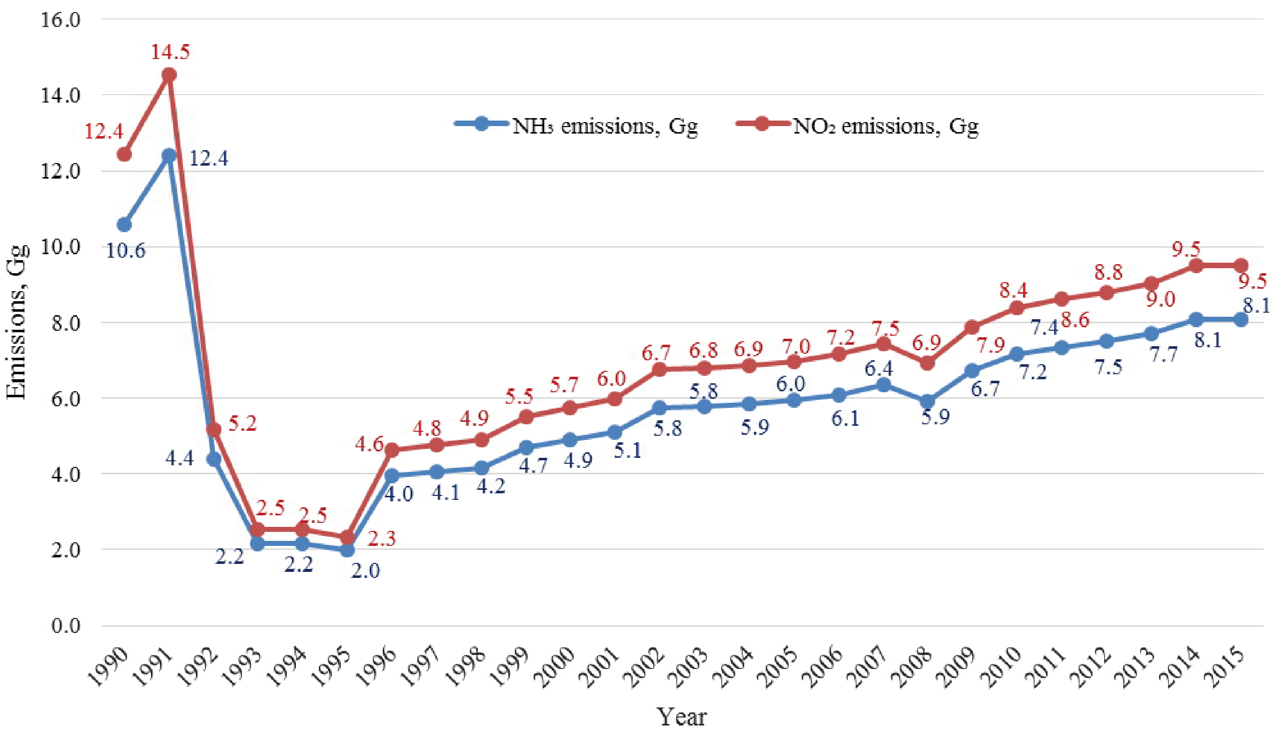


Figure 5.3-1 NH3 and NOx emissions for the period 1990-2015.

1990/2015 NH_3 and NO_x emissions decreased by 23.7%, while 2005/2015 emissions increased by 35.9%.

5.4. Waste application to Soils (3.D.a.2)

Lithuania's Environmental Protection Agency gathers information on the waste collection [7], destruction, reuse, and management. This is done according to minister's statute no. 217 "Waste Management Rules" [8]. Data from this register, available on the www.gamta.lt website under R10 category (reuse of waste in agriculture beneficial for agriculture), was taken and used for the pollutant emission calculations for the 3.D.a.2 section.

5.5. Animal Manure Application to Soils (3.D.a.2.a)

5.5.1. Overview of the Category

With the approval of the latest 2016 EMEP/ EEA guidebook, NH_3 emission factors from for this sector were included. It can be mentioned that Lithuanian EPA collects information on the amount of manure and dung, and used straw applied on the soil beneficial for the soil. However, additional data is needed, such as dry mass amount in the mixture or separate substances, nitrogen amount in the dry matter and other details.

5.5.2. Methodology

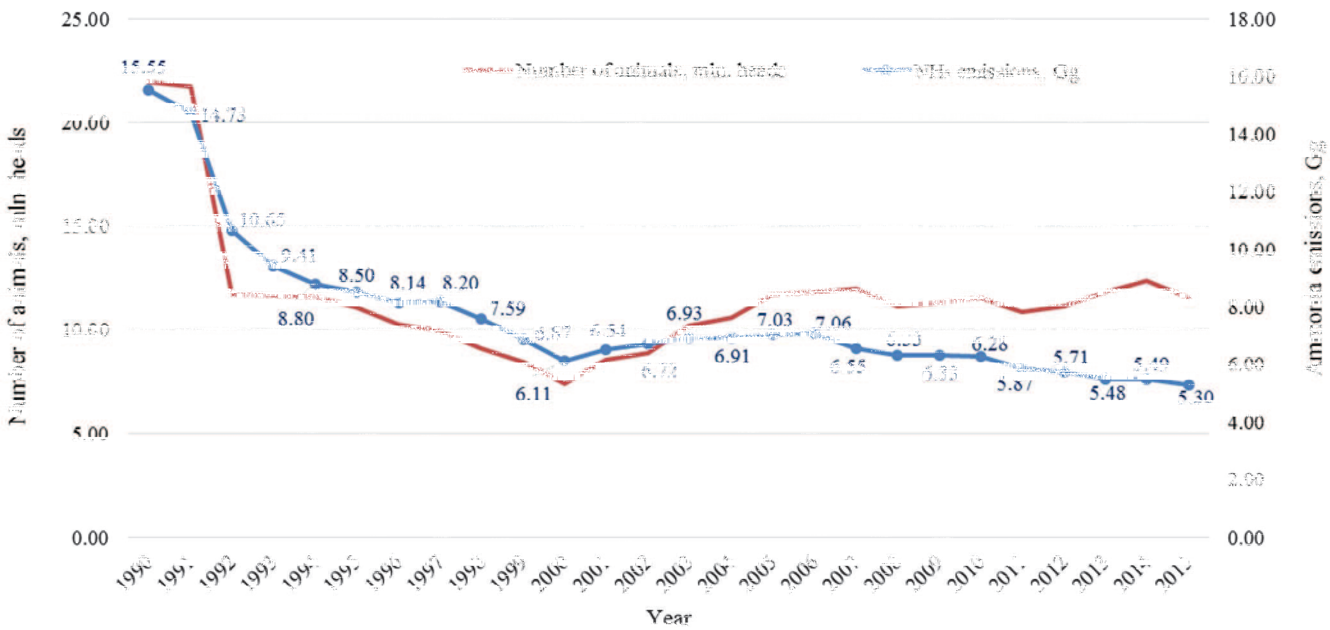
Methodology for estimation of NH_3 emissions was taken from 2016 EMEP/EEA Guidebook. The following methodology was used to estimate NH_3 release to the atmosphere:

Equation 5.4: $E_{NH(3)} = AAP_{Animal\_category} \times EF_{Pollutant\_Animal\ category} \times Percentage\ of\ Manure_{Manure\_type} \times Unit\ Conversion\ Factor;$

where AAP is annual average population of animal category (animals per annum);
and EF represents emission factors for different animal categories (kg of NH_3 per AAP per year).

The ammonia emissions 1990/2015 and 2005/2015 trends showed similar declines as for 3B category. 1990/ 2015 pollutant release to the atmosphere decreased by 65.9%, while 2005/ 2015 emissions dropped by 24.5%. The total number of livestock, poultry and other animals does not closely correlate with the emission trend (see figure below). Although total animal population decreased by 47.4% from 1990, emissions dropped by 65.9%. This can be explained in terms of different emission factors for different animal groups and different animal group numbers development over time.

Figure 5.5: numbers of animals (million heads) and corresponding ammonia emissions (Gg) from animal manure application to soils.

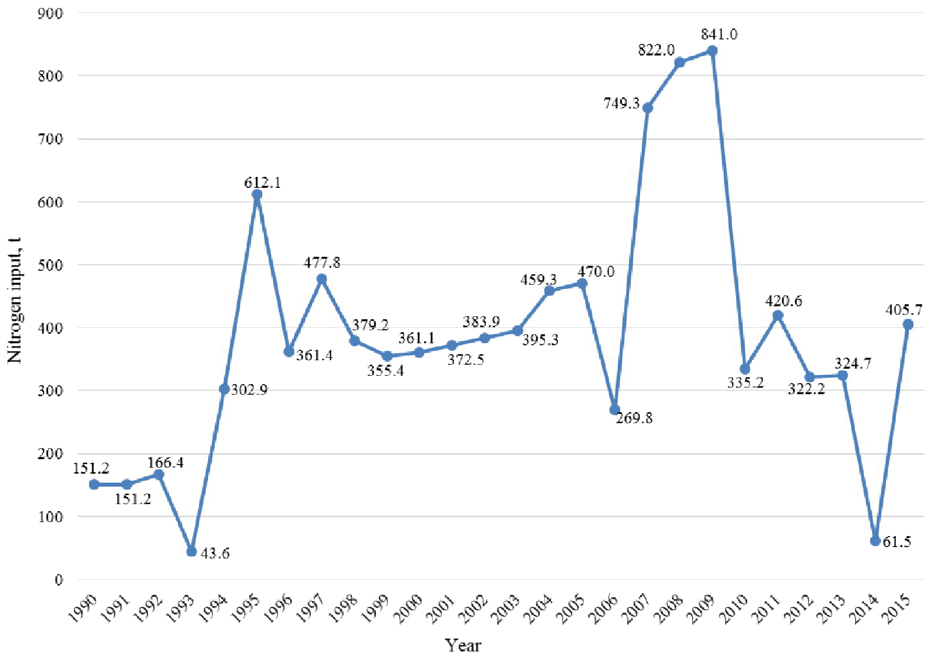


5.6. Sewage Sludge Applied to Soils (3.D.a.2.b)

5.6.1. Overview of the Category

Sewage sludge in Lithuania is used as soil amendment. Amounts of nitrogen sludge applied to soils were obtained from Lithuanian Environmental Protection Agency (EPA). Information for 1990, 2000-2003 and 2015 years was not available, thus data was filled by assuming identical value as on 1991, by intrapolation or by extrapolation, respectively. 2015 value was found by applying linear equation y = -3140.748*x + 6734355, where x = 2015 (R^2 = 0.01).

Figure 5.6: nitrogen mass (tons) applied to soils.



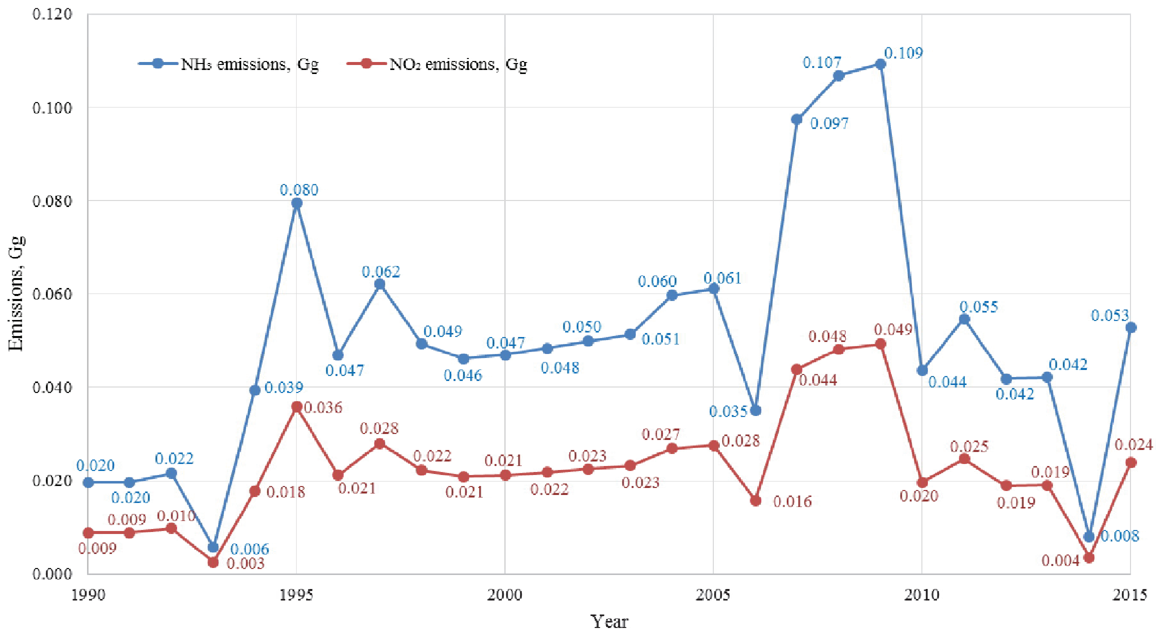
5.6.2. Methodology

Amount of nitrogen was multiplied with 2016 EMEP/EEA Guidebook's emission factor. In order to obtain NO_2 emissions 0.04 kg NO_2 / (kg N in sewage sludge) emission factor was used, while for NH_3 – 0.13 kg NH_3 x (kg N in sewage sludge)$^{-1}$. The following equation was applied:

Equation 5.5: *$E_{Pollutant}$ = Total Sewage Sludge Applied x Dry Matter Content x Total Nitrogen Content x Emission Factor x Unit Conversion Factor x Conversion Factor to Specific Pollutant;*

2015 emissions are much larger when compared with the base year's emissions. However, this category is only a minor contributor to the total NO_x and NH_3 emissions.

Figure 5.6: NH_3 and NO_2 emissions (Gg) from application of sewage sludge to soils.

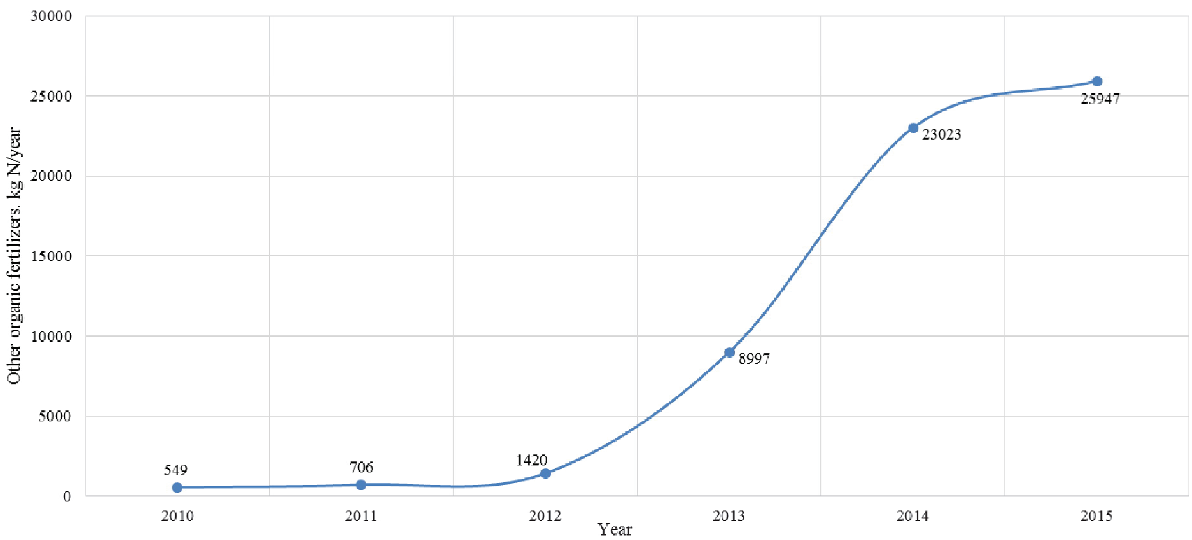


5.7. Other Organic Fertilizer Application (3.D.a.2.c)

5.7.1. Overview of the Category

Using financial resources from 2004-2006 EU ISPA/Cohesion funds Lithuania financed of about 50 green waste composting sites (GWCS), which started operating from 2010. Regional waste management centers (RWMC) provided data on quantities of compost and corresponding dry matter (DM) and nitrogen content. Average DM content in compost was equal to 0.0063 kg/kg, while average nitrogen content in DM – 54%.

Figure 5.7: amount in kilograms of nitrogen in other organic fertilizers.



5.7.2. Methodology

Amount of nitrogen in compost was used with 2016 EMEP/EEA Guidebook emission factors. NO emissions were estimated using emission factor equal to 0.04 kg NO x (kg waste-N applied)$^{-1}$, while NH_3 emissions were calculated using emission factor of 0.08 kg NH_3 x (kg waste-N applied)$^{-1}$. General equation is shown below:

Equation 5.6: *$E_{Pollutant}$ = Total Organic Fertilizer Applied x Dry Matter Content x Total Nitrogen Content x Emission Factor x Unit Conversion Factor x Conversion Factor to Specific Pollutant;*

Emissions prior 2010 were labelled as not occurring.

Table 5.6: NH_3 and NO_2 emissions (Gg) from application of other organic fertilizers.

	2010	*2011*	*2012*	*2013*	*2014*	*2015*
	Emissions, Gg					
NH_3	4.39E-05	5.65E-05	1.14E-04	7.20E-04	1.84E-03	2.08E-03
Nox (as NO_2)	3.22E-05	4.14E-05	8.33E-05	5.28E-04	1.35E-03	1.52E-03

5.8. Urine and Dung Deposited by Grazing Livestock (3.D.a.3)

5.8.1. Overview of the Category

This category was not estimated in 2016 inventory submission. In 2016 2nd joint EMEP/ WGE session updated guidebook was approved, which includes tier 1 emission factors for this category. Therefore, release of ammonia was estimated using the latest 2016 EMEP/ EEA guidebook.

5.8.2. Methodology

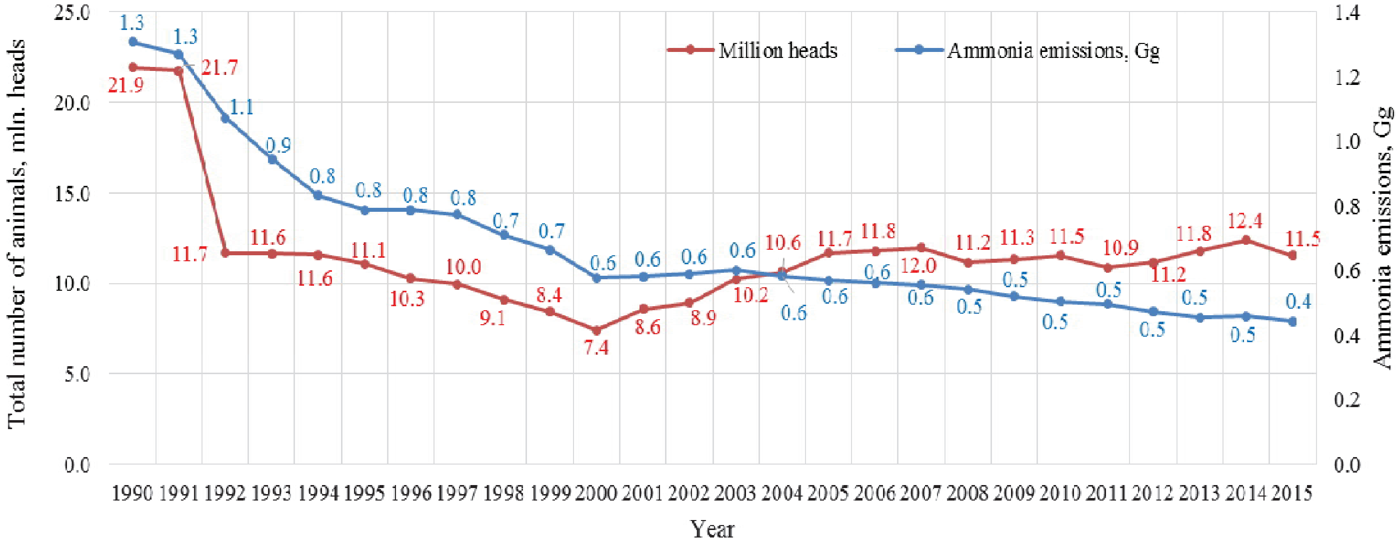
Tier 1 methodology for estimation of NH_3 emissions was taken from 2016 EMEP/EEA Guidebook. The following methodology was used to estimate NH_3 release to the atmosphere:

Equation 5.7: *$E_{NH(3)} = AAP_{Animal\_category}$ x $EF_{Pollutant\_Animal\ category}$ x Percentage of $Manure_{Manure\_type}$ x Unit Conversion Factor;*

where AAP is annual average population of animal category (animals per annum);
and EF represents emission factors for different animal categories (kg of NH_3 per AAP per year).

Figure below shows how ammonia emissions developed over time. In the last decade emissions were constantly dropping, which can be attributed to the cattle, outdoor swine and horses populations decrease. There is no impact for this king of emissions from the poultry and indoor swine.

Figure 5.8: NH_3 (in Gg) emissions from dung and urine deposited by grazing livestock.



5.9. Crop Residues Applied to Soils (3.D.a.4)

Not estimated.

5.10. Indirect Emissions from Managed Soils (3.D.b)

Not estimated.

5.11. Off-farm Agricultural Operations (3.D.d)

Not estimated.

5.12. Cultivated Crops (3.D.e)

Included elsewhere: under 3.D.a.1 category.

5.13. Agriculture Other Including Use of Pesticides (3.D.f, 3.I)

5.13.1. Overview of the Section

This category addresses emission sources that are not included in other Agriculture sections. Emissions may arise from application of pesticides (NFR 3.D.f), and other (NFR 3.I), such as treatment of straw with ammonia. Agriculture is the main sector from which the biggest pollution from pesticide use originate.

5.14. Use of Pesticides (3.D.f)

5.14.1. Overview of the Category

Use of pesticides (i.e. insecticides, fungicides, plant growth regulators, rodenticides, herbicides and other) for plant protection increases human health and environmental hazards. The 2001 Stockholm Convention on Persistent Organic Pollutants (POPs) and Protocol to the Convention on LRTAP banned production and consumption of 11 specific POPs. [444 and fff] Also, multiple Directives concerning maximum levels of pesticide residues in and on fruits and vegetables (Directive 76/895/EEC), cereal products (86/362/EEC), food of animal origin (86/363/EEC), plant origin products (90/642/EEC), placing of plant products on the market (91/414/EEC) and biocidal products on the market (98/8/EEC), framework for Community action for sustainable pesticide use (Directive 2009/128/EC), maximum levels of pesticides on and in animal food and feed (EC regulation No. 396/2005), and other.

According to the latest study the mostly consumed pesticides in 2014 were herbicides (43%), 29% - fungicides, 26% - plant growth regulators and 2% - insecticides. [ggg] The major herbicides used were glyphosate (20.6%), MCPA (16.8%) and 57 other active ingredients. In fungicides category – 57 active ingredients (major: tebuconazole - 25.6%), insecticides – 18 active substances (major: thiacloprid with 45.5% of total instecticides used) and only 5 active substances in plant growth regulators with major substance being chlormequat (84.3%).

90-95% of sugar beetroot, sweetcorn, rapes and cereal all species were processed with pesticides, while other species' smaller percentage of harvest was treated with pesticides: potatoes (62%), vegetables (26%), and fruit and berries (23%). On average 1.08 kg of active ingredient was used for one hectare processed, with the most for berries and fruit (3.09 kg/ha) and the least for sweetcorn (0.38 kg/ha).
http://chm.pops.int/default.aspx
http://www.unece.org/fileadmin/DAM/env/lrtap/full%20text/ece.eb.air.104.e.pdf
https://osp.stat.gov.lt/informaciniai-pranesimai?articleId=3975263

5.15. Use of Pesticides (3.D.f)

Information on the amounts of different pesticide used (i.e. insecticides, fungicides, herbicides, etc.) for the 1992-2014 period can be gathered from the Statistics Division of the Food and Agriculture Organization of UN (short form FAOSTAT) [11].

No national data on total or plant-specific pesticide consumption is available. In 2014 conducted study showed that estimates taken from EUROSTAT and FAOSTAT are much larger.

Emissions from the use of pesticides reporting with the Convention on LRTAP is limited to HCB emissions as other pesticides are not included into the NFR form.

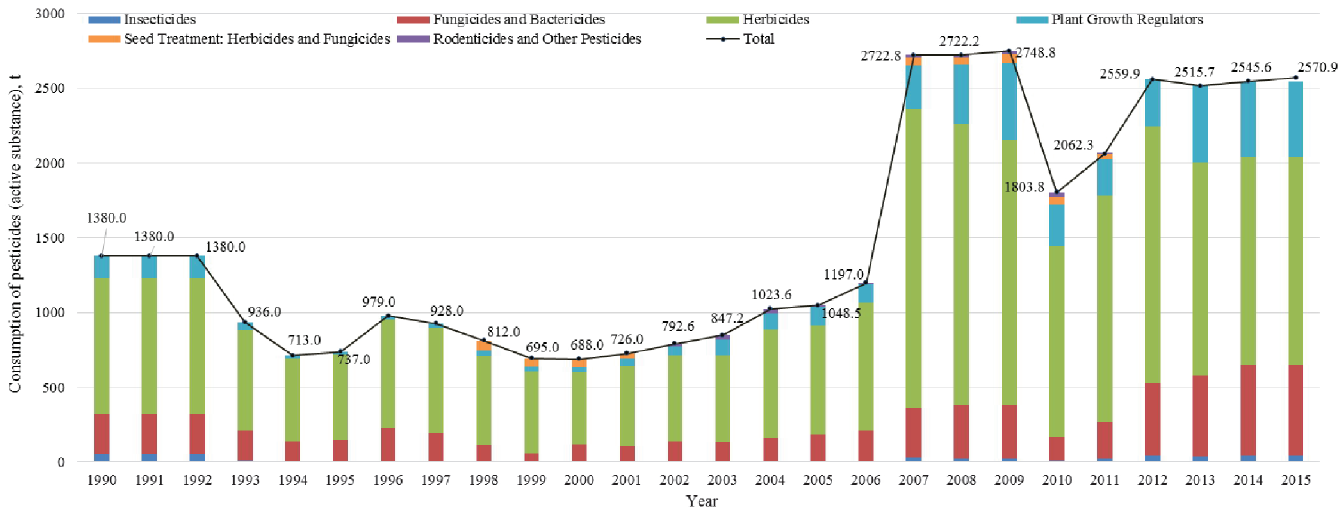


Figure 5.15-1 Active substance in different types of pesticides consumption, tons. Data gathered from FAOSTAT and EUROSTAT databases

5.16. Methodology

Pesticides which contain minor amounts of HCB as impurity were addressed. Only two chemicals, chlorothalonil and clopyralid, were identified which are included into the 1185/2009 regulation and may contain small amounts of HCB. 2014 HCB emission was determined using emission factors given by Yang (2006) [3.2]. EFs for HCB from chlorothalonil and clopyralid are equal to 10 g/ Mg and 2.5 g/ Mg of pesticide, respectively. Pesticides quantities were obtained from the statistical study which are equal to 5190.07 kg of chlorothalonil and 1359.65 kg clopyralid.

No annual statistics are collected on the pesticide consumption. HCB emission from the use of pesticides in 1990 was calculated based on reported HCB emissions by other countries. The average ratio of HCB emitted per agricultural land (kg of HCB per 1000 ha) was applied for agricultural area (3389 thousand ha) in Lithuania in 1992 (no data on agricultural land in 1990 is available at FAOSTAT database) and reported for 1990 on assumption that HCB emissions from this sub-sector were similar for years 1990 and 1992.

Table 5.8: Agricultural land (1000 ha), reported HCB emissions from NFR 3.D.f and ratio by country. Agricultural land data was gathered from FAOSTAT database.

Country	*Agricultural Land, 1000 ha (1990)*	*Reported HCB emission from NFR 3.D.f (1990)*	*Ratio, kg/1000 ha*
Denmark	2788	18.280	6.56E-03
Finland	2393	1.207	5.04E-04
Italy	16840	23.486	1.39E-03
Germany	18032	21.830	1.21E-03
United Kingdom	18203	116.326	6.39E-03
		Average	*3.21E-03*

Obtained HCB emissions for 1990 and 2015 are equal to 10.88 kg and 5.530 x 10^{-2} kg, respectively. The emission decreased by 99.49%. Similar changes in HCB emissions were reported in Denmark's (-99.83%), Finland's (-98.18%) and Italy's (-98.34%) NFRs.

5.17. Agriculture Other (3.I)

This section includes use of ammonia-treated straw and other pollution sources, but those emissions have not been estimated.

5.18. Field Burning of Agricultural Residues (3.F)

5.18.1. Overview of the Category

Field burning of agricultural residues such as stubble, is forbidden by the order no. 269 on Environmental Protection Requirements for Burning Plants or Plants' Residues. Hundreds of hectares of stubble are burnt every year (see figure 56611). In 2015 area of fields where stubble was burnt increased 4.2 times compared to 2014 and was the largest in the last decade. In 2014 162.1 ha of stubble was burnt which is 49% more than in 1990 (108.7 ha).

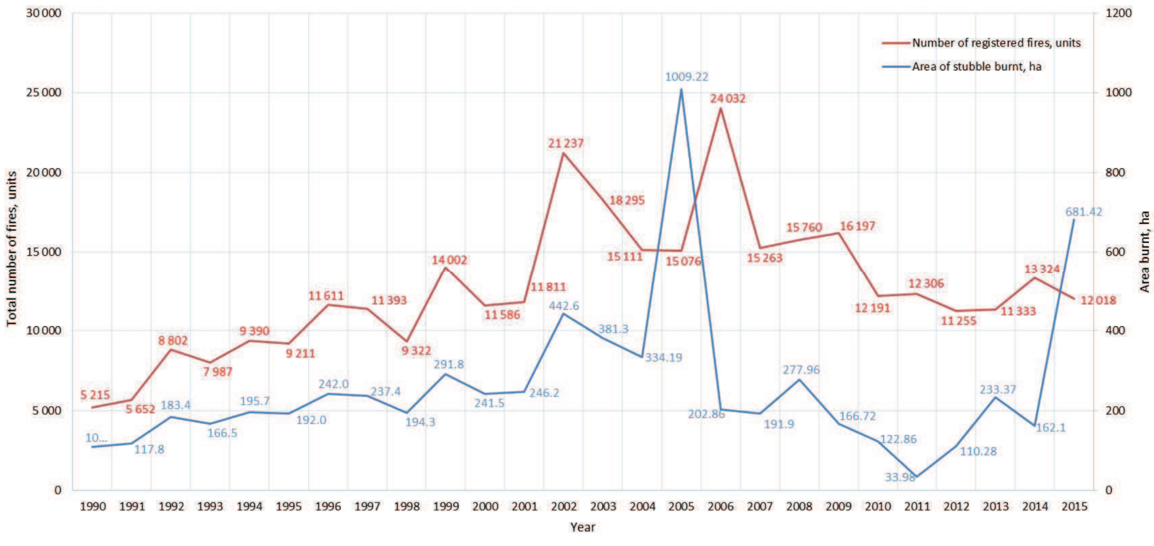


Figure 5.18-1 Figure 10: number of registered fires (units) – red curve and area of stubble burnt, ha (blue curve)

5.18.2. Methodology

Detailed information (number of fires, area in ares) for the period 2004 – 2015 was gathered from the Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania. For the remaining period 1990 – 2004 approximate area of stubble burnt was estimated using average area of stubble burnt per every fire registered (average was estimated from 2004 – 2015 data, equal to 0.02084 ha/fire).

In order to estimate amount of residue burnt guidebook's approach was used.

Equation. 5.8: $AR_{Residue\_Burnt} = A \times Y \times s \times d \times p_b \times C_f$,
where A is the area of land that was burnt (hectares);
Y is the yield of the crops (kg/ ha);
s is the ratio between the mass of the crop residues and the crop yield;
d is dry matter content;
p_b is proportion of residues that are being burnt;
C_f is the combustion factor.

Due to unavailability of detailed data default values for wheat combustion were used (as directed in the guidebook): $Y = 3.6$; $C_f = 0.9$; $s = 1.3$; $d = 0.85$; $p_b = 1$.
The mass of stubble residues burnt in 2015 is much larger than in 1990, but lower than in 2005. This directly affects pollutants emissions from this category. However, emissions are low and not significant in the context of the whole inventory.

Table 6.9: pollutant emissions and activity data of area and mass of residues burnt.

	1990	1995	2000	2005	2010	2013	2014	2015
Area of Stubble Burnt, h	108.7	192.0	241.5	1009.2	122.9	233.4	162.1	681.4
Residues Burnt, Gg	0.39	0.69	0.86	3.61	0.44	0.84	0.58	2.44
Emissions, Gg								
Nox	8.9E-04	1.6E-03	2.0E-03	8.3E-03	1.0E-03	1.9E-03	1.3E-03	5.6E-03
CO	2.6E-02	4.6E-02	5.8E-02	2.4E-01	2.9E-02	5.6E-02	3.9E-02	1.6E-01
NMVOC	1.9E-04	3.4E-04	4.3E-04	1.8E-03	2.2E-04	4.2E-04	2.9E-04	1.2E-03
Sox	1.9E-04	3.4E-04	4.3E-04	1.8E-03	2.2E-04	4.2E-04	2.9E-04	1.2E-03
NH3	9.3E-04	1.6E-03	2.1E-03	8.7E-03	1.1E-03	2.0E-03	1.4E-03	5.9E-03
TSP	2.3E-03	4.0E-03	5.0E-03	2.1E-02	2.6E-03	4.8E-03	3.4E-03	1.4E-02
PM10	2.2E-03	3.9E-03	4.9E-03	2.1E-02	2.5E-03	4.8E-03	3.3E-03	1.4E-02
PM2,5	2.1E-03	3.7E-03	4.7E-03	2.0E-02	2.4E-03	4.5E-03	3.1E-03	1.3E-02
BC	1.9E-04	3.4E-04	4.3E-04	1.8E-03	2.2E-04	4.2E-04	2.9E-04	1.2E-03
Emissions, Mg								
Pb	4.3E-05	7.6E-05	9.5E-05	4.0E-04	4.8E-05	9.2E-05	6.4E-05	2.7E-04
Cd	3.4E-04	6.0E-04	7.6E-04	3.2E-03	3.9E-04	7.4E-04	5.1E-04	2.1E-03
Hg	5.4E-05	9.6E-05	1.2E-04	5.1E-04	6.2E-05	1.2E-04	8.1E-05	3.4E-04
As	2.5E-06	4.4E-06	5.5E-06	2.3E-05	2.8E-06	5.3E-06	3.7E-06	1.6E-05
Cr	3.1E-05	5.5E-05	6.9E-05	2.9E-04	3.5E-05	6.7E-05	4.6E-05	2.0E-04
Cu	2.8E-05	5.0E-05	6.3E-05	2.6E-04	3.2E-05	6.1E-05	4.2E-05	1.8E-04
Ni	2.0E-05	3.6E-05	4.5E-05	1.9E-04	2.3E-05	4.3E-05	3.0E-05	1.3E-04
Se	7.8E-06	1.4E-05	1.7E-05	7.2E-05	8.8E-06	1.7E-05	1.2E-05	4.9E-05
Zn	2.2E-04	3.8E-04	4.8E-04	2.0E-03	2.5E-04	4.7E-04	3.2E-04	1.4E-03
Emissions, g								
PCDD/F	1.9E-04	3.4E-04	4.3E-04	1.8E-03	2.2E-04	4.2E-04	2.9E-04	1.2E-03
Emissions, Mg								
Benzo(a)	2.6E-02	4.7E-02	5.9E-02	2.4E-01	3.0E-02	5.7E-02	3.9E-02	1.7E-01
Benzo(b)	7.4E-02	1.3E-01	1.6E-01	6.8E-01	8.3E-02	1.6E-01	1.1E-01	4.6E-01
Benzo(z)	3.1E-02	5.5E-02	7.0E-02	2.9E-01	3.5E-02	6.7E-02	4.7E-02	2.0E-01
Indeno	2.3E-02	4.0E-02	5.0E-02	2.1E-01	2.5E-02	4.8E-02	3.4E-02	1.4E-01

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6. WASTE

6.1 Overview of the Sector

The waste section constitutes of the following categories:

6.3 Solid Waste Disposal on Land: Both Managed and Unmanaged (NFR 5.A);
6.4 Biological Treatment of Waste (NFR 5.B):
    Biological Treatment of Waste: Compost Production (NFR 5.B.1);
    Biological Treatment of Waste: Anaerobic Digestion (NFR 5.B.2);
6.5 Waste Incineration (5.C)
        Municipal Waste Incineration (NFR 5.C.1.a);
        Other Waste Incineration of (NFR 5.C.1.b):
            Ind. Wastes Incl. Hazardous and Sewage Sludge (NFR 5.C.1.b.i-ii);
            Clinical Waste (NFR 5.C.1.b.iii);
            Cremation (NFR 5.C.1.b.v);
    Open Waste Burning (NFR 5.C.2);
6.6 Wastewater Handling (NFR 5.D):
    Wastewater Treatment in Industry and Domestically (NFR 5.D.i-ii);
    Wastewater Treatment in Residential Sector: Latrines (NFR 5.D.iii);
6.7 Other Waste, Incl. House, Industrial and Car Burns (NFR 5.E).

Emissions from the processes included under the *Waste* sector contribute a relatively small part to the total inventory. There are not many facilities which fall under this category. Emissions emerging from some of the facilities, e.g., UAB Toksika and UAB Fortum Klaipeda, which incinerate waste with energy recovery are reported under the 1A1a category.

For this submission emissions from *NFR 5B2 Biological treatment of waste – Anaerobic digestion at biogas facilities*, *5.C.2 Open burning of waste, 5D3 Other wastewater handling – latrines,* and *5E Other waste* categories were estimated, while other categories were recalculated.

The main information on the waste production, management and reuse is available on Lithuanian Environmental Protection Agency‘s website, waste register [1]. Demographic information was taken from Lithuania‘s Statistics Department (LTSTD) [2]. Data on the part of population using latrines was collected from 2016 GHG NIR [3]. Also, figures on waste production, management and reuse has been double-checked with GHG NIR. Statistics of car, house, industrial and other fires were gathered from Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania [4].

6.2 Methodology

Pollutant emissions from the waste production, management, and reuse were estimated using the 2016 EMEP/EEA Air Pollutant Emission Inventory Guidebook, the 2006 IPCC Guidelines and the 2000 IPCC Good Practice Guidance. Statistical data reported in IIR/NFR (Informative

Inventory Report) are consistent with the information in the GHG (Green-House Gas) NIR/CRF (National Inventory Report) where applicable.

6.3 Solid Waste Disposal on Land: Managed and Unmanaged (5.A)

6.3.1. Overview of the Section

This category addresses emissions from waste disposal on land. Relatively small amounts of pollutants, mainly NMVOC which emissions decreased by about 52.3% from 2005 to 2015, are emitted from this category. Such reduction of NMVOC emissions is a major improvement and is associated with the waste treatment and recovery using other, more environmental friendly methods, such as recycling. TSP and PM levels were estimated as well.

Waste is managed according to waste disposal and recovery operations stated by the national law no. 217 [5]. Please refer to the table below for more information on the operations. Waste statistics are collected and stored according to European waste list adopted by the European Commission [111]. [111] http://eur-lex.europa.eu/legal-content/GA/TXT/?uri=CELEX:32000D0532 Statistics are collected and archived by the Lithuanian Environmental Protection Agency.

Table. Average composition of MSW in Lithuania

Ingredient	Amount
Plastic	9%
Paper and cardboard	14%
Glass	9%
Metal	3%
Textile	4%
Biodegradable (kitchen) waste	42%
Composite packaging	2%
Construction and demolition waste	4%
Hazardous waste	2%
Leather, rubber	1%
Wood	2%
Sand, sweepings	4%
Other	4%

Table 6.1: waste disposal and recovery operations.

Waste disposal operations	
D 1	Deposit into or on to land (e.g. landfill, etc.)
D 2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils, etc.)
D 3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories, etc.)
D 4	Surface impoundment (e.g. placement of liquid or sludgy discards into pits, ponds or lagoons, etc.)
D 5	Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc.)
D 6	Release into a water body except seas/oceans
D 7	Release to seas/oceans including sea-bed insertion
D 8	Biological treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D 1 to D 12
D 9	Physico-chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D 1 to D 12 (e.g. evaporation, drying, calcination, etc.)
D 10	Incineration on land
D 11	Incineration at sea
D 12	Permanent storage (e.g. emplacement of containers in a mine, etc.)
D 13	Blending or mixing prior to submission to any of the operations numbered D 1 to D 12
D 14	Repackaging prior to submission to any of the operations numbered D 1 to D 13
D 15	Storage pending any of the operations numbered D1 to D 14 (excluding temporary storage, pending collection, on the site where the waste is produced)
Waste recovery operations	
R 1	Use principally as a fuel or other means to generate energy
R 2	Solvent reclamation/regeneration
R 3	Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)
R 4	Recycling/reclamation of metals and metal compounds
R 5	Recycling/reclamation of other inorganic materials
R 6	Regeneration of acids or bases
R 7	Recovery of components used for pollution abatement
R 8	Recovery of components from catalysts
R 9	Oil re-refining or other reuses of oil
R 10	Land treatment resulting in benefit to agriculture or ecological improvement
R 11	Use of waste obtained from any of the operations numbered R 1 to R 10
R 12	Exchange of waste for submission to any of the operations numbered R 1 to R 11
R 13	Storage of waste pending any of the operations numbered R 1 to R 12 (excluding temporary storage, pending collection, on the site where the waste is produced)

Methodology

Tier 1 approach with default pollutant emission factors was used for both managed and unmanaged solid waste disposal. Information on the waste disposal from 1991 to 2014 was taken from the 2016 GHG report and compared with data gathered from Lithuanian EPA database. It was assumed that identical amount of waste was disposed on 1990 as on 1991 and on 2015 as on 2014 as no information was available at the time. From 2004 data classified under D1 (*Deposition into or on to land (e.g. landfill, etc.)*) and D5 (*Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc.)*) was considered.

Equation 6.1: $E_{Pollutant} = AR_{Waste} \times EF_{Pollutant} \times Conversion\ Factor$,
where $E_{Pollutant}$ is emission of specific pollutant in Gg;
AR_{Waste} is activity data (waste disposed) in kg mega grams;
$EF_{Pollutant}$ is the emission factor for specific pollutant;
Conversion Factor is number which converts units to Gg.

There is a declining trend in amounts of waste disposal on land. Wastes are not disposed in unmanaged and semi-aerobically managed ways. The unmanaged waste amounts dropped from 231.8 Gg in 2007 to 69.5 Gg in 2008 and 0.0 Gg in 2010. The amounts of anaerobically managed waste decreased significantly as well (e.g. in 2014 compared with 2010 waste amount reduced by 51%). This change can be attributed to the improved landfills compliance with the EU landfill directive 1999/31/EC.

Table 6.2: activity data and estimated emissions from solid waste disposal on land

		1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Activity data, Gg	Solid waste disposal								
	Managed anaerobic	757.6	687.7	785.8	670.1	1062.6	661.9	524.5	524.5
	Managed semi-aerobic	243.5	221.0	252.6	195.1	0.0	0.0	0.0	0.0
	Unmanaged	252.8	237.7	276.1	233.5	0.0	0.0	0.0	0.0
	Sewage sludge disposal								
	Unmanaged deep, >5m	53.2	83.4	84.4	36.5	32.7	24.8	8.6	8.6
	Unmanaged shallow, <5m	143.9	225.5	228.3	98.6	88.4	67.0	23.2	23.2
	Total	**1451.0**	**1455.3**	**1627.2**	**1233.8**	**1183.6**	**753.7**	**556.2**	**556.2**
Emissions, Gg									
Pollutant	**NMVOC**	2.26	2.27	2.54	1.92	1.85	1.18	0.87	0.87
	TSP	6.7E-04	6.7E-04	7.5E-04	5.7E-04	5.5E-04	3.5E-04	2.6E-04	2.6E-04
	PM10	3.2E-04	3.2E-04	3.6E-04	2.7E-04	2.6E-04	1.7E-04	1.2E-04	1.2E-04
	PM2.5	4.8E-05	4.8E-05	5.4E-05	4.1E-05	3.9E-05	2.5E-05	1.8E-05	1.8E-05

6.4 Biological Treatment of Waste (5.B)

6.4.1. Overview of the Sector

This section addresses emissions from biological treatment of waste by composting and anaerobic digestion with biogas production. The ammonia emissions from these categories are relatively small, although NH_3 emissions for the period from 2005 to 2015 have increased more than 3 times (to 0.049 Gg in 2015).

6.5. Compost Production (5.B.1)

6.5.1. Overview of the section

The waste reporting regulations have changed several times since the independence of Lithuania:

- Recording of waste disposal and recovery started in 1991. From 1991 to 1999 composted waste was included under *R15* category – composting. Value of waste composted in 1990 was chosen to be identical as in 1991;
- From 2000 to 2004 composting was reported under *3.2* category – biological treatment of non-hazardous waste;
- With entry to the EU in 2004 waste framework directive 75/442/EEC (now 2008/98/EC [6]) was adopted and composting has been recorded under *R3* category – recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

6.4.2. Methodology

Data on the compost production was gathered from 2016 GHG report. Tier 1 emission factor from 2016 EMEP/EEA guidebook was used to estimate ammonia emissions from 1990 to 2015.

Please see table below for NH_3 emissions from 1990. The 2005/2015 emissions increased almost 3 times. However, this category is only a minor contributor to the total inventory.

Table 6.3: amount of compost produced (Gg) and according amounts of ammonia released.

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Activity data, Gg	40.37	53.59	19.96	68.75	65.91	121.78	204.43	204.43
NH_3 emissions, Gg	**0.010**	**0.013**	**0.005**	**0.016**	**0.016**	**0.029**	**0.049**	**0.049**

6.5. Anaerobic Digestion (5.B.2)

Biofuel, including biogas, production has become very popular in Lithuania. There is a financial support from the national budget provided to biofuel (rapeseed-based) producers according to order no. 3D-417 issued by the minister of the Ministry of Agriculture of the Republic of Lithuania [7].

The biogas production involves anaerobic digestion of waste (biomass) with release of methane as major component gas, which after purification and removal of pollutants (e.g., Sulphur) can be burnt to release energy. Biogas plants, which only collect gas and/or burn it for energy, are included under 1.A.1.a category. Most of these plants (currently 9 operating [ssss]) are built in existing or closed landfills (examples of operating plants in Lithuania include landfills in Vilnius (Kazokiskes), Klaipeda (Kalote and Dumpiu), Kaunas (Lapiu) and other).

Biogas production from anaerobic digestion started in 2002. Currently there are 12 biogas generating facilities in agricultural sector [8] which do not exploit all the production potential. However, in the recent Lithuanian country-side development 2014 – 2020 programme support for biogas production from agricultural and other wastes is foreseen [9]. This programme focusses on the improvement of establishment conditions of biogas plants in the largest animal-breeding facilities. There were 7 biogas generating facilities in Idavang pig farms (manure and silage based), Kurana (plant waste based), Vilniaus Degtine (spirits production waste), Rokiskio suris (milk and cheese waste) and Agaras (carcass based).

There are also few water treatment facilities which produce biogas from sewage sludge treatment. Gas generated form anaerobic treatment of biogenic material is then cleaned and combusted or sold/transferred to other facilities. Major companies in Lithuania are: Kauno vandenys, Aukstaitijos Vandenys and Utenos Vandenys [10].

6.5.1. Methodology

Information on the biogas production from treatment of agricultural (i.e., food, manure, slurry, other household and crop) wastes and sewage sludge wastes (such as floatation sludge) can be accessed at the Statistics Lithuania on the fuel balance datasheet. However, no other details (e.g. dry matter in the sludge, nitrogen content and other) are available thus increasing uncertainty and reducing quality of the results.

Volumes of biogas produced were gathered from the Statistics Lithuania. In order to estimate emissions from the biogas production according to the methodology provided in the 2016 EMEP/ EEA guidebook, the biogas volume was converted to approximate amount of biogenic material.

Firstly, the gas volume was converted to the mass of dry matter. For biogas produced from agricultural wastes conversion factors of pig slurry, cattle slurry, maize and grass wastes, and household wastes were averaged. Averaged value equaled to 0.444 m^3 of biogas/ kg of DM. For sewage sludge averaged conversion factor equaled to 0.635 m^3/ kg of DM and equal to conversion factor of floatation sludge.

It was assumed that DM content in the biogenic material is 9% on average which depends on biogas production mechanism. Obtained values were assumed to be equal to the amount of biogenic material and liquid digestate used in the biogas production.

Activity data with 2016 EMEP/ EEA guidebook tier 2 emission factors for storage (before digestion) biogenic material and liquid digestate storage (after digestion) were used. The sum of the mentioned tier 2 emission factors was applied in the following equation:

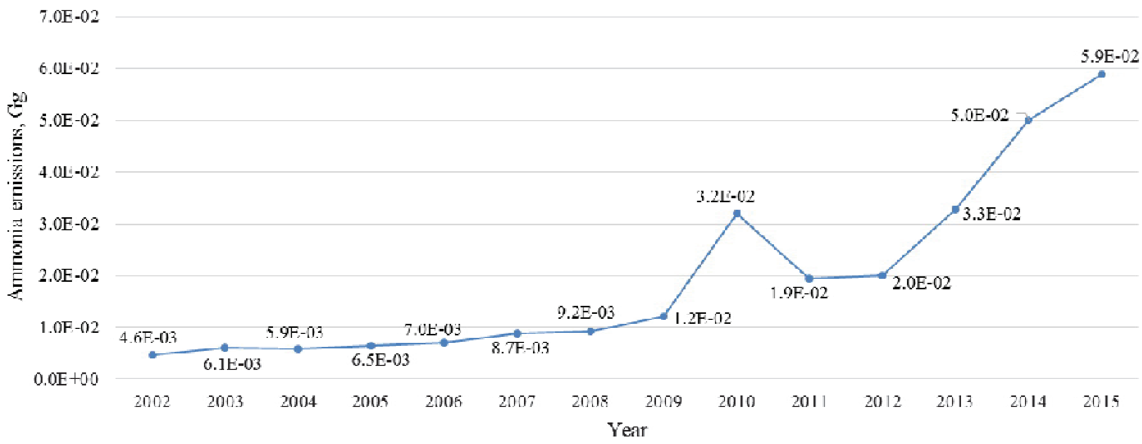
Equation: $E_{Biogas\_NH3} = EF_{Default\_NH3} \times AD_{Total\ Biogas\ Production} \times Conversion\ Factor;$

Where E_{Biogas_NH3} is ammonia emissions from biogas production (Gg);
$EF_{Default\_NH3}$ is the sum of the two emission factors from the 2016 EMEP/EEA guidebook;
$AD_{Total\ Biogas\ Production}$ is converted activity data from National Statistics;

Conversion Factor is the number to convert units to Gg per year.

6.5.2. Activity Data

Figure 6.1: NH_3 emissions (in Gg) from the anaerobic digestion of agricultural and sewage sludge wastes.



The figure above shows emission from the 5.B.2 *Anaerobic digestion* category from 2002 to 2015. Biogas production amounts during 1990 – 2002 were estimated to be 0 by the Statistics Lithuania. The biogas production from 2002 to 2015 increased by almost 10 times resulting in according ammonia emissions increase.

6.6. Waste Incineration (5.C)

6.6.1. Overview of the Sector

Emissions from waste incineration in Lithuania contribute only a small amount of the total pollutant emissions. With no municipal waste incineration, amounts of industrial waste and clinical waste incinerated have decreased resulting in smaller pollutant emissions. Emissions from *NFR 5.C.1.b.i* – ii categories decreased by about 18.3% from 2005 to 2015. Emissions from cremation (*NFR 5.C.1.b.v*) are small as well.

6.7. Municipal Waste Incineration (NFR 5.C.1.A)

6.7.1. Overview of the Sector

Emissions from municipal waste incineration were recalculated. In 1990 only 2.5 tons of waste was burnt without energy recovery. It was assumed that minimal abatement technologies were used at that time.

In 2015 UAB Fortum Klaipeda was the major company incinerating municipal/ industrial waste (non-hazardous municipal and non-hazardous industrial) with energy recovery, thus emissions from UAB Fortum Klaipeda are reported under 1.A.1.a category and 5.C.1.A is labelled as NO. The company started operating in 2013 and has been incinerating 140 – 300 thousand tons of waste and biomass every year. Sophisticated technologies are installed in the company to minimize air pollution from the process:

- Natural gas is used during incineration initiation and termination;
- First chamber incineration temperature is 850 – 1100°C;
- Waste separation, size reduction and mixing;
- Semi-dry smoke technology equipment with CaO and active carbon reagents, fabric filter and SNKR – selective non catalytic reduction;
- And other.

In 2014 facility incinerated 22.8 Gg of non-hazardous industrial waste and 119.7 Gg of non-hazardous municipal waste: cardboard and paper waste, organic waste, flammable waste, mechanically processed waste, textile waste and other.

From 2015 UAB Toksika started incinerating hazardous waste with energy recovery. Therefore, part of the emissions from the facility will be reported under the *NFR 1A1a* category.

6.7.2. Methodology

Activity data and information on the UAB Fortum Klaipeda were obtained from Lithuanian Environmental Protection Agency database

There has not been any waste incinerations in Lithuania since 2000, thus this category is labelled as NO in the NFR for years after 1999. Until year 2000 default emission factors incorporated into eq. 6.1 were used to determine pollutants' emissions. Data was collected from Lithuania's EPA waste management database.

6.8. Industrial Waste Incineration (NFR 5.C.1.B.i)

6.8.1. Overview of the Sector

In 2015 UAB Toksika and UAB Fortum Klaipeda incinerated industrial waste. However, no emissions are reported under this category as UAB Fortum Klaipeda burns non-hazardous waste with energy recovery, while UAB Toksika incinerates hazardous and medical waste. No information on how much industrial waste was burnt in 1990 was available. Industrial waste incinerated before 2000 was reported as included elsewhere as there was no separation at the time between incinerated municipal and industrial waste. Therefore, emissions from all industrial and municipal waste incinerated are reported under NFR 5C1A category.

6.8.2. Methodology

See 5.C.1.B.iii for details.
See details under 5.C.1.B.iii.

6.9. Hazardous Waste Incineration (NFR 5.C.1.B.ii)

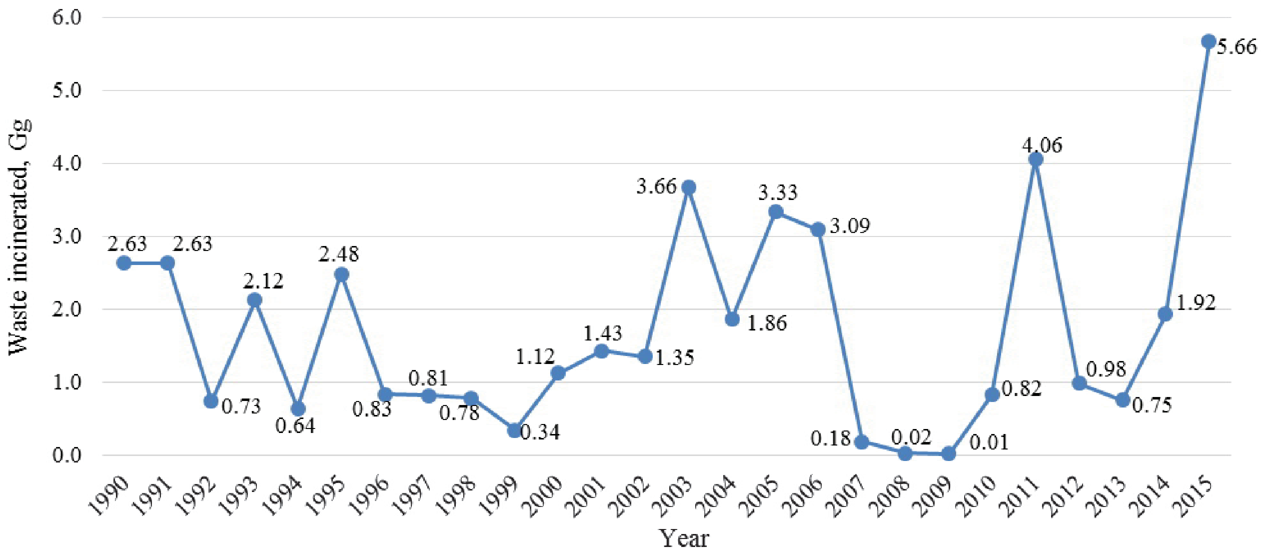
6.9.1. Overview of the Sector

Hazardous waste has been incinerated throughout all Lithuania's Independence since 1990 with the largest amount (5.66 kt) incinerated in 2015. Only one company UAB Toksika incinerates hazardous waste in Lithuania. Major hazardous wastes that were incinerated in UAB Toksika in 2015 were:

- Absorbent, filter material, wiping clothes, protective clothing all of which are contaminated with hazardous chemicals (28.8% of the total);
- Contaminated wood, sawdust, and other wood by-products (24.9% of the total).

Please see next section *Clinical Waste Incineration (NFR 5.C.1.B.iii)* for more details.

Figure 6.2: hazardous waste incinerated (Gg) 1990-2015.



6.9.2. Methodology

Activity data for 1990-2015 was obtained from Lithuanian EPA. For the period before 2013 when UAB Toksika started incinerating hazardous waste, emissions from this category were estimated using tier 1 emission factors from the 2016 EMEP/EEA guidebook. For the activity data gathered from UAB Toksika upper values of tier 1 emission factors were used.

Emissions from this source are relatively small when taking into account whole inventory. In 2015 emissions from this category contributed less than 1% of the total emissions, although 2005/2015 emissions increased by almost 70%.

Figure 6.4: pollutants emissions (Gg) from hazardous waste incineration.

		1990	1995	2000	2005	2010	2013	2014	2015
	Hazardous waste	2.63	2.48	1.12	3.33	0.82	0.75	1.92	5.66
Pollutant	Emissions, Gg								
	NO_x	2.29E-02	2.15E-02	9.76E-03	2.90E-02	7.16E-03	6.55E-03	1.67E-03	4.93E-03
	CO	1.84E-03	1.73E-03	7.85E-04	2.33E-03	5.76E-04	5.27E-04	1.35E-04	3.96E-04
	NMVOC	1.95E-01	1.83E-01	8.30E-02	2.47E-01	6.09E-02	5.57E-02	1.42E-02	4.19E-02
	SO_2	1.24E-03	1.16E-03	5.27E-04	1.57E-03	3.87E-04	3.54E-04	9.04E-05	2.66E-04
	TSP	6.05E-03	5.70E-03	2.58E-03	7.67E-03	1.89E-03	1.73E-03	1.92E-05	5.66E-05
	PM_{10}	3.95E-04	3.72E-04	1.68E-04	5.00E-04	1.23E-04	1.13E-04	1.35E-05	3.96E-05
	$PM_{2.5}$	2.63E-04	2.48E-04	1.12E-04	3.33E-04	8.23E-05	7.52E-05	7.69E-06	2.27E-05
	BC	1.84E-05	1.73E-05	7.85E-06	2.33E-05	5.76E-06	5.27E-06	2.69E-07	7.93E-07
	Emissions, Mg								
	Pb	5.00E-03	4.71E-03	2.13E-03	6.33E-03	1.56E-03	1.43E-03	2.50E-03	7.36E-03
	Cd	3.95E-04	3.72E-04	1.68E-04	5.00E-04	1.23E-04	1.13E-04	1.92E-04	5.66E-04
	Hg	2.10E-04	1.98E-04	8.98E-05	2.67E-04	6.58E-05	6.02E-05	1.08E-04	3.17E-04
	As	5.00E-05	4.71E-05	2.13E-05	6.33E-05	1.56E-05	1.43E-05	3.08E-05	9.06E-05
	Ni	5.00E-04	4.71E-04	2.13E-04	6.33E-04	1.56E-04	1.43E-04	2.69E-04	7.93E-04
	PAHs	1.58E-04	1.49E-04	6.73E-05	2.00E-04	4.94E-05	4.51E-05	3.85E-05	1.13E-04
	Emissions, kg								
	HCB	0.053	0.050	0.022	0.067	0.016	0.015	0.004	0.011
	Emissions, g								
	PCDD/F	0.921	0.867	0.393	1.167	0.288	0.263	0.019	0.057

6.10. Clinical Waste Incineration (NFR 5.C.1.B.iii)

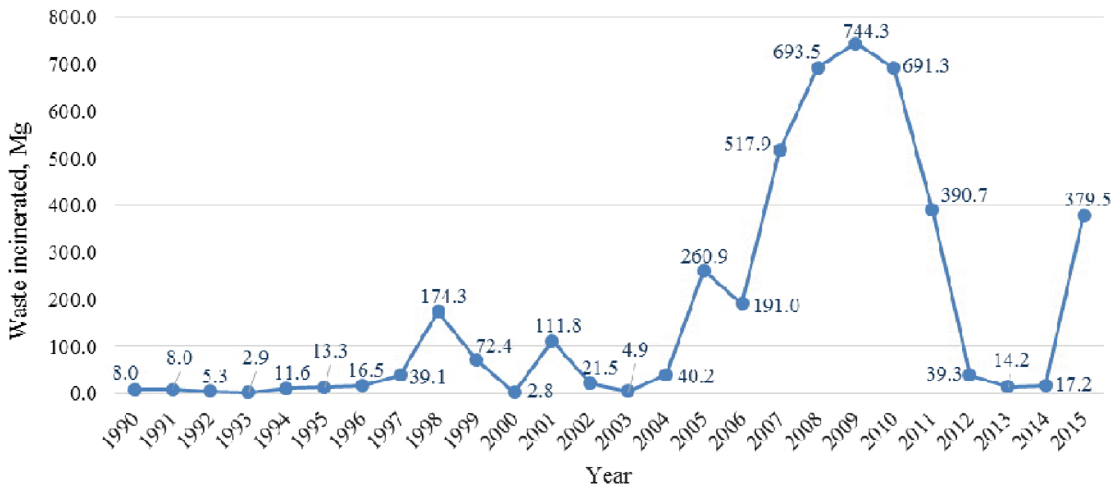
6.10.1. Overview of the Sector

UAB Toksika is one of the major broad spectrum waste burning facilities in Lithuania at the moment, incinerating up to 3 kilotons of waste per year. Waste that is burnt includes industrial and medical wastes. It is described under this category as the incinerator used for waste combustion is adapted for medical waste incineration (rotary kiln incinerator with sophisticated abatement technologies).

The following abatement is used to minimize emissions from incineration:

- Smoke from incineration is treated using semi-dry scrubbers (consisting of absorption part with NaOH solution injection and second – with NaHCO3 and activated carbon injection system), fabric filter (FF), wet smoke-cleaning system/ scrubber (spray tower), selective non-catalytic reduction (SNCR) system and catalytic (TiO2 + WO3 + V2O5);
- Temperature in the secondary incineration camera is maintained at 850 - 1100°C;
- Constant pollutant monitoring;
- And other.

Figure 6.5: amounts (Mg) of clinical waste incinerated from 1990 to 2015.



6.10.2. Methodology

Activity data was gathered from Lithuanian Environmental Protection Agency's database. No detailed information on the facilities which incinerated clinical waste in 1990 is available, thus it was assumed that no abatement technologies were used resulting in application of tier 1 emission factors for year 1990. In 2015 medical waste was burnt in UAB Toksika which technical specifications are available in Impact on the Environment Report (IER), Inventorization Report (IR) and Integrated Pollutant Prevention and Control (IPPC) permit. Sophisticated abatement technologies are used in the facility thus emission factors for controlled incineration in rotary kiln with SD/ CI/ FF abatement from USA EPA 1993 guidelines were used to estimate emission for 2014 and 2015.

Emissions before 2014 were estimated using 1993 USA EPA guidelines for controlled incineration with uncontrolled emissions.
Emissions from this category contribute a minor amount to the total inventory. 54.3% increase is observed in pollutants emissions from 2005 to 2015. Please see table below.

Table 6.3: pollutants' emissions from clinical waste incineration.

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Emissions, Gg								
NO_x	1.8E-05	3.1E-05	6.4E-06	6.0E-04	1.6E-03	3.3E-05	4.2E-05	9.3E-04
CO	1.5E-06	2.5E-06	5.3E-07	5.0E-05	1.3E-04	2.7E-06	4.3E-07	9.5E-06
NMVOC	5.6E-06	9.3E-06	1.9E-06	1.8E-04	4.8E-04	9.9E-06	1.2E-05	2.7E-04
SO_2	4.3E-06	7.2E-06	1.5E-06	1.4E-04	3.8E-04	7.7E-06	2.6E-06	5.7E-05
TSP	1.4E-04	2.3E-04	4.8E-05	4.5E-03	1.2E-02	2.5E-04	6.5E-07	1.4E-05
BC	3.2E-06	5.3E-06	1.1E-06	1.0E-04	2.8E-04	5.7E-06	1.5E-08	3.3E-07
Emissions, Mg								
Pb	5.0E-04	8.2E-04	1.7E-04	1.6E-02	4.3E-02	8.8E-04	6.3E-07	1.4E-05
Cd	6.0E-05	1.0E-04	2.1E-05	2.0E-03	5.2E-03	1.1E-04	2.1E-07	4.6E-06
Hg	3.5E-04	5.8E-04	1.2E-04	1.1E-02	3.0E-02	6.2E-04	6.3E-06	1.4E-04
As	1.3E-06	2.2E-06	4.6E-07	4.3E-05	1.1E-04	2.4E-06	2.9E-06	6.3E-05
Cr	1.8E-05	2.9E-05	6.1E-06	5.8E-04	1.5E-03	3.1E-05	6.6E-07	1.5E-05
Cu	7.8E-04	1.3E-03	2.7E-04	2.5E-02	6.8E-02	1.4E-03	3.5E-06	7.8E-05
Ni	1.4E-05	2.3E-05	4.9E-06	4.6E-04	1.2E-03	2.5E-05	3.1E-07	6.8E-06
PAHs	3.2E-07	5.3E-07	1.1E-07	1.0E-05	2.8E-05	5.7E-07	6.9E-10	1.5E-08
Emissions, kg								
PCB	1.6E-04	2.7E-04	5.5E-05	5.2E-03	1.4E-02	2.8E-04	3.4E-04	7.6E-03
HCB	8.0E-04	1.3E-03	2.8E-04	2.6E-02	6.9E-02	1.4E-03	1.7E-03	3.8E-02
Emission, g-I TEQ								
PCDD/F	3.2E-01	5.3E-01	1.1E-01	1.0E+01	2.8E+01	5.7E-01	9.0E-03	2.0E-01

6.11. Sewage Sludge Incineration (NFR 5.C.1.B.iv)

6.11.1. Overview of the Sector

Sewage sludge from waste water treatment was incinerated in early 1990s (1990 – 1994) and only quantities incinerated are available. There are no currently operating sewage sludge incineration facilities in Lithuania. Although small amounts of sewage sludge have been incinerated since Toksika opening in 2013, the facility incinerates small quantities of contaminated sewage sludge, thus it is not separated under this category but included in *Hazardous waste incineration* (NFR 5.C.1.b.iii).

6.11.2. Methodology

Activity data was obtained from Lithuanian Environmental Protection Agency.
In 1990 12.45 t of sewage sludge was incinerated. Tier 2 emission factors from 2016 EMEP/ EEA guidebook were used to estimate emissions for 1990-1994. After 1995 sewage sludge was not incinerated, thus emissions were reported as not occurring.

Time Series

Table 6.6: activity data and emission arising from sewage sludge incineration.

	1990	1991	1992	1993	1994
Sewage sludge incinerated, kt	*0.0125*	*0.0125*	*0.3202*	*0.3000*	*0.0474*
			Gg		
NO(x)	3.11E-05	3.11E-05	8.01E-04	7.50E-04	1.19E-04
CO	1.93E-04	1.93E-04	4.96E-03	4.65E-03	7.35E-04
NMVOC	1.05E-05	1.05E-05	2.69E-04	2.52E-04	3.98E-05
SO_2	1.74E-04	1.74E-04	4.48E-03	4.20E-03	6.64E-04
TSP	6.47E-04	6.47E-04	1.67E-02	1.56E-02	2.47E-03
PM_{10}	5.10E-05	5.10E-05	1.31E-03	1.23E-03	1.94E-04
$PM_{2.5}$	1.37E-05	1.37E-05	3.52E-04	3.30E-04	5.22E-05
BC	4.79E-07	4.79E-07	1.23E-05	1.16E-05	1.83E-06
			Mg		
Pb	6.23E-04	6.23E-04	1.60E-02	1.50E-02	2.37E-03
Cd	1.99E-04	1.99E-04	5.12E-03	4.80E-03	7.59E-04
Hg	2.86E-05	2.86E-05	7.36E-04	6.90E-04	1.09E-04
As	5.85E-05	5.85E-05	1.50E-03	1.41E-03	2.23E-04
Cr	1.74E-04	1.74E-04	4.48E-03	4.20E-03	6.64E-04
Cu	4.98E-04	4.98E-04	1.28E-02	1.20E-02	1.90E-03
Ni	9.96E-05	9.96E-05	2.56E-03	2.40E-03	3.79E-04
Se	1.87E-06	1.87E-06	4.80E-05	4.50E-05	7.11E-06
Zn	8.22E-04	8.22E-04	2.11E-02	1.98E-02	3.13E-03
			kg		
PCBs	5.60E-05	5.60E-05	1.44E-03	1.35E-03	2.13E-04
HCB	5.85E-05	5.85E-05	1.50E-03	1.41E-03	2.23E-04
			g		
PCDD/F	5.79E-02	5.79E-02	1.49E+00	1.40E+00	2.21E-01
			Mg		
Benzo(a)pyrene	6.35E-09	6.35E-09	1.63E-07	1.53E-07	2.42E-08
Benzo(b)pyrene	8.72E-10	8.72E-10	2.24E-08	2.10E-08	3.32E-09
Benzo(k)pyrene	7.59E-09	7.59E-09	1.95E-07	1.83E-07	2.89E-08
Indeno(1,2,3-cd)pyren	1.25E-09	1.25E-09	3.20E-08	3.00E-08	4.74E-09
4 PAHs	1.61E-08	1.61E-08	4.13E-07	3.87E-07	6.12E-08

6.12. Cremation (5.C.1.b.v);

6.12.1. Overview of the Section

There is only one cremation company in Lithuania AB K2 LT. The facility's construction was finished in the late 2011 after Lithuanian government passed a law on cremation service in 2007. There are sophisticated incineration and pollution prevention technologies installed in the facility, i.e.:

- Electromechanic loading mechanism with hermetical loading cell doors, which prevent coffin incineration in the cremation cell and smoke in gas incineration cell below minimal temperature (650°C and 850°C, respectively);
- The gas incineration cell (at 850 - 900°C) is used to burn smoke emitted in the coffin incineration cell;
- Smoke cleaning system consists of cyclone, chemicals' addition to neutralize pollutants, reactor with spherical rotator for effective chemical additives use in circulation process and fabric filter. Gas cleaning system is mainly used to reduce particulate matter and dioxin/furan emissions. Sorbalit® 30% (activated carbon) is used in the process among other chemicals.
- And other.

Natural gas is used for body combustion in the facility.

6.12.2. Methodology

JSC K2 LT provides information in the Inventorization reports on the estimation of several pollutants from the facility and how/from what sources those pollutants are emitted. However, only 6 pollutants' emissions were predicted (NO_x, NMVOC, SO_x, TSP, CO, and Hg). It is also noted that no PCDD/PCDF emissions were detected. Guidebook-provided, default tier 1 emission factors with facility-level projected abatement efficiency (85 %) were used in equation 6.1.

Table 6.7: activity data (number of cremations) and emitted pollutants (mass units) from the cremation process.

	2011	2012	2013	2014	2015	Projected annual emissions predicted by the company (year 2016)
Activity Data, no. of cremations	120	1423	2118	2770	3502	
			Emissions, Gg			
Nox	1.5E-05	1.8E-04	2.6E-04	3.4E-04	4.3E-04	5.4E-06
NMVOC	2.3E-07	2.8E-06	4.1E-06	5.4E-06	6.8E-06	1.3E-08
SO2	2.0E-06	2.4E-05	3.6E-05	4.7E-05	5.9E-05	4.3E-08
PM2,5	6.2E-07	7.4E-06	1.1E-05	1.4E-05	1.8E-05	-
PM10	6.2E-07	7.4E-06	1.1E-05	1.4E-05	1.8E-05	-
TSP	6.9E-07	8.2E-06	1.2E-05	1.6E-05	2.0E-05	5.0E-08
CO	2.5E-06	3.0E-05	4.4E-05	5.8E-05	7.4E-05	1.6E-08
			Emissions, Mg			
Pb	5.4E-07	6.4E-06	9.5E-06	1.2E-05	1.6E-05	-
Cd	9.1E-08	1.1E-06	1.6E-06	2.1E-06	2.6E-06	-
Hg	2.7E-05	3.2E-04	4.7E-04	6.2E-04	7.8E-04	1.0E-09
As	2.4E-07	2.9E-06	4.3E-06	5.7E-06	7.1E-06	-
Cr	2.4E-07	2.9E-06	4.3E-06	5.6E-06	7.1E-06	-
Cu	2.2E-07	2.7E-06	3.9E-06	5.2E-06	6.5E-06	-
Ni	3.1E-07	3.7E-06	5.5E-06	7.2E-06	9.1E-06	-
Se	3.6E-07	4.2E-06	6.3E-06	8.2E-06	1.0E-05	-
Zn	2.9E-06	3.4E-05	5.1E-05	6.7E-05	8.4E-05	-
			Emissions, g I-TEQ			
PCDD/F	4.9E-07	5.8E-06	8.6E-06	1.1E-05	1.4E-05	-
			Emissions, Mg			
Benzo(a)pyrene	2.4E-10	2.8E-09	4.2E-09	5.5E-09	6.9E-09	-
Benzo(b)fluoranthene	1.3E-10	1.5E-09	2.3E-09	3.0E-09	3.8E-09	-
Benzo(k)fluoranthene	1.2E-10	1.4E-09	2.0E-09	2.7E-09	3.4E-09	-
Indeno(1,2,3-cd)pyrene	1.3E-10	1.5E-09	2.2E-09	2.9E-09	3.7E-09	-
			Emissions, kg			
HCB	2.7E-06	3.2E-05	4.8E-05	6.2E-05	7.9E-05	-
PCB	2.9E-03	3.4E-02	5.1E-02	6.7E-02	8.4E-02	-

6.13. Open Burning of Waste (NFR 5.C.2)

6.13.1. Overview of the Sector

Order no. 269 on Environmental Protection Requirements for Burning Plants or Plants' Residues forbids to incinerate more than 5m^3 of agricultural wastes and any incineration of municipal or industrial wastes. Open small-scale waste burning including burning of crop residues, wood, plastics, other biomass and general waste statistics are not available on national and institutional databases. Emissions from this category were estimated using other countries NFR data - pollutant emissions from this sub-sector reported by other countries.

6.13.2. Methodology

Emissions from open waste burning category were calculated based on the averaged pollutant emissions per 1000 people. Population sizes for individual countries on specific years were taken from EUROSTAT database. Example of the process is shown in the table below.

Averaged values were used with population size in Lithuania on specific year (number of inhabitants on the 1st of January represented population size in the previous year).
Table 6.8: PCDD/ PCDF emissions per 1000 inhabitants per different country for year 1990.

Country	*Population, 1000 inhabitants*	*PCDD/PCDF emission (1990), g I-TEQ*	*Percentage contribution to the inventory, %*	*PCDD/ PCDF emission per 1000 people (g I-TEQ/ 1000 inhabitants)*
France	58313.439	40.03	2.25	6.87E-04
United Kingdom	57338.199	51.17	3.93	8.92E-04
Italy	56744.119	6.76	1.34	1.19E-04
Spain	38881.416	25.76	14.27	6.63E-04
Poland	38183.16	1.70	0.61	4.44E-05
Hungary	10373.153	0.89	0.79	8.61E-05
Ireland	3520.977	0.94	1.39	2.66E-04
			Average	*3.94E-04*

Table 6.9: estimated pollutants emissions and 2015/1990 changes from the category are shown below.

	1990	**1995**	**2000**	**2005**	**2010**	**2013**	**2014**	**2015**	**Change 2015/ 1990, %**
Emissions, Gg									
NOx (as NO2)	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	*-22.6*
NMVOC	0.17	0.12	0.09	0.09	0.09	0.08	0.08	0.08	*-52.7*
SOx (as SO2)	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	*-98.6*
NH3	NE	NE	NE	NE	NE	NE	NE	NE	*-*
PM2.5	0.13	0.13	0.12	0.11	0.10	0.10	0.10	0.10	*-23.2*
PM10	0.14	0.14	0.13	0.12	0.11	0.11	0.11	0.11	*-23.1*
TSP	0.15	0.15	0.13	0.13	0.12	0.12	0.12	0.11	*-23.2*
BC	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	*-33.6*
CO	1.44	1.26	1.11	1.26	1.15	1.14	1.09	1.08	*-25.3*
Emissions, Mg									
Pb	0.18	0.08	0.04	0.02	0.01	0.01	0.01	0.01	*-93.2*
Cd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*-71.4*
Hg	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00	*-99.7*
As	0.15	0.14	0.14	0.17	0.15	0.14	0.14	0.14	*-8.9*
Cr	0.20	0.19	0.18	0.24	0.22	0.20	0.20	0.20	*-2.8*
Cu	0.11	0.10	0.09	0.11	0.09	0.09	0.09	0.08	*-20.1*
Ni	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*-64.9*
Se	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	*-27.1*
Zn	1.53	1.28	1.14	1.61	1.42	1.19	1.17	1.15	*-24.8*
Emissions, g I-TEQ									
PCDD/ PCDF (dioxins/ furans)	1.46	1.24	1.01	0.97	0.66	0.63	0.62	0.62	*-57.7*
Emissions, Mg									
Benzo(a)pyrene	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	*-78.0*
Benzo(b)fluoranthene	0.07	0.05	0.05	0.05	0.03	0.04	0.03	0.03	*-50.6*
Benzo(k)fluoranthene	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.03	*-57.0*
Indeno (1,2,3-cd) pyrene	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	*-47.8*
Total 1-4	0.19	0.15	0.15	0.13	0.09	0.09	0.09	0.09	*-54.6*
Emissions, kg									
HCB	0.10	0.04	0.01	NE	NE	NE	NE	NE	*-*
PCBs	3.25	3.22	2.81	2.37	1.40	1.33	1.31	1.30	*-60.1*

All pollutants release to the atmosphere decreased from 1990 to 2015 due to declining population in Lithuania and lower average values of waste incinerated per inhabitant by other countries.

6.14. Wastewater Handling (5.D):

6.14.1. Overview of the Sector

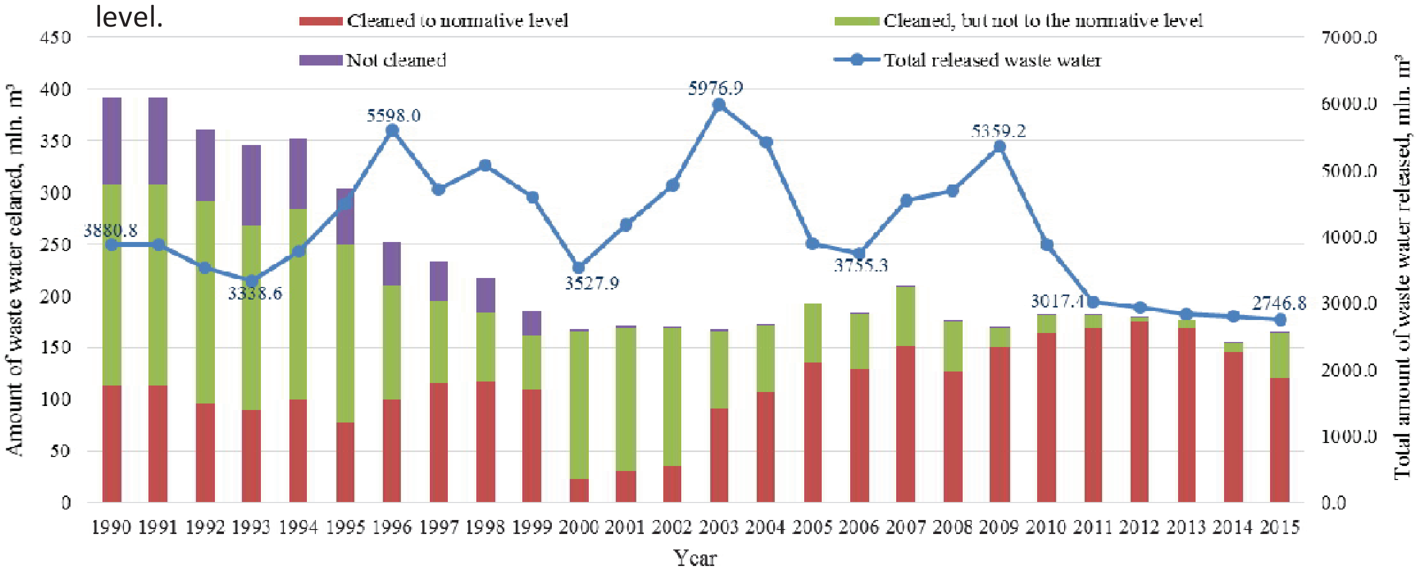
The Council Directive 91/271/EEC which addresses urban waste water treatment was adopted on May 1991 by European Union [14]. According to the Directive all agglomerations having more than 2000 inhabitant equivalents (organic biologically degradable load) must use secondary, biological or equivalent, waste water treatment technology, while those with more than 10 thousand inhabitant equivalents must reduce nitrogen and phosphorus levels as well using tertiary treatment technology. In order to accomplish Directive's requirements 46 waste water treatment mechanisms were reconstructed or built until 2013 [15]. The major treated waste water reception sites are rivers and lakes, minor – Baltic Sea (only by Palanga agglomeration).

6.15. Wastewater Treatment in Industry and Domestically (5.D.1 and 5.D.2);

6.15.1. Overview of the Sector

Information on the waste water treatment for 1990 – 2015 was provided by Lithuanian EPA [16], Water Condition Assessment division specialists. Information was checked with data provided by Statistics Department for period 2002 – 2013. Figure below shows that less than 10% of all waste water that is released is cleaned. This is because most of the waste water is not polluted enough, but is still recorded (e.g. JSC Kruonis hydro accumulation power station released 2362 mln. m^3 (86% of total) of waste water in 2015). Not cleaned but still released waste water amounts have decreased significantly from 1990 (by 99.9995% from 1990 to 2015).

Figure 6.4: amount (million m^3) of waste water collected and cleaned to or below normative level.



6.15.2. Methodology

This category covers emissions from wastewater treatment and transportation, while disposal of sewage is reported under 5A category.

2016 EMEP/ EEA guidebook was used to estimate emissions from this sector. Information of wastewater treatment and discharge for 2002 – 2015 is publically available on LT EPA (the remaining data for 1991 – 2002 is available on special request). Data gathering is regulated by order no. 408 by Minister of Environment of the Republic of Lithuania introduced on 20/12/1999 and amended twice, last time on 03/01/2013.

Statistics reported by EPA are distributed into two categories according to wastewater's type: a) surface wastewater and b) industrial and domestic wastewater. Surface wastewater is not treated biologically, only using primary treatment or no treatment. Only industrial and domestic wastewater were taken into calculation: treated to required normative values and treated but not to the normative value. The calculation approach is shown in eq. 6.1.

Please note that emissions from wastewater which was released domestically or from industry treatment were not separated into two categories. 5D2 category was labelled as 'IE'.
Table 6.10: NMVOC emissions (Gg) from the waste water cleaning.

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
NMVOC emissions, Gg	4.61E-03	3.75E-03	2.47E-03	2.87E-03	2.72E-03	2.64E-03	2.33E-03	2.47E-03
2015/1990 difference, %		*-46.5*		2015/2005 difference, %			*-14.2*	

As shown in the table above NMVOC emissions from waste water treatment decreased by 46.5% from 1990 to 2015. It must be noted that untreated waste water released to the surface waters quantities dropped as well (38505 m³ in 2015 or 0.0014% of all water released) while volume of waste water which was treated, but not to the normative values and then release to the surface waters decreased compared with volumes before 2009. Less waste water is produced, thus less is needed to be treated.

6.16. Wastewater Treatment in Residential Sector: Latrines (5.D.3);

6.16.1. Overview of the Sector

Information on the number of households and part of population connected to the sewerage is provided by Lithuanian water suppliers association [17], which members provide clean water and treat waste water nationwide. The rest of population is assumed to be using septic tanks or latrines. Information on population part using latrines was gathered from Lithuania Statistics. Lithuania Statistics has conducted surveys on this topic since 2005.

Much larger part of rural inhabitants is utilizing latrines (about 20-30% of rural population is connected to the sewerage), while percentage is smaller for city population, which 90-96% is connected to centralized sewerage [18].

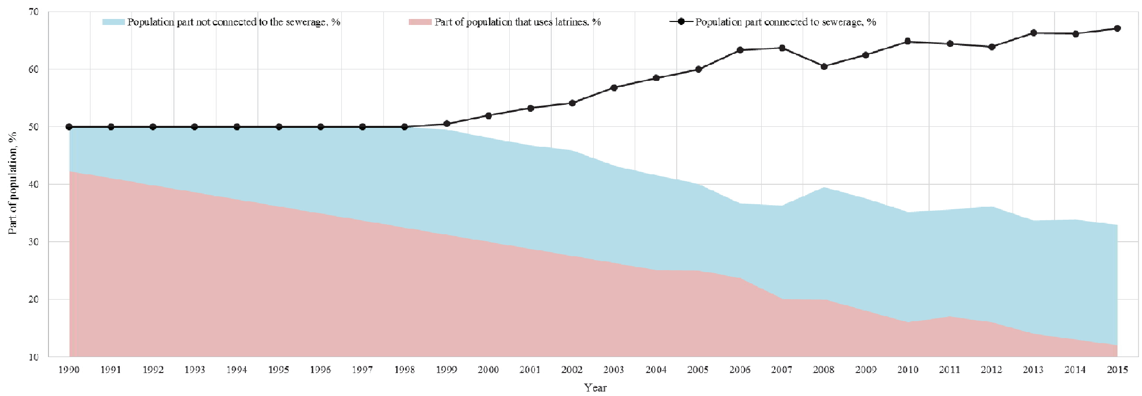


Figure 6.5: part of population (%) that is connected or not connected to the sewerage and percentage of population that is using latrines.

6.16.2. Methodology

Calculation of emissions from this section was based on the population part which is using latrines. The percentage of population utilizing latrines during 2005 – 2015 and population size from 1990 to 2015 were gathered from Lithuania Statistics.

Statistics on the population part using latrines for the 1990 – 2004 period was calculated using 11 data points (2005 – 2015 statistics). Correlation line was drawn with resulting correlation factor R^2 = 0.948. Default tier 2 emission factor from 2016 EMEP/ EEA guidebook was used in eq. 6.1 to determine ammonia emissions.

Table 6.11: activity data (no. of inhabitants) and amounts of NH_3 (Gg) emitted from the process.

	1990	*1995*	*2000*	*2005*	*2010*	*2013*	*2014*	*2015*
Population, thousand inhabitants	3697.8	3629.1	3499.5	3322.5	3097.3	2957.7	2932.4	2904.9
Part of population using latrines, %	42.8	36.5	30.2	25.0	16.0	14.0	13.0	13.0
Emissions, Gg								
NH_3 emissions	2.50	2.10	1.68	1.33	0.79	0.66	0.61	0.56
Change 2015/1990, %			***-77.7***		***Change 2015/2005, %***			***-58.0***

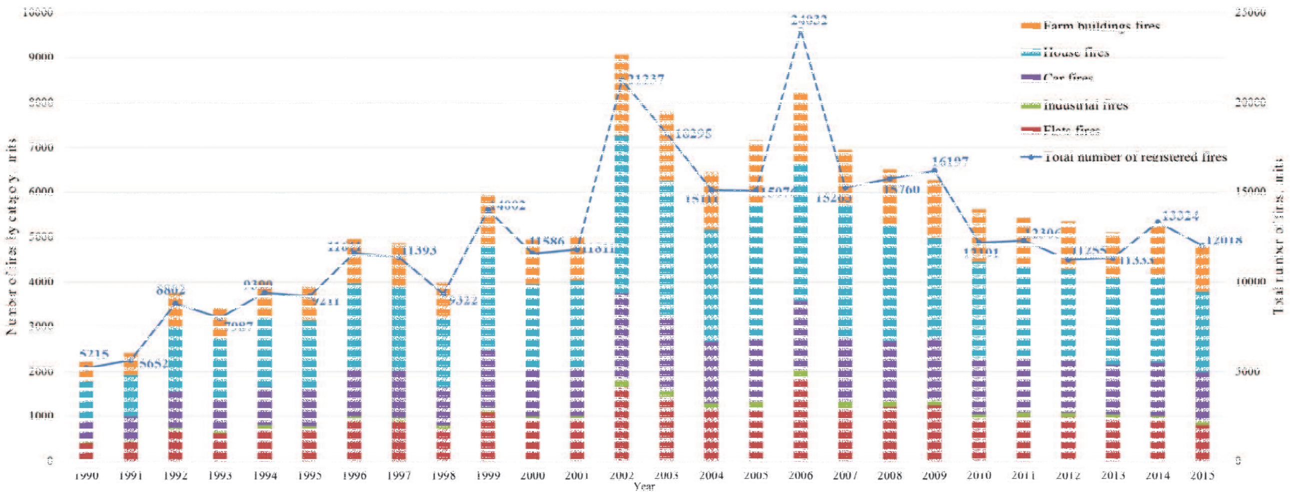
Emissions from this section are steadily decreasing as larger part of population connect to the sewerages or install septic tanks. In the future emissions from this category ought to reach small, 1close to zero, values.

6.17. Other Waste, Including House, Industrial and Car Fires (5E)

6.17.1. Overview of the Sector

Database on car and building fires statistics was established in 2004 by the Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania (FRD). The detailed information is publically available on institution's website [4]. Values before 2005 were estimated using averages of building fires per total registered fires. Please see figure below.

Figure 6.6: presented total number of fires (dark blue curve) with fires by category (bar chart) for the period from 1990 to 2015. The number for period 1990 – 2004 were estimated using data from 2005 – 2015.



Registered fire rate increased by about 130% from 1990 to 2015. The major fire category shown in the figure above is house fires, while the least occurring - industrial buildings fires.

6.17.2. Methodology

Statistics from 2005 to 2015 on the numbers of fires of cars, houses and industrial buildings were obtained from Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania. The total number of registered fires per year were gathered from National Statistics Yearbooks and compared with data from FRD.

Ratios between the number of specific fires (e.g. flat, car and etc.) per year and total number of fires on that year were averaged. Total number of fires for the 1990 – 2005 period was used with obtained averaged ratios in order to estimate numbers of specific fires on specific years before 2005. See figure 6.6 for results.

Default tier 2 emission factors from 2016 EMEP/ EEA guidebook with numbers of specific fires per year were used to estimate pollution from this category. See equation 6.1 for calculation example.

There is a direct relationship between emissions and number of fires. Both pollution (comparing 1990 and 2015 emissions in Gg) from this category and number of fires increased by a factor of 2.15 from 1990 to 2015, while pollutants release to the atmosphere declined by 35 % from 2005 to 2015. Please see table below.

Table 6.12: activity data (units) and amounts of pollutants emitted from the process.

	1990	1995	2000	2005	2010	2013	2014	2015
Industrial Fires	43	76	96	166	97	87	90	88
Car Fires	474	836	1052	1380	1227	1113	1182	1088
House Fires	860	1519	1911	2996	2185	1934	1969	1793
Agricultural Buildings Fires	444	785	987	1437	1155	1009	1139	1016
Flats fires	405	715	900	1171	947	961	926	811
Total registered fires	**5215**	**9211**	**11586**	**15076**	**12191**	**11333**	**13324**	**12018**
Total emissions, Gg								
TSP	0.172	0.304	0.383	0.573	0.437	0.391	0.412	0.371
PM_{10}	0.172	0.304	0.383	0.573	0.437	0.391	0.412	0.371
$PM_{2.5}$	0.172	0.304	0.383	0.573	0.437	0.391	0.412	0.371
Total emissions, Mg								
Pb	5.0E-04	8.8E-04	1.1E-03	1.7E-03	1.3E-03	1.1E-03	1.2E-03	1.1E-03
Cd	1.0E-03	1.8E-03	2.2E-03	3.4E-03	2.6E-03	2.3E-03	2.4E-03	2.2E-03
Hg	1.0E-03	1.8E-03	2.2E-03	3.4E-03	2.6E-03	2.3E-03	2.4E-03	2.2E-03
As	1.6E-03	2.8E-03	3.6E-03	5.4E-03	4.1E-03	3.6E-03	3.8E-03	3.5E-03
Cr	1.5E-03	2.7E-03	3.4E-03	5.1E-03	3.9E-03	3.5E-03	3.7E-03	3.3E-03
Cu	3.6E-03	6.3E-03	7.9E-03	1.2E-02	9.0E-03	8.1E-03	8.5E-03	7.7E-03
Total emissions, g I-TEQ								
PCDD/F	1.74	3.07	3.86	5.78	4.42	3.94	4.16	3.74

6.18. QA/QC and Verification

Activity data was checked with information in the GHG-NIR, where applicable.

6.19. Recalculations

Determination of pollutant emissions for previously not estimated categories was carried out (i.e. 5Bii, 5Dii, 5Diii, and 5E). Recalculated values for other categories were checked with previous submission and changed accordingly.

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