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LATVIA'S INFORMATIVE INVENTORY REPORT

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Data sheet

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Authors

Asnate Skrebele, Laine Lupkina, Līga Rubene, Intars Cakars, Lauris Siņics

Latvian Environment, Geology and Meteorology Centre

Gaidis Klāvs, Larisa Gračkova, Jānis Reķis

Institute of Physical Energetics

Laima Bērziņa, Olga Frolova

Latvia University of Life Sciences and Technologies

Andis Lazdiņš, Arta Bārdule

Latvian State Forest Research Institute "Silava"

Gridded emissions

Anete Bērziņa

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Santija Treija

Latvian Environment, Geology and Meteorology Centre

Edited

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Central Statistical Bureau

Cover photo

Dzintars Lapiņš

Design

Dārta Narkeviča

Contact

Asnate Skrebele

Latvian Environment, Geology and Meteorology Centre

Maskavas street 165, Riga, LV-1019, Latvia

E-mail: asnate.skrebele@lvgmc.lv

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Abbreviations

CR – Register of Chemical Substances and Chemical Mixtures

CSB – Central Statistical Bureau of Latvia

EMEP – Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe

EMEP/CORINAIR – Atmospheric emission inventory guidebook, Co-operative Programme for Monitoring and Evaluation on the Long Range Transmission of Air Pollutants in Europe, The Core Inventory of Air Emissions in Europe

EMEP/EEA 2016 – EMEP/EEA air pollutant emission inventory guidebook 2016

GHG – Greenhouse gases

HDD – Heating degree days

IPCC – Intergovernmental Panel on Climate Change

IPCC GPG 2000 – IPCC Good Practice Guidance and Uncertainty management in national Greenhouse Gas Inventories (2000)

IPCC GPG LULUCF 2003 – IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003)

2006 IPCC Guidelines – 2006 IPCC Guidelines for National Greenhouse Gas Inventories

IPPU – Industrial processes and Product use

KCA – Key category analysis

LEGMC – Latvian Environment, Geology and Meteorology Centre

LULUCF – Land Use, Land Use Change and Forestry

MEPRD – Ministry of the Environmental Protection and Regional Development

MoA – Ministry of Agriculture

NCV – Net calorific value

NFR – Nomenclature For Reporting

QA – Quality assurance

QC – Quality control

REBs – Regional Environmental Boards

RTSD – Road Traffic Safety Department

SFS – State Forest Service

TERT – Technical Expert Review Team

UN – United Nations

UNFCCC – United Nations Framework Convention on Climate Change

Pollutants

Main pollutants (from 1990)

NO_x – nitrogen oxides, expressed as NO₂

NM_{VOC} – non-methane volatile organic compounds

NH₃ – ammonia

SO₂ – sulphur dioxide

Other (from 1990)

CO – carbon monoxide

POPs – persistent organic pollutants (from 1990)

PCDD/PCDF – polychlorinated dibenzodioxins/furans

HCB – hexachlorobenzene

PCB – polychlorinated biphenyls

PAHs – polycyclic aromatic hydrocarbons, includes:

benzo(a)pyrene

benzo(b)fluoranthene

benzo(k)fluoranthene

indeno(1,2,3-cd)pyrene)

PM – particulate matter (from 1990)

PM_{2.5} – particulate matter, particle size <2.5 μm

PM₁₀ – particulate matter, particle size <10 μm

TSP – total suspended particulates

BC – black carbon

HM – heavy metals (from 1990)

Pb – lead

Cd – cadmium

Hg – mercury

As – arsenic

Cr – chromium

Cu – copper

Ni – nickel

Se – selenium

Zn – zinc

Executive summary

Inventory report of air pollution in Latvia has been prepared by Latvian Environment, Geology and Meteorology Centre in collaboration with Ministry of the Environmental Protection and Regional Development (MEPRD), Central Statistical Bureau (CSB), Institute of Physical Energetics, Latvian State Forest Research Institute "Silava", Latvia University of Life Sciences and Technologies, according to the 2014 Reporting Guidelines and revised Gothenburg Protocol and NEC directive. The Informative Inventory Report (IIR) is submitted to the UNECE Secretariat and EEA annually.

This report includes information on the emission data from 1990 to 2019 for anthropogenic emissions of NO_x, NMVOC, SO₂, NH₃ (main pollutants); CO (other); TSP, PM₁₀, PM_{2.5}, BC (particulate matter); Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn (heavy metals) and PCDD/PCDF, PAHs, PCB, HCB (persistent organic pollutants), compiled according to the guidelines for estimating and reporting emissions. Emission data is reported in the Nomenclature for Reporting format as requested in the Reporting Guidelines. Summary about total emissions can be found in Chapter 2. Detailed information about emission trends and pollutants produced in each sector can be found under appropriate sectors and subsectors.

Latvia's IIR 2021 includes detailed information about air pollutant sectors – Energy, Industrial Processes and Product Use, Agriculture, Waste, Natural emissions and Other and their subsectors. Each subsector is described with following chapters – an overview, trends in emissions, methods, emission factors, activity data, uncertainties, QA/QC and verification, recalculations and planned improvements. Activity data used for emission calculation was obtained by CSB, EU ETS, national databases "2-Air", "2-Water", "3-Waste", other different databases and directly from enterprises and institutions.

Comparing emissions between Submission 2020 and Submission 2021, changes in reported national totals and calculations can be detected. The recalculations are done due to updated activity data and emission factors, implementation of sector specific research and 2020 Comprehensive Technical Review of National Emission Inventories results. Detailed information about recalculations done in IIR Submission 2021 can be found in Chapter 8.1 and in each sector appropriate subsectors chapter. Implementation status of 2020 Comprehensive Technical Review of National Emission Inventories results can be found in Chapter 8.3. Information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV.

1 Introduction

1.1 Background information on emission inventory

The Republic of Latvia has ratified the Convention on Long-Range Transboundary Air Pollution (Geneva, 1979) by Resolution Nr. 63 of 7 July 1994 of the Cabinet of Ministers of Latvia. Later on, Latvia has signed following Protocols of Convention:

- The 1998 Protocol on Persistent Organic Pollutants (POPs);
- The 1998 Protocol on Heavy Metals;
- The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone.

On 31 December 2016 Directive (EU) 2016/2284 of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC or NEC directive entered into force. Directive¹ sets out new emission reduction commitments for Latvia regarding sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and fine particulate matter. The reduction commitments have the year 2005 as base year and shown as percentage reduction (Table 1.1).

Table 1.1 Emission reduction commitments for Latvia set out in NECD

Pollutant	For any year from 2020 to 2029	For any year from 2030
SO ₂	8%	46%
NO _x	32%	34%
NMVOG	27%	38%
NH ₃	1%	1%
PM _{2.5}	16%	43%

In order to follow the progress towards attainment of emission reduction commitments, Latvia also has to provide annual national emission inventory, emission projections and informative inventory report, which describes the emission calculations made in more detail.

Local legislation acts regarding air quality monitoring:

- No. 614 of Cabinet on Ministers (02.10.2018) - Regulations for reducing and recording the total air pollutant emissions;
- No. 737 of Cabinet on Ministers (12.12.2017) - Development and Management of National System for Greenhouse Gas Inventory and Projections.

According to the revised Guidelines for Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125, revised 13 March 2014 hereinafter referred to as the Reporting Guidelines) Party have to annually submit emission inventory to the secretariat of the Convention on Long-Range Transboundary Air Pollution (CLRTAP).

This report is prepared based on emission data submitted on 15 March 2021 and covers information on trends in emissions, descriptions of each NFR category, recalculations and planned improvements. It contains information on emission inventories in Latvia from 1990 to 2018 for anthropogenic emissions of:

Main pollutants: NO_x, NMVOC, SO₂, NH₃ (kt)

Other: CO (kt)

Particulate matter: TSP, PM₁₀, PM_{2.5}, BC (kt)

Heavy metals: Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn (t)

POPs: PCDD/PCDF (g i-Teq), PAHs (t), PCB, HCB (kg)

¹ http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.344.01.0001.01.ENG

Emission data is reported in the Nomenclature for Reporting (NFR 2019-1) format as requested in the Reporting Guidelines.

The latest recalculations in emission inventory were done for the time period from 1990 to 2018. Recalculations were done due to the change of activity data, implementation of research, as well as implementing recommendations received after 2020 Comprehensive Technical Review of National Emission Inventories. Detailed information about recalculations done in each sector is described in appropriate subsector.

1.2 Description of the institutional arrangement for inventory preparation

Latvian IIR is prepared by the state Ltd "Latvian Environment, Geology and Meteorology Centre" (LEGMC) in cooperation with other institutions. The purpose of LEGMC is to collect and process environmental information, to carry out environmental monitoring and inform the public of the status of the environment, to provide geological supervision and rational use of natural resources, to implement the state policies in geology, meteorology, climatology, hydrology and air quality and to assess the impact of transboundary air pollution.

The experts of LEGMC have created emission inventory by using expert publications and evaluations and in co-operation with following institutions:

- Ministry of the Environmental Protection and Regional Development;
- Central Statistical Bureau;
- Institute of Physical Energetics;
- Latvian State Forest Research Institute "Silava";
- Latvia University of Life Sciences and Technologies;
- Ministry of Agriculture;
- Ministry of Transport;
- Ministry of Economics.

1.3 Description of the process of inventory preparation

The process of inventory compilation consists of inventory planning, which includes decision making of methodological and organisational issues, and time frame for inventory preparation.

In the first stage, specific responsibilities are defined and allocated. In the second stage, the inventory preparation process, activity data, emission factors and all relevant information needed for final emission estimation is collected.

Emission inventory of Latvia is generally based on the EMEP/EEA 2019 with a exceptions in few sectors where previous versions of EMEP emission inventory guidebooks and data and methodologies from 2006 IPCC Guidelines are used.

NFR 2019-1 format is used to prepare inventory for years 1990-2019. For all sectors, except Road transport, supplemental databases in Ms Excel format have been developed and used for emission calculations. For transport emission calculations special "Computer Programme to calculate Emissions from Road Transportation" (COPERT 5.3), which is proposed to be used by EEA member countries for the compilation of EMEP/EEA emission inventories, is used. Additional research in different source categories was made, to compile data and investigate appropriate approach to fulfil Convention obligations.

Activity data is obtained from CSB, Ministry of Agriculture, Ministry of Economics, Ministry of Transport and other enterprises and institutions.

The deadline for submitting the activity data and its description for all institutions involved in inventory process is 1st of November. Deadline of data submission regarding fuel consumption is 30th of November when CSB prepares Energy balances for EUROSTAT according to additional agreement.

More detailed information on methodologies and activity data is given in the description of the sectors in Chapters 3-7.

1.4 Description of key source categories

The Key category analysis (KCA) for 1990 and 2019 was done according to the EMEP/EEA 2019 Level and Trend assessment. According to EMEP/EEA 2019, key categories are emission sources that together contribute to 80% of the total national emissions. KCA was performed for each reported pollutant separately using Approach 1 - Level assessment and Approach 1 - Trend assessment. The level assessment key categories for 1990 and 2018 are shown in Table 1.2 and Table 1.3.

Table 1.2 Level assessment key categories in 1990²

	Key categories (Sorted from high to low from left to right)												Total (%)	
NO_x	1A3biii 10.7%	1A1a 10.6%	1A3c 10.4%	1A3bi 10.3%	1A4aii 6.4%	3Da1 5.4%	1A4ai 5.2%	1A2gviii 4.6%	1A2gvii 4.5%	1A2e 4.3%	1A4cii 4.3%	1A4ciii 3.4%	80.2%	
NMVOC	1A3bi 18.9%	1A4bi 14.2%	3B1a 12.7%	2D3d 5.7%	1A4cii 4.4%	3B1b 4.3%	2H2 3.8%	1A3biii 3.6%	1A4ai 3.4%	1A2gvii 2.9%	1A3bii 2.6%	1B2b 2.4%	2D3a 2.1%	81.2%
SO₂	1A1a 35.8%	1A4ai 22.3%	1A4bi 8.4%	1A2e 8.0%	1A2gviii 7.6%								82.1%	
NH₃	3Da2a 23.5%	3B1a 22.9%	3B3 16.9%	3Da1 13.7%	3Da3 4.9%								82.0%	
PM_{2.5}	1A4bi 60.7%	1A4ai 9.6%	6A 5.2%	1A4aii 3.4%	1A1a 2.9%								81.8%	
PM₁₀	1A4bi 51.6%	1A4ai 8.4%	3Dc 8.4%	6A 5.2%	1A1a 3.2%	1A4aii 2.8%	2A2 2.4%							82.0%
TSP	1A4bi 44.9%	1A4ai 7.3%	3Dc 6.7%	6A 6.6%	2A2 5.1%	1A1a 3.6%	3B3 3.5%	3B4gi 2.6%					80.3%	
BC	1A4bi 39.2%	1A4aii 11.9%	1A4ai 8.6%	1A2gvii 8.2%	1A4cii 7.4%	1A3biii 4.0%	1A3c 3.3%						82.6%	
CO	1A3bi 47.7%	1A4bi 24.1%	1A4cii 6.8%	1A3bii 5.9%									84.5%	
Pb	2C1 70.0%	1A3bi 16.8%											86.8%	
Cd	2C1 46.8%	1A4bi 30.1%	1A4ai 10.6%										87.6%	
Hg	1A4ai 47.0%	1A4bi 19.3%	1A1a 12.4%	1A4ci 6.4%									85.2%	
PCDD/ PCDF	1A4bi 62.2%	1A4ai 12.2%	5C1biii 10.9%										85.3%	
PAHs	1A4bi 65.8%	1A4ai 13.8%	6A 13.8%										93.4%	
HCB	3Df 96.5%												96.5%	
PCBs	1A4ai 62.0%	1A4bi 27.2%											89.2%	

In 1990, Energy sector was a key source for the largest part of pollutants. For SO₂, PM_{2.5}, PM₁₀, TSP, BC, Hg, PCDD/PCDF, PAHs and PCBs emissions the main contributor was Stationary combustion (NFR 1A1, 1A2, 1A4), especially Residential subsector (NFR 1A4b). For NO_x, NMVOC and CO emissions - Transport sector (NFR 1A3), particularly Road transport (NFR 1A3b). The main contributor for NH₃ and HCB emissions in 1990 was Agriculture sector (NFR 3), and for Pb, Cd emissions the main contributor was IPPU sector (NFR 2C).

Table 1.3 Level assessment key categories in 2019

	Key categories (Sorted from high to low from left to right)										Total (%)
NO_x	1A3biii 16,9%	1A3bi 11,8%	1A1a 11,3%	3Da1 9,7%	1A3c 8,0%	2A1 6,1%	1A4cii 5,3%	1A4bi 4,9%	1A2gviii 4,3%	1A3bii 4%	82,0%

² Full list of NFR codes can be seen on Annex IV.

Key categories (Sorted from high to low from left to right)											Total (%)	
NMVOC	1A4bi	1A2gviii	3B1a	2D3i	2D3d	2D3a	2D3g	1A3bi	2H2	3B1b	81,9%	
	23,8%	11,0%	9,9%	9,6%	8,1%	6,5%	3,4%	3,3%	3,2%	3,1%		
SO ₂	1A4bi	1A1a	1A2gviii	1A4cii	1A4ai						84,1%	
	27,6%	25,5%	18,4%	7,0%	6%							
NH ₃	3Da2a	3B1a	3Da1	1A4bi	3B3	3Da3						83,2%
	27,0%	20,2%	19,5%	7,4%	5,3%	3,9%						
PM _{2.5}	1A4bi	1A1a	1A2gviii									82,6%
	58,7%	13,4%	10,5%									
PM ₁₀	1A4bi	2D3b	1A1a	3Dc	1A2gviii	2A5b						86,0%
	40,9%	11,5%	10,6%	9,6%	7,3%	6,1%						
TSP	2D3b	1A4bi	2A5b	1A1a	1A2gviii						82,2%	
	32,4%	25,9%	12,2%	7,1%	4,6%							
BC	1A4bi	1A2gviii	1A3bi	1A4ai								81,1%
	48,6%	21,5%	6,1%	4,9%								
CO	1A4bi	1A3bi	1A2gviii	1A4bii								81,9%
	63,6%	7,8%	7,1%	3,3%								
Pb	1A3bi	1A4bi	1A1a	1A2gviii	1A3bvi							86,2%
	25,5%	20,6%	13,8%	13,6%	13%							
Cd	1A4bi	1A2gviii	1A4ai									84,7%
	45,7%	31,8%	7,2%									
Hg	1A1a	1A4bi	1A2gviii	5C1bv	1A4ai							82,1%
	41,5%	16,9%	10,9%	7,4%	5,4%							
PCDD/ PCDF	1A4bi	5E	1A2gviii									85,3%
	65,6%	12,0%	7,7%									
PAHs	1A4bi	6A										87,4%
	77,7%	9,7%										
HCB	3Df	1A4bi	1A1a	1A2gviii								93,5%
	38,7%	20,8%	19,5%	14%								
PCBs	1A1a	1A4bi	1A2f	1A4ai								92,7%
	41,1%	20,1%	15,9%	16%								

Table 1.2 and Table 1.3 show that the key sources have slightly changed in 2019 in comparison with 1990. The main source for the majority of pollutants has remained to be the Energy sector, (NFR 1) especially the Residential subsector (NFR 1A4b). Agriculture sector (NFR 3) has remained as a key category for NH₃ and HCB emissions. In comparison with key categories from 1990 main contributor for NMVOC emissions in 2019 is Residential sector (NFR 1A4b) as well as for CO emissions. For TSP emissions, main contributor is Road paving with asphalt (NFR 2D3b).

The trend assessment key categories for 2019 can be seen in Table 1.4.

Table 1.4 Trend assessment key categories in 2019

Key categories (Sorted from high to low from left to right)														Total (%)	
NO _x	1A3c	1A1a	1A3bi	1A3biii	1A4aii	1A4ai	1A2gvii	1A2e	1A2gviii	3Da1	1A4cii	1A4cii	1A2f	82,5%	
	10,7%	10,1%	9,6%	8,9%	7,7%	5,9%	5,2%	5,1%	4,5%	4,2%	3,9%	3,9%	2,7%		
NMVOC	1A3bi	3B1a	1A4bi	1A4cii	1A3biii	3B1b	2D3d	1A2gviii	1A2gvii	2H2	1A4ai	1A3bii	2D3i	1B2b	82,6%
	21,7%	11,8%	8,7%	5,1%	4,2%	4,1%	4,1%	3,8%	3,5%	3,5%	3,2%	3,1%	3,0%	2,8%	
SO ₂	1A1a	1A4ai	1A2e	1A4bi	1A2gviii										82,1%
	36,0%	22,6%	8,1%	8,0%	7,4%										
NH ₃	3B1a	3B3	3Da2a	3Da1	3B1b										81,4%
	23,2%	22,3%	20,4%	10,0%	5,5%										
PM _{2.5}	1A4bi	1A4ai	1A1a	1A2gviii	6A	1A4aii	1A2gvii								80,9%
	35,0%	12,2%	10,1%	9,2%	5,9%	5,1%	3,6%								
PM ₁₀	1A4bi	2D3b	1A4ai	1A1a	1A2gviii	6A	1A4aii	2A2	1A2gvii						82,1%
	22,4%	14,9%	10,3%	9,8%	8,6%	5,5%	4,1%	3,6%	2,9%						
TSP	2D3b	1A2gviii	1A1a	1A4ai	2A2	6A							81,8%		
	54,9%	6,9%	6,1%	5,3%	5,0%	3,7%									
BC	1A4bi	1A4aii	1A2gviii	1A2gvii	1A4cii	1A4ai	1A3biii	1A3bi						82,0%	
	18,8%	15,6%	12,9%	10,5%	8,7%	8,1%	3,9%	3,6%							

Key categories (Sorted from high to low from left to right)					Total (%)
CO	1A3bi	1A4bi	1A4cii	1A3bii	83,2%
	52,5%	16,6%	7,5%	6,6%	
Pb	2C1	1A3bi			86,9%
	70,2%	16,7%			
Cd	2C1	1A2gviii	1A4bi		83,1%
	55,6%	18,1%	9,4%		
Hg	1A4ai	1A4bi	1A4ci	1A1a	85,9%
	53,6%	19,0%	7,2%	6,1%	
PCDD/ PCDF	1A4bi	1A4ai	5C1biii		80,6%
	48,4%	17,5%	14,7%		
PAHs	1A4bi	1A4ai	6A		91,2%
	58,7%	17,7%	14,7%		
HCb	3Df				96,6%
	96,6%				
PCBs	1A4ai	1A4bi			88,8%
	61,9%	26,9%			

In trend assessment key categories, main contributor remains Energy sector (includes public and industrial heat and power plants, as well as residential installations) and Transport. For PM₁₀, TSP, Pb and Cd main contributor is IPPU sector (NFR 2) with road paving with asphalt (NFR 2D3b) and iron and steel production (NFR 2C1) accordingly. Agriculture (NFR 3) is main contributor for NH₃ and HCB emissions.

1.5 Quality assurance/Quality control

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

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

The inventory is archived each year and it is possible to regenerate the information.

Quality Control (QC):

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

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

QC activities include general methods, such as accuracy checks on data acquisition and calculations, the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. These activities are implemented by sectoral experts and national inventory compiler.

Before submitting data to CEIP/EEA, NFR tables are checked with RepDab³, an electronic tool to check the format, completeness and internal consistency of submissions, provided by CEIP as well as emission data are compared with data reported in National Inventory Report (NIR) under UNFCCC and the Kyoto Protocol.

Quality meetings are held between sectoral experts in order to discuss problems and necessary improvements. Meeting together with external institutions are held in order to coordinate and adjust necessary data for reporting and introduce them with latest changes in emissions and report.

³ <https://www.ceip.at/repdab-check-your-inventory/>

Before submission of the report it is sent to external organizations (MEPRD, CSB, MoA, MoT) for quality control. Comments received after inventory review are then analysed and implemented in report.

Quality assurance (QA)

Quality Assurance (QA) activities include a system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. In the inventory preparation process, general quality control procedures have been applied. Some specific quality control procedures related to check of activity data and emission factors were carried out.

1.6 General uncertainty evaluation

The calculation of uncertainty estimates was made according to Tier 1 method presented in EMEP/EEA 2016. Tier 1 method is based on emission estimates and uncertainty coefficients for activity data and emission factors (Table 1.5).

Uncertainty coefficients have been assigned based on expert judgement or on default uncertainty estimates according to IPCC GPG 2000, 2006 IPCC Guidelines, EMEP/EEA 2016 and EMEP/EEA 2019 Guidebook, because there is not enough information about background data to make actual calculations. For each source the uncertainty for activity data and emission factors were estimated and presented in percentage. The uncertainty analysis was done for all the sectors: Energy, IPPU, Agriculture, Waste and LULUCF (reported as "Other" under NFR 6A). Uncertainties were estimated for main pollutants - NO_x, NMVOC, SO₂, NH₃ and CO, as well as for particulate matter (PM_{2.5}, PM₁₀, TSP, BC), priority heavy metals (Pb, Cd, Hg) and POPs (PCDD/F, PAHs, HCB, PCBs).

Table 1.5 Uncertainty assessment results in 2019

	Overall uncertainty, %	Trend uncertainty, %
NO_x	12,96%	2,11%
NMVOC	15,37%	5,51%
SO₂	5,88%	0,19%
NH₃	20,33%	3,94%
CO	32,65%	6,82%
PM_{2.5}	32,11%	28,37%
PM₁₀	24,04%	33,69%
TSP	23,92%	47,29%
BC	27,07%	10,90%
Pb	12,96%	2,11%
Cd	28,35%	13,18%
Hg	23,69%	7,75%
PCDD/F	33,48%	6,35%
PAHs	44,68%	8,04%
HCB	27,73%	3,26%
PCBs	25,56%	1,28%

1.7 General assessment of the completeness

The emission inventory covers the whole territory of Latvia. Emissions from almost all sectors and subsectors have been estimated. Where this is not the case, notation keys - NE (not estimated), IE (included elsewhere), NA (not applicable) or NO (not occurred) - are used.

NE (not estimated):

"NE" is used for activity data and/or emissions by sources of pollutants that have not been estimated but for which a corresponding activity may occur (Table 1.6).

Table 1.6 Sources not estimated in 2019 (NE)

NFR14 code	Substance(s)	Reason for not estimated
1A1a Public electricity and heat production	NH ₃	no methodology available, NE according to EMEP/EEA 2019
1A1c Manufacture of solid fuels and other energy industries	NH ₃	no methodology available, NE according to EMEP/EEA 2019
1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NH ₃	no methodology available, NE according to EMEP/EEA 2019
1A2gvii Mobile Combustion in manufacturing industries and construction	Hg, As, PCDD/F, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2019
1A3ai(i) International aviation LTO (civil)	NH ₃ , As, Cr, Cu, Ni, Se, Zn	no methodology available, NE according to EMEP/EEA 2016
1A3aii(i) Domestic aviation LTO (civil)	NH ₃ , As, Cr, Cu, Ni, Se, Zn	no methodology available, NE according to EMEP/EEA 2016
1A3bvi Road transport: Automobile tyre and brake wear	Hg, PCDD/F, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, PAHs, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2016
1A3bvii Road transport: Automobile road abrasion	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, PAHs, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2016
1A3c Railways	Pb, Hg, As	no methodology available, NE according to EMEP/EEA 2016
1A3dii National navigation (shipping)	Pb, Hg, As	no methodology available, NE according to EMEP/EEA 2016
1A4ai Commercial/institutional: Mobile	Hg, As, PCDD/F, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2019
1A4bii Residential: Household and gardening (mobile)	Hg, As, PCDD/F, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2019
1Aci Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Hg, As, PCDD/F, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2019
1A4ciii Agriculture/Forestry/Fishing: National fishing	NH ₃ , benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, PAHs	no methodology available, NE according to EMEP/EEA 2019
1A5b Other, Mobile (including military, land based and recreational boats)	NH ₃ , benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, PAHs	no methodology available, NE according to EMEP/EEA 2019
1B1a Fugitive emission from solid fuels: Coal mining and handling	NMVOC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn	no methodology available, NE according to EMEP/EEA 2019
1B2av Distribution of oil products	So ₂ , PCDD/F	no methodology available, NE according to EMEP/EEA 2019
2A1 Cement production	Pb, Cd, As, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo (b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs	no methodology available, NE according to EMEP/EEA 2019
2A3 Glass production	NH ₃ , PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs, HCB	no methodology available, NE according to EMEP/EEA 2019
2D3a Domestic solvent use including fungicides	Hg	no methodology available, NE according to EMEP/EEA 2019
2D3b Road paving with asphalt	NO _x , SO ₂ , CO, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs, HCB	no methodology available, NE according to EMEP/EEA 2019
2D3c Asphalt roofing	NO _x , Pb, Cd, Hg, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs, HCB	no methodology available, NE according to EMEP/EEA 2019
2H2 Food and beverages industry	PM _{2.5} , PM ₁₀ , TSP, BC	no methodology available, NE according to EMEP/EEA 2019

NFR14 code	Substance(s)	Reason for not estimated
2I Wood processing	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, As, Cu	no methodology available, NE according to EMEP/EEA 2019
5A Biological treatment of waste - Solid waste disposal on land	NH ₃ , CO, Hg	no methodology available, NE according to EMEP/EEA 2016
5B1 Biological treatment of waste - Composting	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO	no methodology available, NE according to EMEP/EEA 2016
5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities	NO _x , NMVOC, SO, PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, Cr, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2016
5C1bii Hazardous waste incineration	NH ₃ , Cr, Cu, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene	no methodology available, NE according to EMEP/EEA 2016
5C1biii Clinical waste incineration	NH ₃ , PM _{2.5} , PM ₁₀ , Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene	no methodology available, NE according to EMEP/EEA 2016
5C1bv Cremation	BC	no methodology available, NE according to EMEP/EEA 2016
5E Other waste (please specify in IIR)	NO _x , NMVOC, SO ₂ , BC, CO, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, PAHs, HCB, PCBs	no methodology available, NE according to EMEP/EEA 2016

IE (included elsewhere):

“IE” is used for emissions by sources of pollutants that are estimated but included elsewhere in the inventory instead of under the expected source category (Table 1.7).

Table 1.7 Sources included elsewhere in 2018 (IE)

NFR14 code	Substance(s)	Included in NFR category
3Da2a Animal manure applied to soils	NMVOC	3B Manure management
3Da3 Urine and dung deposited by grazing animals	NMVOC	3B Manure management

NA (not applicable) is used for activities under a given source category that do occur within the Party but do not result in emissions of a specific pollutant.

C (confidential) is used for emissions by sources of pollutants whose reporting could lead to the disclosure of confidential information. In case of Latvia, particular notation key is used for glass production (2A3) due to only one glass fibre production company operating in the country, for various Solvents (2D3e Degreasing, 2D3f Dry cleaning, 2D3g Chemical products, 2D3h Printing) and amount of pesticides used (3F Use of pesticides).

NO (not occurring) is used for categories or processes within a particular source category that do not occur within a Party.

The completeness is estimated taking into account the usage of notation key NE relation to total amount of the subcategories. Completeness is checked for all emissions.

2 Air pollutant emission trends

2.1 Overview

The emission estimates of air pollutants in Latvia include emissions from following gases: sulphur dioxide, nitrogen oxides, carbon monoxide, non-methane volatile organic compounds, ammonia, particulate matter (TSP, PM₁₀, PM_{2.5}), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn), PAHs, PCBs and PCDD/F.

2.2 Main pollutants (NO_x, NMVOC, SO₂, NH₃, CO)

Sulphur dioxide, nitrogen oxides, carbon monoxide, non-methane volatile organic compounds and ammonia emission trend and the main emission sources are shown in Figure 2.1-Figure 2.5. However, detailed information about emission trends in each sector can be found in relevant chapters.

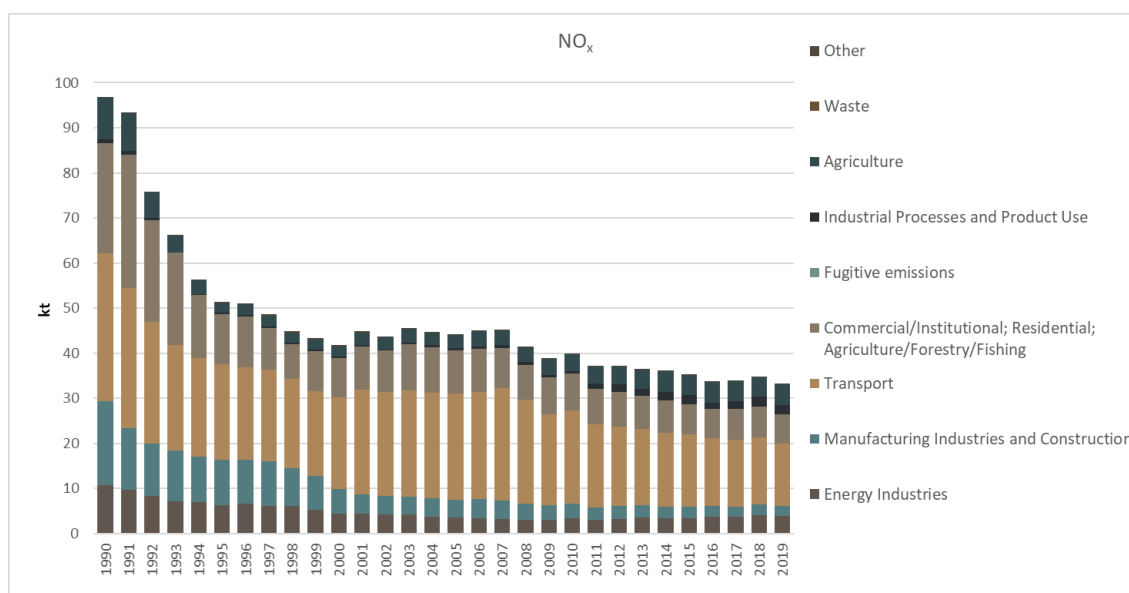


Figure 2.1 Total NO_x emissions, kt

The total NO_x emissions have decreased by 65.8% from 96.91 kt in 1990 to 33.11 kt in 2019 (Figure 2.1). Generally, the reduction is due to decrease of total fuel consumption that was caused by transformation of national economy as well as increasing of energy efficiency, especially for Transport sector. Also replacement of solid fuels and heavy liquid fuels with natural gas and biomass fuels in Energy sector contributes to emission fluctuation.

In 2005-2019 NO_x emissions have decreased by 25.0% mainly due to the emission reduction in Energy (-25.8%) and Transport (-41.7%) sector. Meanwhile emissions in IPPU, Agriculture and Waste sector in this period have almost doubled. In 2018-2019 total NO_x emissions have decreased by 4.5%, mainly due to decreased fuel consumption in Energy sector (-4.4%) and Transport sector (-7.9%). Emissions have increased in Agriculture and Waste by 6.0% and 2.9% accordingly but in IPPU and Other sectors emissions have decreased by 1.6% and 2.1%.

In 2019, the main emission source is Transport (13.78 kt or 41.6%) sector, especially Road transport (NFR 1A3b), which is responsible for 32.3% of total NO_x emissions. NO_x emissions from Transport sector have decreased by 41.7% since 2005. Reason for such trend is increase in share of vehicles with higher environmental performance. A share of EURO4, EURO5 and EURO6 cars have increased for all types of vehicles, namely, passenger cars, LDV and HDV.

The second largest emission source is fuel combustion in Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) with 6.48 kt or 19.6% of total emissions. Since 2005 emissions

have decreased by 32.1% due to the implementation of energy efficiency improvements in buildings which allowed for reduction in fuel consumption.

Agriculture sector is the third largest emitter in 2019 with 4.58 kt or 13.8% of total emissions. Since 2005 emissions have increased by 52.0%. Amount of NO_x emission is linked to the number of produced animals and crops.

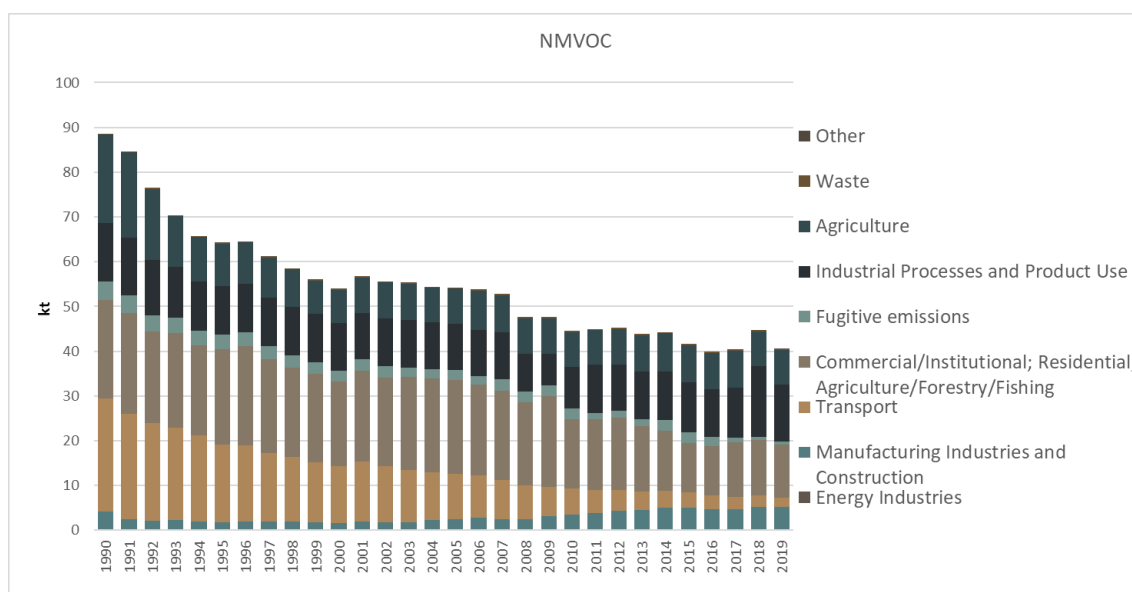


Figure 2.2 Total NMVOC emissions, kt

The total NMVOC emissions have decreased by 54.2% from 88.63 kt in 1990 to 40.63 kt in 2019 (Figure 2.2). Since 2005 emissions have decreased by 25.0% and by 9.1% in 2018-2019. The overall decrease in total NMVOC emissions has happened mainly due to the Transport (91.4% decrease since 1990) and Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) (46.1% decrease since 1990).

IPPU is the largest NMVOC emission source in 2019 with 12.64 kt or 31.1% from total emissions. Main NMVOC emission source in IPPU is Other Solvent and Product Use (NFR 2D; 27.8% from total emissions) and since 2005 emissions in this sector have increased by 22.1%. Emission fluctuation in Solvent Use sector is related to the welfare of the economic state of the country.

In 2019, the second largest NMVOC emission producer is Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) which is responsible for 11.87 kt or 29.2% from total emissions. Since 2005 emissions in Other Sector have decreased by 43.3% which resulted from energy efficiency improvements in buildings.

Agriculture sector contributes 7.81 kt or 19.2% from total NMVOC emissions in 2019. The largest part of NMVOC emissions is related to manure management – 85.5%, crop production and agricultural soils accounted for 13.3%. Since 2005 NMVOC emissions from Agriculture have increased by 0.4%. Similar as with NO_x emissions amount of NMVOC emissions is linked to the number of produced animals and crops.

Transport sector importance to NMVOC emissions since 2005 have significantly decreased (-78.7%). In 2005 Transport sector made up 18.7% from total NMVOC emissions, but in 2019 it is 5.3%. Reason for such trend is increase in share of vehicles with higher environmental performance. A share of EURO4, EURO5 and EURO6 cars have increased for all types of vehicles, namely, passenger cars, LDV and HDV and decreasing of gasoline consumption by passenger cars.

Energy Industries (NFR 1A1) and Manufacturing Industries and Construction (NFR 1A2) constitutes 0.5% and 12.2% accordingly in 2019. Since 2005 emissions from fuel combustion in these sectors have increased.

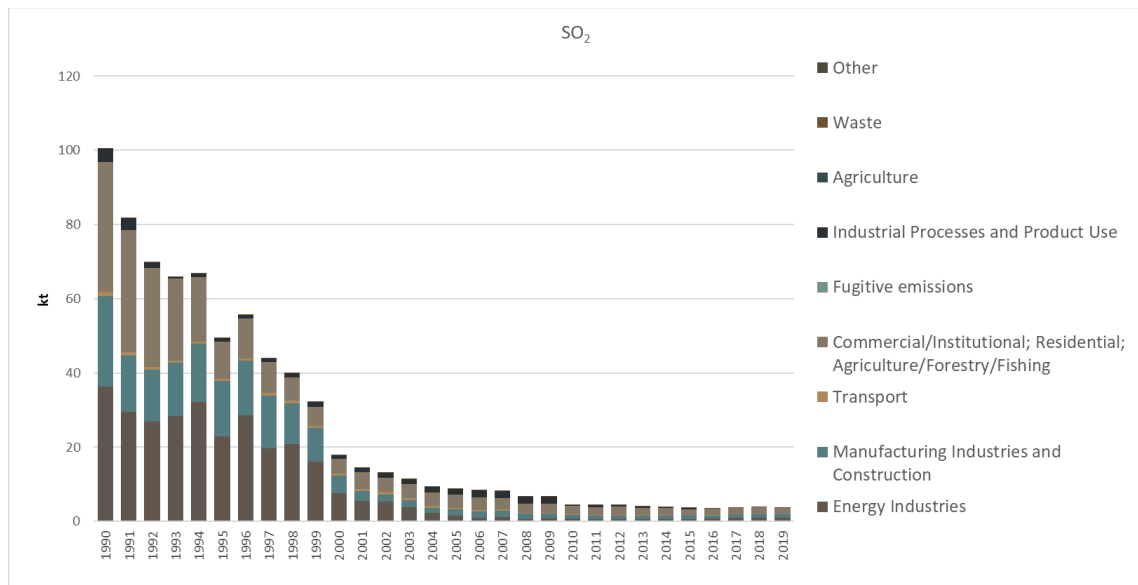


Figure 2.3 Total SO₂ emissions, kt

Since 1990, total SO₂ emissions have decreased from 100.46 kt to 3.70 kt (-96.3%) in 2019 (Figure 2.3). The reduction can be explained with use of fuels with lower sulphur content as well as fuel switching from solid and liquid types of fuel to natural gas and biomass. In 2018-2019 the total SO₂ emissions have decreased by 4.1% mainly from decreased activity in Energy sector.

In 2019, the largest SO₂ emission producer is Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) which is responsible for 45.2% of total emissions. Since 2005 SO₂ emissions in Other Sector have decreased by 54.3% as fuel consumption in sector have also decreased due to the energy efficiency improvements. Solid fossil fuel consumption in sector has also significantly decreased since 2005.

Energy Industries (NFR 1A1) and Manufacturing Industries and Construction (NFR 1A2) constitutes 26.9% and 23.3% accordingly. SO₂ emissions from fuel combustion in these sectors have also decreased since 2005 by 38.1% and 44.9%. Solid fuels and liquid fuels with high sulphur content were replaced with natural gas and biomass.

SO₂ emission reduction in Transport sector (-86.6% since 2005) is due to the implementation of stronger fuel quality requirements. In 2019, Transport and IPPU sector is responsible for 1.5% and 2.8% of SO₂ emissions accordingly.

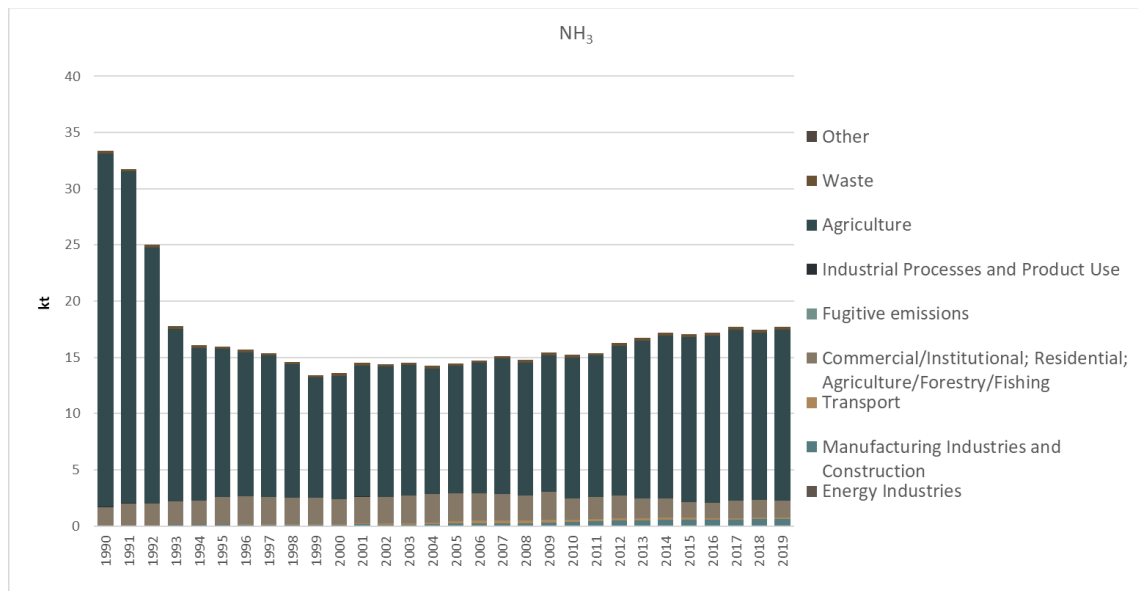


Figure 2.4 Total NH₃ emissions, kt

The total ammonia emissions have decreased by 46.9% from 33.36 kt in 1990 to 17.70 kt in 2019 (Figure 2.4). The large decrease in the beginning of 90ties can be explained with the collapse of USSR, when as a result many farms were closed and because of that agricultural activities reduced. In 2018-2019 emissions have slightly increased by 1.3%.

In 2019, the largest part – 85.8% of NH₃ emissions are produced from Agricultural sector (NFR 3). Emissions in Agriculture sector are divided into emissions from crop production and agricultural soils, as well as emissions from manure management and other sources. In 2019, emissions from crop production and agricultural soils constituted 59.0% (8.97 kt), including emissions from inorganic N-fertilizers, animal manure and other organic fertilizers which were applied to soils, urine and dung from grazing animals. Since 2005 NH₃ emissions in Agriculture have increased by 34.3%.

Second largest NH₃ emission emitter in 2019 is Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) which is responsible for 8.4%. Since 2005 emissions in Other Sector (NFR 1A4) have decreased by 33.2%, which can be explained with energy efficiency improvements in buildings.

Remaining producers of ammonia are Manufacturing Industries and Construction (NFR 1A2), Transport (NFR 1A3), and Waste (NFR 5) sector with 3.1%, 0.8% and 1.5%. Insignificant amount of NH₃ is also produced in IPPU (NFR 2) sector.

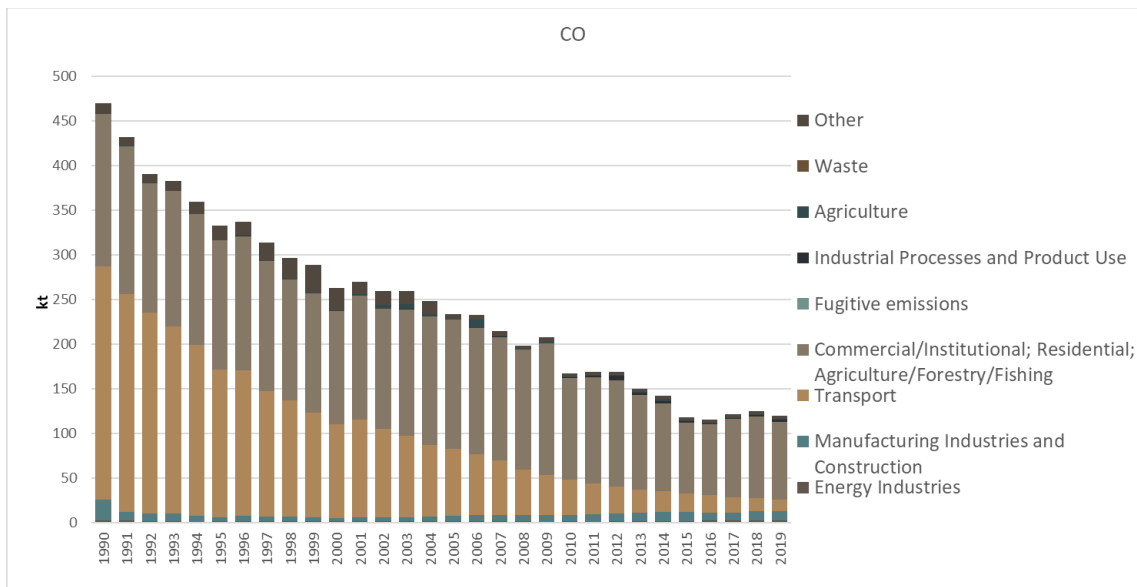


Figure 2.5 Total CO emissions, kt

Carbon monoxide emission trend shows a decrease in emissions by 74.4% from 469.18 kt in 1990 to 119.93 kt in 2019 (Figure 2.5). In 2018-2019 emissions of CO have decreased by 3.9%.

In 2019, CO emission originate generally from the Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) with 72.5% of total emissions. Since 2005 CO emissions have decreased by 40.0%.

Second largest contributor is Transport sector (NFR 1A3) with 10.7% in 2019. Since 2005 CO emissions in Transport sector have decreased by 82.7%. The overall decrease in CO emissions can be mainly explained with better technologies used in cars that prevents gasoline from incomplete combustion.

Remaining producers of carbon monoxide are Energy Industries (NFR 1A1), Manufacturing Industries and Construction (NFR 1A2), IPPU (NFR 2) and Other (NFR 6) with 2.0%, 8.7%, 2.2% and 3.0%. Small amount of CO is also produced in Waste (NFR 5) sector.

2.3 Particulate matter (PM_{2.5}, PM₁₀, TSP, BC)

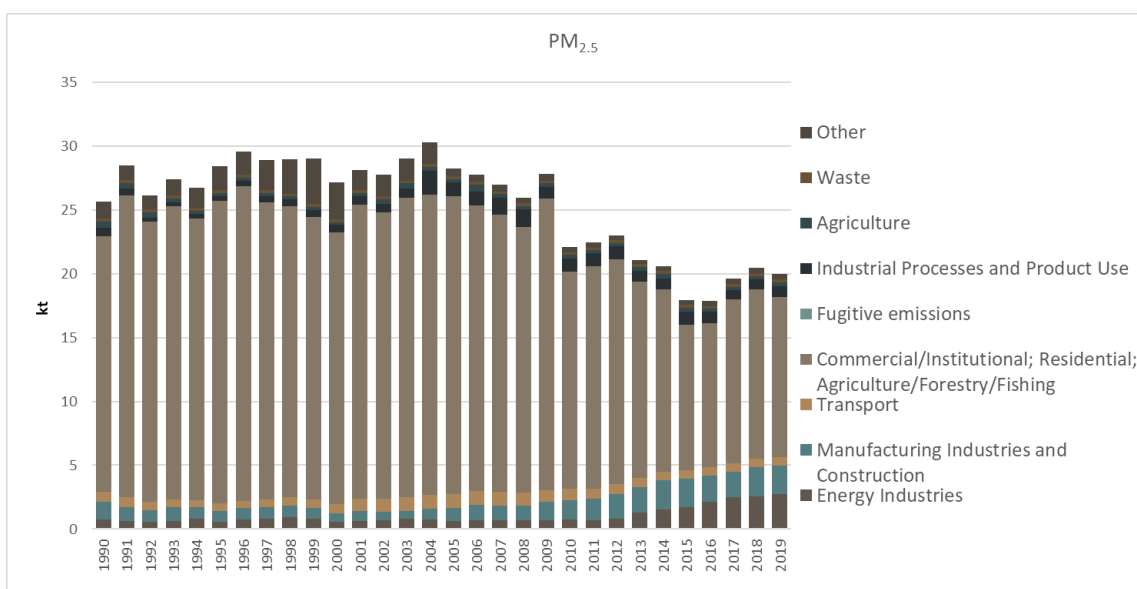


Figure 2.6 Total PM_{2.5} emissions, kt

Total PM_{2.5} emissions have decreased by 22.1% from 25.63 kt in 1990 to 19.97 kt in 2019 (Figure 2.6). The reduction can be explained with decrease of total fuel consumption in Energy sector. There can also be observed a fall in emissions in 2005-2019 by 29.3%, mostly due to decrease in fuel consumed in households. In 2018-2019 PM_{2.5} emissions have decreased by 2.3%.

In 2019 PM_{2.5} emissions are mainly produced in Other Sector (Commercial/Institutional; Residential; Agriculture/Forestry/Fishing) with 62.9% from total emissions. Since 2005 emissions in Other Sector have decreased by 46.1% due to the implementation of energy efficiency improvements in buildings which allowed for reduction in fuel consumption.

Second and third largest PM_{2.5} emitters in 2019 are Energy Industries (NFR 1A1) and Manufacturing Industries and Construction (NFR 1A2) with 13.6% and 11.4% accordingly. Since 2005 PM_{2.5} emissions in these sectors have increased mainly due to the broader use of biomass in both of these sectors.

Transport (NFR 1A3) sectors contributes 3.1% of total PM_{2.5} emissions in 2019, IPPU (NFR 2) – 4.3%, Agriculture (NFR 3) - 1.5%, Waste (NFR 4) - 1.1% and Other (NFR 6) - 2.1%.

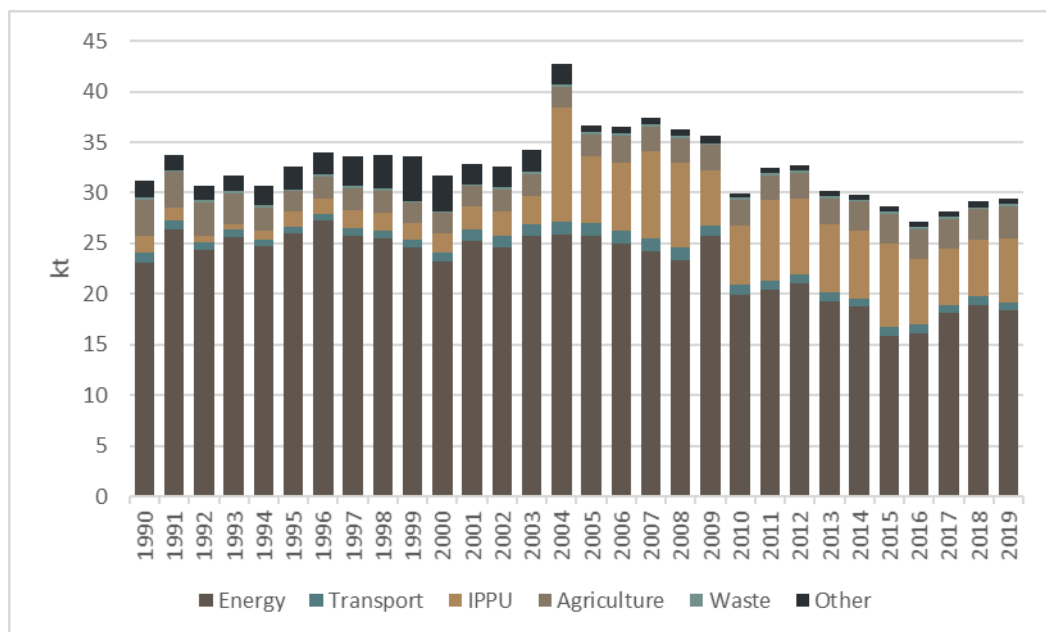


Figure 2.7 Total PM₁₀ emissions, kt

PM₁₀ emissions in 2019 have decreased by 5.7% since 1990 (Figure 2.7), due to the emission decrease in all sectors except IPPU, where emissions have increased almost three times. The largest part of PM₁₀ emissions in 2019 are produced in Energy sector – 62.5%. Compared to 2018 emissions have increased by 1.0%.

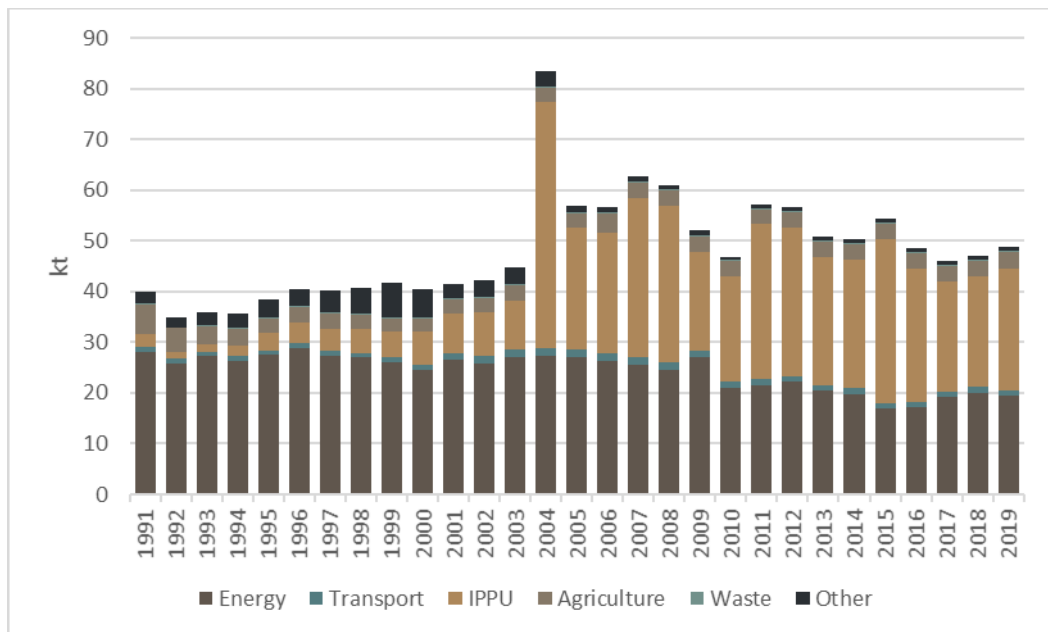


Figure 2.8 Total TSP emissions, kt

In 2019 TSP have increased by 28.3% since 1990 (Figure 2.8), due to the emission increase in IPPU, where emissions have increased more than six times. Peak in PM₁₀ and TSP emissions in 2004 can be explained with increased activities in Road paving (NFR 2D3b). *Via Baltica* (E67) that connects the capitals of all Baltic States was built in that particular year. The largest part of TSP emissions in 2019 are produced in IPPU sector – 49.1%. Compared to 2018 emissions have increased by 3.6%.

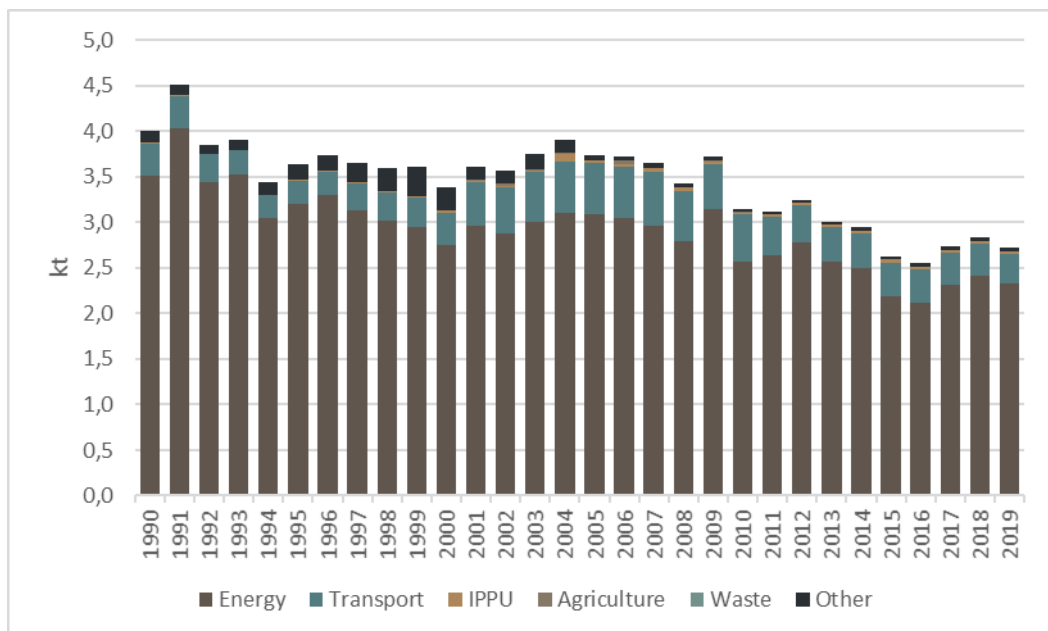


Figure 2.9 Total BC emissions, kt

BC emissions in 2019 have decreased by 32.1% since 1990 (Figure 2.9), due to the emission decrease in all sectors except IPPU and Agriculture. The largest part of BC emissions in 2019 are produced in Energy sector – 85.7%. Compared to 2018 emissions have decreased by 4.1%.

2.4 Heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn)

Emissions of heavy metals are shown in the Figure 2.10-Figure 2.12. In IIR, only priority HMs are described, but emissions for additional heavy metals can be found in NFR tables.

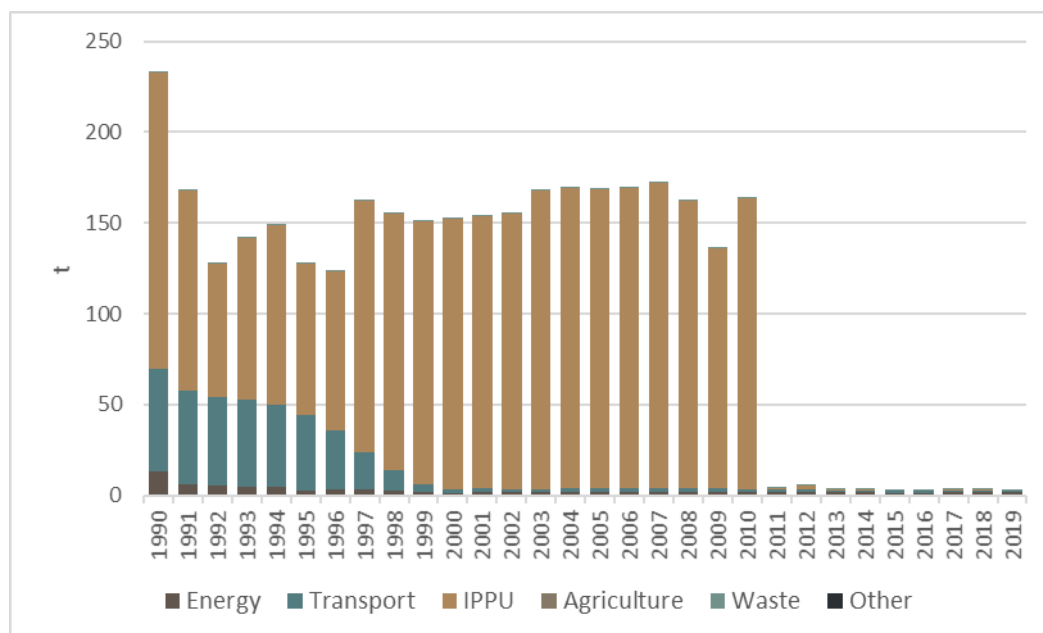


Figure 2.10 Total Pb emissions (t)

The most relevant changes can be seen in lead emissions (Figure 2.10). In comparison with 1990, Pb emissions have decreased by 98.7% in 2019. The amount of Pb emitted in 2019 is 2.99 tonnes, and it has decreased by 2.5% comparing with previous year's emissions. Largest Pb emitter in 2019 is Energy sector including Transport (95.5%). Significant decrease of lead emissions in Transport (NFR 1A3) sector can be seen in 1999. That can be explained with the changes in international legislation that prohibited the use of liquid fuels with high lead content. The most significant emission decrease by 97.4% happened in 2011 due to change of furnace type in metal production (NFR 2C1), other fluctuation in lead trend from IPPU sector can be explained with amount of metal produced.

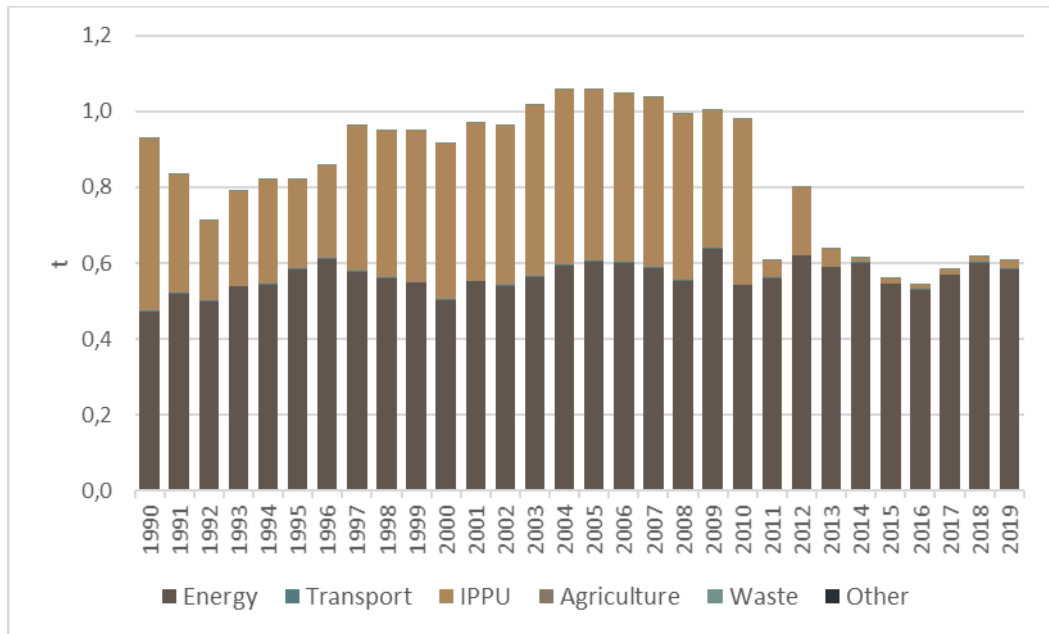


Figure 2.11 Total Cd emissions (t)

In 1990-2019, Cd emissions have decreased by 34.5%, and in 2019 total amounts of Cd emitted are 0.61 tonnes (Figure 2.11), which is by 1.8% less than in 2018. Energy sector (including Transport) contributes to 96.2% of total Cd emissions in 2019. Significant decrease of emissions can be seen in IPPU (95.2%) 1990-2019 due to the bankruptcy of the local metal production company.

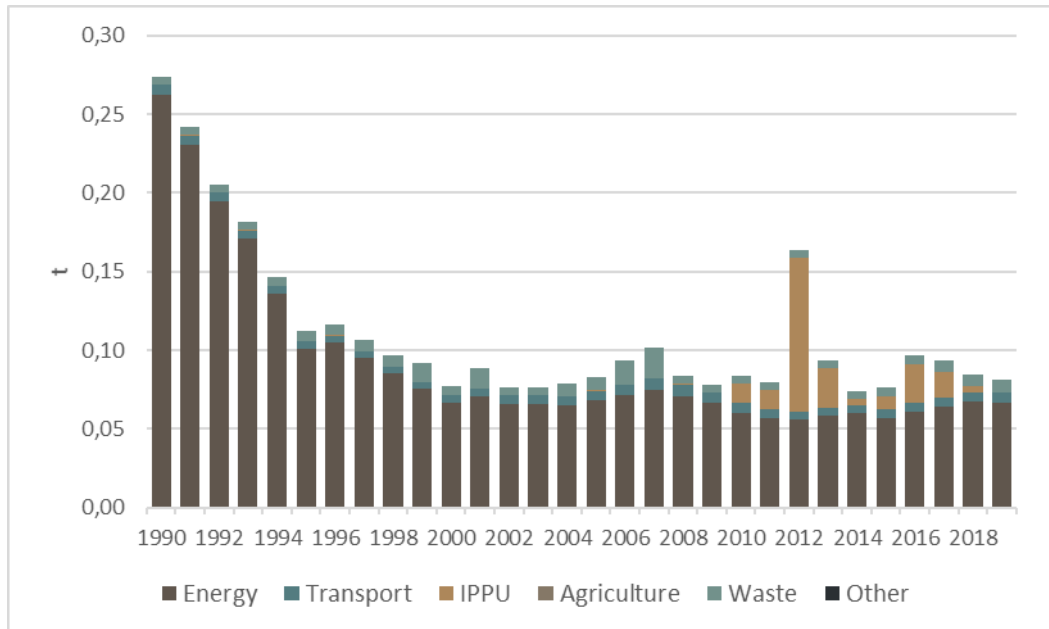


Figure 2.12 Total Hg emissions (t)

Mercury emission trend shows a decrease by 70.5% in emissions for period 1990-2019 (Figure 2.12). Hg emissions, 0.08 t in total (2019), originates generally from the Energy sector (74.5%). The decrease in Hg emissions can be mainly explained with decreasing amounts of fossil fuels used in combustion. Spike of Hg emissions in 2012 in IPPU sector as well as increase of mercury emissions in later years is mainly related with the fuel quality that is used in the local Cement production (NFR 2A1).

2.5 Persistent organic pollutants (PCDD/F, PAHs, PCB, HCB)

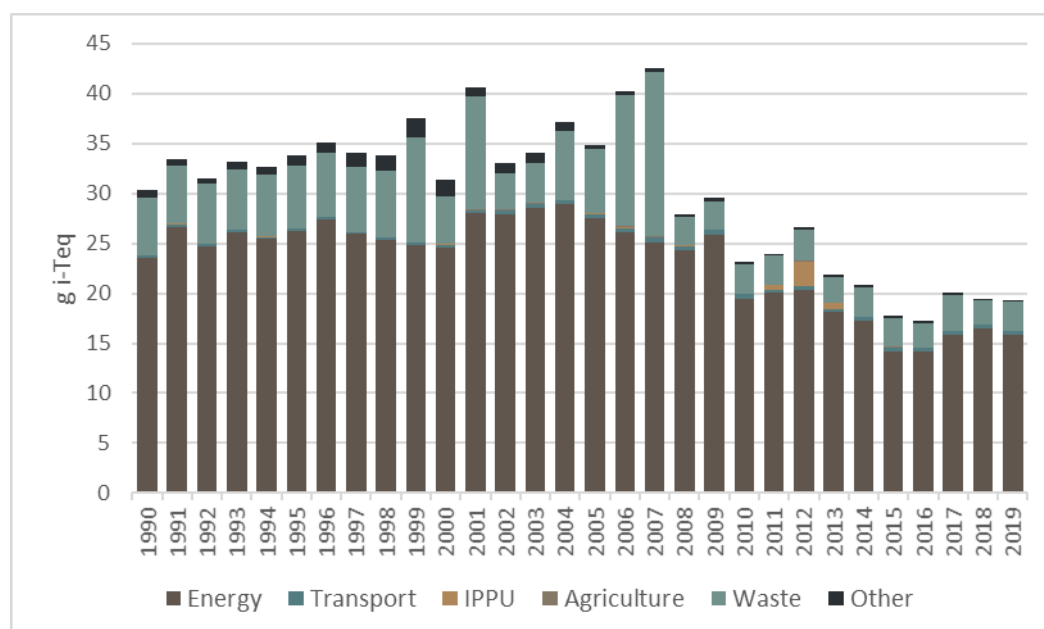


Figure 2.13 Total PCDD/F emissions (g i-Teq)

PCDD/F emissions have decreased by 36.2% in 1990-2019 (Figure 2.13). Fluctuation in emissions is connected with waste incineration processes, as well as biomass combustion. In 2019, approximately 81.9% emissions from all PCDD/F emissions are generated in the Energy sector, but the remaining part of emissions are generated by the Transport sector (NFR 1A3), Waste incineration (NFR 5C), combustion of wood harvesting residues (NFR 6A) and grassland burning (NFR 3I). In Waste incineration PCDD/F emissions are fluctuating significantly due to increased amounts of incinerated clinical waste in 2006-2007, but since 2008 the facility is closed. In Energy sector the emissions have increased due to larger amounts of biomass combusted, for example, in 2018-2019 the emissions have decreased by 0.7%.

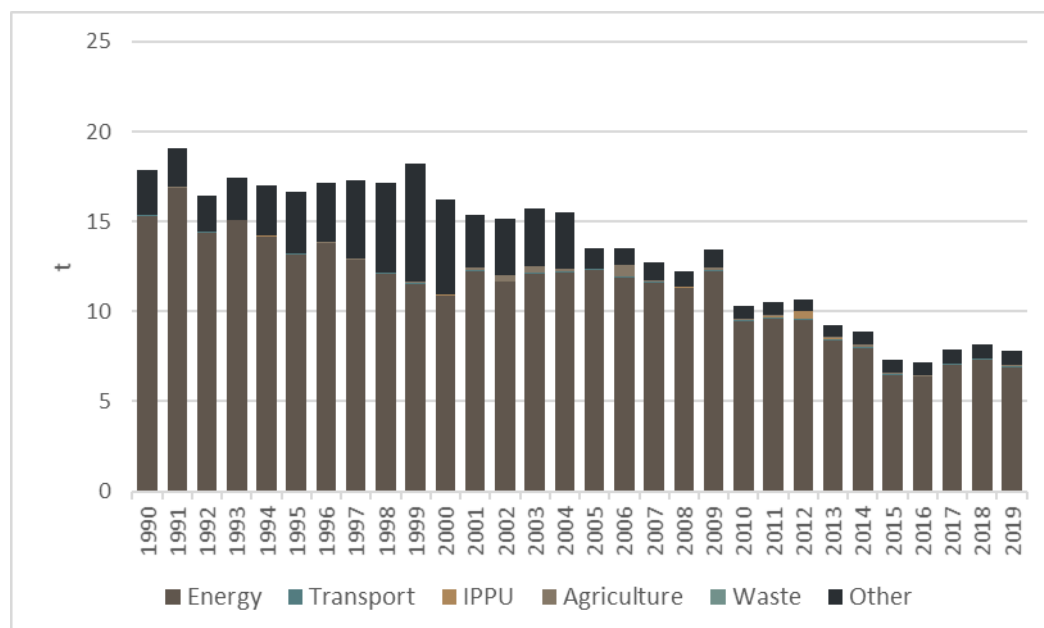


Figure 2.14 Total PAH emissions (t)

PAH emissions in 1990-2019 have decreased by 56.4%, reaching 7.79 tonnes in 2019 (Figure 2.14) which is by 4.7% less comparing with year 2018. The fluctuations through the time series can be explained with

changes in national economy and also weather conditions that influenced the consumption of particular fuels. In 2019 88.5% from PAHs were generated in Energy (including Transport) sector and mainly in solid biomass combustion processes.

It has to be noted that since 1999 total PAH emissions slightly differ from summarized benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene emissions (can be seen in NFR reporting tables, columns X to AA). It is because of unavailability of segregated emission factors for each pollutant and emission factor only for total PAH emissions can be found.

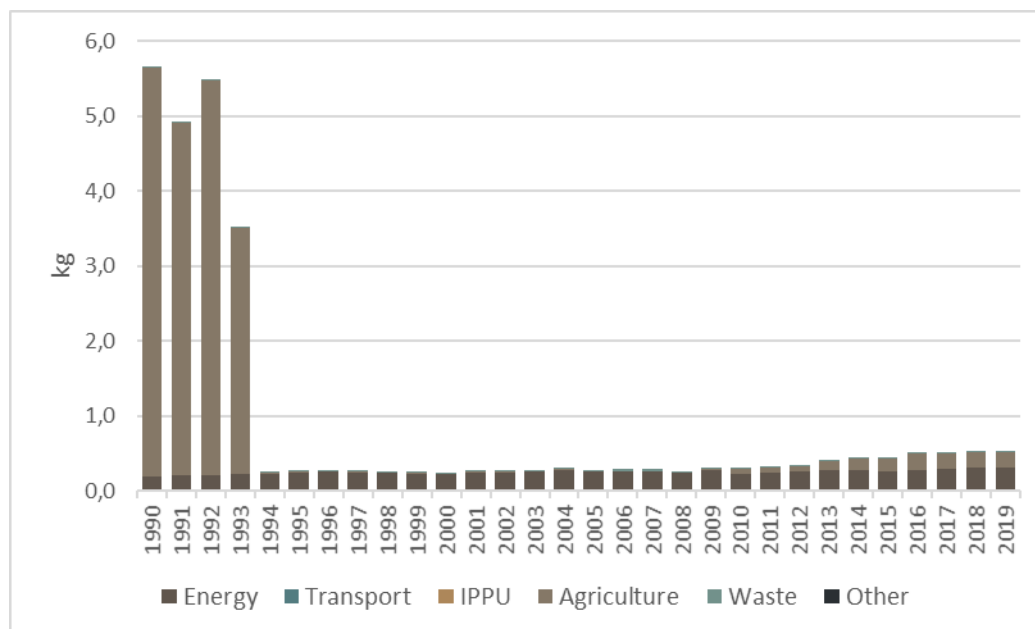


Figure 2.15 Total HCB emissions (kg)

HCB emissions have decreased by 90.9% since 1990, reaching 0.51 kg in 2019 (Figure 2.15). In 2018-2019 emissions have decreased by 0.1%. HCB emissions from stationary fuel combustion are estimated only from solid fuels – coal and coke, and solid biomass combustion activities. 60.9% from HCB emissions in 2019 are generated in Energy (including Transport) and 38.7% in Agriculture (NFR 3).

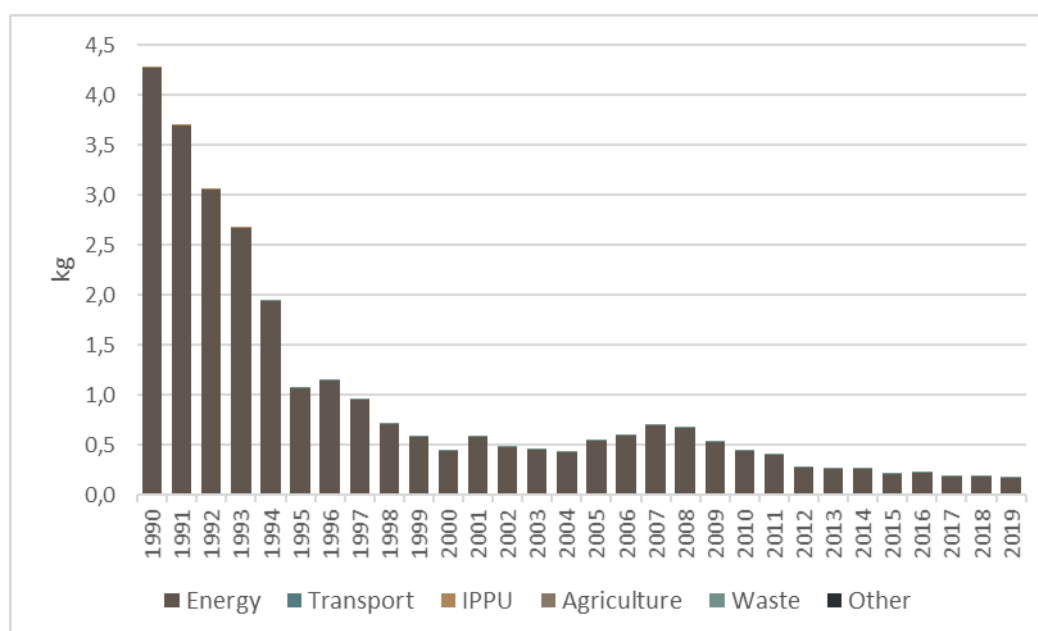


Figure 2.16 Total PCB emissions (kg)

PCB emission trend shows a decrease by 96.0% in emissions for period 1990-2019 (Figure 2.16). In 2018-2019 the emissions continue to fall reaching 0.17 kg (-9.3%). In 2019, PCB emissions originate generally from the Energy sector (including Transport), contributing 99.0% from all emissions. The decrease in emissions can be mainly explained with less amounts of fossil fuels used in combustion. Spike of emissions in 2012 from IPPU can be explained with significant activity increase in the particular year in Iron and steel production (NFR 2C1).

3 Energy sector (NFR 1)

3.1 Sector overview

3.1.1 Quantitative overview

Both the imported (natural gas, liquid gas, oil and oil products, coal) and local fuels (wood, peat, hydro resources) are used in the Energy sector in Latvia (Table 3.1). Mainly the imported fuels (natural gas, coal) are used in heat generation. Smaller boiler houses burn local fuel (wood) and coal as well.

Table 3.1 Consumption of energy resources in Latvia (TJ)⁴

Fuel type	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Energy consumption	318551	176154	143517	178621	185659	173140	175880	176378	175230	175968	180679	182094	186003	192664
Liquid fuels, total	161188	81668	53511	68003	72018	64401	64363	64650	65478	68606	72012	73181	64811	75231
Shale Oil	NO	78	2440	157	39	79	39	NO	NO	NO	7	1	8	9
LPG	3691	1548	2095	2552	2103	2414	3279	3840	4235	4103	4174	4226	3892	3432
Gasoline	26752	18130	14833	15131	12666	11925	10145	9286	9023	8922	8752	8363	8031	7638
Jet Kerosene	3068	1172	1142	2525	4929	4941	5029	5209	4646	4530	5170	5924	6497	6688
Other Kerosene	647	432	43	NO	NO	NO	NO	NO	NO	NO	6	4	4	1
Diesel Oil	48023	18273	20907	36712	41923	38453	38877	39367	40661	45521	47458	49399	46098	55572
RFO	76326	41290	9462	10231	8661	6535	6942	6852	6821	5467	6258	5154	207	1822
Petroleum Coke	NO	NO	NO	429	627	NO	NO	NO	NO	NO	124	44	5	NO
Other Oil Products	2681	745	2590	266	1070	54	52	96	93	63	63	66	68	69
Solid fuels, total	26249	7225	2785	3199	4378	4509	3645	2905	2473	1950	1678	1689	1894	1644
Anthracite	NO	NO	NO	NO	NO	NO	82	27	NO	NO	27	7	NO	NO
Coal	25984	7172	2759	3145	4378	4509	3563	2878	2473	1950	1651	1679	1893	1643
Coke	237	53	26	54	NO	NO	NO	NO	NO	NO	NO	3	1	1
Oil Shale	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat products, total	3217	3837	2392	80	46	43	34	64	35	11	34	40	135	72
Peat	2350	3436	2361	80	40	40	30	60	30	10	34	29	119	54
Peat Briquettes	867	401	31	NO	6	3	4	4	5	1	NO	11	16	18
Natural gas	99517	41304	44962	56685	61044	53528	50301	49994	44798	45758	46751	41193	48494	45680
Biomass, total	27501	42120	39774	49676	47633	49875	56632	57622	61132	58362	59283	64818	69017	68552
Wood	27501	42102	39695	49124	45375	46594	52169	52806	55531	52231	53905	59118	61890	61617
Charcoal	NO	NO	NO	60	60	60	59	90	90	60	65	66	68	87
Straws	NO	NO	NO	NO	60	43	38	58	99	135	161	223	414	457
Biodiesel	NO	NO	NO	101	1116	1067	938	895	998	1047	500	453	1665	1635
Landfill Gas	NO	NO	NO	251	331	349	347	371	369	420	409	422	405	365
Sludge Gas	NO	18	41	90	114	100	105	97	91	99	107	106	87	98
Other Biogas	NO	NO	NO	NO	66	469	1726	2270	2688	3239	3328	3463	3242	2970
Municipal Wastes	NO	NO	37	49	510	1193	1250	1035	1266	1131	808	968	1247	1324
Other fuels, total	879	NO	94	977	540	784	905	1143	1314	1281	921	1172	1651	1484
Municipal Waste	NO	NO	NO	NO	320	332	577	707	892	934	736	962	1215	1086
Industrial Waste	NO	NO	94	125	84	331	242	379	358	284	155	180	338	320
Other Fossil Fuels	NO	NO	NO	6	42	33	28	28	35	33	5	3	65	66
Waste Oil	879	NO	NO	847	95	88	58	29	29	29	25	27	33	13

Liquid fossil fuels have an important place as energy resource. Its share was about 39.0% in 2019. The essential decrease of heavy oil share in Energy Balance is explained with increasing fuel costs because of

⁴ Excluding electricity.

implementation of the EU Directive 1999/32/EC prescribing that sulphur content of heavy oil should not exceed 1%. The biggest part of the liquid fuel consumption contributes diesel oil with approximately 73.9% from total liquid fuel consumption in 2019; diesel oil is mostly used in Transport sector. The total consumption of liquid fuels in 2019 has decreased by 53.3% since 1990. Reason for such drastic decrease can be explained with changes in technology, with exception of Transport sector and Other (NFR 1A5), that, technology that uses liquid fuel, is replaced with one that uses natural gas and biomass.

Total share of *solid fossil fuels* in national market is low – approximately 0.9% in 2019. The solid fuel consumption in recent years is stable. The total consumption of solid fuels in 2019 has decreased by 93.7% since 1990. A decrease (19.3%) in solid fuel consumption can be seen in 2008-2009 due to the global economic crisis. Decrease of solid fuel consumption can be explained with technology change, when solid fuel combustion was replaced with natural gas and biomass for heat and energy production.

Peat and peat briquettes are local fuels that were used in Latvia in 1990 with 1.0% of total energy consumption. However, nowadays amounts of peat products used for stationary burning have decreased by 97.8% compared to 1990 and has 0.04% of total share in 2019. Peat was widely used in heat production, but now mostly biomass and gaseous fuels are used for both heat and electricity production.

The largest consumers of *natural gas* are combined heat and power plants, and heat generation enterprises as well as industrial enterprises. Natural gas has a stable place in total fuel consumption where its share was 31.2% in 1990 and 23.7% in 2019. Natural gas consumption has decreased by 54.1% in 1990-2019. Decrease in natural gas use could be explained with fuel switching from natural gas to biomass as well as increased energy efficiency in buildings.

Biomass fuels are wood and wood products, straw, charcoal, liquid biofuels (bioethanol and biodiesel), biogas (landfill gas, sludge gas, other biogas). In the total fuel consumption, the share of firewood and other wood products is substantial – 35.6% of total energy consumption in 2019, while in 1990 all biomass fuels in total made up only 8.6% from total energy consumption. In 2010-2019 use of wood and wood products have increased by 35.8%. Such fuels as straws are used more often and have an increasing trend in the past few years (10.4% in 2018-2019).

*Industrial and municipal waste*⁵ was also consumed and in 2019 reached 1.4% share from the total energy consumption in 2019. In 2019 consumption decreased by 2.5% in comparison with 2018. Waste oils are reported as other fuels.

Hydroelectric power plants (HPP) and combined heat and power plants (CHP) produce part of the electrical power, while part is imported (Table 3.2, Table 3.3). Volume of electricity generation in HPP directly depends on the through-flow of the river Daugava. Also, the import and export of electricity from Estonia, Lithuania and Russia has a significant role in the internal electricity market in Latvia.

Table 3.2 Heat production and consumption in Latvia (TJ)

Year	Production	Own use and losses	Final consumption		
			NFR 1A2	NFR 1A4	TOTAL
1990	99439	15171	32929	51339	84268
1995	46112	7156	1969	36987	38956
2000	31867	6815	659	24393	25052
2001	33937	7038	641	26258	26899
2002	33048	6541	630	25877	26507
2003	33516	6409	626	26481	27107
2004	31093	6174	608	24311	24919
2005	31144	5886	684	24574	25258
2006	30056	5454	634	23968	24602

⁵ For reporting purposes municipal waste has been divided into fossil and non-fossil fractions, but in the particular paragraph it is described as whole.

Year	Production	Own use and losses	Final consumption		
			NFR 1A2	NFR 1A4	TOTAL
2007	28685	4911	554	23220	23774
2008	26402	4010	356	22036	22392
2009	26308	4099	298	21911	22209
2010	28662	4590	387	23685	24072
2011	25000	4104	268	20628	20896
2012	26857	4464	259	22134	22393
2013	26249	4551	479	21219	21698
2014	25747	4608	890	20249	21139
2015	25459	4358	1450	19651	21101
2016	28967	4635	2506	21826	24332
2017	29989	4668	3291	22030	25321
2018	29688	4494	3781	21413	25194
2019	28612	4288	3324	21000	24324

Table 3.3 Electricity production and consumption in Latvia (TJ)

Year	Production	Own use and losses	Import	Export	Final consumption			TOTAL
					NFR 1A2	NFR 1A3	NFR 1A4	
1990	23933	6883	25700	12798	11484	918	17550	29952
1991	20318	6681	15217	7	10807	785	17255	28847
1992	13803	5646	14688	7	8316	745	13777	22838
1993	14126	6101	9619	612	5440	688	10904	17032
1994	15984	6681	9533	2988	5076	670	10102	15848
1995	14324	6371	9529	1408	5130	677	10267	16074
1996	11254	7989	12377	760	4975	641	9266	14882
1997	16218	7692	6566	4	5519	634	8935	15088
1998	20869	6559	3290	1382	5296	612	10310	16218
1999	14796	5775	9349	2311	5130	554	10375	16059
2000	14890	5203	7589	1159	5159	547	10411	16117
2001	15408	5688	8424	1645	5562	623	10314	16499
2002	14310	5188	10217	1764	5494	518	11563	17575
2003	14310	5065	9616	137	5778	490	12456	18724
2004	16881	4976	9839	2290	5882	500	13072	19454
2005	17658	4766	10278	2545	6120	533	13972	20625
2006	17607	4522	10116	1087	6332	540	15242	22114
2007	17176	4194	17870	7070	6538	504	16740	23782
2008	18987	4198	16715	7643	6066	497	17298	23861
2009	20048	4032	15333	9378	5421	436	16114	21971
2010	23857	4626	14303	11160	5724	453	16197	22374
2011	21938	4133	14432	9950	6012	446	15829	22287
2012	22202	3636	17766	11678	7175	464	17015	24654
2013	22352	3556	18018	13140	6509	446	16719	23674
2014	18500	3138	19221	10883	6003	421	17276	23700
2015	19921	3215	18888	12330	6130	384	16750	23264
2016	23129	3513	17382	13662	6005	378	16953	23336
2017	27111	3535	14662	14893	6345	377	16623	23345
2018	24210	3498	18625	15353	6630	374	16980	23984
2019	23178	3257	16599	12574	6646	418	16882	23946

Types of fuels used for combustion in Latvia:

Liquid fuels are mainly imported from Latvia's neighbouring countries – Lithuania, Belarus, Russian Federation, Scandinavian countries and others and consist of:

- shale oil;

- liquefied petroleum gas (LPG);
- motor gasoline and aviation gasoline;
- kerosene type jet fuel;
- other kerosene;
- gasoline type jet fuel;
- motor diesel oil and heating gas oil;
- residual fuel oil (RFO);
- other liquids;
- petroleum coke.

Solid fuels consist of coal and coke are mainly imported from Russian Federation, Kazakhstan and Ukraine;

Peat products consists of peat and peat briquettes and mainly are domestic;

Gaseous fuels (natural gas) are imported from Russian Federation and Lithuania;

Biomass fuels:

- solid biomass – wood and other wood products, charcoal, straw and are mainly domestic,
- biogas that is produced domestic – landfill gas that is used since 2002 when first landfill started to collect and combust biogas with energy recovery, sludge gas that is combusted with energy recovery since 1993 largest sewage purification plant, and other biogases that is produced from agriculture crops, animal slurries, breweries and other agro-food industries from anaerobic fermentation,
- liquid biofuels – biogasoline and biodiesel, are mainly imported from Latvia's neighbouring countries.

Other fuels are municipal waste and industrial waste – used tires, different types of industrial fuel collected by and combusted in cement production plant in Latvia, as well as waste oils.

3.2 Fuel Combustion (NFR 1.A)

3.2.1 Overview of sector

Emissions from fuel combustion comprise all in-country fuel consumption for heat and electricity production purposes and to provide operation of transport vehicles. These emissions include point sources, transport and other fuel combustion. Emissions from fuel combustion in the Energy sector are divided into following subcategories:

- NFR 1A1 – Energy Industries;
- NFR 1A2 – Manufacturing Industries and Construction;
- NFR 1A3 – Transport;
- NFR 1A4 – Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/ Fisheries);
- NFR 1A5 – Other (Not elsewhere specified).

Source categories and methods used are listed in Table 3.4, reported emissions are reported in Table 3.5

Table 3.4 Source categories and methods for Fuel combustion

NFR code	Description	Method	AD	EF
1A1a	Public electricity and heat production	Tier 1, 2	NS ⁶	D ⁷
1A1c	Manufacture of solid fuels and other energy industries	Tier 1	NS	D
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Tier 1	NS	D
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Tier 1	NS	D

⁶ National statistics

⁷ Default EF from EMEP/EEA 2016, EMEP/EEA 2019

1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Tier 1	NS	D
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Tier 1	NS	D
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Tier 1	NS	D
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Tier 1	NS, PS ⁸	D
1A2g	Stationary and mobile combustion in manufacturing industries and construction: Other	Tier 1, 2	NS	D
1A3a	Domestic and international Civil aviation	Tier 1, 2	NS	D
1A3b	Road transport	Tier 3	NS	D
1A3c	Railways	Tier 2	NS	D
1A3d	National navigation and international maritime navigation	Tier 1	NS	D
1A4a	Commercial/Institutional	Tier 1, 2	NS	D
1A4b	Residential	Tier 1, 2	NS	D
1A4c	Agriculture/Forestry/Fishing	Tier 1, 2	NS	D
1A5b	Other, Mobile (including military, land based and recreational boats)	Tier 1	NS	D

Table 3.5 Reported emissions in Energy sectors in 2019

NFR code	Emissions
1A1a	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A1b	NO
1A1c	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2a	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A2b	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2c	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2d	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2e	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2f	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A2g	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A3ai(i)	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg
1A3aii(i)	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg
1A3bi	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3bii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3biii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3biv	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3bv	NMVOC
1A3bvi	PM _{2.5} , PM ₁₀ , TSP, BC
1A3bvii	PM _{2.5} , PM ₁₀ , TSP
1A3c	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs
1A3di(ii)	NA, NE
1A3dii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs, indeno(1,2,3-cd)pyrene, total PAHs
1A3ei	NO

⁸ Plant specific (AD – data obtained from plant)

NFR code	Emissions
1A4ai	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A4aii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs
1A4bi	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A4bii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs
1A4ci	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCB
1A4cii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs
1A4ciii	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, HCB, PCB
1A5b	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, HCB, PCB

3.2.2 Key sources

In 2019, in stationary combustion the Energy Industries (NFR 1A1) was the most important source for Hg, As, Ni and Se, Transport (NFR 1A3) was the most important sector for NO_x, Pb and Cu, Other Sectors (commercial/institutional, residential, agriculture/forestry/fishery; NFR 1A4) for NMVOCs, SO₂, NH₃, PMs, CO, Cd, Cr, Se, Zn, PCDD/F, PAHs, HCB and PCBs emissions Figure 3.1.

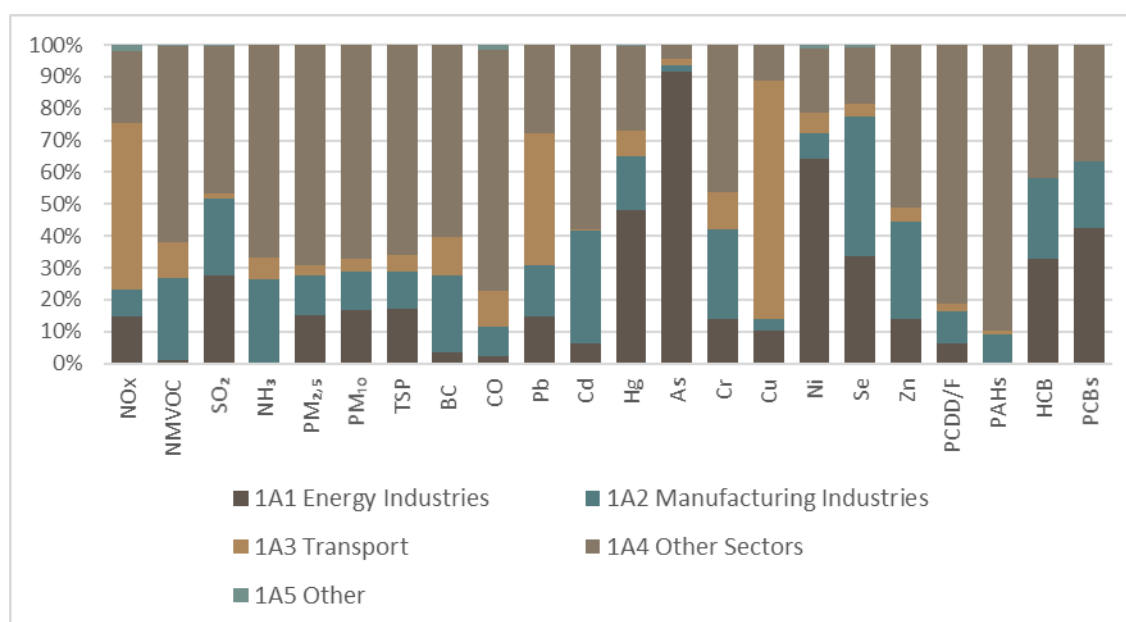


Figure 3.1 Distribution of emissions from Fuel combustion in 2019, %

Main pollutants

NO_x emissions generated in fuel combustion made up 79.7% from total emissions generated in Latvia in 2019. The largest part were produced in 1A3 Transport (52.2%) sector. **SO₂** emissions from fuel combustion were 96.9% from total SO₂ emissions in 2019, and 1A4 Other Sector was the most significant with 46.2%. **NMVOC** emissions from Energy sector contributed to 47.2% of the total Latvia's NMVOC emissions in 2019. 1A4 Other Sector contributed to the largest part with 61.6%. The most important source for NMVOC emissions from stationary fuel combustion is solid biomass combustion in Residential sector. The largest part of **NH₃** emissions in fuel combustion are produced in 1A4 Other Sector – in 2019 8.4% of total NH₃ emissions or 66.8% from fuel combustion. In EMEP/EEA 2019, there are no emission factors for NH₃ emission estimation in 1A1 sector, therefore notation key NE in the particular sector was used.

In 2019, fuel combustion sectors accounted for 94.0% of the total **CO** emissions in Latvia. 1A4 Other Sector was the largest emission source accounting for 75.7% of fuel combustion emissions.

Particulate matter

Fuel combustion generated 91.0% of **PM_{2.5}** emissions, 65.2% of **PM₁₀** emissions, 42.1% of **TSP** emissions and 97.5% of total **black carbon** emissions in 2019. The largest part of PM emissions is generated in 1A4 Other Sectors (around 60-70%). Mainly particulate matter emissions are produced in biomass combustion process.

Heavy metals

Lead emissions from fuel combustion were 95.5% from total Pb emissions in 2019, and 1A3 Transport was the one with the highest contribution 41.2%. **Cadmium** emissions from fuel combustion account for 96.2% from total emissions, and 1A4 Other Sector is the biggest producer of cadmium emissions with 58.0% from total Cd emissions in the energy sector. In 2019 fuel combustion accounted for 89.9% of the total **mercury** emissions. Mercury emissions from fuel combustion are mainly emitted in solid fuels and biomass combustion, and the largest part of emissions are produced in 1A1 Energy Industries (47.9%).

POPs

Fuel combustion is the main producer of POPs emissions in Latvia – **PCDD/F** (83.8%), **PAHs** (89.4%), **HCB** (60.9%) and **PCB** (99.0%). 1A4 Other Sector is the largest sector of HCB emissions with 41.6% of total fuel combustion emissions. Solid biomass combustion is the main source of PAHs emissions in 2019, and 1A4 Other Sector is the largest contributor to PAH emissions with 89.8% from fuel combustion respectively. In fuel combustion, 1A4 Other Sectors is 81.4% for the PCDD/F emissions where solid biomass and solid fuels are the main emitters for the particular emissions.

3.2.3 Trends in emissions

Table 3.6 Reported emissions from fuel combustion in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		86.56	48.66	38.96	40.61	35.46	28.69	27.59	27.60	28.15	26.39	-69.5
NMVOC		51.39	40.46	33.19	33.53	24.88	19.42	18.79	19.71	20.21	19.19	-62.7
SO_x		96.89	48.45	16.82	7.27	4.13	3.32	3.35	3.53	3.75	3.59	-96.3
NH₃		1.69	2.55	2.37	2.93	2.46	2.12	2.06	2.23	2.32	2.22	31.3
PM_{2.5}	kt	22.92	25.70	23.24	26.04	20.19	15.98	16.14	17.96	18.77	18.17	-20.7
PM₁₀		24.05	26.67	24.07	26.97	20.99	16.78	17.01	18.93	19.77	19.18	-20.2
TSP		25.86	28.38	25.51	28.59	22.31	17.93	18.20	20.25	21.14	20.53	-20.6
BC		3.87	3.46	3.11	3.65	3.08	2.56	2.48	2.67	2.77	2.65	-31.5
CO		457.26	315.92	236.83	227.59	161.75	111.60	110.59	116.00	118.85	112.73	-75.3
Pb		69.78	44.50	3.41	3.84	3.40	2.82	2.82	2.89	2.92	2.85	-95.9
Cd	t	0.47	0.59	0.50	0.61	0.54	0.55	0.53	0.57	0.60	0.59	23.5
Hg		0.27	0.11	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	-72.9
PCDD/F	g I-Teq	23.77	26.49	24.86	27.95	19.93	14.57	14.51	16.16	16.90	16.21	-31.8
PAHs	t	15.37	13.22	10.91	12.34	9.52	6.50	6.42	7.09	7.35	6.97	-54.7
HCB		0.19	0.25	0.23	0.26	0.23	0.26	0.27	0.30	0.32	0.31	67.9
PCBs	kg	4.27	1.07	0.44	0.54	0.44	0.21	0.22	0.19	0.19	0.17	-96.1

The majority of total emissions from stationary fuel combustion have decreased in 1990-2019, with exception of NH₃, Cd and HCB emissions (Table 3.6). An increase in particular emissions is directly related with the increased use of biomass.

SO₂ emissions have the biggest decrease (96.3%) in 1990-2019. The emission decrease can be explained with fuel switch from heavy liquid fuels and solid fuels to natural gas and biomass use and to meet the commitments of EU ETS.

There is also a large decrease (69.5%) in NO_x emissions, that can be explained with change in fuel types – solid fossil fuels widely used previously were changed to biomass that have lower emission factor, therefore NO_x emissions decreased.

NH₃ emissions have increased by 31.3% in 1990-2019, mainly because of increased use of biomass. NH₃ emissions are calculated only from biomass burning processes in sectors 1A2 Manufacturing Industries and Constructions and 1A4 Other Sector.

Particulate matter emissions have decreased by approximately 20% in 1990-2019. Since 2005 particulate matter emissions have decreased due to the decrease of total fuel consumption (decrease in solid fuel use and increase use of gaseous fuels).

Heavy metal emissions have decreased by 70-95% in 1990-2019, except Cd, which has increased by 23.5%. Decrease of emissions can be explained with a decrease of total fuel consumption in early nineties due to economic crisis in the country. In recent years heavy metal emissions decreased due to fuel switch from heavy liquid and solid fossil fuels to natural gas and biomass consumption, except for Cd, which has relatively high emission factor for biomass.

From 1990 to 2019 PAH emissions have decreased by 54.7%, HCB emissions increased by 67.9% and PCDD/F emissions decreased by 31.8%, which can be explained with sharp increase of solid biomass consumption and decrease of fossil fuel consumption. The decrease of PCB emissions by 96.1% can be explained with decrease of solid fuel consumption – solid fossil fuels have significantly higher emission factor than solid biomass therefore the decrease of first mentioned has a bigger effect.

3.2.4 Energy Industries (NFR 1A1)

3.2.4.1 Overview

NFR 1A1 Energy Industries sector includes emissions from fuel combustion in point sources in energy and heat production. According to the 2006 IPCC Guidelines, emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) are assigned to the sector where they were generated and not under NFR 1A1 (included in sectors NFR 1A2, NFR 1A4a and NFR 1A4c).

Emissions from combustion installations with NACE 2 codes 35.11 and 35.30 are reported in NFR 1A1a sector. There are no petroleum refineries in Latvia therefore in NFR 1A1b notation key „NO” is used. NFR 1A1 sector also includes the emissions from on-site use of fuel in the energy production facilities and emissions from manufacturing of solid fuels (peat briquettes and charcoal production plants) – these emissions are reported under 1A1c Manufacture of solid fuels and other energy industries sector.

3.2.4.2 Trends in emissions

Table 3.7 Trends in emissions from 1A1 Energy Industries sector in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NOx		10.640	6.249	4.404	3.607	3.382	3.435	3.749	3.692	3.971	3.850	-63.8
NMVOG		0.220	0.123	0.116	0.122	0.125	0.165	0.191	0.201	0.213	0.216	-2.0
SOx		36.393	22.829	7.635	1.612	0.685	0.635	0.798	0.911	0.981	0.997	-97.3
PM_{2.5}	kt	0.753	0.564	0.563	0.652	0.750	1.704	2.152	2.490	2.570	2.721	261.2
PM₁₀		0.994	0.728	0.683	0.762	0.874	1.984	2.506	2.900	2.994	3.170	219.0
TSP		1.376	0.970	0.810	0.860	0.974	2.200	2.781	3.218	3.322	3.518	155.6
BC		0.041	0.027	0.021	0.022	0.025	0.056	0.071	0.082	0.085	0.090	121.3
CO		2.654	1.387	1.558	1.659	1.419	1.932	2.230	2.433	2.438	2.451	-7.7
Pb		0.238	0.177	0.138	0.103	0.118	0.263	0.333	0.385	0.399	0.422	77.6
Cd	t	0.056	0.034	0.020	0.011	0.011	0.023	0.029	0.033	0.035	0.037	-35.2
Hg		0.037	0.023	0.020	0.011	0.013	0.023	0.028	0.032	0.033	0.035	-4.9
PCDD/F	g I-Teq	0.176	0.163	0.216	0.242	0.285	0.643	0.812	0.939	0.969	1.025	481.3
PAHs	t	0.002	0.002	0.004	0.005	0.007	0.016	0.020	0.023	0.024	0.025	1503.1
HCB	kg	0.032	0.038	0.034	0.023	0.030	0.064	0.081	0.094	0.097	0.103	224.5
PCB		0.002	0.004	0.011	0.015	0.019	0.044	0.056	0.065	0.067	0.071	4519.4

Part of emissions from NFR 1A1 Energy Industries sector have decreased in 1990-2019, but emissions have increased of PMs, Pb, PAHs and dioxins, as well as HCB and PCB emissions (Table 3.7). These changes in emissions can mainly be explained with decrease of liquid and solid fuels consumption and increased use of biomass consumption in the sector.

3.2.4.3 Methods

Tier 1 and Tier 2 method was used to calculate emissions from the stationary fuel combustion. Calculation of all emissions from fuel combustion is done in Excel database. Tier 2 methodology was used to calculate emissions from natural gas use in sector NFR 1A1a for period 2005-2019.

The general method for emission calculation:

$$Em = EF \times B_q$$

where:

Em – total emissions (kt)

EF – emission factor (t/TJ)

B_q – amount of fuel in thermal units (TJ)

3.2.4.4 Emission factors

The main source for emission factors is EMEP/EEA 2019 (emission factors used for Energy sector are presented in Annex I, Table 1). Detailed information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM.

SO₂ emission factors were calculated by formula taken from EMEP/EEA 2019 and were calculated by national expert considering physical characterization of fuel types used in Latvia and taking into account national and international legislation. Percentage amount of sulphur content in used fuels is taken from the national database "2-Air" where polluters report the sulphur content data for certain types of fuels (Annex I, Table 3).

Emission factors for SO₂ are calculated by using the following equation:

$$EF = 2 \times \left(\frac{s}{100}\right) \times \frac{1}{Q} \times 10^6 \times \left(\frac{100 - r}{100}\right) \times \left(\frac{100 - n}{100}\right)$$

where:

EF – emission factor (kg/TJ)

2 – SO₂ / S (kg/kg)

s – sulphur content in fuel (%)

r – retention of sulphur in ash (%)

Q – net calorific value (TJ/kt)

10⁶ – (unit) conversion factor

n – efficiency of abatement technology and/or reduction efficiency (%).

The default emission factors used in emission estimations were taken from EMEP/EEA 2019 (Annex I, Table 1). Emission factors for sludge gas, landfill gas and other biogas were equalized to natural gas emission factors due to unavailability of particular emission factors for biogas. Emission factors for biodiesel were equalized to diesel emission factor.

3.2.4.5 Activity data

Emissions from fuel combustion are mainly calculated using fuel consumption data from the CSB Energy Balance, prepared by CSB. Data on fuel consumption in NFR 1A1 sector is presented in Annex II.

The CSB data collection system is based on detailed compulsory survey 2-EK (annual). Form 2-EK "Survey on acquisition and consumption of energy resources" is collected from about 6000 enterprises and organizations (with all kind of economic activity) that are included in the lists of suppliers of statistical information.

Approximately 6000 respondents were surveyed - all enterprises of the local and public administration employing 10 or more persons, other enterprises employing 80 and more persons, as well as enterprises with largest statistical units with turnover of 50% of total industry turnover, and other enterprises that CSB considers to be significant enough to include in the CSB Energy Balance, for example, with large imports of coal and oil products as well as wooden briquettes and chip pellets manufacturers. Enterprises and organizations that are not included in the above mentioned selection were surveyed by random sampling and the acquired results were extrapolated afterwards. Survey 2–EK represents the basic tool for creating energy balances at a country level. The amount of methane from combusted landfill gas is described in Chapter 7.2 Solid waste disposal and is consistent with numbers of recovered amounts of landfill gas in Waste sector (NFR 5A). The amount of methane from combusted sludge gas is given by only Sludge gas combustion enterprise and is consistent with numbers of gas, recovered from Wastewater handling sector (NFR 5D).

Fuel consumption by fuel types in 1990-2019 in Energy Industries sector can be seen in Figure 3.2. Gaseous fuels are mostly used in Energy Industries in this time period. Liquid fuels were mostly used in the beginning of 1990-ties and in the beginning of 2000 the use of them noticeably decreased. The amounts of biomass consumed are constantly increasing, while the consumption of solid fossil fuels and peat have decreased.

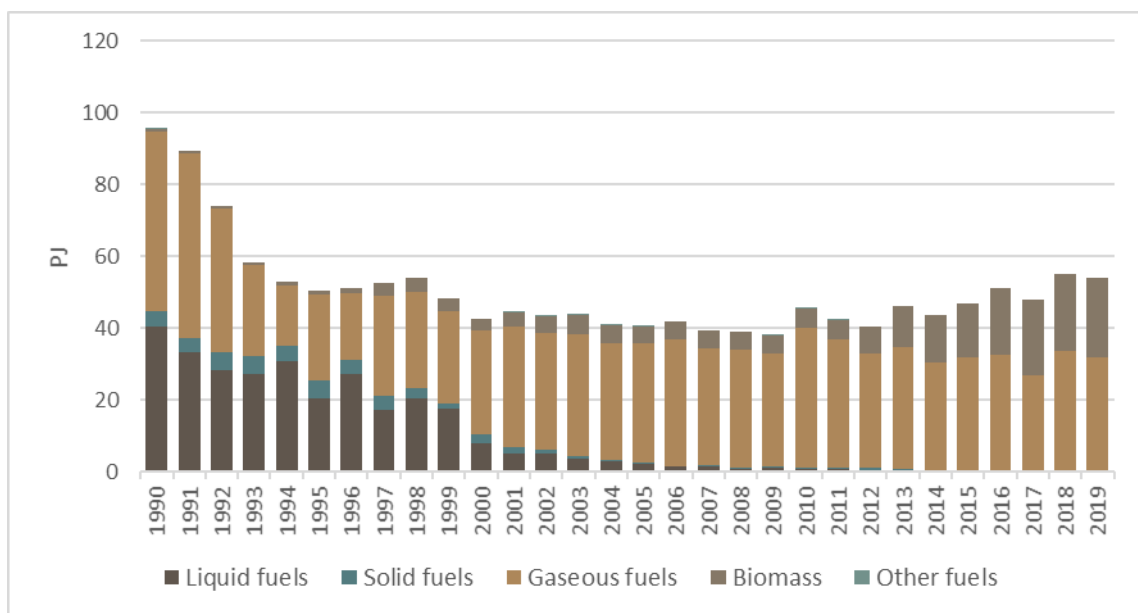


Figure 3.2 Fuel consumption in NFR 1A1 Energy Industries in 1990-2019, PJ

The largest decrease in 1990–2019 for the two sub-sectors of 1A1 Energy Industries sector was for liquid fuel (by 99.0%). It can be explained with fuel switching when liquid fuels were switched to cheaper fuels. Also, a stronger legislation contributed fuel switch to the type of fuels with lower level of emissions. It also explains why consumption of solid fuels have decreased (by 96.8%). Use of gaseous fuels decreased by 37.6% in comparison with 1990. In 2018-2019 fuel consumption increased for liquid fuels (15.6%) but decreased for solid fuels (35.0%), and gaseous fuels (5.8%). Consumption of biomass fuel has significantly increased in 1990–2019 more than 50 times. Solid biomass is a local fuel and due to biomass CO₂ neutrality, enterprises switched from fossil fuels to biomass. As biomass keeps replacing fossil fuels, consumption of biomass in 2019 increased by 4.5% in comparison with 2018.

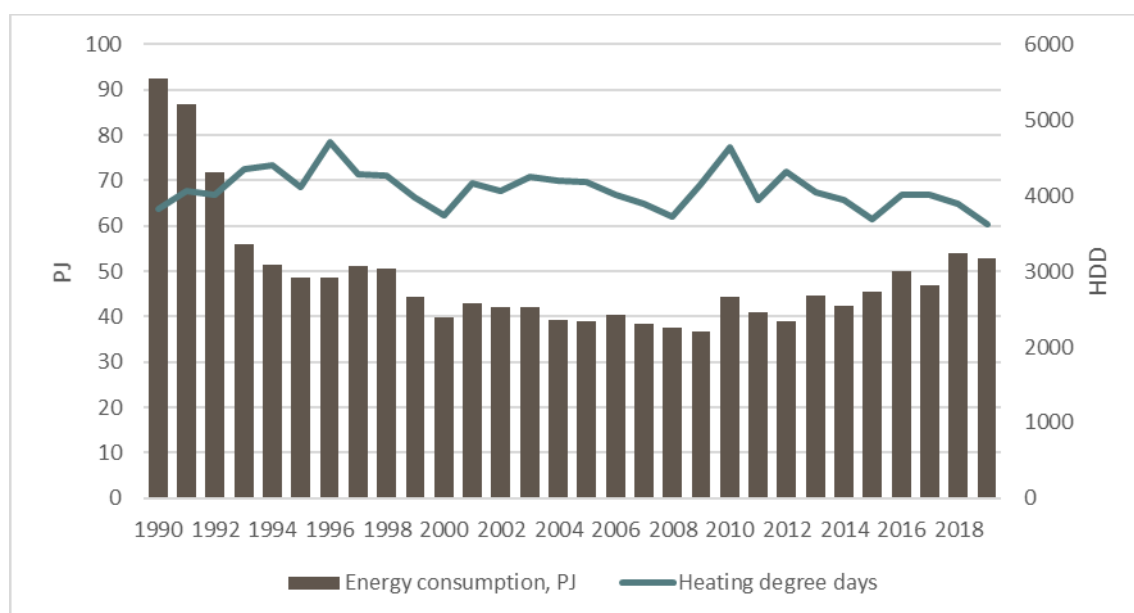


Figure 3.3 Fuel consumption in NFR 1A1a Public electricity and heat production and heating degree days in Latvia

As it can be seen in Figure 3.3 the fuel consumption in 1A1.a sector can be related with the HDD with an exception of 1990s when Soviet Union collapsed and reorganizations took place in Latvia. From 1997 to 2002 in years where energy consumption reduced, the HDD were also reduced. Years 2006-2008 had quite high average temperature therefore the fuel consumption of combined heat plants and heat plants for heat production decreased as there was limited need for heat production. In 2009-2010 the average temperature was lower and the use of fuel consumption increased. However, in 2011 the fuel consumption decreased because of a relatively warm winter, and in 2012 the consumption of fuel continued to decrease despite the fall of average temperature (hence the decrease in HDDs), which could be explained with better heat insulation installed in houses and therefore less heat needed.

3.2.4.6 Uncertainties

Uncertainty of activity data for fuel combustion in NFR 1A1 is $\pm 2\%$ in 2019. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, since data is obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass was assigned 1% as biomass activity data was collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty for peat combustion activity data was assigned 2%. Uncertainty of sludge gas stationary combusted in enterprises covered by 1A1 Energy Industries sector was assumed rather low – 2% because the combusted fuel amount is obtained directly from wastewater treatment plant that has a precise measurement equipment for accounting combusted fuel. The same applies to landfill gas.

Emission factor uncertainty is assumed as 50%, as these are default emission factors taken from EMEP/EEA 2019.

3.2.4.7 QA/QC and verification

Disaggregated data at the finest level possible is presented in the corresponding Annex II. Data completeness has been explained in the previous subchapter.

Activity data is checked with the data provider – CSB, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data is received, the sectoral

expert responsible for the emission estimation and reporting is comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

To verify the emissions, logical mistakes are checked, which is done by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for substances reported also under UNFCCC as indirect GHGs are cross-checked for verification purposes.

3.2.4.8 Recalculations

Corrected natural gas consumption in NFR 1A1c after consultation with CSB and natural gas provider.

3.2.4.9 Planned improvements

Calculate emissions using a Tier 2 methodology for category 1A1a (1990 – 2004).

3.2.5 Manufacturing Industries and Construction (NFR 1A2)

3.2.5.1 Overview

NFR 1A2 Manufacturing industries and construction sector includes emissions from fuel combustion in combustion installations for industrial production including emissions from off-road. NFR 1A2 sector also includes the emissions from on-site use of fuel in the industrial production facilities (autoproducers) – these emissions are reported under particular sub-sectors of NFR 1A2 according to 2006 IPCC Guidelines.

Under NFR 1A2g Other sector emissions from following industrial sectors are reported:

- Manufacturing of Machinery;
- Manufacturing of Transport equipment;
- Mining and Quarrying;
- Wood and Wood Products;
- Construction;
- Textiles and Leather;
- Other non-specified (Industry).

3.2.5.2 Trends in emissions

Table 3.8 Trends in emissions from NFR 1A2 Manufacturing Industries and Construction sector in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		18.73	10.11	5.47	3.83	3.24	2.51	2.35	2.28	2.45	2.27	-87.9
NM_{VO}C		3.92	1.65	1.46	2.35	3.31	4.88	4.46	4.42	5.01	4.95	26.1
SO_x		24.33	15.08	4.70	1.56	0.99	0.84	0.79	0.76	0.88	0.86	-96.5
NH₃		0.02	0.09	0.10	0.21	0.36	0.58	0.53	0.52	0.59	0.59	2368.8
PM_{2.5}	kt	1.38	0.86	0.65	1.01	1.49	2.23	2.04	2.02	2.31	2.27	65.2
PM₁₀		1.39	0.88	0.66	1.04	1.53	2.28	2.09	2.07	2.36	2.32	66.9
BC		1.41	0.90	0.68	1.08	1.60	2.39	2.19	2.16	2.47	2.43	73.1
TSP		0.63	0.35	0.24	0.29	0.44	0.64	0.58	0.58	0.65	0.64	0.9
CO		22.82	4.65	3.72	6.44	7.33	10.27	9.36	9.19	10.44	10.38	-54.5
Pb		3.26	0.31	0.12	0.30	0.31	0.44	0.40	0.40	0.46	0.46	-85.9
Cd	t	0.012	0.033	0.036	0.075	0.128	0.203	0.185	0.184	0.210	0.207	1562.2
Hg		0.025	0.013	0.009	0.017	0.013	0.012	0.011	0.011	0.013	0.012	-50.5
PCDD/F	g I-Teq	0.42	0.40	1.59	2.43	1.05	1.58	1.45	1.43	1.65	1.63	286.3
PAHs	t	0.85	0.54	0.30	0.44	0.47	0.59	0.54	0.53	0.62	0.61	-27.8
HCB	kg	0.004	0.012	0.021	0.038	0.049	0.078	0.071	0.071	0.080	0.080	1867.4
PCB		0.26	0.11	0.04	0.17	0.06	0.02	0.02	0.01	0.03	0.04	-86.5

As it can be seen in Table 3.8, the largest part of emissions with an exception of NO_x, SO₂, CO, Pb, Hg, PAHs and PCB have increased in 1990-2019, which can be explained with increased use of biomass and other

fossil fuels comparing to 1990. Emissions from NFR 1A2 Manufacturing Industries and Construction are decreasing in the latest years with a fluctuating trend. The increase in 2000-ties were due to sharp development of nation economy and industry as well as increase of demand of industrial production and improvement of well-being of population. Increase of emissions is also caused by constant increase of solid fuels – coal, and other fuels (used tires) consumption, which is mostly combusted in Mineral and Steel production industry. Decrease of emissions in 2007-2008 was influenced by the features of national economy development when in-country industrial production had started to decrease due to increase of costs of the production and dominance of imported products. Crisis in national economy in the second half of 2008 also caused a decrease of total emissions. In 2019 all emissions have decreased in comparison with 2018.

3.2.5.3 *Methods*

Tier 1 and Tier 2 method was used to calculate emissions from the fuel combustion. Calculation of all emissions from fuel combustion was done in Excel database. Tier 2 methodology was used to calculate emissions form natural gas and solid fuel use in sector NFR 1A2gviii for period 1990-2019 and emissions from mobile combustion in sector NFR 1A2gvii.

The general method for emission calculation:

$$Em = EF \times B_q$$

where:

Em – total emissions (kt)

EF – emission factor (t/TJ)

B_q – amount of fuel in thermal units (TJ)

Fuel combustion emissions from Non-metallic Minerals (NFR 1A2f) are calculated using Tier 1 methodology from 1990-2019. But in 2009 cement production plant “SIA CEMEX” changed technology from wet to dry process kiln and in 2010 started automatically measuring and reporting emissions in national database “2-Air”. Due to that emission calculation in NFR 2A1 Cement production switched from Tier 1 methodology to Tier 3 and emissions are taken from national database “2-Air” directly since 2010. Emission measurements are done in the main chimney and it is impossible to separate emissions that should be reported in IPPU to the ones, that should be reported in Energy sector. Therefore, to avoid double counting since 2010 total emissions from this cement production plant is reported in IPPU NFR 2A1.

Detailed information about emissions from Cement production (NFR 2A1) is available in Chapter 4.2.2.3.

Emissions from mobile combustion were calculated using methodology described in EMEP/EEA 2019 1.A.2.g.vi Non-road mobile sources and machinery Chapter 3.3 “Tier 2 technology-dependant approach”.

3.2.5.4 *Emission factors*

The main source of emission factors is EMEP/EEA 2019 (emission factors used for Energy sector are presented in Annex I, Table 3). Detailed information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM.

SO₂ emission factors are calculated using the same methodology as for NFR 1A1 sector, using Tier 2 (see chapter 3.2.4.4).

The default emission factors used in estimation of emissions were taken from EMEP/EEA 2019 (Annex I). Emission factors for biodiesel were equalized to diesel emission factor.

The municipal waste consumption is reported in NFR 1A2f, and the emission factors are taken from Waste sector after 3rd Stage in-depth review in 2013 where Energy expert suggested Latvia to use emission factors from particular sector.

3.2.5.5 Activity data

Mainly emissions from fuel combustion are calculated using fuel consumption data from the national Energy Balance, prepared by CSB. The data collection system for NFR 1A2 sector is the same as for NFR 1A1 sector. Data on fuel consumption in NFR 1A2 sector is presented in Annex II, Table 2.

Autoproducers data prepared by CSB is taken into account calculating emissions from NFR 1A2 sector according to the 2006 IPCC Guidelines.

Gasoline combustion is reported as off-roads in NFR 1A2 sector. Also, total diesel oil combustion is reported as off-road in NFR 1A2 sector, with exception for sectors: NFR 1A2a (stationary combusted 35% from total diesel oil combustion), NFR 1A2gi (stationary combusted 1% from total diesel oil combustion) and NFR 1A2gv (stationary combusted 1% from total diesel oil combustion).

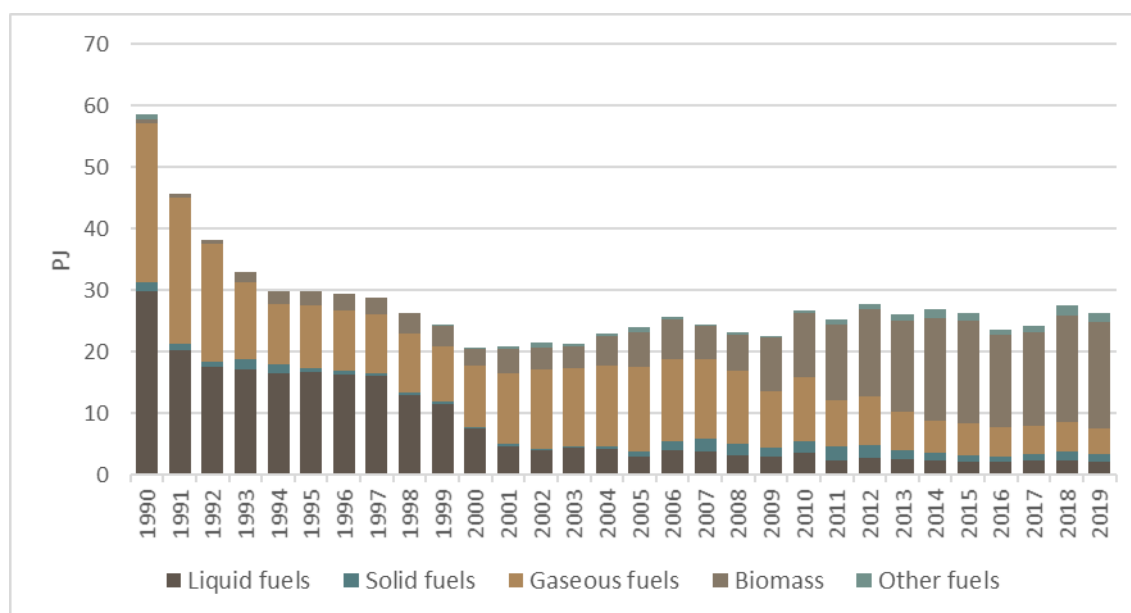


Figure 3.4 Fuel consumption in NFR 1A2 Manufacturing Industries and Construction in 1990-2019, PJ

Most of the fuel types with an exception of biomass and other fossil fuels have decreased in 1990-2019 (Figure 3.4). Liquid fuels have the biggest decrease 93.0%. It is explained with fuel switching processes when liquid fuels were replaced with other cheaper fuels. Also stronger legislation contributed fuel replacement to the type of fuels with lower level of emissions. Decrease of natural gas (-83.6%) reflects the total decrease of industrial production if compared with 1990.

The consumption of solid fuels (mainly coal) decreased in 1990-2004 mainly due to increased use of coal in Construction and Textiles and Leather sectors. Solid fuels consumption was growing approximately 7 times from 2004 until 2008 because of the growth in national economy and decreased by 31.6% in 2009 due to global crisis. In 2019 coal consumption decreased by 9.5% mainly due to the decreased fuel consumption in NFR 1A2f Non-metallic mineral sector.

After in the beginning of 1990s natural gas consumption started decreasing steadily with some small exceptions due to fuel replacement processes and development of national economy or due to the changes in demand. In 1990-2019 natural gas consumption have decreased by 83.6% and in 2018-2019 consumption have decreased by 13.7%.

Consumption of biomass have increased significantly, it is approximately 28 times bigger than it was in 1990. Large availability of the fuel in-country as well as development of EU ETS were reasons for liquid and solid fuels' replacement with biomass and natural gas.

Consumption of used tires and municipal waste in Mineral production (information about wastes burnt in cement production company taken from „SCHWENK“, the only company which combusts used tires and municipal waste for energy purposes) reported as other fossil fuels have increased approximately 50 times since 1999. The increase was influenced by intensified cement production that was caused by increased demand of construction materials and sharp development of construction sector. In the category other fossil fuels waste oils are also reported, and the amounts of this fuel are fluctuating over the years with a decreasing trend in recent years. In 2018-2019 consumption decreased by 11.%.

3.2.5.6 *Uncertainties*

Uncertainty for activity data of fuel combustion in NFR 1A2 sector is $\pm 2\%$ in 2019. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, as data is obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass was assigned 1% as biomass activity data was collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty for peat combustion activity data was assigned 2%.

Uncertainty of other fuels consumption – municipal and industrial waste used in mineral production is assumed also low as 2% as the activity data is obtained from only one producer within EU ETS therefore the data is verified by accredited verifier and Regional Environmental Board.

Emission factor uncertainty is assumed as 50% as emission factors are taken from EMEP/EEA 2019.

3.2.5.7 *QA/QC and verification*

Disaggregated data at the finest level possible is presented in the corresponding Annex II. Data completeness has been explained in the previous subchapter.

Activity data is checked at the data provider – CSB, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data is received, the sectoral expert responsible for the emission estimation and reporting is comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

To verify the emissions, logical mistakes are checked. It is done by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for substances reported also under UNFCCC as indirect GHGs are cross-checked with for verification purposes.

3.2.5.8 *Recalculations*

No recalculations were made.

3.2.5.9 *Planned improvements*

No improvements planned.

3.2.6 Transport (NFR 1A3)

3.2.6.1 *Sector overview*

3.2.6.1.1 *Source category description*

Transport sector is a major contributor to the national NO_x emissions and it is an important source of the national CO emissions in 2018. The sector includes domestic and international aviation, road transport, railways, national navigation. Road Transport includes all types of vehicles on roads: passenger cars, light duty vehicles, buses, heavy-duty vehicles, motorcycles and mopeds. Railway Transport includes railway

transport operated by diesel locomotives. Domestic Aviation (civil) includes helicopters, airplanes with turbojet engine and airplanes with piston engines. Aircrafts that are not included in Domestic Aviation are included in Other (NFR 1A5b). National Navigation comprises for miscellaneous vessels (tugs, barges, towboats, icebreakers), recreational crafts and personal boats. Emissions from fishing boats are included in NFR 1A4ciii sector. Only the emissions from LTO mode (domestic and international civil aviation) are included in the total national emissions. In its turn, emissions from the cruise mode are included in the memo items.

Table 3.9 shows the methods and source for activity data and emission factors used for emission calculating in Transport sector. Table 3.10 shows list of pollutants, which are produced and calculated in Transport sector.

Table 3.9 Source categories and methods for Transport sector

NFR code	Description	Method	AD	EF
1A3a	Domestic and international Civil aviation	Tier 1, 2	NS ⁹	D ¹⁰
1A3b	Road transport	Tier 3	NS	D
1A3c	Railways	Tier 2	NS	D
1A3d	National navigation and international maritime navigation	Tier 1	NS	D

Table 3.10 Reported emissions in Transport sector in 2019

NFR code	Emissions
1A3ai(i)	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg
1A3aii(i)	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg
1A3bi	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3bii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3biii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3biv	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs
1A3bv	NMVOC
1A3bvi	PM _{2.5} , PM ₁₀ , TSP, BC
1A3bvii	PM _{2.5} , PM ₁₀ , TSP
1A3c	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs
1A3di(ii)	NA, NE
1A3dii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, total PAHs, indeno(1,2,3-cd)pyrene, total PAHs

⁹ National Statistics

¹⁰ Default emission factor from guidelines

3.2.6.1.2 Key sources

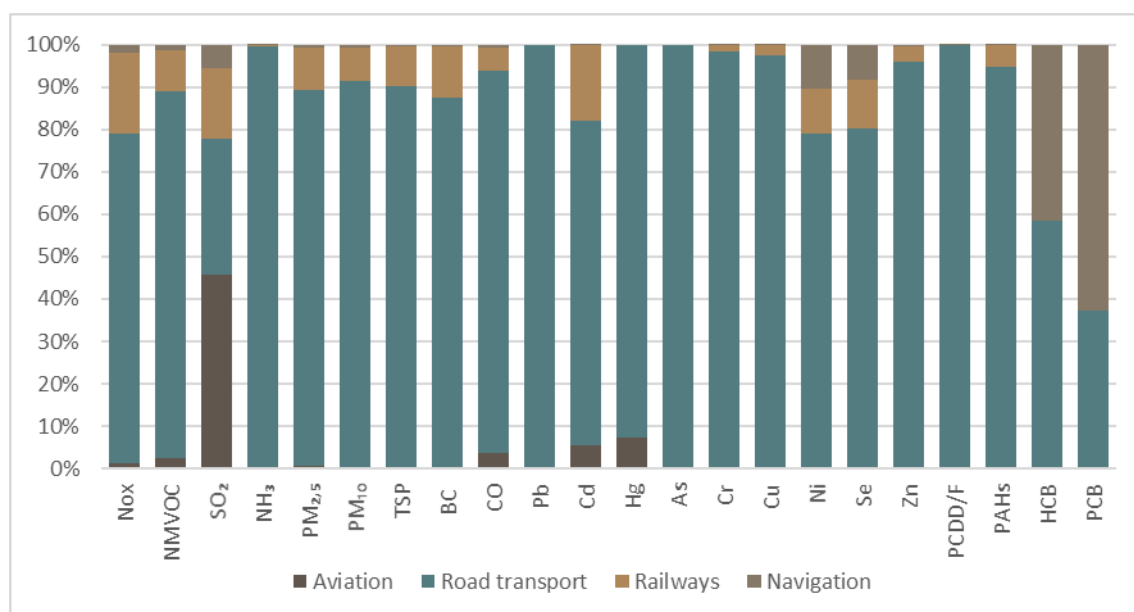


Figure 3.5 Distribution of emissions in Transport sector by subsectors in 2019, %

Road transport takes up the biggest part of Transport sector emissions followed by Railways (Figure 3.5). Domestic and international civil aviation (LTO mode) and national navigation contribute just a small part of transport emissions. Exception is SO₂ emissions where domestic and international aviation (45.6%), railway (16.6%) and navigation (5.6%), in addition to road transport (32.1%), are significant sources of emissions in transport sector.

3.2.6.1.3 Trends in emissions

Table 3.11 Fuel consumption in Transport sector in 2018 and 2019 (TJ)

	Liquid fuel		Change in 2018-2019, %	Biomass		Change in 2018-2019, %
	2018	2019		2018	2019	
Aviation (LTO)	579.8	605.3	4.4	NO	NO	NO
Road transport	42300.98	42590.04	0.7	1504.9	1495.9	-0.6
Railways	2235	1836	-17.9	78	54	-30.8
Navigation	273	136	-50.2	NO	NO	NO

In 2019, total fuel consumption in the Transport sector (excluded off-road), compared to 2018, has decreased by 0.5% (Table 3.11). In different subsectors various changes have taken place in 2019. The main impact to changes in total fuel consumption related to decreasing of fuel consumption in railway where the fuel consumption has decreased by around 18.3%.

In total, Road transport consumes around 94.1%, railway – around 4.0%, civil aviation – around 1.3% (including domestic and international LTO), national navigation – the remaining share of fuel.

Diesel oil is the major fuel type in the transport sector and it constitutes around 75%, and is followed by gasoline – 15.7%, but LPG constitutes 4.3% and biofuels (biodiesel and bioethanol) 3.3% of the total fuel consumption in the transport sector. Biofuel includes biodiesel and bioethanol and it mainly is used in road transport but small portion is consumed in railway as well. In 2019 it was not in place a growth of LPG consumption compared to the time period 2010 - 2015 trend. LPG consumption has decreased by 12.3% in 2019 compared to 2018.

Table 3.12 Trends in emissions from Transport sector in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		32.83	21.20	20.30	23.63	20.64	16.07	15.00	14.81	14.96	13.78	-58.0
NMVOOC		25.21	17.43	12.73	10.12	5.84	3.40	3.19	2.84	2.54	2.16	-91.4
SO_x		1.049	0.593	0.552	0.424	0.178	0.054	0.054	0.056	0.061	0.057	-94.6
NH₃		0.016	0.029	0.069	0.223	0.216	0.197	0.188	0.181	0.165	0.149	855.4
PM_{2.5}	kt	0.799	0.574	0.741	1.068	0.939	0.685	0.656	0.655	0.658	0.617	-22.8
PM₁₀		0.944	0.681	0.860	1.238	1.124	0.860	0.829	0.838	0.846	0.806	-14.6
TSP		1.195	0.843	1.029	1.477	1.371	1.096	1.057	1.075	1.091	1.046	-12.5
BC		0.366	0.257	0.360	0.558	0.514	0.372	0.354	0.350	0.349	0.321	-12.3
CO		261.58	165.76	105.26	74.42	39.25	20.29	19.01	16.64	14.91	12.89	-95.1
Pb		56.191	41.782	1.873	2.003	1.761	1.284	1.257	1.241	1.211	1.175	-97.9
Cd		0.0033	0.0019	0.0018	0.0026	0.0027	0.0026	0.0025	0.0025	0.0026	0.0025	-23.7
Hg		0.0063	0.0046	0.0045	0.0061	0.0067	0.0056	0.0057	0.0060	0.0057	0.0058	-7.2
As		0.0032	0.0025	0.0027	0.0040	0.0042	0.0041	0.0041	0.0043	0.0044	0.0045	38.6
Cr	t	0.114	0.085	0.093	0.134	0.146	0.138	0.138	0.146	0.150	0.151	32.6
Cu		2.494	1.831	1.991	2.853	3.084	2.935	2.915	3.072	3.167	3.177	27.4
Ni		0.0297	0.0189	0.0190	0.0262	0.0320	0.0290	0.0294	0.0305	0.0333	0.0296	-0.4
Se		0.0038	0.0024	0.0024	0.0034	0.0040	0.0037	0.0037	0.0039	0.0042	0.0038	-1.0
Zn		0.949	0.673	0.735	1.070	1.169	1.112	1.105	1.161	1.199	1.198	26.2
PCDD/F	g I- Teq	0.264	0.204	0.249	0.393	0.468	0.376	0.366	0.375	0.375	0.365	38.1
PAHs	t	0.048	0.033	0.037	0.055	0.065	0.063	0.063	0.067	0.070	0.071	48.3
HCB		0.0002	0.0001	0.0002	0.0003	0.0008	0.0006	0.0007	0.0007	0.0009	0.0006	203.0
PCBs	kg	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002	0.0002	0.0002	0.0003	0.0002	147.8

Generally, most of emissions have decreased in 1990-2019 (Table 3.12) with an exception of NH₃, Cr, Cu and PAHs and some other metal emissions. Emissions from heavy metal species have increased due to increase in fuel consumption as well as change in road transport fuel mix. During last ten years the share of diesel fuel in the total consumption in road transport has increased per 12% points and in 2019 constituted 75.3%. Most of emissions from heavy metal species (Cr, Cu, Ni, Zn) create automobile tyre and brake wear. Consequently, emissions have increased mainly due to increase of road transport activities (number of cars, total vehicle-kilometers). NH₃ emissions are likely to increase due to the increasing number of vehicles equipped with catalytic systems for combustion gas treatment. However, the amounts of ammonia produced in Transport sector are very small, that the significant increase in Transport sector has no impact on national total NH₃ emissions. Development and introduction of technologies for emission abatement especially in road transport have ensured decreasing of NO_x, CO, PM, TSP and BC emissions. Whereas implementation of stronger requirement for fuel quality have decreased SO₂ and Pb emissions.

3.2.6.2 Civil aviation (NFR 1A3a)

3.2.6.2.1 Overview

Civil aviation includes emissions both from domestic and international aviation LTO cycles. This category does not include military aviation, which is reported under 1A5b sector. In Latvia, domestic civil aviation constitutes a small part of total emissions therefore it is not considered as a key source. The aviation gasoline is mainly used by small-sized propeller planes but jet kerosene is used by airplanes with turbo jets and turbo props engines.

3.2.6.2.2 Trends in emissions

Table 3.13 Trends and emissions in Civil aviation in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.116	0.041	0.043	0.069	0.138	0.138	0.137	0.151	0.169	0.176	50.9
NMVOOC	kt	0.074	0.026	0.028	0.022	0.043	0.043	0.043	0.047	0.053	0.055	-26.2
SO_x		0.013	0.005	0.005	0.010	0.020	0.020	0.020	0.022	0.025	0.026	102.9

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
PM_{2.5}	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.003	90.5
PM₁₀	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.003	90.5
TSP	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.003	90.5
BC	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	90.5
CO	0.242	0.086	0.090	0.190	0.379	0.378	0.378	0.415	0.464	0.483	99.3

Different trend tendencies during the time span 1990-2019 have to be noted for emissions in domestic and international civil aviation (Table 3.13). Until 2005 most emissions have decreased due to decreasing of activities in civil aviation (number of flights and fuel consumption). After 2005 there is an increase of emissions mainly due to rather rapid increase of international flights to and from Riga airport (international landing and take-off emissions are included in emissions' calculation). Number of international flights has increased more than 2 times to 2005. In 2019, the number of arriving and departing international flights have increased by around 4.2%, compared to 2018 level.

3.2.6.2.3 Methods

EMEP/EEA 2016 Tier 1 and Tier 2 approaches have been applied. Tier 2 approach with split in LTO and cruise cycles has been applied for jet kerosene emission calculation for time period 2004-2019. Tier 1 approach has been applied for aviation gasoline emission calculation.

3.2.6.2.4 Emission factors

Default emission factors for Civil aviation are taken from EMEP/EEA 2016 methodology and are presented in Table 3.14. Detailed information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM.

Table 3.14 Emission factors used in the calculation of emissions from Civil aviation (kt/PJ)

	NO _x	CO	NM VOC	SO ₂	PM
Aviation petrol	0.25	0.1	0.05	0.005	0.21

Using Tier 2 approach for jet kerosene, emissions for LTO (landing/take off) and cruise are calculated individually. Prior to the emission calculation, representative aircraft type was chosen, for which the fuel consumption and emission data exist in the EMEP/EEA 2016. The calculated average specific fuel consumption of LTO have been compared and verified with Eurocontrol's emission data for time span 2012-2018.

3.2.6.2.5 Activity data

The data about fuel consumption in domestic and international civil aviation is derived from the CSB. CSB has started to collect data for domestic aviation as of year 2004 (Figure 3.6). For the time period 1990-2003 the data is used from the study (IPE, 2004). For 2004 onwards, air flight statistics are provided by Riga International Airport.

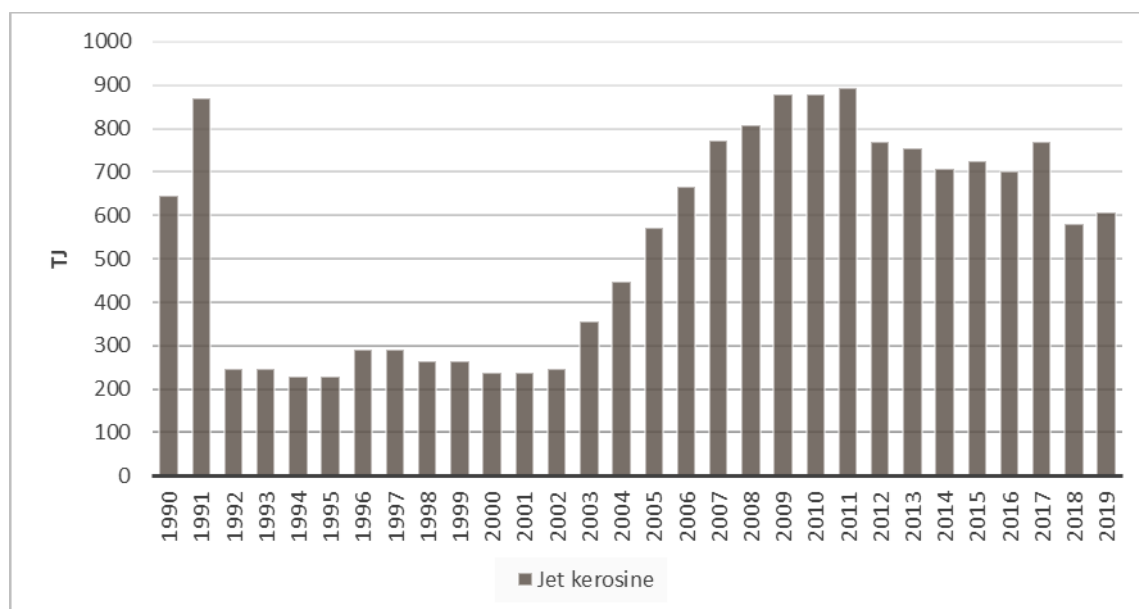


Figure 3.6 Fuel consumption in Civil aviation (domestic and international LTO), TJ

3.2.6.2.6 Uncertainties

CSB gives approximately 2% statistical sample error for statistical data. Considering this uncertainty in total fuel consumption for 2004-2018 is $\pm 2\%$. As fuel consumption for LTO and cruise cycle was calculated based on assumptions concerning representative aircraft model, assumed uncertainty for fuel consumption in LTO and cruise cycle is $\pm 10\%$. For the rest of time period uncertainty in activity data of fuel consumption is $\pm 20\%$. Taking into account that it is used representative emission factors for LTO and cruise activities the uncertainty of EF lies between 20-45%.

3.2.6.2.7 QA/QC and verification

Assessment of trends were performed.

3.2.6.2.8 Recalculations

All emissions for 2017 and 2018 have been recalculated. Recalculations have been done due to corrected average specific fuel consumption of LTO. Average specific fuel consumption calculated based on Eurocontrol's data.

3.2.6.2.9 Planned improvements

No improvements are planned for the next submission.

3.2.6.3 Road transport (NFR 1A3b)

3.2.6.3.1 Overview

Road transport is producing the greatest part of emissions in Transport sector (Figure 3.5). The main source of emissions are passenger cars, light (LDV) and heavy duty vehicles (HDV), but buses and mopeds and motorcycles account for less emissions from total emissions on road transport. In the source category emissions also from gasoline evaporation, automobile road abrasion and automobile tyre and brake wear are calculated.

3.2.6.3.2 Trends in emissions

Table 3.15 Trends and emissions in Road transport in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NOx		22.62	16.58	16.34	18.59	16.09	11.68	11.14	11.18	11.04	10.70	-51.2
NMVOOC		24.32	17.03	12.38	9.69	5.45	3.02	2.85	2.51	2.20	1.87	-90.9
SOx		0.36	0.28	0.29	0.09	0.02	0.02	0.02	0.02	0.02	0.02	-95.0
NH₃		0.01	0.03	0.07	0.22	0.22	0.20	0.19	0.18	0.16	0.15	1085.0
PM_{2.5}	kt	0.59	0.47	0.66	0.96	0.84	0.59	0.57	0.58	0.57	0.55	-3.0
PM₁₀		0.72	0.57	0.77	1.12	1.02	0.76	0.74	0.75	0.76	0.73	5.0
TSP		0.86	0.69	0.89	1.31	1.22	0.95	0.93	0.95	0.96	0.94	11.6
BC		0.23	0.19	0.30	0.49	0.45	0.31	0.30	0.30	0.30	0.28	28.6
CO		258.55	164.41	104.08	72.84	37.72	18.78	17.63	15.29	13.50	11.63	-94.8
Pb	t	56.19	41.78	1.87	2.00	1.76	1.28	1.26	1.24	1.21	1.17	-97.8
Cd	t	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	31.8
PCDD/F	g I-Teq	0.26	0.20	0.25	0.39	0.47	0.38	0.37	0.37	0.37	0.36	41.6
PAHs	t	0.03	0.03	0.03	0.05	0.06	0.06	0.06	0.06	0.07	0.07	90.4

Despite the total fuel consumption in road transport in 2019 was per 31.5% higher, compared to 1990, all main emissions have decreased in 1990-2019 with an exception of NH₃ and PM₁₀ TSP, BC and Cd (Table 3.15). NH₃ emission increase is likely due to the increasing number of vehicles equipped with catalytic systems for combustion gas treatment. Development of PM emissions during the time span 1990-2019 determined two main trends. First, a sharp increase in number of vehicles and vehicle kilometres travelled (VKT) by passenger cars, LDV and HDV increase non-exhaust emissions (automobile tyre and brake wear). Second, development of requirements and technologies concerning exhaust of particles. Increase of Cd emissions is determined mainly by increase in number of vehicles and vehicle kilometres travelled by all types of vehicles and corresponding increase in emissions from automobile tyre and brake wear.

The main reason for decrease of emissions is also a steady improvement of car technologies and introduction of stronger requirements for fuel quality (SO₂ and Pb).

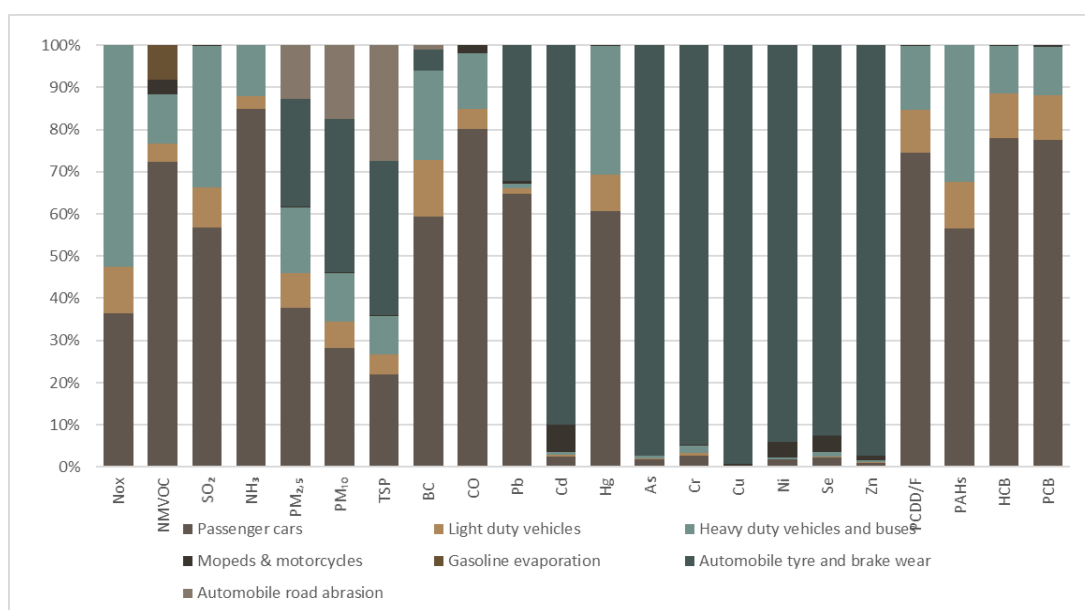


Figure 3.7 Emissions in Road transport, 2019

When analysing the development of emissions in road transport in 2019 following trends could be mentioned:

- Compared to 2018, NMVOC and CO emissions have decreased in 2019 by 15.3% and 13.9% respectively. The main reason for such trend is increase in share of vehicles with higher

environmental performance. A share of EURO4, EURO5 and EURO6 cars have increased for all types of vehicles, namely, passenger cars, LDV and HDV and decreasing of gasoline consumption by passenger cars. Detailed analysis of the vehicle fleet's structure is provided below.

- Compared to 2018, in 2019 PM_{2.5} emissions in road transport have decreased by 4.1%. It has happened due to two reasons. First, due to increase of road transport activities (number of cars, total passenger-kilometres, freight tonne-kilometres) non-exhaust emissions (automobile tyre and brake wear) has increased by 1.0%. Second, positive trend related to passenger cars and HDV vehicles fleets has taken place: increased share of EURO4, EURO5 and EURO6 passenger cars and HDV in 2019 (40% for passenger cars, 48% for HDV). As a result of these changes, exhaust PM_{2.5} emissions decreased by 7.1%
- NMVOC emissions in 2019 have decreased by around 15.3% in comparison with 2018, which is mainly due to decrease in gasoline consumption.

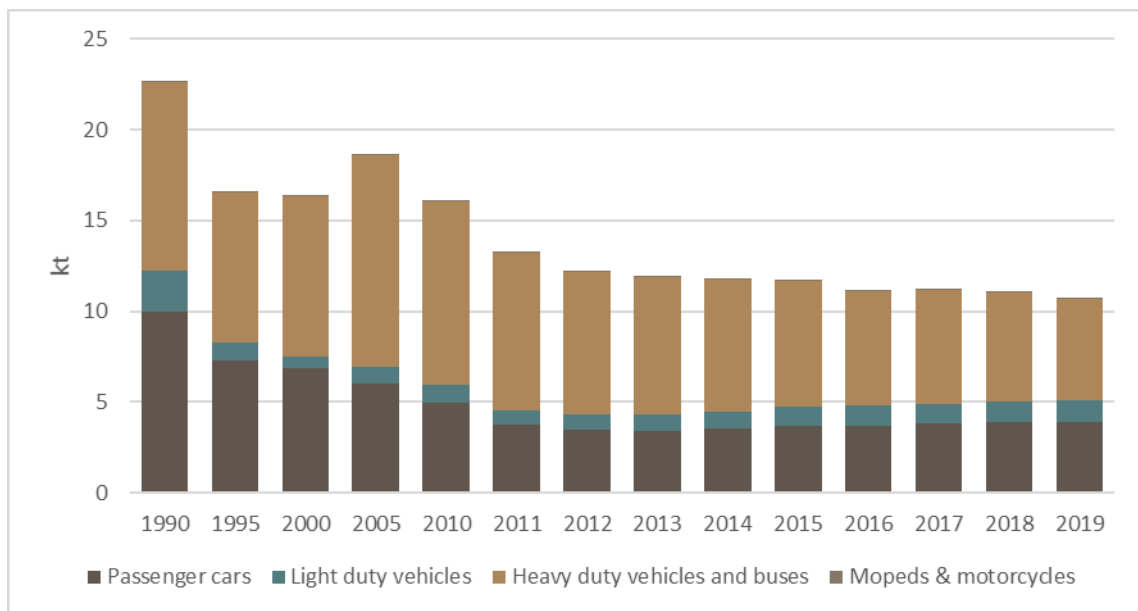


Figure 3.8 Development of NO_x emissions in Road transport, kt

Characterising emissions breakdown by types of road transport vehicles the following has to be noted:

- The main sources of NO_x emissions are HDV and buses (52.4%) followed by passenger cars (39.5%) and LDV (11.0%);
- The main sources of NMVOC emissions are passenger cars - around 72.4%, gasoline evaporation is responsible for 8.1% and mopeds and motorcycles 3.5% of total NMVOC emissions;
- The main sources of SO₂ emissions are passenger cars - around 56.8%, HDV - around 33.7% and LDV - around 9.4%.
- The major part of CO emissions in road transport are created by passenger cars, - 80.2%, followed by HDV - 13.2%;
- In total PM_{2.5} emissions passenger cars contributed to 37.6% (exhaust emissions), automobile tyre and break wear and automobile road abrasion (non-exhaust emissions) to 38.3%, HDV to 15.6%, LDV to 8.3%.

Though total NO_x emissions in road transport in 2019 are per 42.4% lower, compared to 2005, emissions related to passenger cars during this period have decreased per 28.1%. On the one hand, the positive impact has been caused due to increased share of EURO4, EURO5 and EURO6 passenger cars from 0 % (in 2005) up to 45.8% in 2019. On the other hand, the negative impact on total amount of emissions has been created by increase of the share of diesel fuel passenger cars: this share has increased from 24.2% (in 2005) up to 67% in 2019, important is also to note that large share of them is ten and more years old.

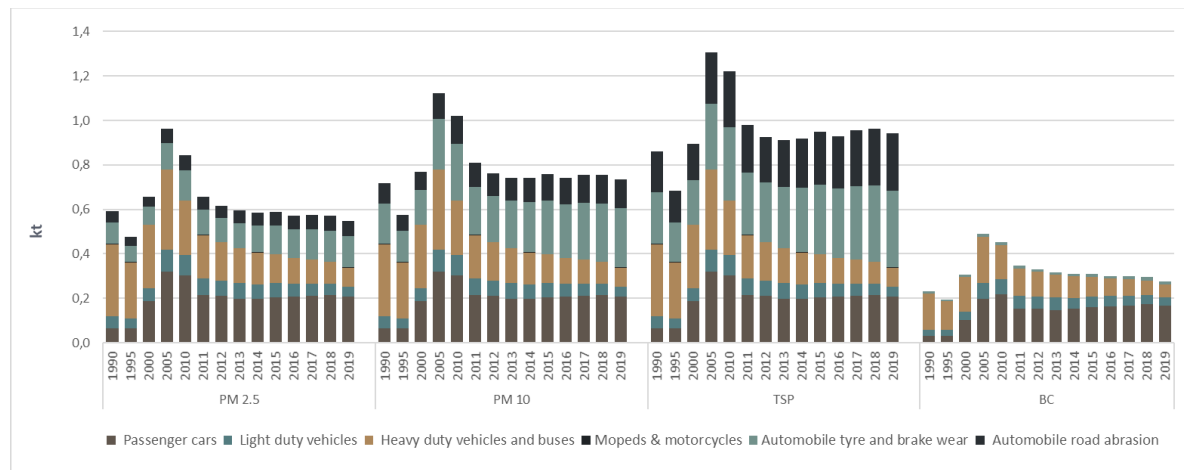


Figure 3.9 Distribution of solid particle emissions by sources in Road transport, kt

3.2.6.3.3 Methods

Emission calculation from Road transport is performed using the “Computer Programme to calculate Emissions from Road Transportation” (COPERT 5), which is proposed to be used by EEA member countries for the compilation of CORINAIR emission inventories. COPERT 5 methodologies can be applied for the calculation of traffic emission estimates at a relatively high aggregation level. Calculation of emissions is based on fuel consumption of road vehicles and on average mileage of vehicles and the fixed emission factors. Road traffic vehicles use five different fuels – gasoline, diesel oil, liquid petroleum gases (LPG), natural gas and biofuel. Before emission calculation COPERT 5 model was calibrated to be consistent with actual consumed fuel (energy balance - statistics). Deviation between fuel consumption in COPERT model and statistics is less than 0.1%. Thus, we can say that all emission calculation is based on actual consumed fuel in road transport.

Corresponding to the COPERT 5 fleet classification, all vehicles in the Latvia fleet are grouped into vehicle classes, subclasses and layers. The layer classification is a further division of vehicle sub-classes into groups of vehicles with the same average fuel consumption and emission factors, according to EU emission legislation levels.

In COPERT 5, fuel consumption and emission simulation can be made for operationally hot engines, considering gradually tighten emission standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated. Estimation of evaporative emissions of hydrocarbons and the inclusion of cold start emission effects are dealt with in the Latvian inventory by using LEGMC meteorological input data for ambient temperature variations during months; the distribution of evaporate emissions in the driving modes are used as a default by COPERT 5 model. Trip-speed dependent basis factors for fuel consumption and emissions are implemented. The fuel consumption and emission factors used in the Latvia inventory are from the COPERT 5 model.

3.2.6.3.4 Activity data

As a basis for model input information, CSB data have been used considering the actual fuel consumption calibration with statistical fuel consumption, Road Traffic Safety Directorate (RTSD) collected and published data was used considering stock of road transport in Latvia. Total mileage data for passenger cars, light duty trucks, heavy duty trucks and buses produced by the RTSD was used for the years 1996-2019 and can be seen on Annex I, Table 4. Lubricant consumption in vehicles with 2-stroke engines and corresponding calculated emissions have been reported under 1A3biv (mopeds and motorcycles). Lubricant consumption is calculated based on VKT of 2-stroke engines and corresponding fuel (gasoline) consumption and implemented ratio for lubricant consumption.

To ensure efficient growth of the share of renewables in the transport sector, the mandatory 4.5-5% volume of bioethanol mix for the gasoline and mandatory 4.5-5% volume of biodiesel mix for the diesel fuel were introduced in Latvia from 01.01.2010. Thus all biofuel is used in blend with fossil fuel and all calculation of emissions have been performed for blend fuel.

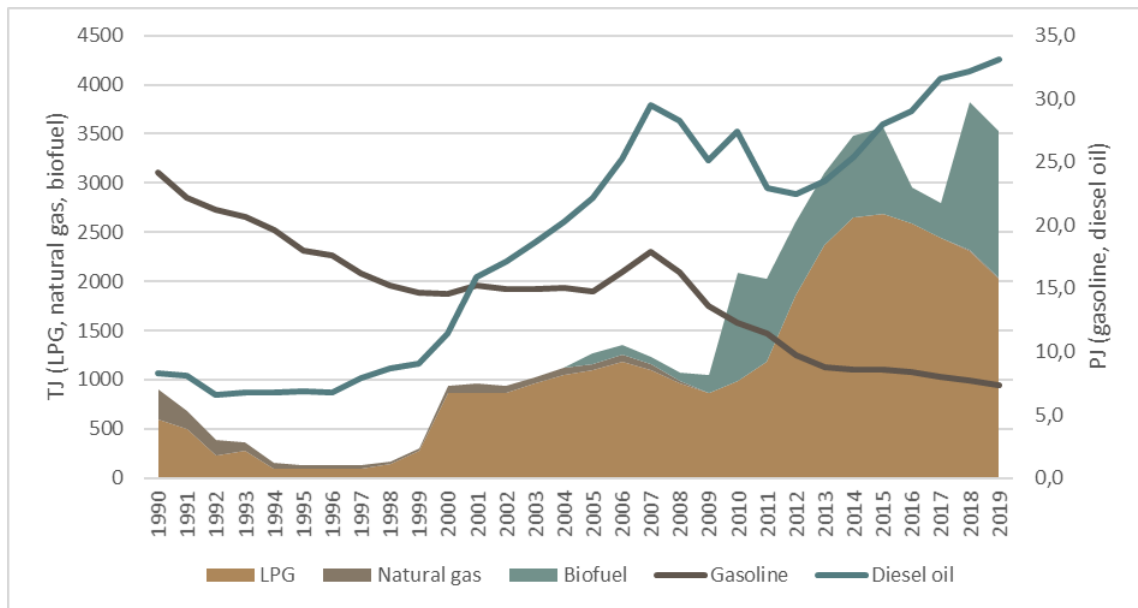


Figure 3.10 Development of fuel consumption in Road transport, TJ

As seen in Figure 3.10 the fuel consumption has changed essentially in 1990-2019. Gasoline consumption from the highest consumption in 1990 has decreased so that until 1999, it reached the lowest consumption and after six-year stabilization period an increase was seen in 2006 and 2007. Consumption of gasoline had decreased by 5.1% in 2019 compared to 2018. Whereas diesel fuel consumption starting from 1997 has increased gradually till 2007. While it decreased in 2008 and 2009 mainly due to economic recession. Diesel fuel consumption has increased by 3.0% in 2019 compared to 2018. Substantial LPG consumption increase in road transport was observed starting from 2011 but in 2016-2019 we can constitute a small decreasing.

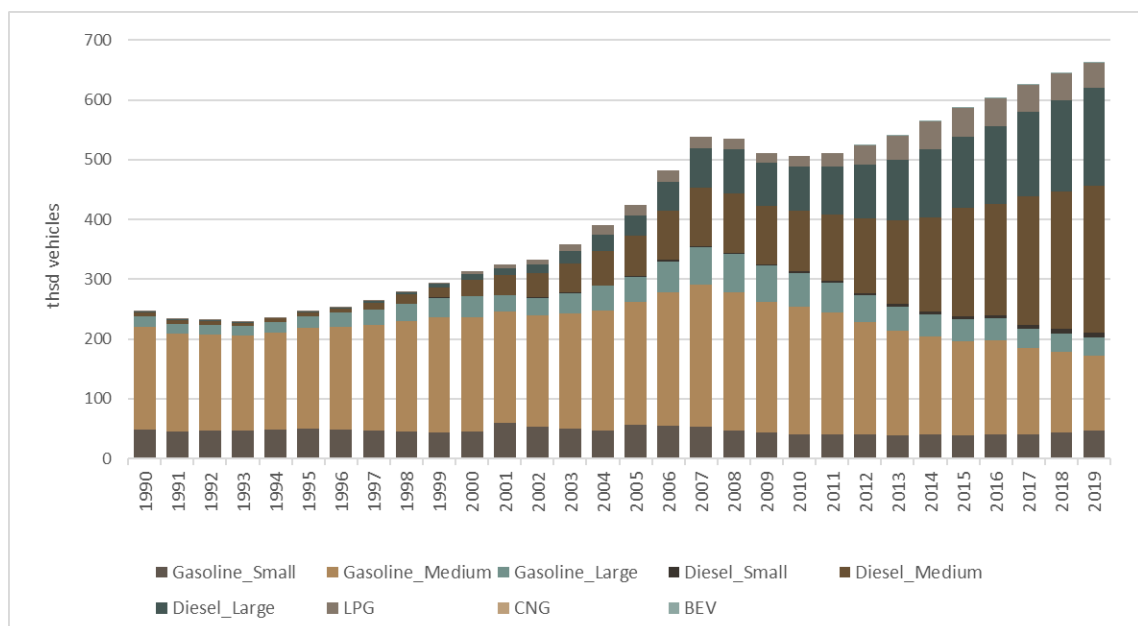


Figure 3.11 Distribution of passenger cars fleet by sub-classes

Analysing the development of the passenger car fleet in 1990-2019, following features can be noted (Figure 3.11, Figure 3.12, Figure 3.13):

- Cars with a diesel engine of a capacity 1.4l - 2.0l (Medium) constitute the major part (37%) but the second leading group (24%) is cars with a diesel engine of a capacity > 2.0l (Large-SUV-Executive); cars with a gasoline engine of a capacity 1.4l - 2.0l (Medium) -19%;
- Cars with a gasoline engine of a capacity < 1.4l during the whole period have small changes and it's constitute approximately 7% in year 2019 from total passenger cars;
- Cars with a gasoline engine of a capacity >2.0l starting from year 2010 have a small decreasing in their share of total passenger cars and they constitute around 4.4% in 2019;
- As of 2000, the number of cars with diesel engines, both, < 2.0l and > 2.0l, grow rapidly and its share is 61.8% from the total number of passenger cars in 2019;
- As of 2005, in the car fleet with a gasoline engine, the number of EURO4, EURO5 and EURO6 cars grows rapidly. In 2019 a share of EURO4 and EURO5 and EURO6 cars constitutes 47.6%;
- As of 2005, in the car fleet with a diesel engine, the number of EURO 4 and EURO 5 cars grows rapidly. In 2019 a share of EURO4, EURO5 and EURO6 cars constitute 45%.

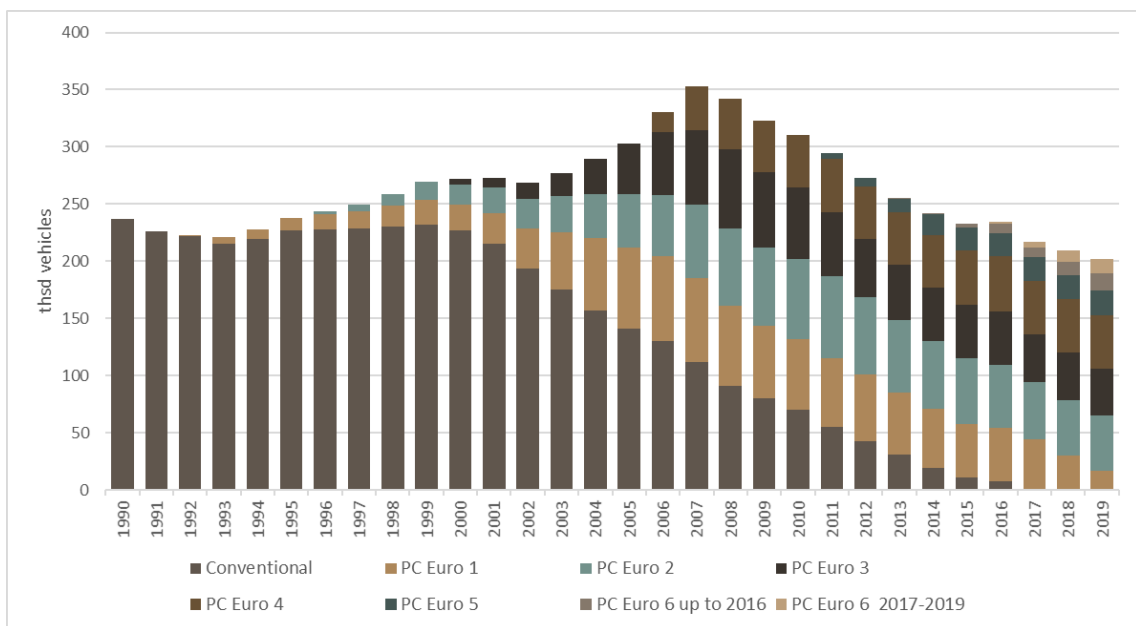


Figure 3.12 Distribution of gasoline passenger cars fleet by layers

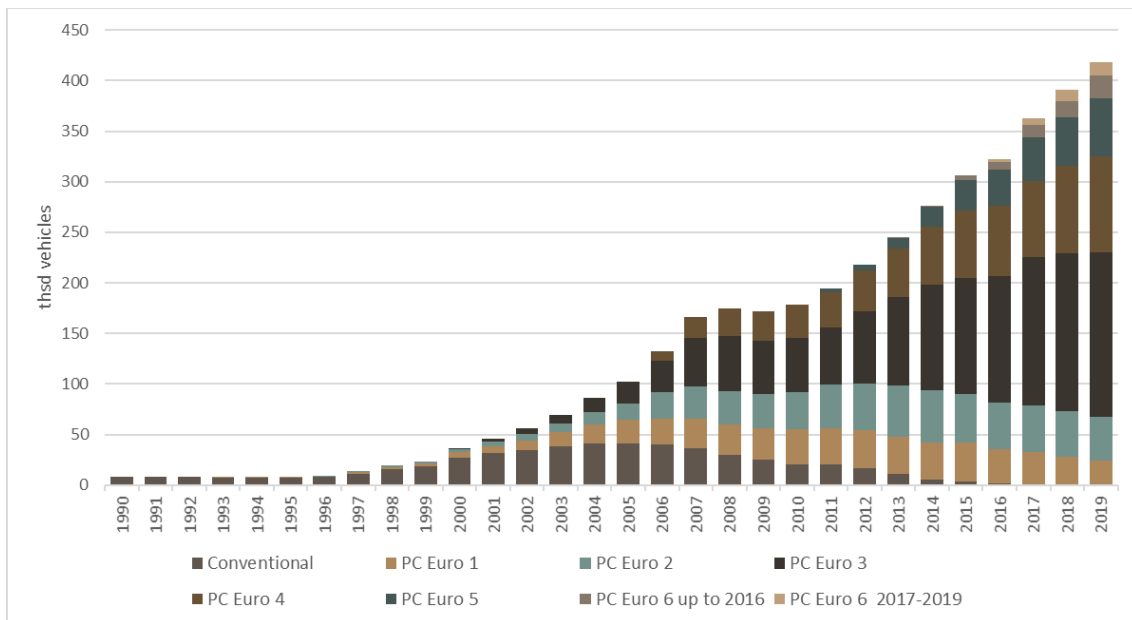


Figure 3.13 Distribution of diesel oil passenger cars fleet by layers

Analysing the development of LDV fleet (Figure 3.14, Figure 3.15) in the following time period, major features can be noted:

- As of 1996, the number of cars with a gasoline engines have decreased;
- As of 2000, the number of cars with a diesel engine rapidly increases. In 2019 the share of diesel cars is 94.4%;

As of 2005, the number of EURO4 and EURO5 and EURO6 cars have increased. In 2019 the share of EURO4, EURO5 and EURO6 cars constitute 66%;

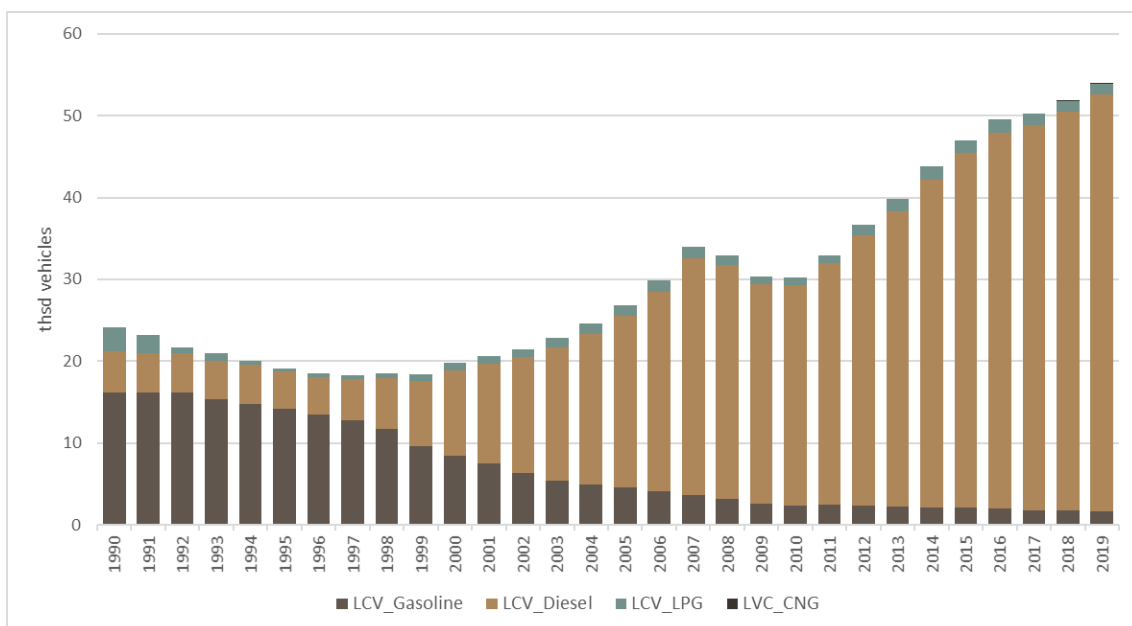


Figure 3.14 Distribution of light duty vehicles fleet by sub-classes

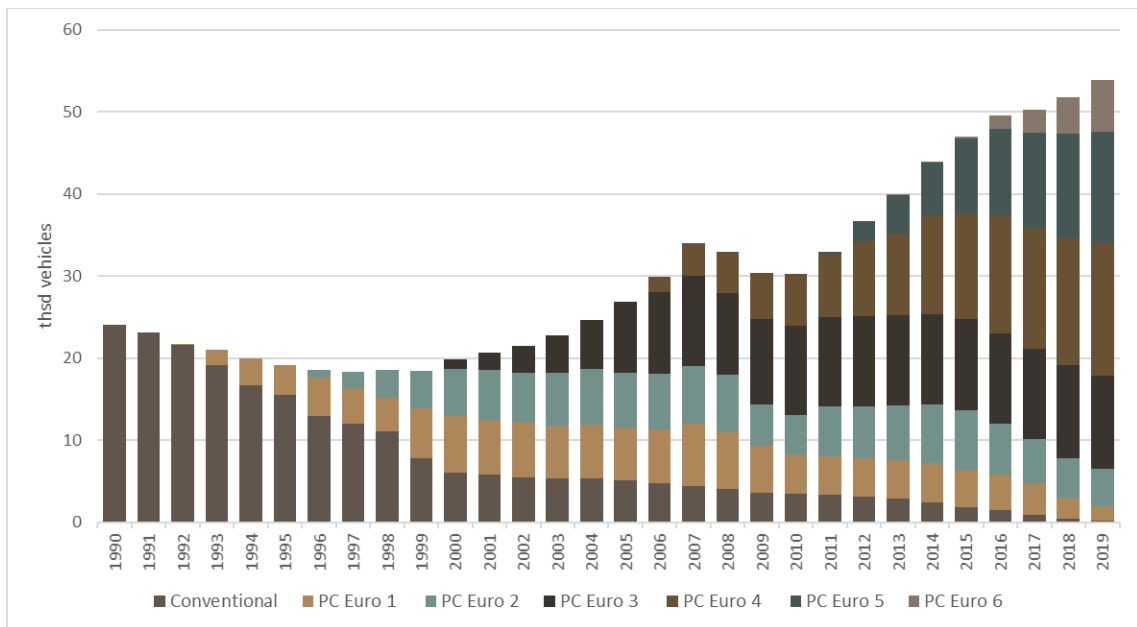


Figure 3.15 Distribution of light duty vehicles fleet by layers

Vehicle numbers per HDV sub-classes and layers are presented in the following figures.

Analysing the development of HDV fleet in the following time period, major features can be noted:

- Since 2000, the number of cars with a gasoline engines have rapidly decreased. The share of gasoline cars has decreased from 28% to 2.3 % corresponding years 2000 and 2019;
- Since 2000, the number HDV cars with tonnage 14-34 t and a diesel engine starts to increase;
- As of 2000, average age reduction of cars takes place gradually. In 2019, the share of EURO IV, EURO V and EURO VI cars constituted 65%.

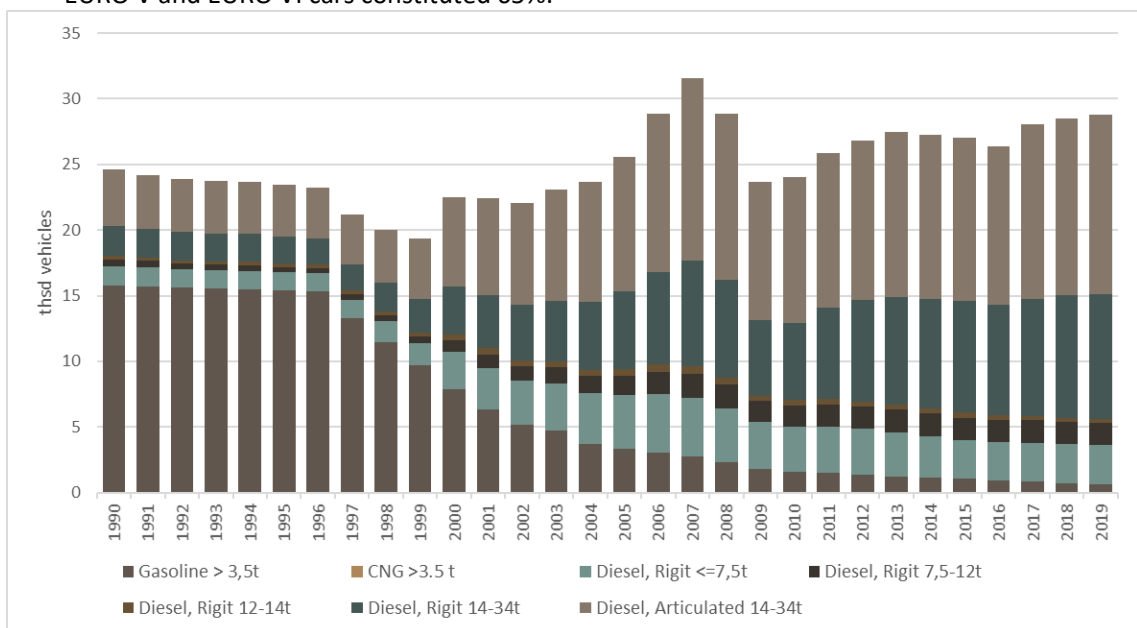


Figure 3.16 Distribution of heavy duty vehicles fleet by sub-classes

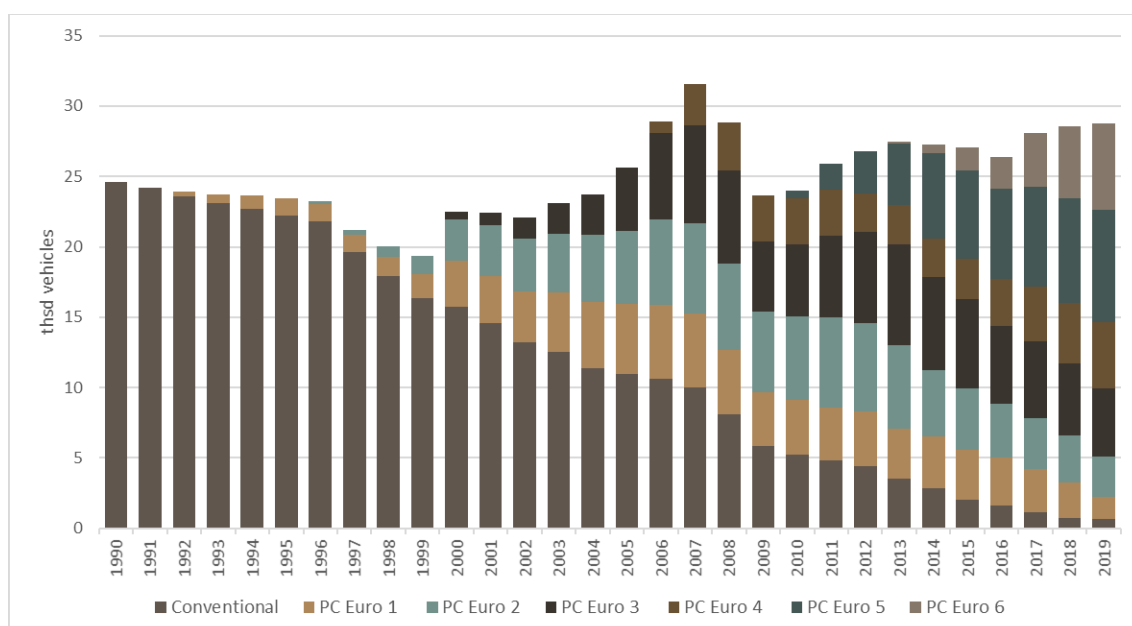


Figure 3.17 Distribution of heavy duty vehicles fleet by layers

Starting from 1990 emission for gasoline evaporation has been calculated according to the COPERT 5 model method. Calculation of PM emissions were performed considering emissions from road abrasion, tyres and brakes.

3.2.6.3.5 Uncertainties

Taking into account that CSB gives approximately 2% statistical sample error for statistical data, uncertainty in activity data of fuel consumption is $\pm 2\%$. To ensure time series consistency any recalculation related with model version updating is realized for all time period. Linear interpolation were implemented only for cases when activity data fluctuation does not take place.

3.2.6.3.6 QA/QC and verification

Assessment of trends were performed.

3.2.6.3.7 Recalculations

All emissions for 2011-2018 were recalculated. Recalculations were done due to corrected distribution of vehicles fleet by sub-classes (2011-2018) according to additional statistical information of the Road Traffic Safety Directorate of Latvia. Due to recalculation, NO_x emissions increased in average by around 1.3% in time period 2011-2018, $\text{PM}_{2.5}$ emissions decreased by around 3% and NMVOC emissions increased by around 1.5%.

3.2.6.3.8 Planned improvements

No improvements are planned for the next submission.

3.2.6.4 Railway (NFR 1A3c)

3.2.6.4.1 Overview

The source category 1A3c Railways includes emissions from all diesel-powered rail transport in Latvia. Freight transport has a dominant role in railway. The railway transport accomplishes around 54% (2018) of the total freight transport in Latvia (traffic of goods in ton-km) and the transit transport traffic is dominant. Since 2012, the transported freight along the railway (measured in tonne-kilometres) have decreased by around 31% due to dependence on transit transport of goods from Russia and other neighboring countries. Fuel consumption has decreased by approximately 44.7% in 2019 compared to 2012. Fuel consumption has decreased by approximately 18.3% in 2019 compared to 2018.

3.2.6.4.2 Trends in emissions

When analysing the development of emissions trends in railway (Table 3.16), following features could be noted:

- Due to the decrease of diesel oil consumption by around 73.7% in railway in time period 1990-2019 all emissions decreased by 70–99%;
- From total emissions in transport sector (2019), railway contributes respectively 19.3% in NO_x, 9.8% in NMVOC, 16.6% in SO₂ and 9.7% in PM_{2.5} emissions.

In 2005-2019 diesel fuel consumption decreased in railway by around 45.8%. It is a reason for PM and TSP emission decrease by around 43% and NO_x emissions by around 46.5%. However, SO₂ emissions decreased by about 97% at the same time due to implementation of stronger fuel quality requirements;

Table 3.16 Trends and emissions in Railway in 1990-2019

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x	10.08	4.56	3.91	4.96	4.02	4.02	3.40	3.14	3.25	2.66	-73.6
NMVOC	0.80	0.36	0.31	0.39	0.32	0.32	0.27	0.25	0.26	0.21	-73.8
SO₂	0.68	0.30	0.26	0.33	0.13	0.01	0.01	0.01	0.01	0.01	-98.6
NH₃	0.0017	0.0008	0.0006	0.0008	0.0007	0.0007	0.0006	0.0005	0.0005	0.0004	-73.7
PM_{2.5} kt	0.21	0.10	0.08	0.10	0.09	0.09	0.07	0.07	0.07	0.06	-70.9
PM₁₀	0.22	0.11	0.09	0.11	0.09	0.09	0.08	0.07	0.08	0.06	-71.1
TSP	0.33	0.16	0.13	0.17	0.14	0.14	0.12	0.11	0.12	0.10	-71.1
BC	0.13	0.06	0.05	0.07	0.06	0.06	0.05	0.04	0.05	0.04	-70.9
CO	2.76	1.23	1.05	1.34	1.07	1.07	0.91	0.83	0.86	0.70	-74.6
Cd	0.0017	0.0008	0.0007	0.0008	0.0007	0.0007	0.0006	0.0005	0.0005	0.0004	-73.7
PAHs t	0.0135	0.0061	0.0052	0.0066	0.0053	0.0053	0.0045	0.0042	0.0044	0.0036	-73.7

Due to the decrease of fuel consumption in railway all emissions decreased by approximately 18% in 2019 compared to 2018.

3.2.6.4.3 Methods

When calculating emissions from railway, Tier 2 method was applied. The Tier 2 approach is based on apportioning the total fuel used by railways to that used by different locomotive types as the measure of activity. Total diesel oil consumption (statistics) has been apportioned on the number of locomotives, categorised by type (line-haul, shunting and rail-cars) and their average usage. The sum of the average fuel consumption and hours of use for three types of locomotives have been calibrated to the total amount of fuel used (statistics). The fuel consumption factors of each locomotive type are derived from Table 3-5. (EMEP/EEA 2016). Total operation hours per year distributed among types of locomotives have been calculated based on available information about number of corresponding locomotive type and available information about total locomotive km per year. This information has been collected from the state railway JSC "Latvijas Dzelzceļš" annual reports.

3.2.6.4.4 Emission factors

Default Tier 2 approach emission factors for Railway are taken from EMEP/EEA 2016 (Table 3-2; Table 3-3; Table 3-4). Other emissions factors for Tier 1 approach (Table 3.17) are taken from EMEP/EEA 2016 as well. The SO₂ emissions factors are used consistent with sulphur content in diesel oil by years (Table 3.18).

Table 3.17 Emission factors used for emissions calculation from Railway

Pollutant	Unit	Diesel oil
Cd		0.00024
Cr		0.00118
Cu	t/PJ	0.04001
Ni		0.00165
Se		0.00024

Pollutant	Unit	Diesel oil
Zn		0.02353
benzo(a)pyrene		0.000706
benzo(b)fluoranthene		0.0011767

Table 3.18 SO₂ emission factors for Diesel oil used in the calculation of SO₂ emissions from Railway

	Sulphur content (%)	NCV (TJ/kt)	EF (kt/PJ)
1990-2002; 2005-2007	0.2	42.49	0.0941
2003-2004	0.05	42.49	0.0235
2008-2014	0.1	42.49	0.0471
2015-2019	0.001	42.49	0.005

3.2.6.4.5 Activity data

Information about fuel consumption from CSB was used as the basis for emission calculation. In 2009 and 2010 transported freight along the railway and therefore diesel consumption slightly decreased, compared to 2008 (Figure 3.18). Since 2012, the transported freight along the railway (measured in tonne-kilometres) have decreased by around 31% due to dependence on transit transport of goods from Russia and other neighboring countries. Fuel consumption has decreased by approximately 44.7% in 2019 compared to 2012. Fuel consumption decreased by around 18.3% in 2019 compared to 2018.

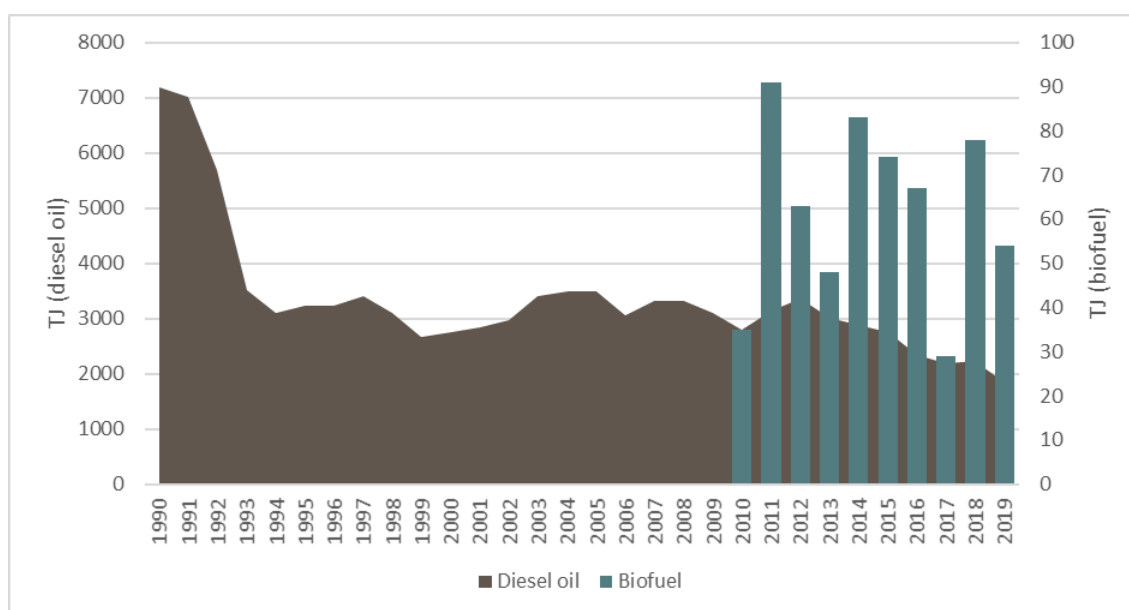


Figure 3.18 Fuel consumption in Railway transport, TJ

3.2.6.4.6 Uncertainties

Uncertainty in activity data of fuel consumption is $\pm 2\%$ in 2019. CSB gives approximately 2% statistical sample error for statistical data. The uncertainty of EF lies between 20-45%.

3.2.6.4.7 QA/QC and verification

Assessment of trends was performed.

3.2.6.4.8 Recalculations

No recalculations were carried out.

3.2.6.4.9 Planned improvements

No improvements are planned for the next submission.

3.2.6.5 National navigation (NFR 1A3di)

3.2.6.5.1 Overview

Although Latvia has several ports, national navigation that provides transport of freight or passengers among local ports is not developed. Major activities in ports deal with international freight transport. In national navigation the emissions are calculated for miscellaneous vessels (tugs, barges, towboats, icebreakers), recreational crafts and personal boats.

Fuel consumption for national navigation has variations. For example, in 2014 diesel oil consumption decreased approximately 2 times compared to 2013. Number of services for international freight in harbours mostly affects the changes in fuel consumption, however, dramatic fuel consumption decrease in 2014 was due to completion of the harbour deepening (a project that was carried out during 2013). Other additional factor which makes impact to fuel consumption in national navigation is weather conditions. This we can definitely see for 2010 and 2011 when air temperature was low and sea was covered by ice. An ice breaker operated many months to ensure operation of ports in 2010 and 2011. This has made an impact on fuel consumption in 2010 and 2011.

Diesel oil consumption increased by approximately 55% in 2019 compared to 2018.

3.2.6.5.2 Trends in emissions

Table 3.19 Trends and emissions in national navigation in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.0213	0.0115	0.0122	0.0107	0.3923	0.2390	0.3262	0.3465	0.4995	0.2447	1047.0
NMVOOC		0.0110	0.0124	0.0144	0.0166	0.0264	0.0209	0.0322	0.0330	0.0302	0.0252	128.5
SO_x		0.0003	0.0002	0.0002	0.0001	0.0051	0.0031	0.0042	0.0045	0.0065	0.0032	1027.7
NH₃		2E-06	9E-07	1E-06	8E-07	3E-05	2E-05	3E-05	3E-05	4E-05	2E-05	1072.3
PM_{2.5}	kt	0.0009	0.0008	0.0009	0.0010	0.0076	0.0049	0.0069	0.0072	0.0095	0.0052	473.1
PM₁₀		0.0009	0.0008	0.0009	0.0010	0.0081	0.0052	0.0073	0.0077	0.0102	0.0055	490.0
TSP		0.0009	0.0008	0.0009	0.0010	0.0081	0.0052	0.0073	0.0077	0.0102	0.0055	490.0
BC		0.0001	0.0001	0.0001	0.0001	0.0022	0.0014	0.0019	0.0020	0.0028	0.0014	880.3
CO		0.0345	0.0389	0.0452	0.0522	0.0761	0.0616	0.0959	0.0978	0.0862	0.0752	117.9
Cd	t	6E-07	7E-07	8E-07	9E-07	7E-07	7E-07	1E-06	1E-06	7E-07	9E-07	65.2
PAHs		1E-05	1E-05	1E-05	1E-05	0.0002	0.0001	0.0001	0.0002	0.0002	0.0001	733.5

Analysing the development of the emission trends in domestic navigation (Table 3.19), following features can be noted:

- Due to remarkable increase (more than 10 times) in fuel consumption in 1990-2019 all emissions increased several times;
- In 2019 NO_x and SO₂ emissions decreased by around 51% compared to 2018 but PM_{2.5} and PM₁₀ emissions by around 45% due to decrease in diesel fuel consumption. NMVOC emissions decreased by around 16%.

3.2.6.5.3 Methods

When calculating emissions from navigation, Tier 1 method was applied.

3.2.6.5.4 Emission factors

Default EFs (Table 3.20) for navigation is used (EMEP/EEA 2016) and "Emission factors used in the estimations of emissions from combustion (Last update: Jan. 18. 2017)":

Table 3.20 Emission factors used in the calculation of emissions from navigation, kt/PJ

	NO _x	CO	NMVOOC	NH ₃	PM _{2.5}	PM ₁₀	TSP
Diesel oil	1.84749	0.17416	0.06589	0.00016	0.03295	0.0353	0.0353
Gasoline (from 2003)	0.214	13.05505	4.12875	0.00016	0.21611	0.21611	0.21611

Gasoline (1990-2002)	0.2138	13.0549	4.12702	0.00016	0.21611	0.21611	0.21611
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EFs for gasoline are different due to varying NCV. The SO₂ emission factors are used consistent with sulphur content in diesel oil and gasoline.

Table 3.21 Emission factors used in the calculation of emissions from navigation, t/PJ

	Cd	Cr	Cu	Ni	Se	Zn	benzo(a)	benzo(b)	benzo (k)
Diesel oil	0.0000002	0.00118	0.02071	0.02353	0.00235	0.02824	0.00014	0.00066	0.00031

3.2.6.5.5 Activity data

The data about diesel oil and gasoline consumption in domestic navigation is derived from the CSB. CSB started to collect data about diesel oil consumption and gasoline consumption in domestic navigation from 2006. For the time period 1990-2005 the data for fuel consumption was used from the study "Evaluation of fuel consumption for domestic aviation and navigation" (IPE, 2004). Development of the fuel consumption in navigation is presented in Figure 3.19 below.

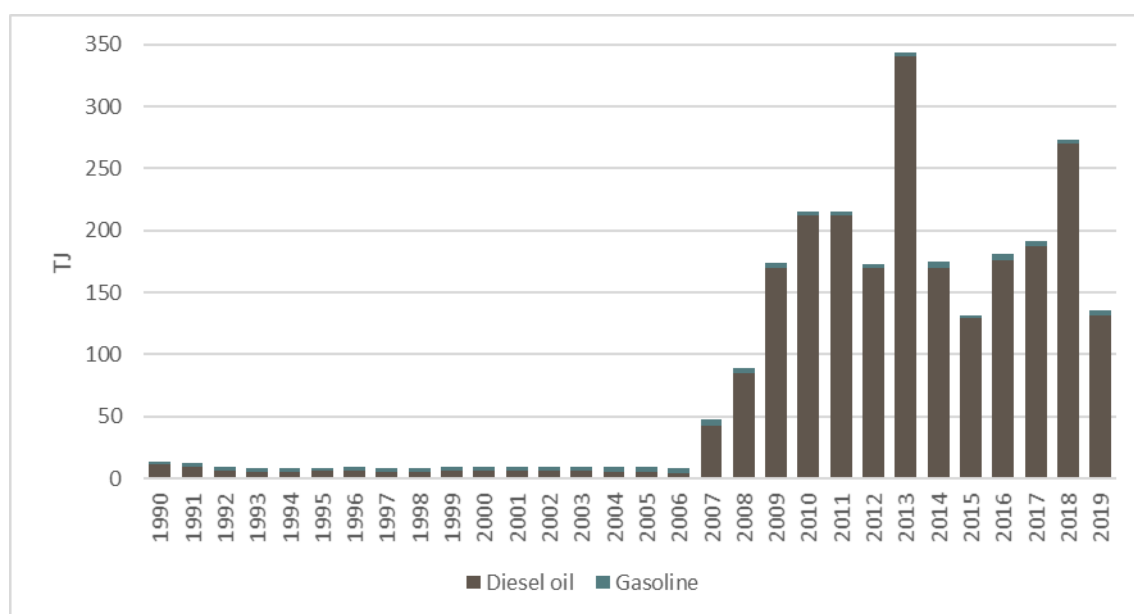


Figure 3.19 Development of gasoline and diesel oil fuel consumption in Navigation

3.2.6.5.6 Uncertainties

Uncertainty in activity data of fuel consumption for time period 2006-2018 is $\pm 2\%$. CSB gives approximately 2% statistical sample error for statistical data. For the rest of the time period uncertainty in activity data of fuel consumption is $\pm 20\%$. The uncertainty of EF lies between 20-40%.

3.2.6.5.7 QA/QC and verification

Assessment of trends were performed.

3.2.6.5.8 Recalculations

No recalculations were carried out.

3.2.6.5.9 Planned improvements

No improvements are planned for the next submission.

3.2.7 Other Sectors (NFR 1A4)

3.2.7.1 Overview

NFR 1A4 Other Sectors include emissions from the small combustion plants used in Commercial/Institutional, Residential sectors and Agriculture/Forestry/Fisheries. Emissions from autoproducers are included in relevant sectors of NFR 1A4 as it is stated that emissions have to be reported in sector they are produced. Also emissions from mobile machinery used in Commercial (NFR 1A4aii), Residential (NFR 1A4bii) and Agriculture/Forestry (NFR 1A4cii) and Fishery (NFR 1A4ciii) sectors are reported as off-road is included in this sector.

3.2.7.2 Trends in emissions

Table 3.22 Trends in emissions from NFR 1A4 Other Sectors in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		24,36	11,09	8,78	9,41	8,04	6,47	6,26	6,50	6,34	5,99	-75,4
NM₁₀VOC		22,03	21,22	18,88	20,91	15,59	10,95	10,93	12,23	12,41	11,83	-46,3
SO_x		35,12	9,95	3,93	3,66	2,27	1,79	1,70	1,79	1,81	1,66	-95,3
NH₃		1,65	2,44	2,20	2,50	1,89	1,35	1,34	1,52	1,56	1,48	-10,2
PM_{2.5}	kt	19,99	23,70	21,28	23,30	17,00	11,35	11,29	12,79	13,23	12,55	-37,2
PM₁₀		20,72	24,38	21,86	23,93	17,46	11,65	11,58	13,12	13,57	12,87	-37,9
BC		21,88	25,67	22,98	25,16	18,36	12,24	12,17	13,78	14,25	13,52	-38,2
TSP		2,83	2,83	2,49	2,77	2,11	1,49	1,47	1,65	1,68	1,60	-43,6
CO		170,20	141,72	126,24	144,31	113,17	78,58	79,04	87,43	90,02	85,35	-49,9
Pb		10,10	2,24	1,28	1,44	1,21	0,83	0,83	0,87	0,85	0,79	-92,1
Cd	t	0,40	0,52	0,45	0,52	0,40	0,32	0,31	0,35	0,36	0,34	-15,5
Hg		0,200	0,065	0,037	0,039	0,034	0,022	0,021	0,022	0,021	0,019	-90,4
PCDD/F	g I-Teq	22,91	25,72	22,80	24,88	18,12	11,96	11,89	13,42	13,91	13,18	-42,4
PAHs	t	14,47	12,65	10,56	11,83	8,98	5,83	5,79	6,47	6,64	6,26	-56,8
HCB		0,15	0,20	0,17	0,20	0,15	0,12	0,12	0,13	0,14	0,13	-13,6
PCBs	kg	4,01	0,96	0,38	0,36	0,36	0,14	0,14	0,11	0,08	0,06	-98,5

All emissions have decreased in 1990-2019 NFR 1A4 Other Sectors (Table 3.22). It can be explained with changes of structure of national economy as well as with significant decrease of fuel consumption in the sector. Increase of emissions in 2008–2009 is explained with development of national economy and well-being of population. But in years 2009-2010 a decrease in emissions can be seen, which can be explained with consequences caused by crisis. The emissions are also affected by weather conditions and recent increase of individual heating supply consumers in 1A4b Residential sector. The increase of gaseous fuels consumption, steady biomass fuel consumption and increase of peat consumption caused the increase of all emissions with the exception of SO₂ and PCBs emissions. Also high cost of liquid fuels and increase of natural gas price in Latvia have caused the situation when previously used fuels have switched to biomass.

3.2.7.3 Methods

Tier 1 and Tier 2 method was used to calculate emissions from the stationary fuel combustion. Calculation of all emissions from fuel combustion is done in Excel database. Detailed information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM. Tier 2 methodology was used to calculate emissions from natural gas use and solid fuel in sector NFR 1A4ai for period 1990-2019 and emissions from mobile combustion in sector NFR 1A4aii and NFR 1A4cii.

The general method for emission calculation:

$$Em = EF \times B_q$$

where:

Em – total emissions (kt)

EF – emission factor (t/TJ)

B_q – amount of fuel in thermal units (TJ)

Emissions from mobile combustion were calculated using methodology described in EMEP/EEA 2019 1.A.4.a.ii, 1.A.4.c.ii Non-road mobile sources and machinery Chapter 3.3 “Tier 2 technology-dependant approach”.

For residential sector Tier 2 method was used to calculate emissions, taking into account also the combustion installations. The following method for estimation of emissions from EMEP/EEA 2019 was used:

$$E_i = \sum_{j,k} EF_{i,j,k} \times A_{j,k}$$

where:

E_i – annual emission of pollutant i ,

$EF_{i,j,k}$ – default emission factor of pollutant i for source type j and fuel k

$A_{j,k}$ – annual consumption of fuel k in source type j

Calculations of all emissions are done in Excel database.

3.2.7.4 Emission factors

The main source for emission factors is EMEP/EEA 2019. Emission factors used for Energy sector are presented in Annex I, Table 3.

SO₂ emission factors are calculated using the same methodology as for NFR 1A1 and 1A2 sectors, using Tier 2 (see chapter 3.2.4.4), where sulphur content is country-specific for each fuel type.

The default emission factors used in estimation of emission were taken from EMEP/EEA 2019 (Annex I, Table 1). Emission factors for landfill gas were equalized to natural gas emission factors due to unavailability of particular emission factors for landfill gas. Emission factors for biodiesel were equalized to diesel emission factor.

3.2.7.5 Activity data

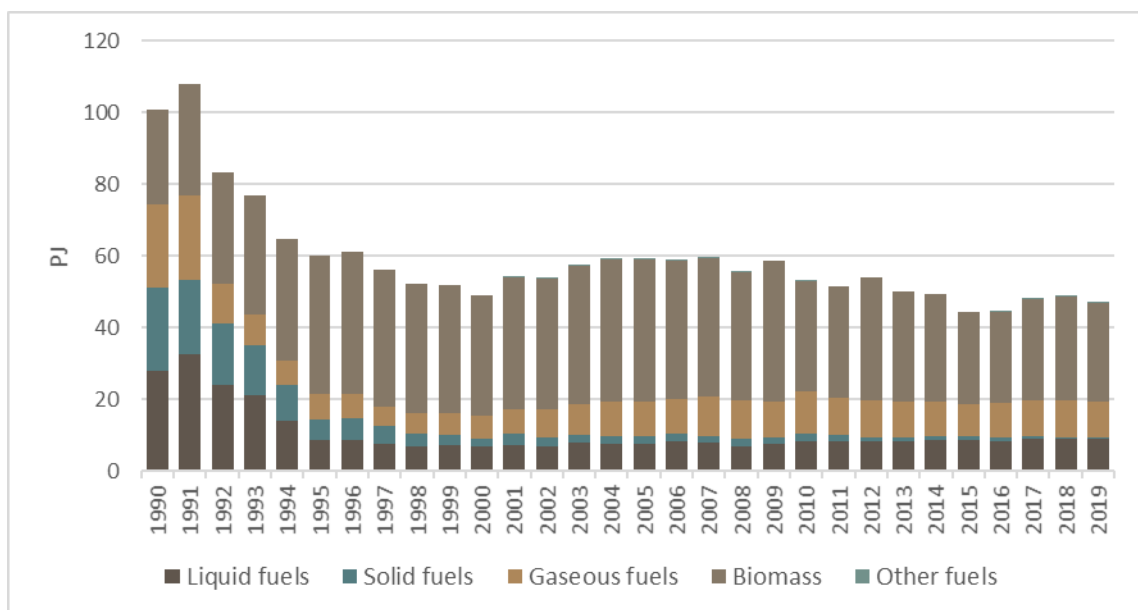


Figure 3.20 Fuel consumption in NFR 1A4 Other Sectors in 1990-2019, PJ

biggest decrease in 1990-2019 was for solid fuel consumption – 98.5%, liquid fuels consumption – 67.5% (Figure 3.20) and gaseous fuels by 56.3%. It is explained with fuel switching processes when solid and liquid fuels were replaced with cheaper fuels. Also stronger legislation contributed fuel switching to the type of fuels with a lower level of emissions.

Since 1990 biomass dominates as a fuel in NFR 1A4 sector. The biggest part of solid biomass consumption goes to Residential sector where biomass is the main fuel in small capacity burning installations. Consumption of biomass fuel has increased by 3.5% in 1990–2019 in Other Sector. It can be seen that the amounts of biomass have been fluctuating over the recent years which can be explained with temperature fluctuations during winter. In 2019 biomass combustion decreased by 4.5% in comparison with 2018.

Since 1997 gaseous fuel consumption was constantly increasing until 2007, due to lower costs and the fact that liquid and solid fuels were replaced with natural gas. The increase in fuel consumption in NFR 1A4 Other Sectors is linked to decrease in fuel consumption in NFR 1A1 Energy Industries when central heating supply consumers switched to individual heating supply. In the recent years a decreased consumption in natural gas is observed, which was influenced by increasing costs of particular fuel.

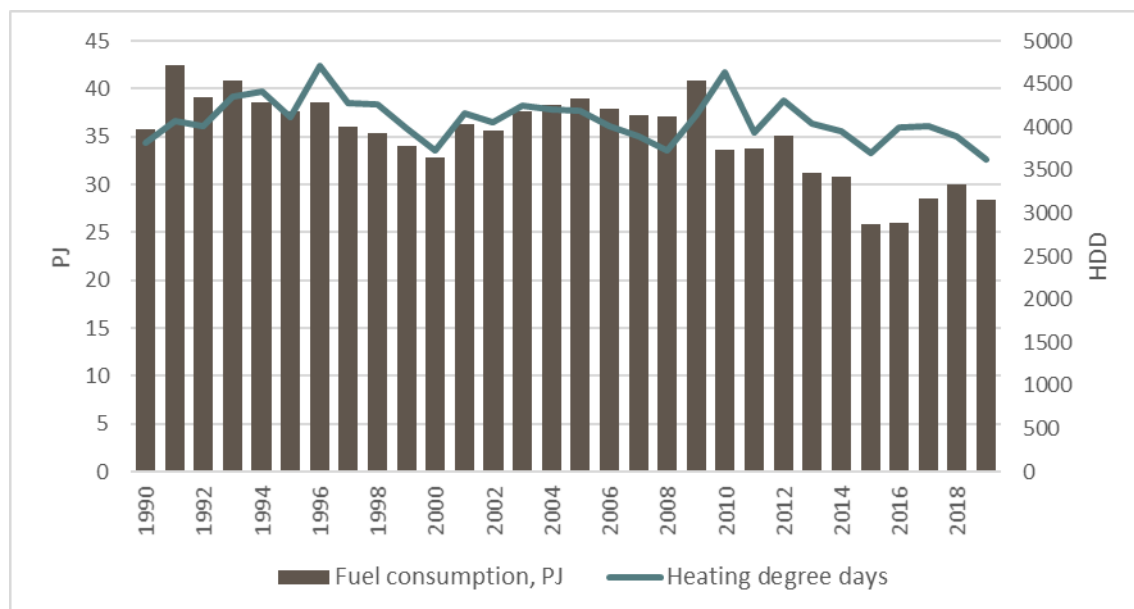


Figure 3.21 Fuel consumption in NFR 1A4b Residential sector and heating degree days in Latvia

As it can be seen in Figure 3.21, fuel consumption in 1.A.4.b sector is related with changes in temperature – in years where HDD are more, the amounts of consumed fuel are also larger, especially it can be seen in 1994-2003. In 2009-2010 the correlation between HDDs and consumption is less visible because of impact of global crisis, which clearly affected the Residential sector. Difference in trend between fuel used and HDD could be explained with changes in heating devices that impact the amount of fuel used (more energy efficient). Higher efficiently boiler will use less fuel to produce the same amount of heat. Also, energy efficiency is increasing due to building new and renovating residential buildings to be more energy efficient.

3.2.7.6 Uncertainties

Uncertainty for activity data of fuel combustion in NFR 1A4 sector is $\pm 2\%$ in 2019. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, as data is obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass was assigned 1% as biomass activity data was collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty for peat combustion activity data was assigned 2%. Uncertainty of landfill gas stationary combusted in enterprises covered by NFR 1A4 Other Sectors was assumed rather low – 2% because the combusted fuel amount is obtained directly from landfill plant that has precise measurement equipment for accounting of combusted fuel.

Emission factor uncertainty is assumed as 50%.

3.2.7.7 QA/QC and verification

Disaggregated data at the finest level possible are presented in the corresponding Annex II.

Activity data is checked with the data provider – CSB, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data is received, the sectoral expert responsible for the emission estimation and reporting is comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

To verify the emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for substances reported also under UNFCCC as indirect GHGs are cross-checked with for verification purposes.

3.2.7.8 Recalculations

Corrected natural gas consumption after consultations with CSB and natural gas providers.

3.2.7.9 Planned improvements

Work on developing Tier 2 calculation methodology for biomass combustion in sector NFR 1A4a;

Work on developing Tier 2 calculation methodology for sector NFR 1A4ciii.

3.2.8 Other (NFR 1A5)

3.2.8.1 Overview

NFR 1A5 Other include emissions from mobile sources from liquid fuels – aviation gasoline, diesel oil and jet kerosene, used in aircrafts and ships. These emissions appear since 1995 before notation key NE is used.

3.2.8.2 Trends in emissions

Table 3.23 Trends in emissions from NFR 1A5 Other in 1995-2019

	Unit	1995	2000	2005	2010	2015	2016	2017	2018	2019	Changes in 1995-2019, %
NOx		0.0080	0.0002	0.1449	0.1620	0.2079	0.2274	0.3114	0.4338	0.4928	6059.8
NMVOc		0.0380	0.0008	0.0168	0.0146	0.0153	0.0227	0.0155	0.0313	0.0429	12.9
SOx		0.0040	0.0000	0.0084	0.0050	0.0061	0.0073	0.0084	0.0126	0.0150	276.2
NH₃		0.0420	0.0008	0.0252	0.0196	0.0214	0.0300	0.0239	0.0439	0.0580	38.0
PM_{2.5}	kt	NO	NO	0.0025	0.0029	0.0037	0.0040	0.0055	0.0077	0.0087	100
PM₁₀		NO	NO	0.0027	0.0031	0.0039	0.0043	0.0059	0.0082	0.0093	100
TSP		NO	NO	0.0027	0.0031	0.0039	0.0043	0.0059	0.0082	0.0093	100
BC		NO	NO	0.0008	0.0009	0.0012	0.0013	0.0018	0.0025	0.0029	100
CO		2.4000	0.0528	0.7538	0.5761	0.5234	0.9523	0.3084	1.0462	1.6586	-30.9
Pb		NO	NO	0.0002	0.0003	0.0003	0.0004	0.0005	0.0007	0.0008	100
Cd	t	NO	NO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	100
Hg		NO	NO	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	100
PCDD/F	g I-Teq	NO	NO	0.0002	0.0003	0.0003	0.0004	0.0005	0.0007	0.0008	100
HCB		NO	NO	0.0001	0.0002	0.0002	0.0002	0.0003	0.0004	0.0005	100
PCBs	kg	NO	NO	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	100

Almost all emissions have increased in 1995-2019 NFR 1A5 Other (Table 3.23). Emissions from this sector are not influenced by the changes in national economy or in the economy of Latvia's trade partners. In the recent years there has been an increase of fuel consumption and increase in emissions.

3.2.8.3 Methods

Tier 1 method was used to calculate emissions from the stationary fuel combustion. Calculation of all emissions from fuel combustion is done in Excel database. Detailed information about inclusion or exclusion

of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM.

The general method for emission calculation:

$$Em = EF \times B_q$$

where:

Em – total emissions (kt)

EF – emission factor (t/TJ)

B_q – amount of fuel in thermal units (TJ)

3.2.8.4 Emission factors

The main source for emission factors is EMEP/EEA 2016. Emission factors used for Energy sector are presented in Annex I, Table 3.

SO₂ emission factors are calculated using the same methodology as for NFR 1A1, NFR 1A2 and NFR 1A4 sectors, using Tier 2 (see chapter 3.2.4.4), where sulphur content is country-specific for each fuel type.

The default emission factors used in estimation of emission were taken from EMEP/EEA 2019 (Annex I, Table 1).

3.2.8.5 Activity data

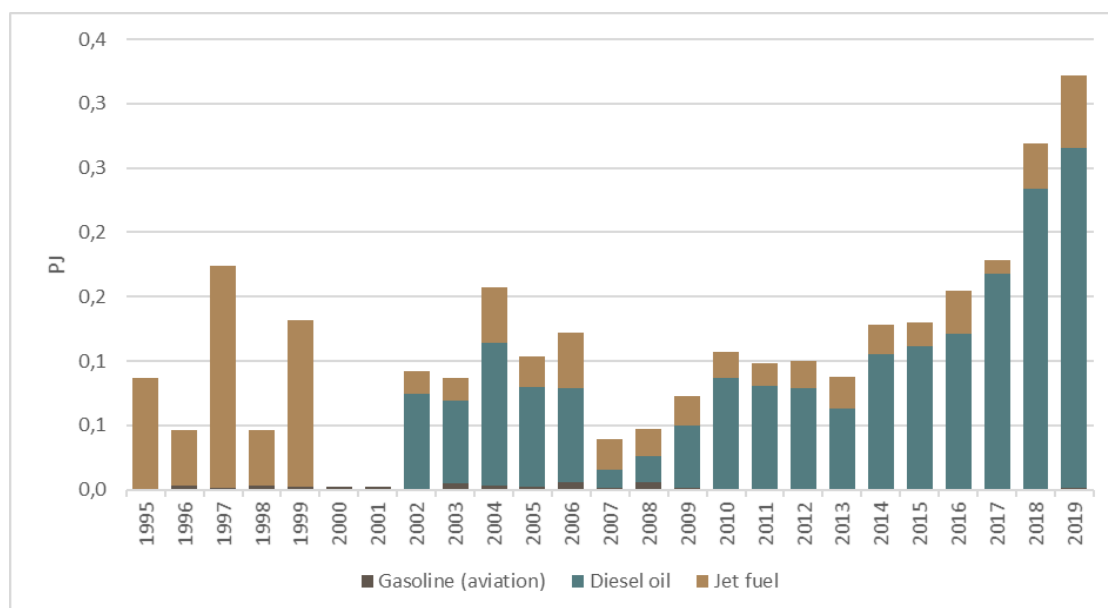


Figure 3.22 Fuel consumption in NFR 1A5 Other in 1990-2019, PJ

Fuel consumption in Other (NFR 1A5) have increased more than 3 times from 1995-2019 (Figure 3.22).

3.2.8.6 Uncertainties

Uncertainty for activity data of fuel combustion in sectors NFR 1A5b is 2±% in 2019 because official statistical information from CSB is used.

Emission factor uncertainty is assumed as 50%.

3.2.8.7 QA/QC and verification

Disaggregated data at the finest level possible are presented in the corresponding Annex II.

Activity data is checked with the data provider – CSB, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data is received, the sectoral expert responsible for the emission estimation and reporting is comparing all data changes with the

previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

To verify the emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for substances reported also under UNFCCC as indirect GHGs are cross-checked with for verification purposes.

3.2.8.8 Recalculations

No recalculations were made.

3.2.8.9 Planned improvements

No improvements planned.

3.3 Fugitive emissions (NFR 1B)

3.3.1 Overview of sector

Under fugitive emissions from fuels, Latvia reports following categories:

- NFR 1B1a Fugitive emission from solid fuels: Coal mining and handling includes fugitive particulate matters emissions from coal transportation and storage;
- NFR 1B2a v Distribution of oil products includes NMVOC emissions from oil storage;
- NFR 1B2b Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other) includes NMVOC emissions from natural gas transmission, storage and distribution systems in Latvia;
- NFR 1B2c Venting and flaring (oil, gas, combined oil and gas) includes NMVOC emissions from natural gas venting in Latvia.

There are no oil refineries in Latvia, therefore NMVOC emissions from gasoline distribution were calculated for the time period 1990–2019.

Fugitive particulate matters emissions in 1990-2019 from the operations of solid fuels – coal and coke, transportation via railways and storage and handling, are estimated.

3.3.2 Trends in emissions

Table 3.24 Fugitive emissions in 1990-2019, kt

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NMVOC	4,18	3,19	2,48	2,28	2,35	2,40	2,06	0,91	0,65	0,71	-83,0
PM_{2.5}	0,00028	0,00008	0,00003	0,00004	0,00005	0,00002	0,00002	0,00002	0,00002	0,00002	-92,7
PM₁₀	0,0028	0,0008	0,0003	0,0004	0,0005	0,0002	0,0002	0,0002	0,0002	0,0002	-92,7
TSP	0,0070	0,0020	0,0008	0,0010	0,0013	0,0006	0,0005	0,0005	0,0006	0,0005	-92,7

NMVOC emissions are decreasing due to decrease in use of gasoline (Table 3.24). Also, particulate matter emissions have decreased if compared to 1990.

3.3.3 Methods

LEGMC received data about CH₄ emissions from the natural gas holding company JSC "Latvijas Gāze" for the time period 1990–2016. Consequently JSC "Latvijas Gāze" calculates emissions itself, using data of natural gas density and other physical parameters and measures the content of methane and other chemical compounds in natural gas, therefore it is assumed as Tier 2 method, using country-specific data and calculations. In 2017 after liberalization of the Latvian gas market JSC "Conexus Baltic Grid" was handed over the natural gas infrastructure (main transmission system and underground gas storage) and JSC "Gasol" natural gas distribution. Therefore information about fugitive emissions from natural gas starting 2017 is received from new companies. JSC "Conexus Baltic Grid" calculates emissions from main transmission

system and underground gas storage for venting, transmission and storage and JSC "Gaso" from distribution system for venting, distribution and other.

EMEP/EEA 2016 Tier 1 methodology is used to estimate fugitive NMVOC emissions from operations with gasoline in 1990–2019. It uses the general equation where emissions are obtained by multiplying the total amount of gasoline sold with the emission factor.

Particulate matter emissions are estimated by using Tier 2 methodology from EMEP/EEA 2019.

3.3.4 Emission factors

NMVOC emission factor – 2 kg/t oil – for emission from gasoline distribution was taken from EMEP/EEA 2019, Chapter 1.B.2.a.v Distribution of oil products, Table 3-1.

Emission factors for particulate matters emission estimation are taken from EMEP/EEA 2019, Chapter 1.B.1.a Fugitive emissions from solid fuels: Coal mining and handling, Table 3-6 (Table 3.25). Detailed information about inclusion or exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors can be found in Annex IV: Summary Information on Condensable in PM.

Table 3.25 PM emission factors, g/t

	PM _{2.5}	PM ₁₀	TSP
Coal	0.3	3	7.5

3.3.5 Activity data

In Figure 3.23 and Figure 3.24 and Table 3.26 activity data used for calculation can be seen.

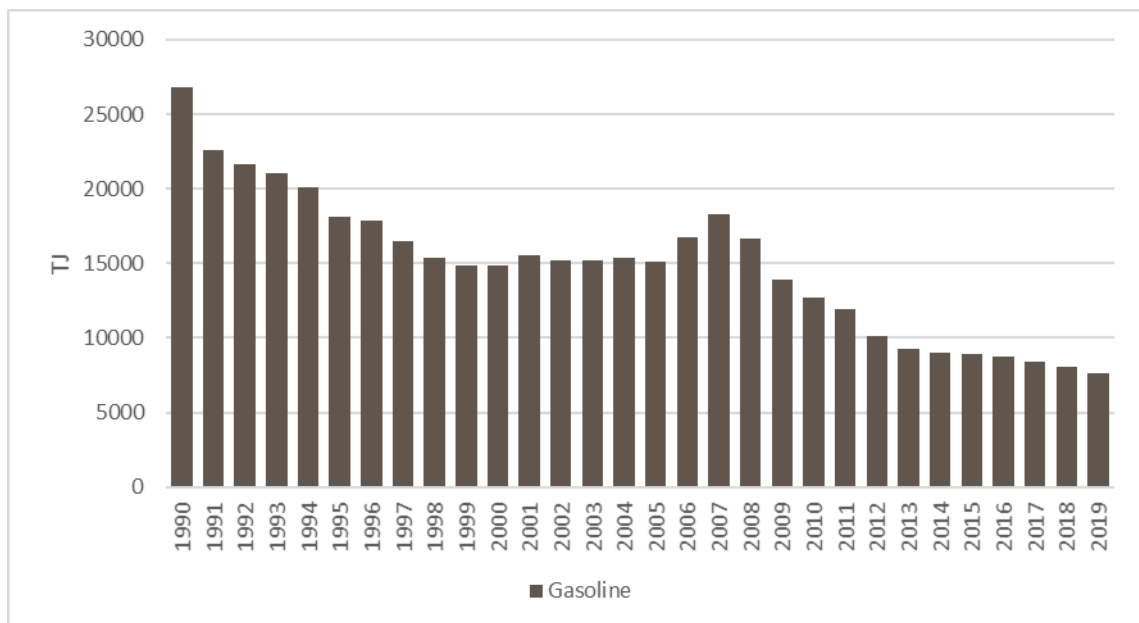


Figure 3.23 Gasoline consumption in Latvia in 1990-2019, Tj

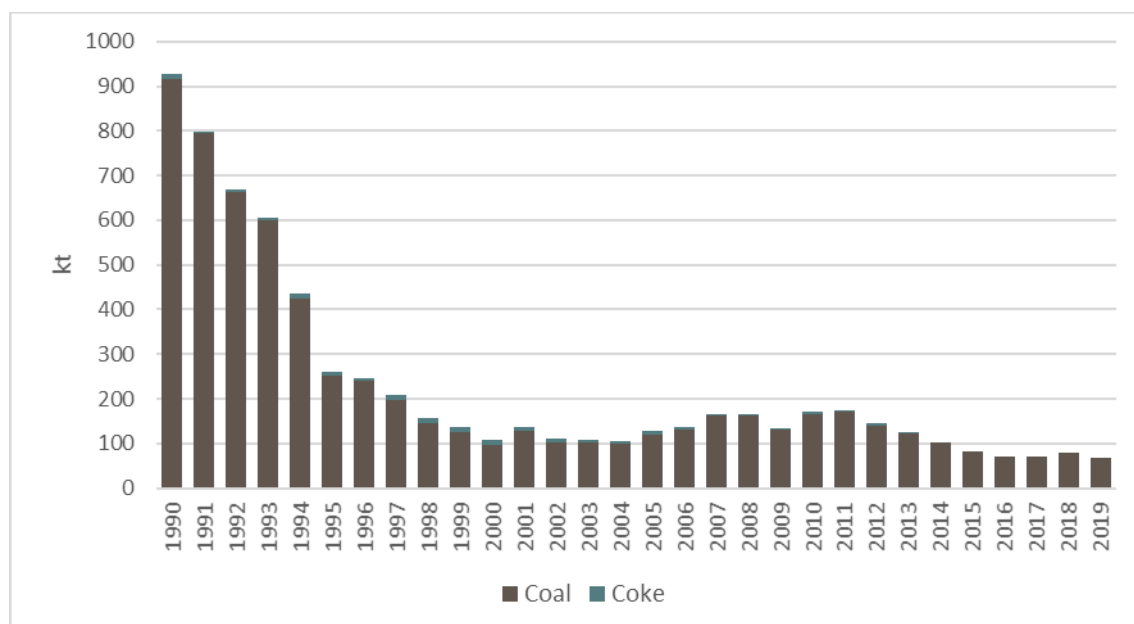


Figure 3.24 Activity data used for particulate matters emissions calculation in 1990–2019, kt

Table 3.26 Amounts of natural gas leaked in 1990-2019 (10^6 m^3)

Year	Venting	Transmission and storage	Distribution	Other	Total
1990	5.61	0.13	0.69	12.44	18.87
1991	5.38	0.13	0.69	11.98	18.17
1992	4.83	0.13	0.59	10.92	16.47
1993	4.58	0.13	0.69	10.44	15.85
1994	4.46	0.13	0.69	10.21	15.48
1995	4.32	0.13	0.69	9.94	15.08
1996	4.13	0.13	0.69	9.58	14.53
1997	3.80	0.13	0.69	8.94	13.56
1998	3.63	0.11	0.69	8.58	13.01
1999	3.42	0.11	0.69	8.18	12.40
2000	3.11	0.11	0.69	7.57	11.48
2001	0.30	0.10	0.69	10.03	11.14
2002	0.98	0.10	0.69	9.86	11.63
2003	1.09	0.10	0.69	7.20	9.07
2004	1.56	0.09	0.69	6.63	8.98
2005	3.25	0.09	0.69	6.12	10.15
2006	1.80	0.08	0.69	4.71	7.28
2007	1.76	0.07	0.69	4.95	7.47
2008	2.44	0.07	0.69	4.48	7.67
2009	1.78	0.06	0.69	4.71	7.25
2010	1.64	0.06	0.69	4.59	6.98
2011	1.77	0.05	0.69	1.70	4.21
2012	1.34	0.05	0.69	3.35	5.43
2013	1.09	0.04	0.69	4.06	5.89
2014	1.53	0.04	0.66	5.69	7.93
2015	0.95	0.04	0.71	4.35	6.06
2016	0.93	0.04	0.67	5.18	6.83
2017	0.83	0.01	0.73	7.82	9.39
2018	0.41	0.01	0.73	4.42	5.57
2019	0.84	0.01	0.74	4.40	6.00

3.3.6 Uncertainties

Activity data for fugitive emissions from operations with gasoline and coal handling were taken from CSB and uncertainty was assumed as low - about 2% - as a statistical frame mistake. Uncertainty for emission factor is assumed as 50%.

The level of uncertainty was determined by natural gas distributing company JSC „Latvijas Gāze”, JSC “Conexus Baltic Grid” and JSC “Gasol”. The uncertainty both for activity data (gas amounts) and emissions from gas venting and natural gas leakages in gas distribution and transmission systems, as well as in gas storage facility is assigned as quite low – 10%, as these were estimated by the enterprise operated with natural gas by methodology developed for enterprise. However, for other leakage the uncertainty for the emissions is assumed as 35%.

Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no “not estimated” sectors.

3.3.7 QA/QC and verification

Activity data was checked at the data provider – CSB, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data was received, the sectoral expert responsible for the emission estimation and reporting were comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

As all emission factors are taken from EMEP/EEA 2019, no additional verification procedures were performed.

To verify the NMVOC emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions are also cross-checked with emissions reported within UNFCCC for verification purposes.

3.3.8 Recalculations

No recalculations.

3.3.9 Planned improvements

No improvements are planned.

3.4 International bunkers

3.4.1 Overview

International bunkers cover International and Domestic Civil Aviation (only cruise mode) and International maritime navigation according to the IPCC GPG 2000. Emissions from International Aviation and Navigation are not included into national total emissions.

3.4.2 Trends in emissions

International maritime navigation contributed around 95%, 81% and 95% in total international emissions correspondingly for NO_x and SO₂ and PM_{2.5} emissions in 2019.

3.4.3 Emission factors

Default emission factors for International Aviation and Navigation are taken from EMEP/EEA 2016 methodology and are presented in Table 3.27 and Table 3.28. The emission factors for Particulate Matters for International Navigation are taken from CEPMEIP/TNO database (Table 3.29).

Table 3.27 Emission factors to calculate emissions from International Aviation, kt/PJ

	NO _x	CO	NMVOC	SO ₂
Jet fuel	0.25	0.1	0.05	0.023

Table 3.28 Emission factors to calculate emissions from International Navigation

	NO _x	CO	NMVOC	NH ₃	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	kt/PJ												
	t/PJ												
Diesel oil	1	0.25	0.11	0.0038	0.0024	0.00024	0.0012	0.0012	0.0009	0.0012	0.0016	0.0047	0.0118
RFO	1.6	0.5	0.11	0.0062	0.0049	0.00074	0.0005	0.0123	0.0049	0.0123	0.7389	0.0099	0.0222

Table 3.29 Emission factors for Particulate Matters for International Navigation, kt/PJ

	PM ₁₀	PM _{2.5}	TSP
Diesel oil	0.035	0.033	0.035
RFO	0.1527	0.1379	0.1527

The SO₂ emissions factors are used consistent with sulphur content in diesel oil (Table 3.30, Table 3.31).

Table 3.30 SO₂ emission factors used for Diesel oil in the SO₂ calculation of emissions for International Bunkers

	Fuel content, %	NCV, TJ/kt	EF, kt/PJ
1990-2007	0.2	42.49	0.094
2008-2018	0.1	42.49	0.0471

Table 3.31 SO₂ emission factors used for RFO in the SO₂ calculation of emissions for International Bunkers

	Fuel content, %	NCV, TJ/kt	EF, kt/PJ
1990-2006	2.8	40.6	1.352
2007-2018	1.5	40.6	0.7241

3.4.4 Activity data

Fuel consumption for emission calculation is obtained from CSB (Figure 3.25). To provide the consistent allocation of fuel consumption between domestic and international mode in the navigation and aviation, CSB each month collects and summarises the information that is submitted by enterprises which perform fuel bunkering. For this purpose, the particular statistical report format is elaborated in which the enterprises have to fill in the data regarding amount of fuel sold respectively in domestic and international navigation and aviation.

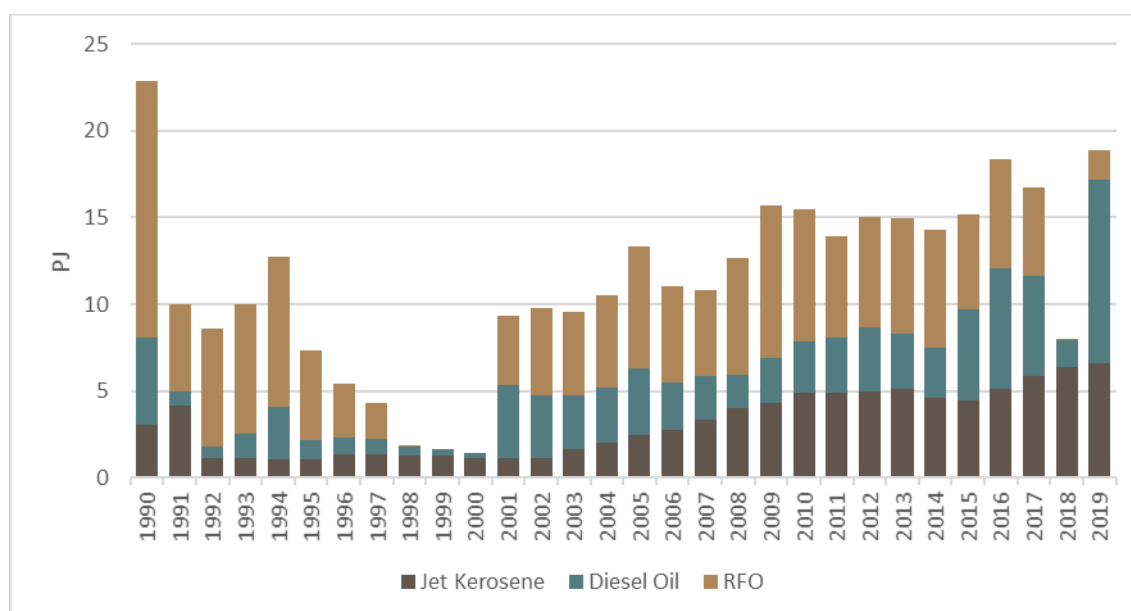


Figure 3.25 Fuel consumption in International Transport (PJ)

Considering the fact that ports in Latvia are focused on transit cargo transport, navigation activities have big fluctuations and depend on neighbouring countries' economical and international trading activities and competitiveness of Latvian ports with other neighbouring ports in Baltic Sea. At the same time fuel consumption and emissions from aviation are more stable, and recent trend depicts a persistent increase from year 2003. After the sulphur regulation for marine fuels was entered into force on 1st of January 2015 in the North Sea and the Baltic Sea sulphur emission control area, SECA, a change in the fuel types used has occurred. The allowed sulphur content in marine fuels was decreased from 1 per cent to 0.1 per cent by mass. To fulfil requirement concerning sulphur content limit, from 2015 ships have used more diesel oil (Figure 3.25). Important reason for the fluctuation of fuel consumption in international navigation has been the variation in bunker fuel prices. Vessels can refuel in one or other country depending on fuel prices. This was the main factor for a sharp decrease in fuel consumption in 2018.

Table 3.32 Trends and emissions in International Transport in 1990-2019

	Unit	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		38.70	12.34	0.87	21.24	21.03	18.00	20.11	19.68	19.42	21.02	25.913	21.670	4.114	23.987	-38.02
NMVOC		1.39	0.65	0.27	0.74	0.74	0.64	0.72	0.70	0.69	0.75	0.93	0.780	0.174	0.878	-36.82
SO₂		20.45	7.09	0.05	9.95	5.73	4.44	4.89	5.07	5.14	0.59	0.72	0.632	0.212	0.717	-96.50
NH₃		0.0034	0.0011	0.0001	0.0019	0.0018	0.0015	0.0017	0.0017	0.0017	0.0018	0.0023	0.0019	0.0003	0.0021	-37.98
PM_{2.5}	kt	2.210	0.752	0.016	1.109	1.162	0.924	1.021	1.043	1.050	0.940	1.109	0.920	0.088	0.613	-72.28
PM₁₀		2.440	0.831	0.017	1.223	1.282	1.017	1.124	1.148	1.157	1.033	1.218	1.009	0.092	0.663	-72.82
TSP		2.440	0.831	0.017	1.223	1.282	1.017	1.124	1.148	1.157	1.033	1.218	1.009	0.092	0.663	-72.82
BC		0.301	0.099	0.006	0.160	0.165	0.138	0.153	0.152	0.151	0.152	0.184	0.155	0.030	0.149	-50.37
CO		3.624	1.155	0.084	2.004	1.997	1.716	1.915	1.876	1.847	1.999	2.464	2.072	0.431	2.302	-36.49
Cd		0.0084	0.0028	0.0001	0.0044	0.0044	0.0036	0.0040	0.0040	0.0040	0.0039	0.0047	0.0039	0.0004	0.0033	-60.58
PAHs	t	0.0156	0.0039	0.0008	0.0107	0.0088	0.0089	0.0103	0.0091	0.0086	0.0135	0.0178	0.0147	0.0036	0.0247	59.02

4 Industrial processes and product use (NFR 2)

4.1 Sector overview

4.1.1 Overview of sector

Sources of emissions from Industrial processes and product use (IPPU) are:

- Mineral products (NFR 2A);
- Metal production (NFR 2C);
- Other solvent and product use (NFR 2D-2L);
- Other industry production (NFR 2H).

There are no emissions reported from Wood processing (NFR 2I), POPs production (NFR 2J) as well as POPs and heavy metal consumption (NFR 2K) and other sectors (NFR 2L) in Latvia.

Table 4.1 Source categories and methods for Industrial processes and product use sector

NFR code	Description	Method	AD	EF
2A1	Cement production	Tier 1, Tier 2, Tier 3	PS	D, PS
2A2	Lime production	Tier 1, Tier 2	PS, NS	D
2A3	Glass production	Tier 1, Tier 3	PS, NS	D, PS
2A5a	Quarrying and mining of minerals other than coal	Tier 1	NS	D
2A5b	Construction and demolition	Tier 1	NS	D
2A5c	Storage, handling and transport of mineral products	Tier 1, Tier 3	NS	D
2A6	Other mineral products	NO	NO	NO
2B1	Ammonia production	NO	NO	NO
2B2	Nitric acid production	NO	NO	NO
2B3	Adipic acid production	NO	NO	NO
2B5	Carbide production	NO	NO	NO
2B6	Titanium dioxide production	NO	NO	NO
2B7	Soda ash production	NO	NO	NO
2B10a	Chemical industry: Other (please specify in the IIR)	NO	NO	NO
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	NO	NO	NO
2C1	Iron and steel production	Tier 2	NS, PS	D
2C2	Ferroalloys production	NO	NO	NO
2C3	Aluminium production	NO	NO	NO
2C4	Magnesium production	NO	NO	NO
2C5	Lead production	NO	NO	NO
2C6	Zinc production	NO	NO	NO
2C7a	Copper production	NO	NO	NO
2C7b	Nickel production	NO	NO	NO
2C7c	Other metal production (please specify in the IIR)	NO	NO	NO
2C7d	Storage, handling and transport of metal products (please specify in the IIR)	NO	NO	NO
2D3a	Domestic solvent use including fungicides	Tier 1, Tier 2	NS	Tier 2
2D3b	Road paving with asphalt	Tier1	NS	D
2D3c	Asphalt roofing	Tier1	NS	D
2D3d	Coating applications	Tier 1, Tier 2	NS	Tier 1
2D3e	Degreasing	CS	NS	Tier 1
2D3f	Dry cleaning	CS	NS	CS
2D3g	Chemical products	CS	NS	Tier 1, Tier 2
2D3h	Printing	CS	NS	Tier 1
2D3i	Other solvent use (please specify in the IIR)	Tier 1, Tier 2	NS	Tier 1, Tier 2
2G	Other product use (please specify in the IIR)	Tier 2	NS	Tier 2

NFR code	Description	Method	AD	EF
2H1	Pulp and paper industry	Tier 1	NS	D
2H2	Food and beverages industry	Tier 2	NS	D
2H3	Other industrial processes (please specify in the IIR)	NO	NO	NO
2I	Wood processing	NE	NE	NE
2J	Production of POPs	NO	NO	NO
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NO	NO	NO
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)	NO	NO	NO

Table 4.2 Reported emissions in Industrial processes and product use sector in 2019

NFR code	Emissions
2A1	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Hg
2A3	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO
2A5a	PM _{2.5} , PM ₁₀ , TSP
2A5b	PM _{2.5} , PM ₁₀ , TSP
2A5c	PM _{2.5} , PM ₁₀ , TSP
2D3a	NMVOC, Hg
2D3b	NMVOC, PM _{2.5} , PM ₁₀ , TSP, BC
2D3c	NMVOC, PM _{2.5} , PM ₁₀ , TSP, BC, CO
2D3d	NMVOC
2D3e	NMVOC
2D3f	NMVOC
2D3g	NMVOC
2D3h	NMVOC
2D3i	NMVOC
2G	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/PCDF, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, Indeno (1,2,3-cd) pyrene, total PAHs
2H2	NMVOC

4.1.2 Key sources

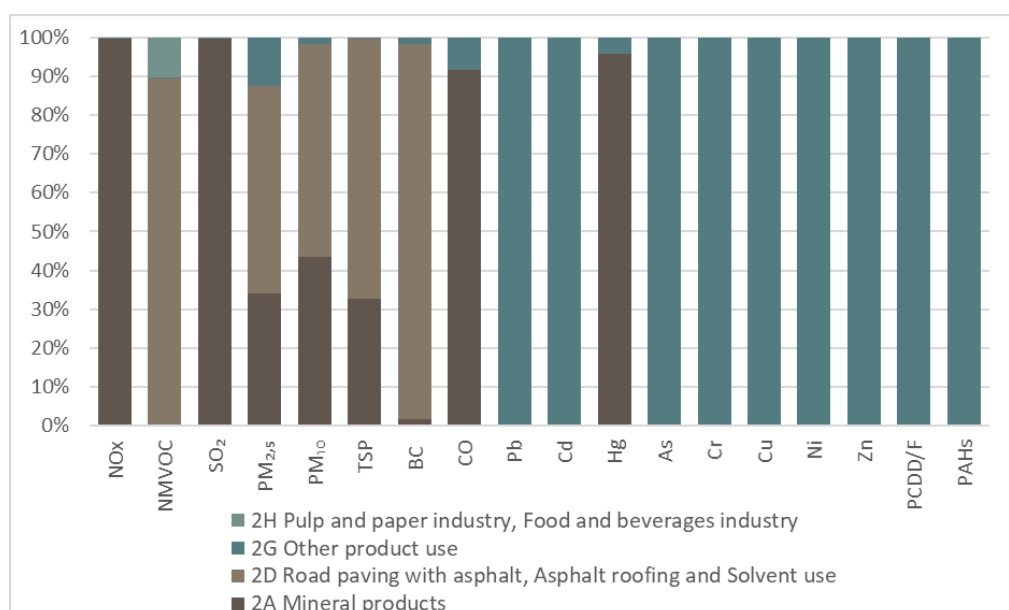


Figure 4.1 Emissions from Industrial processes and product use sector by subsectors in 2019

Main categories in IPPU sector are – mineral production dominates in NO_x, SO₂, CO; other solvent and product use dominates in NMVOC and particulate matter emissions and again other product use dominates in heavy metal emissions. Coating application sector (NFR 2D3d) dominates in NMVOC, particulate matter

and BC emissions (Figure 4.1). Division of emission most likely could be different because several emissions are not estimated due to lack of official methodology and default or country specific emission factors.

The main share of total NMVOC emissions was contributed by Coating (2D3d) – 8.1% or 3.28 kt and Other solvent use (2D3i) – 9.6% or 3.90 kt.

4.1.3 Trends in emissions

Table 4.3 Change in emissions from Industrial processes and product use sector in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.910	0.243	0.233	0.470	0.597	1.970	1.410	1.750	2.131	2.096	130.2
NMVOC		13.090	10.885	10.564	10.349	9.243	11.309	10.653	11.292	15.783	12.641	-3.4
SO₂		3.570	0.943	0.933	1.481	0.205	0.255	0.104	0.085	0.106	0.105	-97.1
NH₃		0.010	0.009	0.009	0.007	0.007	0.007	0.008	0.008	0.010	0.017	68.1
PM_{2.5}	kt	0.684	0.384	0.574	1.140	1.017	1.053	0.857	0.743	0.765	0.864	26.3
PM₁₀		1.698	1.446	1.981	6.616	5.795	8.213	6.402	5.500	5.627	6.287	270.2
TSP		3.399	3.425	6.644	24.028	20.584	32.334	26.248	21.700	21.788	23.956	604.8
BC		0.013	0.007	0.017	0.034	0.028	0.036	0.035	0.028	0.027	0.027	103.1
CO		0.14	0.13	0.13	0.12	0.96	1.79	0.82	1.39	1.62	2.64	1737.2
Pb		163.02	82.76	149.12	164.85	160.36	0.14	0.14	0.15	0.14	0.13	-99.9
Cd		0.454	0.235	0.411	0.453	0.437	0.012	0.010	0.011	0.014	0.022	-95.2
Hg		0.000	0.000	0.000	0.000	0.012	0.008	0.024	0.016	0.004	0.000	-51.9
As		16.301	8.274	14.895	16.459	16.025	0.0004	0.0002	0.0003	0.0002	0.0002	-100.0
Cr	t	1.260	0.637	1.147	1.272	1.231	0.003	0.003	0.003	0.003	0.003	-99.8
Cu		0.180	0.098	0.254	0.321	0.232	0.070	0.089	0.097	0.092	0.097	-46.2
Ni		5.464	2.771	4.983	5.515	5.352	0.017	0.010	0.011	0.012	0.016	-99.7
Se		0.035	0.008	0.006	0.018	NO,NA,NE	NO,NA,NE	NO,NA,NE	NO,NA,NE	NO,NA,NE	NO,NA,NE	-100.0
Zn		4.448	2.258	4.098	4.563	4.372	0.085	0.051	0.056	0.053	0.055	-98.8
PCDD/PCDF	g I-teq	0.057	0.029	0.045	0.055	0.039	0.038	0.0002	0.0002	0.0003	0.0004	-99.3
PAHs	kg	0.009	0.005	0.007	0.009	0.006	0.006	0.0004	0.0005	0.0006	0.0010	-89.5
PCBs		0.000	0.000	0.000	0.000	0.000	0.000	NO.NA	NO.NA	NO.NA	NO.NA	-100.0

Emissions in the IPPU sector are linked with the economic situation in the country as well as availability of statistical data. The largest decrease in emissions occurred between 1990 and 1993, when industry was affected by a crisis (Table 4.3).

At the beginning of 1990s during the countrywide change of government system and national economy, statistics were not well kept, therefore there is a lack of statistical data regarding industry during this time period or it is vague.

From 2000 to 2008 the emissions from IPPU increased because of growing demand for industrial products in neighbouring countries. It led to rapid development of Latvian industry due to increased activity in construction and production of building materials.

Industrial production faced significant decrease at the end of 2008 and 2009, caused by financial crisis in economy of Latvia. It led to reduction in purchase capacity which can be explained with decrease of population welfare. As a result, the activity in building and construction sector decreased and companies were taxed with higher taxes.

In 2010 entire IPPU emissions increased with exception of SO₂ and NO_x which decreased by 88.9% and 5.9% accordingly compared to previous year. Decrease was related to switching from wet to dry cement production technology in the first half of 2010. The data of SO₂ and NO_x in 2010 may not be representative because the new dry process cement production technology began to work with full capacity only in July 2010. After switching from wet to dry process SO₂ and NO_x emissions are measured automatically by cement plant itself and are considered as plant-specific data and available from the national database "2-Air".

Heavy metal emissions from metal industry decreased remarkably comparing 1990 to 2019 due to technological changes in metal production plant that occurred in 2011 as well as due to cessation of the production of steel in 2016. Since 2011 crude steel was produced only in Electric arc furnace (EAF) whose EFs are lower than Open hearth furnace (OHF) technology which was used in 1990-2010. In relation to persistent organic pollutants (POPs) since 2016 submission PCDD/PCDF, PAHs and PCBs emissions from metal industry were calculated. PCBs emissions are applicable only for EAF technology. PCBs emissions were reported for 2011-2015 while PCDD/PCDF and PAHs were reported for 1990-2015. Since 2016 there are no emissions from 2.C.1 Iron and steel production due to interruption of steel production in the country.

From 2014-2016 the downward trend can be observed due to decrease in cement and glass production but from 2017 CO emissions are growing due to increased cement production. CO emissions are automatically measured at cement and glass fibre plants and available from the national database "2-Air".

In Solvent use the fluctuation of NMVOC emissions in the period 1990-2019 has mostly occurred due to the welfare of the economic state of the country. A slight decrease in emissions occurred between years 1990 and 2006. From 2006 until 2008 the economy began to grow, when the world was struck by the economic crisis which also affected the Solvent Use sector in Latvia. During the later period of 2010 till 2019 NMVOC emissions were fluctuating.

4.2 Mineral products (NFR 2A)

4.2.1 Source category description

4.2.1.1 Overview

This chapter includes industrial production emissions from production processes:

- NFR 2A1 Cement production – NO_x, NMVOC, SO₂, CO, particulate matter, BC and Hg emissions;
- NFR 2A2 Lime production - particulate matter, BC;
- NFR 2A3 Glass and glass fibre production – NO_x, NMVOC, SO₂, CO, particulate matter and BC emissions;
- NFR 2A5a Quarrying and mining of minerals other than coal - particulate matter emissions;
- NFR 2A5b Construction and demolition - particulate matter emissions;
- NFR 2A5c Storage, handling and transport of mineral products - particulate matter emissions.

Since 2016 there are no particulate matter and BC emissions from NFR 2A2 Lime production (NO) because the only lime producer ceased lime production in the country.

4.2.1.2 Trends in emissions

Table 4.4 Change in emissions from Mineral products in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.9025	0.2372	0.2257	0.4635	0.5912	1.9658	1.4062	1.7470	2.1261	2.0887	131.4
NMVOC		0.1550	0.0420	0.0412	0.0724	0.0291	0.0170	0.0165	0.0147	0.0166	0.0173	-88.8
SO₂		3.4094	0.8960	0.8526	1.3919	0.1186	0.2538	0.1033	0.0848	0.1054	0.1042	-96.9
PM_{2.5}	kt	0.2807	0.1191	0.0624	0.3357	0.3033	0.3730	0.1893	0.2063	0.2321	0.2942	4.8
PM₁₀		1.1025	0.8752	0.3653	2.9386	2.7514	3.4443	1.7466	1.8394	2.0984	2.7403	148.6
TSP		2.3422	1.7412	0.6845	8.5676	8.0431	10.2908	4.7494	4.8430	5.6040	7.8360	234.6
BC		0.0043	0.0010	0.0009	0.0016	0.0005	0.0005	0.0004	0.0005	0.0004	0.0004	-90.1
CO		NA,NE	NA,NE	NA,NE	NA,NE	0.8525	1.6784	0.7120	1.2781	1.4772	2.4175	183.6
Pb		0.0741	0.0173	0.0125	0.0385	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Cd		0.0057	0.0013	0.0010	0.0029	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Hg		0.0001	0.0000	0.0000	0.0001	0.0120	0.0076	0.0242	0.0158	0.0042	0.0002	68.3
As	t	0.0083	0.0019	0.0014	0.0043	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Cr		0.0100	0.0023	0.0017	0.0052	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Cu		0.0003	0.0001	0.0001	0.0002	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Ni		0.0213	0.0050	0.0036	0.0111	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
Se		0.0349	0.0082	0.0059	0.0181	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0
Zn		0.0161	0.0038	0.0027	0.0084	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	-100.0

During the time period 1990-2019 NO_x, PM_{2.5}, PM₁₀, Hg, CO and TSP emissions from Mineral products were increasing. At the same time NMVOC, SO₂, BC and heavy metal (excluding Hg) emissions decreased. Emission trend in 2A sector is linked with economic situation in the country which influences demand for mineral products (Table 4.4).

In 2019 NO_x emissions have increased by 131.4% compared to 1990 but CO emissions increased by 183.6% in 2019 compared to 2010 due to an increased amount of clinker produced. In cement plant NO_x, SO₂ and CO emissions, as well as particulate matter and Hg emissions are measured automatically by plant itself. Compared to 1990 emissions of PM_{2.5}, PM₁₀ and TSP increased by 4.8%, 148.6% and 234.6% accordingly. To reduce particulate matter emissions, all mineral producing plants are equipped with filters.

NMVOC emissions decreased by 88.8% in 2019 compared to 1990. It is mainly due to closing of glass production plant in 2005 and change of cement production technology. Important condition which causes NMVOC emission fluctuations in glass production sector is market demand which determines necessity for different raw materials.

4.2.2 Cement production (NFR 2A1)

4.2.2.1 Overview

Under 2A1 sector NO_x, NMVOC, SO₂, PM_{2.5}, PM₁₀, TSP, BC and Hg emissions from Cement production are reported.

4.2.2.2 Trends in emissions

Table 4.5 Change in emissions from Cement production in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.902	0.237	0.226	0.358	0.492	1.864	1.305	1.672	2.055	2.028	124.7
NMVOC		0.154	0.040	0.038	0.061	0.008	0.009	0.007	0.009	0.011	0.011	-92.9
SO₂		3.409	0.896	0.853	1.354	0.075	0.191	0.064	0.067	0.088	0.088	-97.4
PM_{2.5}	kt	0.120	0.032	0.030	0.048	0.019	0.019	0.010	0.014	0.019	0.018	-85.4
PM₁₀		0.341	0.090	0.085	0.135	0.029	0.029	0.014	0.022	0.029	0.027	-92.2
TSP		0.401	0.105	0.100	0.159	0.030	0.030	0.015	0.023	0.030	0.028	-93.1
BC		0.004	0.001	0.001	0.001	0.0002	0.0003	0.0002	0.0002	0.0003	0.0003	-91.5
CO		NE	NE	NE	NE	0.812	1.644	0.685	1.267	1.467	2.410	196.9
Hg	t	NE	NE	NE	NE	0.012	0.008	0.024	0.016	0.004	0.000	-98.2

There is only one cement producing company "SIA SCHWENK" in Latvia. During 1990-2010 cement was manufactured in wet process kiln and emissions were estimated by multiplying clinker production data with emission factors (Tier 1 and Tier 2 method). Starting from 2010 company switched from wet to fully dry cement production process and plant specific SO₂, NO_x, CO and particulate matter emission data become available from the national database "2-Air" (Tier 3 method).

Due to the change of cement production technology SO₂ and NO_x emissions in 2010 decreased by 95.7% and 10.4% accordingly compared to 2009. Rapid decrease of SO₂ emissions can be explained with the new technology (wet process) where raw materials and fuel have been chosen so to restrict the content of sulphur compounds. Fuels are mixed in a way that dust mass of clinker and filters can adsorb process SO₂ which causes emission decrease.

NO_x emission decrease in 2010 compared to 2009 and increase starting from 2011 is related to plant specification. The cement producer was asked to confirm correctness of NO_x data and they explained that NO_x emission increase since 2011 is related to technology which was changed when wet process was replaced with dry process. In dry process additional NO_x is caused also from drying of raw materials which

was not done in wet technology. To reduce NO_x emissions from cement production SNCR (Selective Non-Catalytic Reduction System) method is used. Using SNCR system the NO_x emission reduction in flue gas of 40-60% is achievable, depending on the cement kiln type, fuel and NO_x content. Reducing agents such as urea and ammonia are injected into the hot flue gases. They react with nitrogen monoxide and form nitrogen and water. In addition, SNCR are used together with more than 50% ecofuel which functions as blaze extinguisher to reduce NO_x emissions. Cement producer confirmed that ammonia "helps" to keep temperature in kiln so that the NO_x limit is not exceeded.

SO₂ and NO_x emission data reported by cement producer was verified and acknowledged as correct as this is plant specific data. There is no way to create consistent time series for at least 2005-present in case of SO₂ and NO_x as Tier 3 method is applied since 2010 and plant specific data is not available prior to 2010.

In 2019 NMVOC, SO₂ and particulate matter emissions have decreased (Table 4.5) compared to 1990 because all emissions are automatically measured by plant itself. TSP are weighted and returned in further production for different types of cement.

In 2011 and 2012 emissions from NFR 2A1 sector increased due to growing activity in cement production compared to previous year. In 2013 cement production decreased by 6.6% but again in 2014 increased by 3.6%. Then cement production decreased by 16.0% and 26.1%, accordingly in 2015 and 2016 due to decrease of amounts exported and reduced activity in building sector which caused lower demand for cement. In 2017 and 2018 cement production increased by 26% each year. And in 2019 cement production increased by 1.7%. Cement products are mainly exported thereby cement production directly depends on demand in external and internal market.

Hg emission increase in 2016 compared to 2015 can be observed due to the use of solid recovered fuel (SRF). SRF usually is a composition of mixed plastics, paper, paperboard, wood, textiles etc. The composition and quality of SRF is changing all the time and it affects Hg fugitive emissions which are measured in main chimney. The amount of Hg emissions depends on the raw material which is used in the cement production as an additive material. In 2019 raw material supplier has been replaced compared to 2018, therefore emissions decreased by 94.7%.

As of 2010 all emissions from cement production are automatically measured at plant site and are plant specific – Tier 3 method (emission data are taken from the national database "2-Air"). It is not possible to separate emissions emitted from clinker production process and emissions emitted for fuel combustion purpose, because they are measured in main chimney. To ensure consistency and avoid double counting with category 1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-Metallic Minerals Latvia reports fuel related emissions from cement industry under category 1A2f (only for time period 1990-2009). Since 2010 emissions from 2A1 sector include all emitted emissions from clinker production – technology and fuel combustion.

4.2.2.3 *Methods*

In 1990-2009 Tier 2 method was used to calculate NO_x, NMVOC, SO₂ (from EMEP/CORINAIR 2007) and particulate matter emissions (from EMEP/EEA 2009) from cement production considering the amount of produced clinker in wet process kiln and technology based EFs. An exception is BC emissions which are calculated using Tier 1 method from EMEP/EEA 2019.

In the middle of 2009 cement plant changed their technology from wet to dry process kiln, therefore, since 2010 emissions are automatically measured and reported by plant itself (Tier 3). NO_x data are taken from national database "2-Air" since 2010. The Cement production company confirms correctness of NO_x data and explains that NO_x emission increase since 2010 is related to technology which was changed when wet process kiln was replaced with dry process kiln. In dry process kiln additional NO_x is caused from drying of raw materials which was not the case in wet technology. To keep NO_x emissions within set limit (500 mg/m³) the ammonia is sprayed in the kiln. Company of cement production says that ammonia is one of the reasons

why they can keep temperature in kiln so that the NO_x limit is not exceeded. As regards to SO₂ emissions data are taken from "2-Air" since 2010.

According to Industrial emissions directive (IED) permit there are 36 dedusting filters installed in the cement plant with total efficiency approximately 99%¹¹. These filters mainly are designed to collect large coarse particles. Therefore, total TSP emissions decreased by 99% due to installation of filters. The filter method is used in the enterprise, thus obtaining filterable PM. TSP emissions are measured automatically in plant and available from the national database "2-Air".

For 2010-2019 additionally Hg emissions are reported which also were taken from the database mentioned above.

4.2.2.4 Emission factors

As the EFs for NO_x, NMVOC and SO₂ are not available in EMEP/EEA 2019¹² (marked as "Not Estimated") the EFs from EMEP/CORINAIR 2007¹³ were used as these emissions are emitted in the production process according to cement production plant (Table 4.6). EFs were divided for wet process kiln used till the first half of 2009 and for dry process kiln used starting with second half of 2009 and afterwards.

Table 4.6 EFs for cement clinker production, kt/kt

	NO _x	NMVOC	SO ₂	PM _{2.5}	PM ₁₀	TSP	BC
Wet Process Kiln	0.00135	0.00023	0.0051	0.00018	0.00051	0.0006	0.0000054

Since 2010 the plant-specific emission data is reported by plant therefore EFs for new dry process technology are not applied.

4.2.2.5 Activity data

The produced clinker is not weighed in cement production plant, but estimated from final cement type by multiplying it with cement/clinker ratio. As the only cement producer in Latvia participates in European Union Emission Trading Scheme (EU ETS), the activity data are available annually from plant's GHG report¹⁴ under EU ETS (Figure 4.2).

¹¹ http://www.vpvb.gov.lv/lv/piesarnojums/a-b-atlaujas?ur=Schwenk+Latvija+SIA&id_ur=4280

¹² <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/2-industrial-processes/2-a-mineral-products/2-a-1-cement-production/view>

¹³ <http://www.eea.europa.eu/publications/EMEPCORINAIR5/B3311vs2.4.pdf/view> (pages 12-13)

¹⁴ http://www.vvd.gov.lv/izsniegtas-atlaujas-un-licences/seg-atlaujas/?company_name=schwenk&org_id=&perm_date_from=&perm_date_to=&s=1

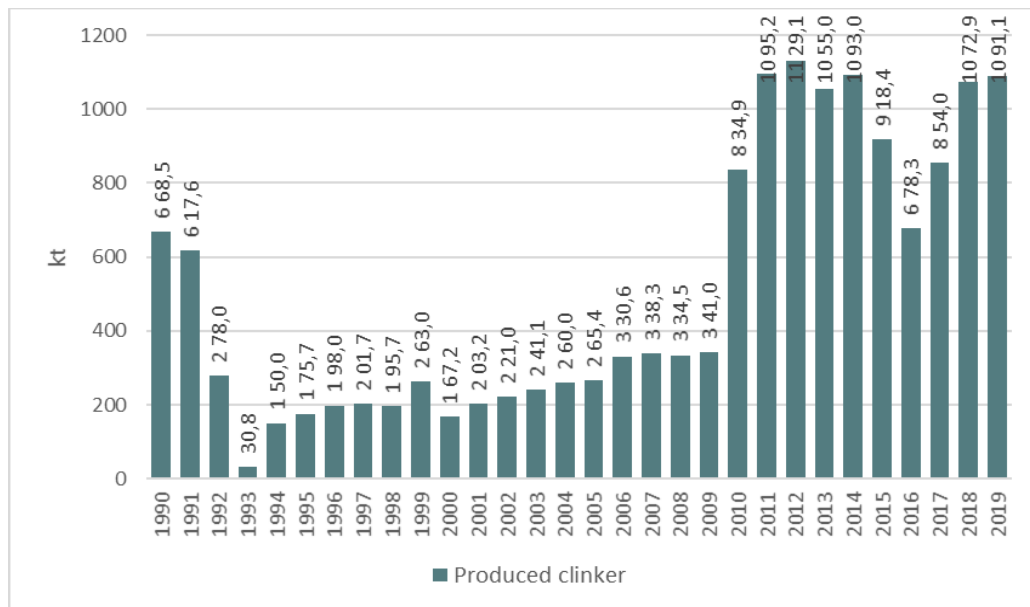


Figure 4.2 Cement production activity data in 1990-2019, kt

4.2.2.6 Uncertainties

Uncertainty of cement production data is taken from Cement production plant's GHG report under EU ETS (2.5% uncertainty for activity data of clinker production and 7.5% uncertainty for activity data of CKD).

The total uncertainty U_{total} is being calculated, using following formula of combined uncertainty:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2}$$

where:

U_{total} - the percentage uncertainty in the product of the quantities

U_i - the percentage uncertainties associated with each of the quantities

Combined activity data uncertainty is calculated as 8%.

Emission factor for NFR 2A1 sector is used only for NMVOC emissions and for all other emissions in 1990 - 2009 and partially in 2010 so uncertainty of 10% is assumed. For CO, NO_x, SO₂, particulate matter and Hg emission factor is not applicable as these emissions are measured automatically at plant site starting from middle of 2010.

Up to 50% of uncertainty may be assigned to the emission estimates of most of the trace elements emitted from major point sources in Europe (Pacyna, 1994). Similar uncertainty can be assigned for emission estimates of these compounds from cement production.

4.2.2.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.2.8 Recalculations

Recalculations of NMVOC and BC were made for 2018 based on updated Activity data.

4.2.2.9 Planned improvements

No improvements are planned for the next submission.

4.2.3 Lime production (NFR 2A2)

4.2.3.1 Overview

Under NFR 2A2 sector PM_{2.5}, PM₁₀, TSP and BC emissions from lime production are reported based on total produced lime data.

4.2.3.2 Trends in emissions

Table 4.7 Emissions from Lime production in 1990-2019

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
PM _{2.5}	0.150	0.0134	0.0055	0.000095	0.000026	0.000026	NO	NO	NO	NO	-100
PM ₁₀	0.750	0.06723	0.02763	0.00063	0.00017	0.00017	NO	NO	NO	NO	-100
TSP	1.928	0.17287	0.07105	0.00127	0.00034	0.00035	NO	NO	NO	NO	-100
BC	0.001	6.2E-05	2.5E-05	4.4E-07	1.2E-07	1.2E-07	NO	NO	NO	NO	-100

In Latvia two companies produced lime during time period 1990-2015. Emissions from lime production were continuously decreasing since the beginning of 1990s due to recession of overall national economy. Economic crisis also affected lime production in 2008-2009. After 2009 emissions from lime production remained very small and fluctuated due to economic situation and changes in industrial activities in the country but in 2016 the lime production was fully stopped. In 2016 the only operating lime producer "SIA Saulkalne S" ceased lime production therefore since 2016 there are no emissions from lime production (NO). Since 1990 and compared to 2019 emissions from 2A2 sector have decreased by 100% (Table 4.7).

4.2.3.3 Methods

Tier 2 approach was used to estimate particulate matter and BC emissions from lime production. One lime producer used limestone in lime production 2007-2012. Second plant used dolomite in lime production from 1990-2015.

4.2.3.4 Emission factors

Both lime production plants had IED permits. Since 2005 the facilities must have the best available techniques (BAT) and the emissions from the production processes have to be controlled. Therefore, controlled EFs from EMEP/EEA 2019 for particulate matter and BC were used for 2005-2015. For 1990-2004 the uncontrolled EFs from EMEP/EEA 2019 were used to estimate particulate matter and BC emissions (Table 4.8).

Table 4.8 Emission factors for lime production in 1990-2015 (kt/kt)

	PM _{2.5}	PM ₁₀	TSP	BC
Lime (total production) 1990-2004	0.0007	0.0035	0.009	0.0000032
Lime (total production) 2005-2015	0.00003	0.0002	0.0004	0.0000001

4.2.3.5 Activity data

The data of produced lime in lime production plants was not available due to confidentiality. This data was re-estimated backwards considering the approximate percentage of the lime that is produced by using raw materials (Table 4.9, Figure 4.3).

Table 4.9 Used raw materials in lime production, kt

	Used limestone	Used dolomite (dry)
1990	NO	383.25
1995	NO	33.67
2000	NO	13.84
2005	NO	5.97
2010	0.35	1.25

	Used limestone	Used dolomite (dry)
2011	0.35	NO
2012	0.32	0.69
2013	NO	0.89
2014	NO	1.49
2015	NO	1.63
2016	NO	NO
2017	NO	NO
2018	NO	NO
2019	NO	NO

The information of technology used in lime production:

- in the first facility lime is produced only from limestone and there are 3 shaft-type kilns installed in facility;
- in the second facility lime is produced only from dolomite using shaft-type kilns.

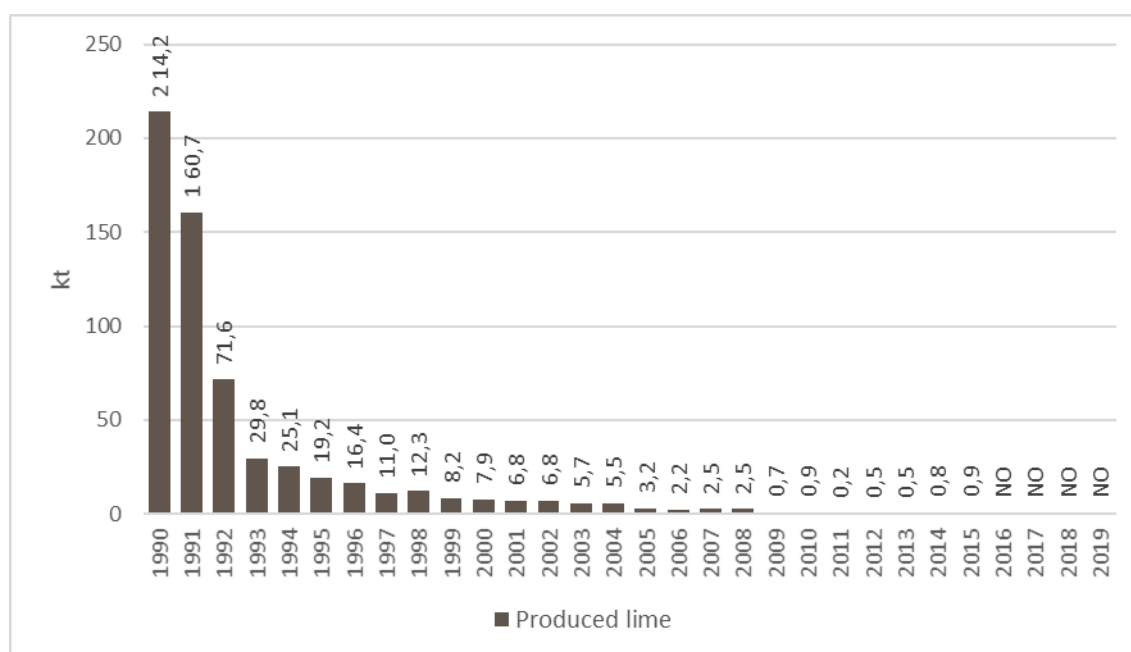


Figure 4.3 Lime production activity data in 1990-2019, kt

In 2011 production was stopped in one of the largest lime production plants due to exhausted limestone career and preparation of implementing the highest BAT. In latest years, there was an overall decrease in activity of lime production due to reduced industrial activity. In 2016 lime production was ceased and there are no emissions from NFR 2A2 sector anymore.

4.2.3.6 Uncertainties

Uncertainty of lime production activity data is taken from Lime production plant's GHG report under EU ETS (8% uncertainty for activity data of lime production).

As default emission factors for lime production from 2006 IPCC Guidelines as well as Monitoring reporting Guidelines (MRG¹⁵) are used uncertainty is assumed 50% due to unavailable plant specific data of produced lime.

¹⁵ Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council

4.2.3.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes comparing calculation database with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.3.8 Recalculations

No recalculations were carried out.

4.2.3.9 Planned improvements

No improvements are planned for the next submission.

4.2.4 Glass production (NFR 2A3)

4.2.4.1 Overview

In this sector NO_x, NMVOC, SO₂, PM_{2.5}, PM₁₀, TSP, BC, heavy metals and CO emissions from glass and glass fibre production are reported for 1990-2019.

In 1990-2004 particulate matter and heavy metal emissions were calculated by using known total produced glass amount from the CSB and applying EFs from EMEP/EEA 2019. In 1990-2004 CO, NO_x and SO₂ is NE because there is no available data from the national database "2-Air" and no EF from EMEP/EEA 2016. Since 2005 PM_{2.5}, PM₁₀, TSP, BC, CO, NO_x and SO₂ emissions are available from the national database "2-Air". Heavy metal emissions were reported 1990-2006 when the total produced glass amount was available. Since 2007 only one glass production plant remained therefore activity data became confidential "C". Based on the information of the glass production plant, no heavy metals are formed in the production process, so for period 2007-2019 is used notation key "NA".

4.2.4.2 Trends in emissions

Table 4.10 Emissions from Glass production in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO _x		NE	NE	NE	0.1052	0.0994	0.1021	0.1015	0.0753	0.0712	0.0609	-42.1
NMVOC		0.0013	0.0016	0.0027	0.0114	0.0207	0.0078	0.0097	0.0061	0.0059	0.0064	401.5
SO ₂		NE	NE	NE	0.0384	0.0441	0.0632	0.0390	0.0180	0.0176	0.0167	-56.5
PM _{2.5}	kt	0.0105	0.0024	0.0018	0.0101	0.0157	0.0142	0.0112	0.0117	0.0063	0.0060	-43.0
PM ₁₀		0.0118	0.0028	0.0020	0.0256	0.0396	0.0360	0.0283	0.0296	0.0158	0.0151	28.0
TSP		0.0131	0.0031	0.0022	0.0532	0.0825	0.0750	0.0590	0.0617	0.0330	0.0314	140.0
BC		0.0000	0.0000	0.0000	0.0002	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001	1738.8
CO		NE	NE	NE	0.0119	0.0410	0.0339	0.0275	0.0113	0.0101	0.0080	-33.2
Pb		0.0741	0.0173	0.0125	0.0385	NA	NA	NA	NA	NA	NA	-100.0
Cd		0.0057	0.0013	0.0010	0.0029	NA	NA	NA	NA	NA	NA	-100.0
Hg		0.0001	0.0000	0.0000	0.0001	NA	NA	NA	NA	NA	NA	-100.0
As		0.0083	0.0019	0.0014	0.0043	NA	NA	NA	NA	NA	NA	-100.0
Cr	t	0.0100	0.0023	0.0017	0.0052	NA	NA	NA	NA	NA	NA	-100.0
Cu		0.0003	0.0001	0.0001	0.0002	NA	NA	NA	NA	NA	NA	-100.0
Ni		0.0213	0.0050	0.0036	0.0111	NA	NA	NA	NA	NA	NA	-100.0
Se		0.0349	0.0082	0.0059	0.0181	NA	NA	NA	NA	NA	NA	-100.0
Zn		0.0161	0.0038	0.0027	0.0084	NA	NA	NA	NA	NA	NA	-100.0

In Latvia three glass producers were active 1990-2006. Since 2007 only one producer remained. Emissions from glass production fluctuate in all time series due to technological changes as well as changes in raw materials and adjuvants during time. Changes in raw materials strongly depend on market demand, for example, if the market requires product with specific quality or properties, producers need to adjust "recipe" of their product. These requirements lead to fluctuations in emissions.

In 2019 NMVOC, PM₁₀, TSP and BC emissions from glass production have increased if compared to 1990 due to increase in the volume of production especially since 2007 till 2011. However, in 2019 NO_x, CO and SO₂ emissions have decreased compared to 2005 but PM_{2.5} emissions have decreased compared to 1990.

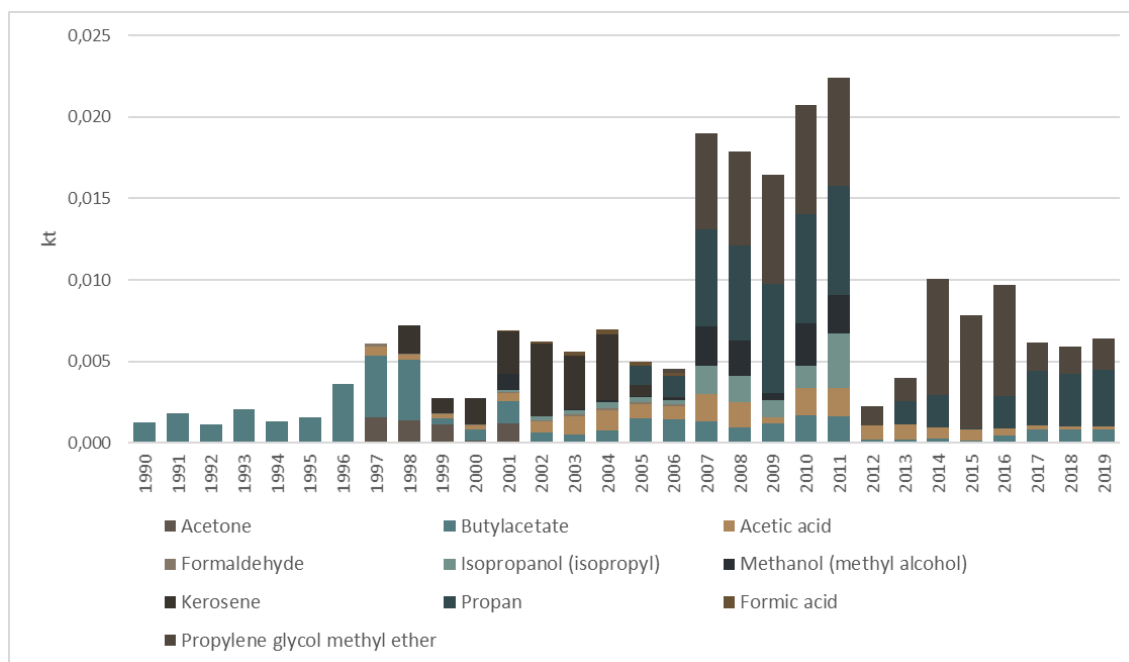


Figure 4.4 NMVOC emissions from glass fibre production in 1990-2019, kt

Several substances were used in glass/glass fibre production in Latvia causing NMVOC emissions. For 1990-1996 only data on butylacetate was available from glass fibre production company's application for GHG permit within EU ETS. Only for 2005 also glass production company reported its NMVOC emissions but since then glass is no longer produced in Latvia, thereby NMVOC emissions from glass production are reported only for 2005. NMVOCs from glass fibre production are still occurring and reported.

In 2019 butylacetate, acetic acid, propan (propyl alcohol) and propylene glycol methyl ether was used in glass fibre production in small amounts (Figure 4.4). NMVOC emission has increased by 8.6% compared to 2018 due to increase in used propylene glycol methyl ether.

4.2.4.3 Methods

EFs of particulate matter (1990-2004) and heavy metals (1990-2006) were taken from EMEP/EEA 2019 for Tier 1 approach.

CO, NO_x, SO₂, NMVOC, particulate matter and BC emissions were taken from the national database "2-Air" where glass fibre production plant reported its emissions therefore no EF was used (Tier 3 method).

4.2.4.4 Emission factors

To estimate particulate matter emissions (1990-2004) and heavy metals (1990-2006), EF from EMEP/EEA 2019 are used (Table 4.11). Particulate matter emissions (2005-2019) are measured using ISO 9096:2003/Cor 1:2006 Stationary source emissions - Manual determination of mass concentration of particulate matter, therefore filterable emissions are gained.

Table 4.11 Emission factors for glass production 1990-2019, g/Mg

	PM _{2.5}	PM ₁₀	TSP	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Glass production	240	270	300	0.062% of PM _{2.5}	1.7	0.13	0.003	0.19	0.23	0.007	0.49	0.8	0.37

4.2.4.5 Activity data

Activity data for particulate matter, BC and heavy metal emission calculation was total produced glass amount which was taken from CSB 1990-2006. Since 2005 emissions are available from the national database "2-Air" were particular glass producer reports their air emissions. Hence to ensure consistent time series since 2005 the particulate matter, BC, CO, NO_x and SO₂ emissions are taken from the data source mentioned above.

NMVOC emissions from 1997 to 2019 were also taken from the national database "2-Air" where glass/glass fibre production plant operator reported it's emissions divided by NMVOC sub-type.

4.2.4.6 Uncertainties

Uncertainty of glass production activity data is taken from Glass production plant's GHG report under EU ETS (2.5% uncertainty for activity data of glass production). The uncertainty is quite low as plant specific reported data is used. Accredited verifiers and Latvia's Regional Environmental Boards verify the activity data reported in production plant's annual GHG reports within EU ETS so the activity data is adequately verified.

EFs for this sector are taken from glass production plant so the uncertainty could be assumed as quite low. Still the estimation of the emission factors can't be adequately verified so the uncertainty is assumed as quite high – 60%, according to 2006 IPCC Guidelines.

4.2.4.7 QA/QC and verification

Assessment of trends were performed. All data was checked on input mistakes by comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.4.8 Recalculations

Recalculations were done for Pb from 2007 to 2018 based on technical corrections in NECD Review 2020. And according to provided information from glass production plant other heavy metals also do not occur during the production process therefore NA is used from 2007 to onwards.

4.2.4.9 Planned improvements

No improvements are planned for the next submission.

4.2.5 Quarrying and mining of minerals other than coal (NFR 2A5a)

4.2.5.1 Overview

Under 2A5a sector PM_{2.5}, PM₁₀ and TSP emissions from quarrying and mining of minerals are reported since 2018 submission.

4.2.5.2 Trends in emissions

In Latvia several non-metallic minerals are quarried:

- Marble, granite, sandstone, porphyry, basalt, other ornamental or building stone (excluding slate);
- Chalk and dolomite;
- Limestone and gypsum;
- Clays and kaolin;
- Sand and gravel;
- Other unclassified non-metallic minerals.

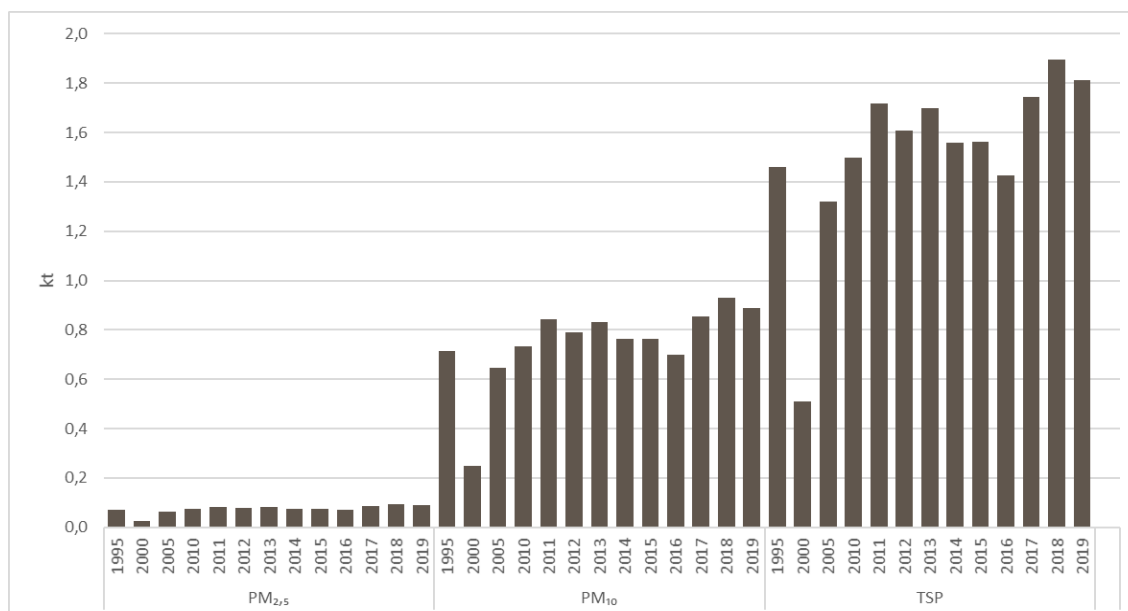
Biggest share of quarried minerals constitutes sand and gravel as well as chalk and dolomite.

Emissions from 2A5a sector are reflected in Table 4.12.

Table 4.12 Emissions from Quarrying and mining of minerals other than coal in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1995-2019, %
PM_{2.5}		NA	0.07	0.03	0.06	0.07	0.08	0.07	0.09	0.09	0.09	24.2
PM₁₀	kt	NA	0.72	0.25	0.65	0.73	0.77	0.70	0.85	0.93	0.89	24.2
TSP		NA	1.46	0.51	1.32	1.50	1.56	1.42	1.74	1.90	1.81	24.2

Particulate matter emissions from quarrying of minerals are reported since 1995 when activity data was available from CSB. Emission fluctuations can be associated with development of construction and building sectors in Latvia which are the main sectors for realization of minerals. Sharp decrease of emissions in 2009 can be observed due to economic crisis in Latvia. After 2009 situation in quarrying of minerals is quite stable. In 2019 compared to 2018 emissions from 2A5a sector have decreased by 4.40% (Figure 4.5).

**Figure 4.5 Particulate matter emissions from quarrying of minerals in 1995-2019, kt**

4.2.5.3 Methods

Tier 1 approach from EMEP/EEA 2019 was used to estimate particulate matter emissions from quarrying of minerals in Latvia.

4.2.5.4 Emission factors

For 1995-2018 the EFs from EMEP/EEA 2019 were used to estimate particulate matter emissions (Table 4.13).

Table 4.13 Emission factors for quarrying of minerals in 1990-2019, g/Mg mineral

	PM _{2.5}	PM ₁₀	TSP
Quarrying of minerals other than coal	5	50	102

4.2.5.5 Activity data

Activity data for 2A5a emission calculation was taken from the CSB database "Material flow accounts-domestic extraction (thsd tonnes)"¹⁶.

¹⁶ https://data1.csb.gov.lv/pxweb/lv/vide/vide__vide__ikgad/VIG080.px

4.2.5.6 Uncertainties

Activity data for particulate matter emissions from quarrying of minerals was taken from CSB and uncertainty was assumed as very low about, 2%, as a statistical frame mistake. Uncertainty for emission factor is assumed as 50%.

4.2.5.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes by comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.5.8 Recalculations

No recalculations were carried out.

4.2.5.9 Planned improvements

No improvements are planned for the next submission.

4.2.6 Construction and demolition (NFR 2A5b)

4.2.6.1 Overview

PM_{2.5}, PM₁₀ and TSP emissions from house and road construction in 2018 submission were calculated for the first time.

Emissions are calculated according to CSB data on number of building permits granted and expected floor space in statistical regions and cities under state jurisdiction. Only construction emissions are calculated due to lack of data regarding demolition in Latvian statistics. According to CSB division there are following types of buildings:

- One-dwelling buildings;
- Summer houses and weekend houses;
- Two- and more dwelling buildings;
- Residences for communities;
- Hotels and similar buildings;
- Office buildings;
- Wholesale and retail trade buildings;
- Traffic and communication buildings;
- Industrial buildings and warehouses;
- Public entertainment, education, hospital or institutional care buildings;
- Other non-residential buildings.

Types mentioned above are classified according to Tier 1 default approach from EMEP/EEA 2019 – residential housing, single or two family, residential housing, apartments and non-residential housing. Particulate matter emissions from road construction are also calculated using statistics of newly constructed road length and width.

4.2.6.2 Trends in emissions

Emissions from 2A5b sector are reflected in Table 4.14.

Table 4.14 Emissions from building and road construction in 1990-2019, kt

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 2005-2019, %
PM _{2.5}		NA	NA	NE	0.21	0.19	0.26	0.10	0.09	0.11	0.18	-15.5
PM ₁₀	Kt	NA	NA	NE	2.13	1.95	2.58	0.97	0.90	1.09	1.80	-15.5
TSP		NA	NA	NE	7.03	6.43	8.58	3.21	2.97	3.60	5.94	-15.5

Particulate matter emissions from building construction are estimated in 2005-2019. Emission fluctuations can be associated with development of construction and building sectors in Latvia.

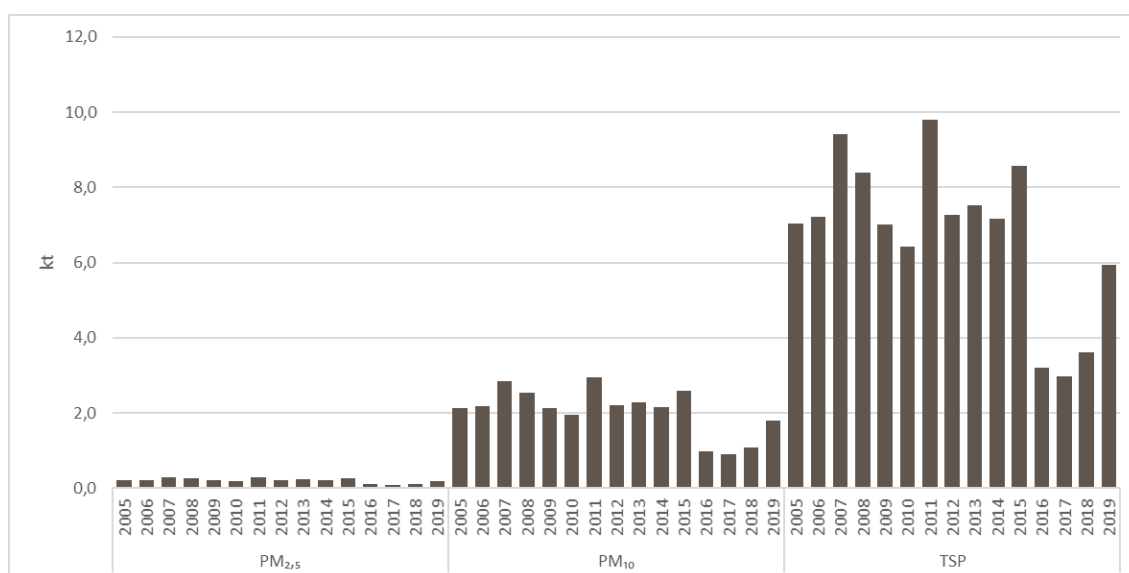


Figure 4.6 Particulate matter emissions from building and road construction in 2005-2019, kt

In 2019 the amount of emissions is increased by 65.1% compared to 2018. The increase in emissions is observed because the amount of building construction has increased in Latvia in 2019. (Figure 4.6).

4.2.6.3 Methods

Tier 1 approach from EMEP/EEA 2019 was used to estimate particulate matter emissions from building and road construction.

4.2.6.4 Emission factors

For 2005-2018 the EFs from EMEP/EEA 2019 were used to estimate particulate matter emissions (Table 4.15).

Table 4.15 Emission factors for building and road construction in 1990-2019, kg/[m² year]

	PM _{2.5}	PM ₁₀	TSP
Residential housing, single or two family	0.01	0.09	0.29
Residential housing, apartments	0.03	0.3	1
Non-residential housing	0.1	1	3.3
Road construction	0.23	2.3	7.7

4.2.6.5 Activity data

Activity data for 2A5b emission calculation was taken from the CSB database “Number of building permits granted and expected floor space in statistical regions and cities under state jurisdiction”¹⁷. Data on new constructed road length and width were received from the State Joint Stock Company “Latvian State Roads” as an answer to data request.

4.2.6.6 Uncertainties

Activity data for particulate matter emission calculation from construction of buildings were taken from CSB and uncertainty was assumed as very low about 2%, as a statistical frame mistake. Data on newly constructed roads was provided directly by “Latvian State Roads” and uncertainty is also assumed 2%. Uncertainty for emission factor is assumed as 50%.

¹⁷ https://data1.csb.gov.lv/pxweb/lv/rupnbuvm/rupnbuvm__buvm__ikgad/BUG040.px

4.2.6.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes by comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.6.8 Recalculations

No recalculations were carried out.

4.2.6.9 Planned improvements

No improvements are planned for the next submission.

4.2.7 Storage, handling and transport of mineral products (NFR 2A5c)

4.2.7.1 Overview

Under 2A5c sector PM_{2.5}, PM₁₀ and TSP emissions from storage, handling and transport of minerals are reported since 2018 submission.

As the cement, lime and glass are being produced in Latvia, emissions from storage, handling and transport of minerals shall be assessed 1990-2019. Prior to 2011 emissions from particulate matter for categories 2A1, 2A2 and 2A3 are calculated using EMEP/EEA Guidebook 2019 Tier 1 approach. It is assumed that these emissions are already included in the EFs applied in the sectorial source categories in the relevant mineral chapter therefore IE is reported (according to the Guidebook). Since 2011 data are available from the national database "2-Air" and figures are reported.

4.2.7.2 Trends in emissions

Emissions from 2A5c sector are reflected in Table 4.16.

Table 4.16 Emissions from storage, handling and transport of mineral products in 1990-2019

	Unit	1990	1995	2000	2005	2011	2015	2016	2017	2018	2019	Change in 2011-2019, %
PM_{2.5}		IE	IE	IE	IE	0.028	0.005	0.002	0.005	0.005	0.002	-93.4
PM₁₀	kt	IE	IE	IE	IE	0.039	0.035	0.035	0.034	0.034	0.011	-72.5
TSP		IE	IE	IE	IE	0.068	0.044	0.044	0.043	0.043	0.021	-68.9

From 1990 till 2010 particulate matter emissions from 2A5c sector are included under 2A1, 2A2 and 2A3 sectors (IE). Since 2011 the data regarding storage, handling and transport of mineral products in case of cement production is available from the national database "2-Air". Particulate matter emissions cannot be accounted under 2A1 sector hence they are reported under 2A5c sector.

Emitted particulate matter amounts in 2A5c sector are very low (Figure 4.7) In 2015, there is a large decrease in emissions because in 2014 there were more plants and warehouses that caused emissions from storage, handling and transport, but from 2015 onwards, these sites have closed. In 2019, a large reduction in emissions is observed, because the total amount of storage and transportation has decreased.

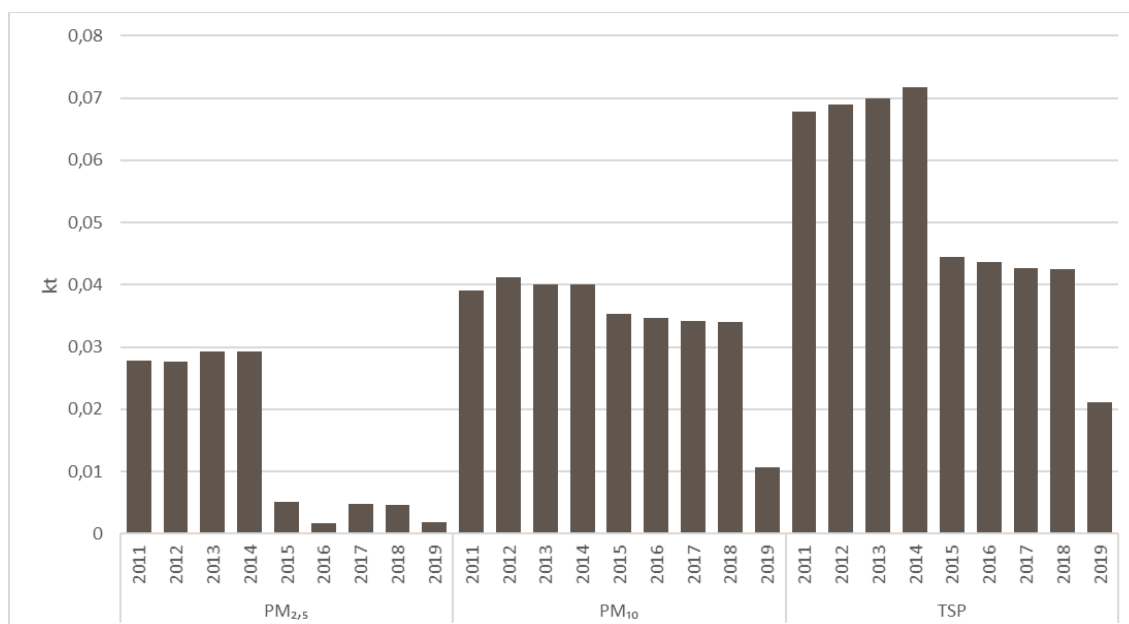


Figure 4.7 PM emissions from storage, handling and transport of mineral products 2011-2019, kt

4.2.7.3 Methods

In 1990-2010 Tier 1 approach from EMEP/EEA 2019 was used to estimate particulate matter emissions from storage, handling and transport of mineral products which assumes all emissions from this source to be included in the sectorial chapters (notation key 'IE'). Since 2011 mineral storage, handling and transport emission data is available from the national database "2-Air" so starting from 2011 it is possible to use Tier 3 approach.

4.2.7.4 Emission factors

In the Tier 1 default approach according to EMEP/EEA 2019 Guidebook, the particulate matter emissions from storage, handling and transport of mineral products are included in the Tier 1 approaches in the respective mineral chapters and no emission factors are used. Since 2011 data is available from the national database "2-Air", so no emission factors are used.

4.2.7.5 Activity data

1990-2010 emissions are assumed as included under respective mineral chapters (cement, lime and glass production) and IE has been reported in NFR. Since 2011 data from the national database "2-Air" on storage, handling and transport of minerals are reported under 2A5c category.

4.2.7.6 Uncertainties

Uncertainty for activity data and emissions is assumed 50%.

4.2.7.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes by comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made based on final completed NFR data table.

4.2.7.8 Recalculations

No recalculations were carried out.

4.2.7.9 Planned improvements

No improvements are planned for the next submission.

4.3 Chemical industry (NFR 2B)

Although there are strong traditions of the chemical industry in Latvia, no chemical industry production processes listed in 2006 IPCC Guidelines and EMEP/EEA 2019 Guidebook were identified.

The biggest part of chemical industry is medicine production and smaller part - paint and varnishes production.

All available data and emissions from chemical and pharmaceutical production are reported and described under sector 2D3g - Chemical products.

4.4 Metal production (NFR 2C)

4.4.1 Overview

Under Metal production sector only air emissions from Iron and steel production (NFR 2C1) are estimated and reported. There are no emissions from the rest of Metal production sectors described in EMEP/EEA 2019 Guidebook.

In Latvia from 1990-2015 only one company produced steel. It used open-heart furnaces (OHF) from 1990 till 2010 and electric arc furnaces (EAF) from 1990 till 2015 in their steel production processes. In 2016 steel production in Latvia was stopped as the only metal producing plant ceased to produce steel.

4.4.2 Trends in emissions

Under 2C1 sector NO_x, NMVOC, SO₂, PM_{2.5}, PM₁₀, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/PCDF, total PAHs, PCBs emissions from Iron and steel production were reported from 1990 till 2015. Since 2016 emissions in this category are not occurring (NO) (Table 4.17).

Table 4.17 Emissions from Metal production in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change from 1990-2019, %
NO _x		0.0037	0.0019	0.0030	0.0036	0.0029	0.0016	NO	NO	NO	NO	-100
NMVOC		0.0112	0.0057	0.0101	0.0112	0.0107	0.0006	NO	NO	NO	NO	-100
SO ₂		0.0873	0.0443	0.0797	0.0881	0.0855	0.0007	NO	NO	NO	NO	-100
PM _{2.5}	kt	0.3260	0.1655	0.2979	0.3292	0.3205	0.0003	NO	NO	NO	NO	-100
PM ₁₀		0.4346	0.2207	0.3972	0.4389	0.4274	0.0003	NO	NO	NO	NO	-100
TSP		0.5433	0.2759	0.4965	0.5486	0.5342	0.0004	NO	NO	NO	NO	-100
BC		0.0078	0.0040	0.0071	0.0079	0.0077	0.000001	NO	NO	NO	NO	-100
CO		0.0123	0.0064	0.0071	0.0105	0.0025	0.0212	NO	NO	NO	NO	-100
Pb		162.940	82.733	148.940	164.557	160.253	0.0324	NO	NO	NO	NO	-100
Cd		0.436	0.221	0.398	0.440	0.428	0.0025	NO	NO	NO	NO	-100
Hg		0.00035	0.00018	0.00019	0.00029	0.00006	0.00062	NO	NO	NO	NO	-100
As	t	16.292	8.272	14.893	16.454	16.025	0.0002	NO	NO	NO	NO	-100
Cr		1.250	0.635	1.142	1.262	1.229	0.0012	NO	NO	NO	NO	-100
Cu		0.163	0.083	0.149	0.165	0.160	0.0002	NO	NO	NO	NO	-100
Ni		5.436	2.760	4.967	5.489	5.342	0.0087	NO	NO	NO	NO	-100
Zn		4.424	2.246	4.035	4.464	4.331	0.0449	NO	NO	NO	NO	-100
PCDD/F	g ⁻¹ - Teq	0.057	0.029	0.045	0.054	0.039	0.0374	NO	NO	NO	NO	-100
PAHs	t	0.009	0.004	0.007	0.008	0.006	0.0060	NO	NO	NO	NO	-100
PCBs	kg	0.000017	0.000009	0.000010	0.000015	0.000003	0.000031	NO	NO	NO	NO	-100

One of the biggest decreases in emissions occurred in 1990-1992 due to the crisis in Latvia's national economy. The crisis in late 1990s was caused by the economic crisis in Russia and it reflected in decrease of demand for products from Metal Production sector. Also, final amount of steel products produced in the only metal plant decreased in latest years. From 1995 emissions were increasing due to increase in metal production.

Till 2009 the situation was quite stable when all producing sectors were affected by the economic crisis.

In 2011 compared to 2010 remarkable decrease (by 69%) of crude steel production emissions can be observed due to changes in technology used in Metal production plant when steel production process was stopped after a semester. The plant switched their technology from OHF to EAF. In 2011 Metal production plant went under reconstruction as a result all crude steel was produced in EAF since then.

In 2012 after plant reconstruction particulate matter emissions decreased by 94.6% and BC emissions decreased by 99.2% compared to 1990. At the same time NO_x, CO, NMVOC and POPs emissions increased significantly compared to the base year. Heavy metal emissions in 2012 compared to 1990 decreased by 81% on average.

In 2013 metal plant operated for 5-7 months, therefore there is noticeable decrease of produced steel amount and related emissions. Comparing emissions with the base year all emissions were decreased, except PCDD/PCDF, PAHs and PCBs which were additionally calculated since 2016 submission. PCBs emissions are applicable only for EAF technology. PCDD/ PCDF and PAHs emissions have increased significantly because these emissions are calculated with quite higher EFs that are applicable for EAF technology.

In 2014 only 0.09 kt crude steel was produced from scrap metal because production was almost stopped. In 2015 the metal production company begun to produce steel again therefore emissions appeared again, however in 2016 steel production in Latvia was stopped as the only metal producing plant ceased to produce steel and there are no air emissions from 2C1 sector anymore.

4.4.3 Methods

Tier 2 method from EMEP/CORINAIR 2007 (1990-2010) and EMEP/EEA 2019 (since 2011) was used to calculate emissions from steel production.

4.4.4 Emission factors

Emission factors for NO_x, CO and SO₂ emissions are taken from EMEP/CORINAIR 2007 for 1990-2010 because EFs are not available in EMEP/EEA 2019 for OHF technology. Particulate matter and heavy metal EFs are taken from EMEP/EEA 2019. According to methodology for estimations of emissions from processes in OHF, where 95% of total steel production is produced, EFs for 1990-2010 taken from EMEP/EEA 2019 are applicable. After 2011 all crude steel was produced in EAF and EFs applicable to this production technology are taken from EMEP/EEA 2019. According to EMEP/EEA 2019, the TSP, PM₁₀ and PM_{2.5} emission factor represents only filterable PM emissions.

Table 4.18 Emission factors for Iron and Steel production

	Unit	1990-2010	1990-2015	
NO _x		5.1	130	
NMVOC		20	46	
SO ₂	g/Mg	160	60	
PM _{2.5}		600	21	
PM ₁₀		800	24	
TSP		1000	30	
BC		% of PM _{2.5}	2.4	0.36
CO	g/Mg	1	1700	
Pb	g/Mg	300	2.6	
Cd		0.8	0.2	
Hg		0.05	0.05	
As		30	0.015	
Cr		2.3	0.1	
Cu		0.3	0.02	
Ni		10	0.7	
Zn		0.81	3.6	
PCDD/F		µg I-TEQ/Mg steel	0.067	3
Total 4 PAHs		g/Mg	0.01	0.48

	Unit	1990-2010	1990-2015
PCB	mg/Mg	NA	2.5

4.4.5 Activity data

Activity data was taken from the CSB and metal plant's GHG report under EU ETS¹⁸ (Figure 4.8).

Activity data on production and output by manufacturing companies is freely available until 1999. CSB gives only restricted information on production and output of goods since 1999, the information is classified as confidential. LEGMC has signed an agreement with CSB to receive data about total production of products from sectors whose data is confidential. Still as industrial producers are participants in the EU ETS the GHG reports of these enterprises have to be freely available.

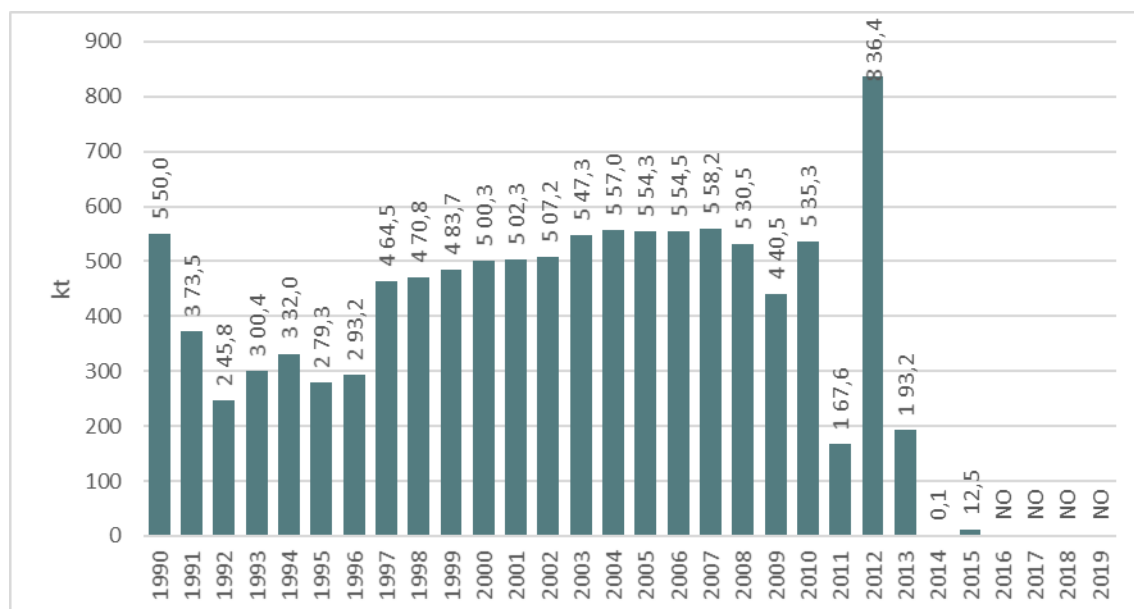


Figure 4.8 Steel production activity data in 1990-2019, kt

After going through a crisis in 2008-2009, there was an increase in all emissions from Metal production in 2010. Rapid decrease of emissions in 2011 can be observed due to change of technology in metal production. Since mid-2011 the OHF is not used anymore in this company. At the end of 2010 installation was dismantled and new one was set up. In 2011 plant was working for 4 months. All crude steel was produced from crude iron and scrap metal in EAF. In 2011-2013 all crude steel was produced in EAF and plant was not operating a full year but only for 4-7 month in these years. In 2012 a rapid increase of produced crude steel can be observed as new technology was implemented, but production plant operated for 7 months with full capacity. In 2014 steel production plant worked only one day for experimental reasons and produced only 0.093 kt steel. In 2015 the metal production company begun to produce steel again therefore emissions appeared and increased again. In 2016 steel production was ceased in the country and no metal production emissions are reported anymore.

4.4.6 Uncertainties

The uncertainty of activity data for this sector is assumed as 5%. The activity data reported in iron and steel production plant's annual GHG report within EU ETS is verified by accredited verifiers and Latvia's Regional Environmental Boards so the activity data is adequately verified.

Uncertainty of emission factors taken from EMEP/EEA 2019 methodologies is assigned as 20% so it is appropriate for OHF and EAF in iron and steel industry in Latvia.

¹⁸http://www.vvd.gov.lv/izsniestas-atlajas-un-licences/seg-atlajas/?company_name=KVV+Liep%C4%81jas+metalurgs&org_id=&perm_date_from=&perm_date_to=&s=1

4.4.7 QA/QC and verification

Assessments of trends were performed. Data was checked on input mistakes by comparing calculation data base with input data from NFR tables in all time series. All figures and tables represented in Submission 2021 are made based on final completed NFR data table.

4.4.8 Recalculations

Recalculations were done for PCBs (1990-2015) due to mistake in use of units of emissions.

4.4.9 Planned improvements

No improvements are planned for the next submission.

4.5 Other solvent and product use (NFR 2D-2L)

4.5.1 Source category description

4.5.1.1 Overview

Other solvent and product use sector includes indirect emissions from:

- 2D3a Domestic solvent use including fungicides;
- 2D3b Road paving with asphalt;
- 2D3c Asphalt roofing;
- 2D3d Coating applications;
- 2D3e Degreasing;
- 2D3f Dry cleaning;
- 2D3g Chemical products;
- 2D3h Printing;
- 2D3i Other solvent and product use;
- 2G Other product use (tobacco, fireworks);
- 2H1 Pulp and paper industry;
- 2H2 Food and beverages industry.

4.5.1.2 Trends in emissions

Table 4.19 Emissions from Other solvent and product use in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NMVOC		12.923	10.837	10.512	10.265	9.203	11.292	10.636	11.278	15.766	12.623	-2.3
SO₂		0.073	0.003	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001	-99.3
PM_{2.5}		0.077	0.100	0.213	0.475	0.394	0.679	0.668	0.536	0.533	0.570	636.0
PM₁₀	kt	0.161	0.350	1.218	3.239	2.617	4.769	4.655	3.660	3.528	3.546	2102.0
TSP		0.514	1.408	5.463	14.912	12.007	22.043	21.499	16.857	16.184	16.120	3038.5
BC		0.001	0.002	0.009	0.024	0.019	0.036	0.035	0.027	0.026	0.026	2521.3
CO		0.131	0.123	0.119	0.099	0.101	0.094	0.103	0.108	0.141	0.223	69.8
Pb		0.006	0.006	0.165	0.260	0.110	0.106	0.140	0.152	0.138	0.132	2050.9
Cd		0.013	0.012	0.012	0.010	0.010	0.009	0.010	0.011	0.014	0.022	69.9
Hg		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2050.9
As	t	1.0E-05	9.8E-06	2.8E-04	4.4E-04	1.9E-04	1.8E-04	2.4E-04	2.6E-04	2.4E-04	2.3E-04	2050.9
Cr		0.000	0.000	0.003	0.005	0.002	0.002	0.003	0.003	0.003	0.003	2050.9
Cu		0.016	0.015	0.105	0.156	0.072	0.069	0.089	0.097	0.092	0.097	490.9
Ni		0.007	0.006	0.012	0.015	0.009	0.009	0.010	0.011	0.012	0.016	138.2
Zn		0.008	0.008	0.060	0.091	0.041	0.040	0.051	0.056	0.053	0.055	545.8
PCDD/F	g i- Teq	0.00024	0.00022	0.00021	0.00017	0.00018	0.00017	0.00018	0.00019	0.00025	0.00040	68.1
PAHs	t	0.00011	0.00010	0.00	0.00	0.00	0.00	0.00	0.00	0.00011	0.00018	68.1

Other solvent and product use sector in 2019 covered 31.1% (12.6 kt) from the total Latvia's NMVOC emissions.

In Solvent use the fluctuation of NMVOC emissions in the period 1990-2019 has mostly occurred due to the welfare of the economic state of the country. A slight decrease in emissions occurred between years 1990 and 2006. From 2006 until 2008 the economy began to grow, when the world was struck by the economic crisis which also affected the Solvent Use sector in Latvia. During the later period of 2010 till 2019 NMVOC emissions were fluctuating.

The emissions from Asphalt roofing and Road paving with asphalt sectors are increasing since the beginning of 1990s. Slight emission decrease in 1999-2000 can be explained with used bitumen percentage division changes for road paving with asphalt and asphalt roofing.

Since Latvia is EU member state from 2004, financial resources from EU projects are available for national infrastructure projects which strongly influences the activities in road paving and building sector.

In 2004 a new highway "Via Baltica", which connects the capitals of all Baltic States, was constructed. This led to rapid emission increase in 2003-2004 that can be explained with availability of funding from EU which was the main reason why the road paving activity increased before and afterwards. In the next years road paving activities decreased, but not to the level before 2004.

4.5.2 Road paving with asphalt and Asphalt roofing (NFR 2D3b, 2D3c)

4.5.2.1 Overview

In this sector NMVOC, particulate matter, BC and CO emissions from construction materials production as well as road paving activities are reported.

According to CSB information, the biggest part of NMVOC and other emissions occurs during road paving with asphalt. Just a small part of all bitumen mixtures is used in asphalt roofing sector.

4.5.2.2 Trends in emissions

Table 4.20 Emissions from Asphalt roofing and Road paving in 1990-2019

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Trend in 1990-2019, %
NMVOC	0.0015	0.0045	0.0116	0.0319	0.0257	0.0472	0.0461	0.0361	0.0346	0.0344	2172
PM_{2.5}	0.0393	0.0131	0.1559	0.4287	0.3449	0.6344	0.6186	0.4847	0.4648	0.4618	1075
PM₁₀	0.0967	0.2901	1.1608	3.1921	2.5679	4.7238	4.6059	3.6086	3.4606	3.4382	3455
TSP	0.4493	1.3477	5.4057	14.8656	11.9584	21.9982	21.4496	16.8049	16.1159	16.0115	3464
BC	0.0007	0.0021	0.0087	0.0239	0.0192	0.0354	0.0345	0.0270	0.0259	0.0258	3519
CO	0.0001	0.0002	0.0004	0.0011	0.0009	0.0016	0.0016	0.0013	0.0012	0.0012	1509

The emissions from these two particular sectors are constantly increasing since the beginning of 1990s.

The main factor, which influences the road paving activities, is availability of funding for road construction. This caused sharp emission increase after Latvia joining the EU in 2004 when EU funding became available and the new highway "Via Baltica" was built. In 2019 emissions from road paving and asphalt roofing decreased by 0.6% compared to 2018 due to decreased amount of used asphalt.

4.5.2.3 Methods

EMEP/EEA 2019 Tier 1 approach was used to estimate NMVOC emissions from the 2D3c. Asphalt roofing and 2D3b Road Paving with Asphalt. According to CSB the biggest part of bitumen mixtures amount is used for road paving. Only a small part is used for roofing activities.

NMVOC emissions are estimated using simpler default methodology:

$$E_{NMVOC} = AD_{bitumen} \times EF_{NMVOC}$$

where:

E_{NMVOC} – NMVOC emissions (kt)

AD_{bitumen} – bitumen and bitumen mixtures used in 2D3b and 2D3c activities (kt)

EF_{NMVOC} – NMVOC emission factor (kt/kt)

4.5.2.4 Emission factors

Default CO and NMVOC, as well as particulate matter and BC emission factors are taken from EMEP/EEA 2019. Due to lack of information about the technology Tier 1 EFs was implemented (Table 4.21). According to EMEP/EEA 2019 Tier 1, TSP, PM_{10} and $PM_{2.5}$ emission factor represents only filterable PM emissions.

Table 4.21 Emission factors for asphalt roofing and road paving

	CO	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
	kt/kt	kt/kt	kt/kt	kt/kt	kt/kt	% of $PM_{2.5}$
Asphalt Roofing	0.0000095	0.00013	0.00008	0.0004	0.0016	5.7
Road Paving with Asphalt	NE	0.000016	0.0004	0.003	0.014	0.013

4.5.2.5 Activity data

The activity data to calculate NMVOC emissions from road paving and asphalt roofing is taken from the CSB (Table 4.22). The amount of bitumen mixtures was used as activity data. According to the CSB the bitumen mixtures include:

- Asphalt bitumen that usually consists of 60% or more of bitumen and solvent. Used for highway paving;
- Emulsion – or a solid asphalt, bitumen, pitch, tar suspensions in water that are used especially in highway paving;
- Asphalt mastic and other bitumen resins, and similar bituminous mixtures that include minerals such as sand or asbestos;
- Products that are sintered in blocks and that are repeatedly melted before use.

According to information provided by CSB the biggest part of bitumen mixtures is used for road paving. According to 2006 IPCC Guidelines typically 80-90% of bitumen is used for road paving materials.¹⁹ Before the beginning of 1990s Latvia was part of former USSR and was going through the economic transition phase, so it was assumed that 80% was used for road paving and remaining was used for asphalt roofing till 2000. After 2000 it is assumed that 90% was used for road paving.

Table 4.22 Activity data for road paving with asphalt and asphalt roofing production

	Amount of bitumen mixtures used, kt	% of asphalt used for road paving	% of asphalt used for roofing	Road paving with asphalt, kt	Asphalt roofing, kt
1990	39.00	80%	20%	31.20	7.80
1991	12.60	80%	20%	10.08	2.52
1992	2.10	80%	20%	1.68	0.42
1993	58.93	80%	20%	47.14	11.79
1994	125.63	80%	20%	100.50	25.13
1995	116.99	80%	20%	93.59	23.40
1996	214.81	80%	20%	171.85	42.96
1997	225.00	80%	20%	180.00	45.00
1998	225.53	80%	20%	180.43	45.11
1999	334.81	80%	20%	267.85	66.96
2000	423.64	90%	10%	381.28	42.36
2001	495.70	90%	10%	446.13	49.57
2002	558.42	90%	10%	502.58	55.84
2003	625.67	90%	10%	563.11	62.57
2004	3651.96	90%	10%	3286.76	365.20
2005	1165.02	90%	10%	1048.51	116.50
2006	1116.70	90%	10%	1005.03	111.67

¹⁹ http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_5_Ch5_Non_Energy_Products.pdf (page 5.14)

	Amount of bitumen mixtures used, kt	% of asphalt used for road paving	% of asphalt used for roofing	Road paving with asphalt, kt	Asphalt roofing, kt
2007	1492.52	90%	10%	1343.27	149.25
2008	1536.66	90%	10%	1382.99	153.67
2009	838.45	90%	10%	754.60	83.84
2010	937.18	90%	10%	843.46	93.72
2011	1481.48	90%	10%	1333.33	148.15
2012	1584.97	90%	10%	1426.48	158.50
2013	1255.14	90%	10%	1129.62	125.51
2014	1289.97	90%	10%	1160.97	129.00
2015	1724.00	90%	10%	1551.60	172.40
2016	1681.00	90%	10%	1512.90	168.10
2017	1317.00	90%	10%	1185.30	131.70
2018	1263.00	90%	10%	1136.70	126.30
2019	1254.82	90%	10%	1129.34	125.48

Amount of materials used and emissions produced in this sector are strictly dependant on funding and activity in road construction and building.

4.5.2.6 Uncertainties

Uncertainty of activity data for estimations of emissions from 2D3c Asphalt roofing sector and 2D3b Road Paving with Asphalt sector is assumed rather low as CSB data of used bitumen mixtures is used and the percentage of IPCC 2006 Guidelines is used to divide bitumen use for roofing and paving activities. As it is not clear how much of the total bitumen is used for asphalt paving and for asphalt roofing (bitumen use in construction sector) the uncertainty is assumed at least 20%.

The emission factors for 2D3c and 2D3b sectors are assumed 70% because default emission factors are used. The uncertainty EFs are taken from EMEP/EEA 2019 and Tier 1 EFs is assumed 50% because default EFs are used.

4.5.2.7 QA/QC and verification

Assessment of trends was performed. All data was checked on input mistakes by comparing calculation data base with input data from NFR tables in all time series. All figures and tables represented in IIR 2021 are made based of final completed NFR data table.

4.5.2.8 Recalculations

No recalculations were carried out.

4.5.2.9 Planned improvements

No improvements are planned for the next submission.

4.5.3 Solvent use (NFR 2D3a, 2D3d, 2D3e, 2D3f, 2D3g, 2D3h, 2D3i)

4.5.3.1 Overview

Solvent Use sector in 2019 covered over 27.8% (11.29 kt) from the total Latvia's NMVOC emissions. From Solvent use sector the main share of total NMVOC emissions contributed Other solvent use – 34.65% or 3.9 kt and Paint application – 29.09% or 3.28 kt (Figure 4.9).

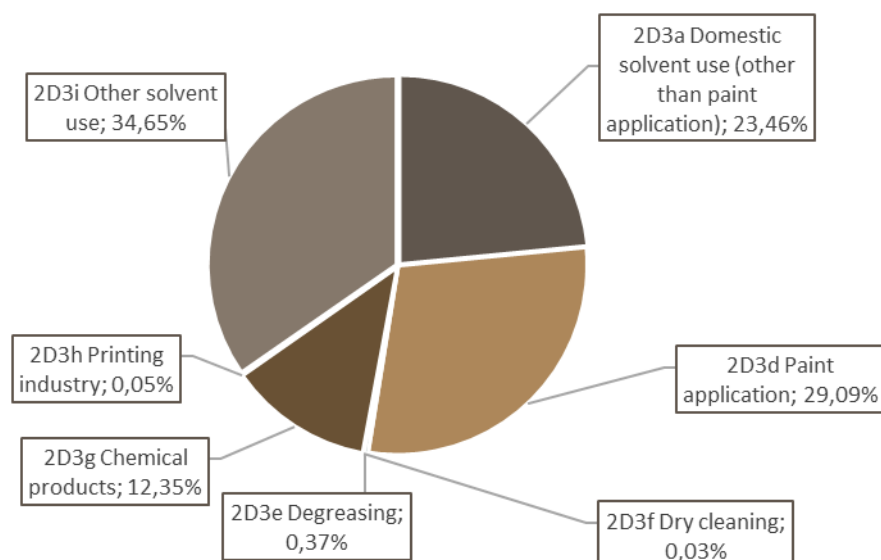


Figure 4.9 Distribution of NMVOC emissions in Solvent use sector in 2019, kt

Domestic solvent use including fungicides (NFR 2D3a) comprises NMVOC emissions from a number of product categories, for instance, cosmetics & toiletries, household products, construction and car care products. This subsector includes also Hg emissions from fluorescent tubes. *Coating applications* (NFR 2D3d) includes paints and varnishes from *Decorative coating application* (paints for architectural application by construction enterprises and professional painters as well as by private consumers), *Industrial coating application* (paint application for manufacture automobiles, car repairing, coil coating, boat building, wood as well as other industrial paint applications) and *Other coating applications*. *Degreasing* (NFR 2D3e) includes cleaning products from water-insoluble substances such as grease, fats, oils waxes and tars. *Dry Cleaning* (NFR 2D3f) includes emissions from clothes and other textiles dry cleaning. *Chemical products* (NFR 2D3g) sector covers NMVOC emissions from the use of chemical products considering many activities such as polyurethane and polystyrene foam processing, organic chemical industry, manufacture of paints, inks and glues, fat edible and non-edible oil extraction and industrial application of adhesives. *Printing* (NFR 2D3h) involved the use of inks, cleaning solvents and organic dampeners. *Other product use* (NFR 2D3i) includes emissions from application of underseal treatment and conservation of vehicles, glues and adhesives, preservation of wood and other solvent use.

To divide the NMVOC containing products by NFR subsectors EMEP/EEA 2019 was used.

4.5.3.2 Trends in emissions

Solvent Use sector in 2019 covered 27.8% (11.29 kt) from the total Latvia's NMVOC emissions. Since 1990, NMVOC emissions have increased in the solvent sector by 18.18%. Categories where increase in NMVOC emissions has occurred in recent years include Domestic solvent use (other than paint application) (2D3a) and Other solvent use (2D3i). The fluctuation of NMVOC emissions in the period 1990-2019 has mostly occurred due to the welfare of the economic state of the country. The slightly decrease in emissions occurred between years 1990 and 2006. From 2006 the economy began to grow until 2008, when the world was struck by the economic crisis which also affected the Solvent Use sector in Latvia. As a result, by the year 2009, NMVOC emissions decrease by 35.05% in comparison with 2007. As shown there is increase of NMVOC emissions during the later period of 2010 till 2019. In 2019 NMVOC emissions increased by 40.16% in comparison with 2005. However, in 2019 NMVOC emissions of Solvent sector have decreased by 21.88% in comparison with 2018 (Table 4.23). This is explained by the fact that one company in 2018 imported massive quantities of cleaning solvent which causes large amount of NMVOC emission. It was found due to recalculations (see chapter 4.5.3.8).

Related to the PAHs emissions under 2D3g Chemical products (subsector Asphalt blowing) emissions are not estimated because in Latvia asphalt blowing is not occurring.

Table 4.23 NMVOC emissions from Solvent use in 1990-2019, kt

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
Domestic solvent use including fungicides (NMVOC)	1.89	1.77	1.68	1.59	1.03	1.82	1.68	1.74	6.10	2.64	39.98
Domestic solvent use including fungicides (Hg)	0.015	0.014	0.013	0.013	0.012	0.011	0.011	0.011	0.011	0.011	-28.04
Coating applications (NMVOC)	5.09	4.77	4.54	4.29	4.51	3.90	3.81	3.99	3.74	3.28	-35.69
Degreasing (NMVOC)	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.04	0.04	18.41
Dry cleaning (NMVOC)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	-86.77
Chemical products (NMVOC)	1.32	1.24	1.18	1.12	1.23	1.54	1.45	1.50	1.36	1.39	5.08
Printing (NMVOC)	0.12	0.11	0.10	0.10	0.01	0.01	0.01	0.01	0.01	0.01	-94.77
Other solvent use (NMVOC)	1.05	0.98	0.94	0.89	0.98	2.59	2.30	2.65	3.16	3.90	271.66

In Latvia Regulation of the Cabinet of Ministers of 3 April 2007 No.231 "Regulations Regarding the Limitation of Emissions of Volatile Organic Compounds From Certain Products" contains legal norms arising from Directive 2004/42/EC. According to this Regulation, I stage of the Directive came into force in 2007 and II stage – in 2010. Meanwhile Regulation of the Cabinet of Ministers of 2 April 2013 No. 186 "Procedure for Limiting Emissions of Volatile Organic Compounds From Equipment Using Organic Solvents" contains legal norms arising from Directive 2010/75/EU.

Although Latvia has adopted these Directives into its legislation, it is difficult to estimate effect on the decrease in NMVOC emissions due the economic growth after the entry into force of stage II of Directive 2004/42/EC in 2010.

4.5.3.3 Methods

NMVOC emissions from Domestic solvent use including fungicides (2D3a), Coating applications (2D3d) and Other solvent use (2D3i) were estimated according to EMEP/EEA 2019 methodology based on Tier 1 or Tier 2 approach (Table 4.24).

NMVOC emissions (kt) from these subcategories of Solvent Use sector were calculated for the time series 2006-2019 using the equation below:

$$E_{NMVOC} = EF_{NMVOC} \times AD$$

where:

E_{NMVOC} – non-methane volatile organic compounds emissions from solvents and other production use (kt);

EF_{NMVOC} – emission factor from EMEP/EEA 2019;

NMVOC emissions data from Degreasing (2D3e), Dry cleaning (2D3f), Chemical products (2D3g) and Printing (2D3h) subsectors was obtained directly from the national database "2-Air" at Ltd. Latvian Environment, Geology and Meteorology Centre (LEGMC) for 2006-2019. From the 1990ties till 2001 statistics for NMVOC emissions data was not kept. The "2-Air" is a database where enterprises (that have any pollution activity and have category A, B, or C polluting activity) report their emissions data. There are 1291 licences currently in force in Latvia (Category A – 84 licences, category B – 1207 licences). From these enterprises data is used

only from the enterprises that produced NMVOC emissions according to the EMEP/EEA 2019. The enterprises have been reporting their produced NMVOC emissions dividing in a particular NMVOC.

According to EMEP/EEA 2019 Hg emissions are not estimated under 2D3a Domestic solvent use including fungicides. In any case Hg emissions according to EMEP/EEA 2016 (Tier 1, EF-5.6 mg/person) are negligible, in 2019 – 0.0108 t respectively.

4.5.3.4 Emission factors

The NMVOC emission factors (Table 4.24) for Domestic solvent use including fungicides (2D3a), Paint application (2D3d) and Other solvent use (2D3i) are taken from the EMEP/EEA 2019.

Table 4.24 Approaches and emission factors for Solvent Use sector

NFR	Tier	EF	Unit	Subsector
2D3a	2a	0.83	t/t solvent	Cosmetics and toiletries (all)
	2a	0.65	t/t solvent	Household products (all)
	2a	0.95	t/t solvent	Household products (soaps: liquid or paste, polishes and creams for floors, show polishes and creams)
	2a	0.95	t/t solvent	DIY/buildings (all), Adhesives, Paint/varnish removers and solvents
	2a	0.975	t/t solvent	DIY/buildings (sealants, filling agents)
	2a	0.94	t/t solvent	Car care products (all)
	2a	0.5	t/t solvent	Car care products (antifreeze agents in windscreen wiper systems)
	2a	0.865	t/t solvent	Pesticides
	2a	0.6	t/t product	Domestic use of pharmaceutical products
	2D3d	2	0.23	t/t paint applied
2		0.23	t/t paint applied	Paint application: domestic use
1		0.4	t/t paint applied	Coating applications: manufacture of automobiles
2		0.72	t/t paint applied	Paint application: car repairing
2		0.48	t/t paint applied	Paint application: coil coating
1		0.4	t/t paint applied	Coating applications: Boat building
2		0.8	t/t paint applied	Paint application: wood
1		0.4	t/t paint applied	Coating applications: Other industrial paint application
2		0.74	t/t paint applied	Other non industrial paint application
2		0.25	t/t solvent	Glass Wool Enduction
2D3i	1	0.002	t/t product used	Fat, edible and non-edible oil extraction
	2	0.562		Application of glues and adhesives
	2	0.945	t/t preservative (organic solvent-borne preservative)	Preservation of wood (Organic solvent-borne preservative)
	2	0.005	t/t preservative (waterborne preservative)	Preservation of wood (Water-borne preservative)
	2	0.342	t/t product	Other solvent and product use

4.5.3.5 Activity data

From the 1990ties till 2005 statistics for Domestic solvent use including fungicides (2D3a), Coating From the 1990ties till 2005 statistics for Domestic solvent use including fungicides (2D3a), Coating applications (2D3d) and Other solvent use (2D3i) were not well kept due to the country-wide changes in the governmental system and the national economy. For 2006-2018 activity data for these subcategories was obtained from the Register of Chemical Substances and Chemical Mixtures (CR) at LEGMC. In the CR data of imported and produced amount of chemical products containing NMVOCs is collected together with the percentage of a particular NMVOC in imported or produced products. It is assumed that the NMVOC containing products imported in the country in a particular year are utilized in the same year as the data of the actual use is not available or is confidential. In the CR information on a particular year, amount of produced and imported chemicals (ton), product group (intended use), trade name, chemical name, CAS number and concentration (from ... till ... %) is provided.

In 2018 for the first time an estimation of exported NMVOC containing products from the country for the period 2006-2017 was carried out. Activity data on export of solvent products for the years 2006-2017 was provided by CSB. The results of estimation of exported NMVOC containing products are presented in Table 4.25. As shown NMVOC emissions have decreased for all time series between 14.6% in 2013 and 30.65% in 2005.

Share of export as percentage, calculated on NMVOC emissions for the year 2018-2019 were extrapolated taking into account GDP taken from CSB database.

Table 4.25 Share of export as percentage, calculated on NMVOC emissions

	Share of export as percentage, calculated from NMVOC emissions, %	Without export, last submission, kt	With export, kt
2006	23.86	10.52	8.01
2007	21.31	11.16	8.78
2008	28.44	9.60	6.87
2009	26.89	7.80	5.71
2010	19.17	9.64	7.80
2011	13.77	10.78	9.29
2012	14.65	10.34	8.82
2013	14.6	10.77	9.19
2014	15.19	11.27	9.56
2015	15.77	11.77	9.91
2016	18.03	11.35	9.30
2017	19.61	12.36	9.94
2018	21.08	18.26	14.41
2019	22.11	14.46	11.26

To obtain a comparable data in time series for 1990-2005 where statistics were not well kept NMVOC emissions were extrapolated considering the number of inhabitants taken from database provided by CSB (Table 4.26).

Table 4.26 The number of population used as activity data under Other solvent and product use for years 1990-2005

	Number of inhabitants
1990	2668140
1991	2658161
1992	2643000
1993	2585675
1994	2540904
1995	2500580
1996	2469531
1997	2444912
1998	2420789
1999	2399248
2000	2377383
2001	2353384
2002	2320956
2003	2299390
2004	2276520
2005	2249724

Activity data from Degreasing (2D3e), Dry cleaning (2D3f), Chemical products (2D3g) and Printing (2D3h) subsectors is not available as that data is not required to be reported under national legislation and could be assumed as confidential.

4.5.3.6 Uncertainties

Latvia has developed a detailed inventory for the Solvent Use sector thereby the uncertainty of activity data is estimated to be the default value of 25 percent according to the IPCC 2006 Guidelines. Emission factor uncertainty is assumed to be $\pm 20\%$ according to EMEP/EEA 2019, 2.D Other solvent and product use. Time series consistency was ensured by using one method for all time series.

4.5.3.7 QA/QC and verification

QAQA/QC check is performed with Tier1 method from EMEP/EEA 2019, 2.D Other solvent and product use.

All estimations of the emissions done in the LEGMC also are checked for logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Quality control check list is filled for each category considering criteria given in QA/QC plan approved in the national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived in centralized archiving system (common FTP folder).

4.5.3.8 Recalculations

In order to obtain more qualitative emission data each year activity data for latest submitted year (in this case year 2018) was reviewed and recalculated if it is necessary. It is found that these recalculations have significantly increased NMVOC emissions in 2018, especially under subsector 2D3a Domestic solvent use (Table 4.27). This is due to the one company which imported massive quantities of cleaning solvent for many uses.

Table 4.27 Recalculated NMVOC emissions for the year 2018, kt

	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	Total
Submission 2020	2.55	3.71	0.04	0.00	1.36	0.01	2.92	10.59
Submission 2021	6.10	3.74	0.04	0.00	1.36	0.01	3.16	14.41
Change, %	139.22	0.81	0.00	0.43	0.00	0.00	8.22	36.07

4.5.3.9 Planned improvements

It is planned to improve NMVOC emission estimation under 2D3a subsector according to EMEP 2019 guidelines.

4.5.4 Other product use (NFR 2G)

4.5.4.1 Overview

Other Product Use sub-sector includes emissions from Use of fireworks and Tobacco combustion. This sub-sector contains SO₂, CO, NMVOC, NH₃, NO_x, TSP, BC, PM₁₀, PM_{2.5}, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, PCDD/PCDF, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, indeno (1,2,3-cd) pyrene emissions.

4.5.4.2 Trends in emissions

The emissions from Other product use subsector have constantly decreased since the beginning of 90ties although emissions from Use of fireworks have increased. Emissions of heavy metals mostly occur from Use of fireworks and their increase in the latest years is linked with the economic situation of the country (Table 4.28).

Table 4.28 Emissions from Other product use sector in 1990-2019

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO _x	0.0043	0.0040	0.0039	0.0032	0.0033	0.0030	0.0033	0.0035	0.0046	0.0073	69.0
NMVOC	0.0115	0.0108	0.0103	0.0083	0.0087	0.0081	0.0088	0.0093	0.0121	0.0194	68.1
SO ₂	0.00002	0.00002	0.0006	0.0010	0.0004	0.0004	0.0005	0.0006	0.0005	0.0005	2050.9
NH ₃	0.0099	0.0093	0.0088	0.0072	0.0075	0.0069	0.0076	0.0080	0.0104	0.0166	68.1

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
PM_{2.5}		0.0643	0.0603	0.0573	0.0466	0.0487	0.0450	0.0492	0.0518	0.0677	0.1081	68.1
PM₁₀		0.0643	0.0603	0.0573	0.0466	0.0487	0.0450	0.0492	0.0518	0.0677	0.1082	68.1
TSP		0.0643	0.0603	0.0573	0.0466	0.0487	0.0450	0.0492	0.0518	0.0677	0.1082	68.1
BC		0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0005	68.1
CO		0.1313	0.1231	0.1185	0.0974	0.1003	0.0927	0.1016	0.1071	0.1395	0.2219	68.9
Pb		0.0062	0.0058	0.1646	0.2595	0.1102	0.1065	0.1401	0.1524	0.1383	0.1324	2050.9
Cd		0.0129	0.0121	0.0118	0.0098	0.0099	0.0092	0.0101	0.0106	0.0138	0.0219	69.9
Hg		4.5E-07	4.2E-07	1.2E-05	1.9E-05	8.0E-06	7.7E-06	1.0E-05	1.1E-05	1.0E-05	9.6E-06	2050.9
As		0.0000	0.0000	0.0003	0.0004	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	2050.9
Cr	t	0.0001	0.0001	0.0033	0.0052	0.0022	0.0021	0.0028	0.0030	0.0028	0.0026	2050.9
Cu		0.0164	0.0153	0.1047	0.1563	0.0722	0.0693	0.0892	0.0967	0.0918	0.0966	490.9
Ni		0.0067	0.0062	0.0120	0.0146	0.0091	0.0086	0.0103	0.0110	0.0121	0.0159	138.2
Zn		0.0085	0.0079	0.0603	0.0907	0.0414	0.0398	0.0514	0.0557	0.0526	0.0547	545.8
PCDD/F	g I-Teq	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0004	68.1
PAH	t	0.0006	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0005	0.0006	0.0010	68.1

4.5.4.3 Methods

Emissions from Use of fireworks and Tobacco combustion were calculated according to EMEP/EEA 2019 methodology and based on Tier 2 approach.

Emissions (kt) from Use of fireworks sector were calculated for the time series 1995-2019 and from Tobacco combustion for the time series 2003-2019 using the equation below:

$$E = EF \times AD$$

where:

E – emissions from Use of fireworks and Tobacco combustion (kt);

EF – emission factor from EMEP/EEA 2019;

AD – activity data from the CSB, (kt).

4.5.4.4 Emission factors

All emission factors for Use of fireworks and Tobacco combustion are taken from the EMEP/EEA 2019.

4.5.4.5 Activity data

From the 1990ties till 1994 statistics for Use of fireworks and from 1990 till 2002 statistics for Tobacco combustion were not well kept due to the country-wide changes in the governmental system and national economy. For 1995-2019 the quantity of used fireworks (CN code 3604) and for 1995-2019 tobacco combusted (CN code 2402) in Latvia is estimated by the import and export data available from database provided by the CSB. Data regarding production of fireworks and tobacco is not available.

To obtain a comparable data for Use of fireworks in time series for 1990-1994 and for Tobacco combustion in time series for 1990-2002 where statistics were not in sufficient quality, emissions were calculated using the same methodology as for the years 1995-2019 and 2003-2019, respectively. Assuming that base year for NMVOC emissions for Use of fireworks is year 1995 and for Tobacco combustion - 2003, emissions for years where statistics were not well kept were calculated proportionally, taking into account the number of inhabitants provided by the CSB (Table 4.26).

4.5.4.6 Uncertainties

Emission factor uncertainty is assumed to be $\pm 20\%$ according to EMEP/EEA Guidebook 2019, 2.D Other solvent and product use. Time series consistency was ensured by using one method for all time series.

4.5.4.7 QA/QC and verification

All estimations of the emissions done in the LEGMC are checked for logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in the national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived in centralized archiving system (common FTP folder).

4.5.4.8 Recalculations

No recalculations were carried out.

4.5.4.9 Planned improvements

No improvements are planned.

4.5.5 Pulp and paper industry and Food and beverages industry (NFR 2H1, 2H2)

4.5.5.1 Overview

Other Production sub-sector includes indirect emissions from:

- Pulp and Paper industry (2H1);
- Food and drink industry (2H2).

Under NFR 2H1 category SO₂ emissions are reported 1990-1996 and under NFR 2H2 NMVOC emissions are reported 1990-2019.

According to information from CSB currently there are no companies producing pulp or paper in processes described in the EMEP/EEA 2019 Guidebook that should belong to category 2H1. No data is available in production statistics regarding pulp and paper produced in Latvia, therefore, since 1997 emissions from pulp and paper are not occurring (NO).

4.5.5.2 Trends in emissions

Table 4.29 Emissions from Pulp and paper industry (NFR 2H1) and Food and beverages industry (NFR 2H2) production sectors in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NMVOC	kt	3.38	1.89	2.00	2.19	1.37	1.33	1.28	1.30	1.31	1.31	-61.3
SO ₂		0.07	0.003	NO	NO	NO	NO	NO	NO	NO	NO	-100

The biggest fluctuations in emissions were observed in 1991-1993 due to the change of economic situation in the country (Table 4.29). Decrease of NMVOC emissions in 1999-2001 can be explained with economic crisis. In 2002-2004 NMVOC emissions were stable. NMVOC emissions decreased by 29.3% in 2006-2007, that could be explained with a decrease (by 35.5%) of produced spirits. Emissions in 2008-2009 decreased by 6.0%, which can be explained with the crisis in national economy that affected food and drink production industry because of decrease in purchasing capacity due to lower salaries, increased taxes etc. After the crisis, in 2010 it increased for about 5.1%. In 2019 the NMVOC emissions constitute 1.31 kt which is 0.3% higher than in 2018 because of higher amount of meat, fish and poultry, cakes, biscuits and breakfast cereals and animal forage

SO₂ emissions are reported in 1990-1996 when there was a pulp and paper industry in the country. In 1996 pulp and paper facility was closed.

4.5.5.3 Methods

Tier 1 method from EMEP/EEA 2019 was used to calculate emissions from Pulp and paper industry and Food and beverages industry.

4.5.5.4 Emission factors

NMVOC emission factors (Table 4.30) are taken from the EMEP/EEA 2019. NMVOC emission factor for spirits production corresponds to "other spirits". CSB provided aggregated statistical data where it can be

seen that 95.5% of all spirits produced in Latvia are produced from grains (sheer alcohol or spirits) and no brandy and whiskey is produced in Latvia. Hence EF for "other spirits" 0.4 kg/hl (alcohol) is used.

Table 4.30 Emission factors for food and beverages and pulp and paper industries

Production	Emission factors
Food and beverages industry (NMVOC)	
Wine	0.08 kg/hl
Beer	0.035 kg/hl
Spirits	0.4 kg/hl
Meat, fish, poultry	0.3 kg/t
Sugar	10 kg/t
Cakes, biscuits, breakfast cereals	1 kg/t
Bread	8 kg/t
Animal feed	1 kg/t
Pulp and paper industry (SO ₂)	
Pulp and paper	0.002 kt/kt

4.5.5.5 Activity data

Activity data for calculation of the NMVOC emissions from the Food and beverages industry is obtained from the CSB. Activity data of pulp and paper industry were also taken from CSB (Table 4.31). Since 2007 data for the category – wine production, was classified as confidential and not publicly available. That's why for this category 2006 year's data was used also for years 2007-2019. The same situation with spirits since 2012.

Table 4.31 Activity data for 2H sector

	Pulp and Paper	Wine	Beer	Spirits	Meat, fish, poultry	Sugar	Cakes, biscuits, breakfast cereals	Bread	Animal feed
	kt	1000 hl	1000 hl	1000 hl	kt	kt	kt	kt	kt
1990	36.6	19.9	87.4	324.5	569.3	31	54.8	314	200
1991	44.7	197.5	1295.3	330	490.4	35	39.2	293	200
1992	30.8	179.8	858.9	259.3	281.6	39	22.1	240	200
1993	4.7	87.7	545.9	217.4	154	26	15.8	177.4	245.4
1994	0.2	134.2	637.9	314.8	95.6	15.8	22.7	161.5	174
1995	1.5	159.2	652.8	341.5	82.8	29.3	24.4	145.4	214.4
1996	1.5	154.7	644.9	379.6	100.5	31.2	13.1	137.1	206.2
1997	NO	114.7	714.8	456.4	129.1	41.2	16.9	132.1	205
1998	NO	99.6	721	417.4	110.9	64.9	18.1	124.8	203.3
1999	NO	65.9	953.2	416	166.9	66.5	20.8	121.5	144.5
2000	NO	68.9	945.1	269.5	197.3	62.8	24.3	121.1	173.8
2001	NO	52.5	996.6	168.5	244.6	56	24.4	123.1	184.9
2002	NO	56.8	1199.2	237.9	262.9	76.8	29	122.6	201.3
2003	NO	45.9	1336.6	226.6	264.4	74.9	37.3	124	201.4
2004	NO	59.7	1313.1	238.8	262.5	67	43.6	119.3	211.8
2005	NO	73.4	1293.3	308.2	243.8	71.1	53.6	116.3	248.6
2006	NO	77.1	1383	360.6	288.4	59.9	45	107.3	244.2
2007	NO	C	1414.3	232.5	286	NO	46.5	102.3	336.8
2008	NO	C	1333.8	220.7	297.7	NO	38.5	100.7	307.3
2009	NO	C	1292.4	180.1	253.5	NO	33.3	95.9	299.3
2010	NO	C	1484.9	177.7	242.2	NO	37.5	89.9	405.8
2011	NO	C	1626.6	166.5	261.5	NO	39.7	88.6	360.9
2012	NO	C	1488.5	C	264.3	NO	44.5	91.4	348.2
2013	NO	C	1513.7	C	286.2	NO	56.4	88.1	380.1
2014	NO	C	967.5	C	270.7	NO	50.4	84.9	379.5
2015	NO	C	887.8	C	260.4	NO	51.8	86.9	396.8
2016	NO	C	760.8	C	234.9	NO	58.4	82.9	389.7
2017	NO	C	845.9	C	235.7	NO	61.3	80.7	415.3
2018	NO	C	821.1	C	253.4	NO	75.1	78.6	424.1
2019	NO	C	779.1	C	249.3	NO	84.6	75.9	442.4

4.5.5.6 *Uncertainties*

Uncertainty of activity data was assumed as $\pm 2\%$ for 1990-2006 because statistical data from the CSB was used. For 2007-2019 the uncertainty is assumed higher – 10%, as no precise information is available for wine production. NMVOC emission factors were assigned as 50% because default emission factors taken from EMEP/EEA 2019 were used.

4.5.5.7 *QA/QC and verification*

Assessment of trends was performed. All data was checked on input mistakes to comparing calculation data base with input data in NFR tables in all time series. All figures and tables represented in IIR 2021 are made on basis of final completed NFR data table.

4.5.5.8 *Recalculations*

No recalculations were carried out.

4.5.5.9 *Planned improvements*

No improvements are planned.

5 Agriculture (NFR 3)

5.1 Sector overview

5.1.1 Overview

In Agriculture sector emissions from following subsectors are calculated for:

- Manure management (NFR 3B), which includes cattle, sheep, goats, horses, swine, poultry and fur animals;
- Agricultural soils (NFR 3D), which includes inorganic N-fertilizers, animal manure, sewage sludge and other organic fertilizers application, urine and dung deposition by grazing animals, farm-level agricultural operations, crop cultivation and use of pesticides;
- Other (NFR 3I), which include emissions from last year's grass burning (Table 5.1).

Table 5.1 Source categories and methods for agriculture sector

NFR code	Longname	Method	EF	AD
3B1a	Manure management - Dairy cattle	Tier 1, 2	D ²⁰ , CS ²¹	NS ²²
3B1b	Manure management - Non-dairy cattle	Tier 1, 2	D, CS	NS
3B2	Manure management - Sheep	Tier 1, 2	D, CS	NS
3B3	Manure management - Swine	Tier 1, 2	D, CS	NS
3B4a	Manure management - Buffalo		NO	
3B4d	Manure management - Goats	Tier 1, 2	D, CS	NS
3B4e	Manure management - Horses	Tier 1, 2	D, CS	NS
3B4f	Manure management - Mules and asses		NO	
3B4gi	Manure management - Laying hens	Tier 1, 2	D, CS	NS
3B4gii	Manure management - Broilers	Tier 1, 2	D, CS	NS
3B4giii	Manure management - Turkeys	Tier 1, 2	D, CS	NS
3B4giv	Manure management - Other poultry (Ducks, Geese and other)	Tier 1, 2	D, CS	NS
3B4h	Manure management - Other animals (Fur animals)	Tier 1, 2	D, CS	NS
3Da1	Inorganic N-fertilizers (includes also urea application)	Tier 2	D, CS	NS
3Da2a	Animal manure applied to soils	Tier 1, 2	D, CS	NS
3Da2b	Sewage sludge applied to soils	Tier 1	D	NS
3Da2c	Other organic fertilizers applied to soils (including compost, digestate and other)	Tier 1	D	NS
3Da3	Urine and dung deposited by grazing animals	Tier 1, 2	D, CS	NS
3Da4	Crop residues applied to soils		NA	
3Db	Indirect emissions from managed soils		NA	
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Tier 1, 2	D	NS
3Dd	Off-farm storage, handling and transport of bulk agricultural products		NA	
3De	Cultivated crops	Tier 1	D	NS
3Df	Use of pesticides		Tier 1	
3F	Field burning of agricultural residues		NO	
3I	Agriculture other	Tier 1	D	NS

NO_x (nitrous oxides), NMVOC (volatile organic compounds), NH₃ (ammonia), PM (particulate matter), TSP (total suspended particulate matter), BC (black carbon), CO (carbon monoxide), DIOX (dioxins), PAH (polycyclic aromatic hydrocarbons) and HCB (hexachlorobenzene) emissions from agriculture sector are included in the submission 2021 report (Table 5.2).

²⁰ Default value from EMEP/EEA 2019 or 2006 IPCC Guidelines

²¹ Country specific value

²² National statistics

Table 5.2 Reported emissions in agriculture sector in 2019

NFR code	Emissions
3B1a	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B1b	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B2	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B3	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4d	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4e	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4gi	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4gii	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4giii	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4giv	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3B4h	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀ , TSP
3Da1	NO _x , NH ₃
3Da2a	NO _x , NH ₃
3Da2b	NO _x , NH ₃
3Da2c	NO _x , NH ₃
3Da3	NO _x , NH ₃
3Dc	PM _{2.5} , PM ₁₀ , TSP
3De	NMVOC
3Df	HCB
3I	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , TSP, CO, PCDD/PCDF, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, total PAHs

5.1.2 Key sources

The Agriculture sector was responsible for the largest part of total NH₃ emissions (85.8%) in 2019. The remaining part originated from transport, combustion in power plants and from households, as well as from wastewater treatment. NO_x emissions share of agriculture are 13.8%, but for NMVOC emissions – 19.2%.

NH₃ emissions in Agriculture sector are divided into emissions from crop production and agricultural soils, as well as emissions from manure management and other sources. In 2019, emissions from crop production and agricultural soils constituted 59.04% (8.97 kt), including emissions from inorganic N-fertilizers, animal manure and other organic fertilizers which were applied to soils, urine and dung from grazing animals. The share of NH₃ emissions from manure management in 2019 were 40.90% (6.22 kt). 95.56% (4.37 kt) of NO_x emissions were reported from crop production and agricultural soils and 3.68% of emissions were linked to manure management.

In 2019, the largest part of NMVOC emissions were related to manure management – 85.51% (6.67kt). Crop production and agricultural soils accounted for 13.32% (1.04 kt) of NMVOC. 55.35% (0.16 kt) of PM_{2.5}, 87.84% (2.82 kt) of PM₁₀ and 59.55% (1.97 kt) of TSP emissions originated from crop production and agricultural soils, while 31.75% (0.09 kt) of PM_{2.5}, 10.73% (0.34 kt) of PM₁₀ and 38.30% (1.27 kt) of TSP were related to manure management (Figure 5.1).

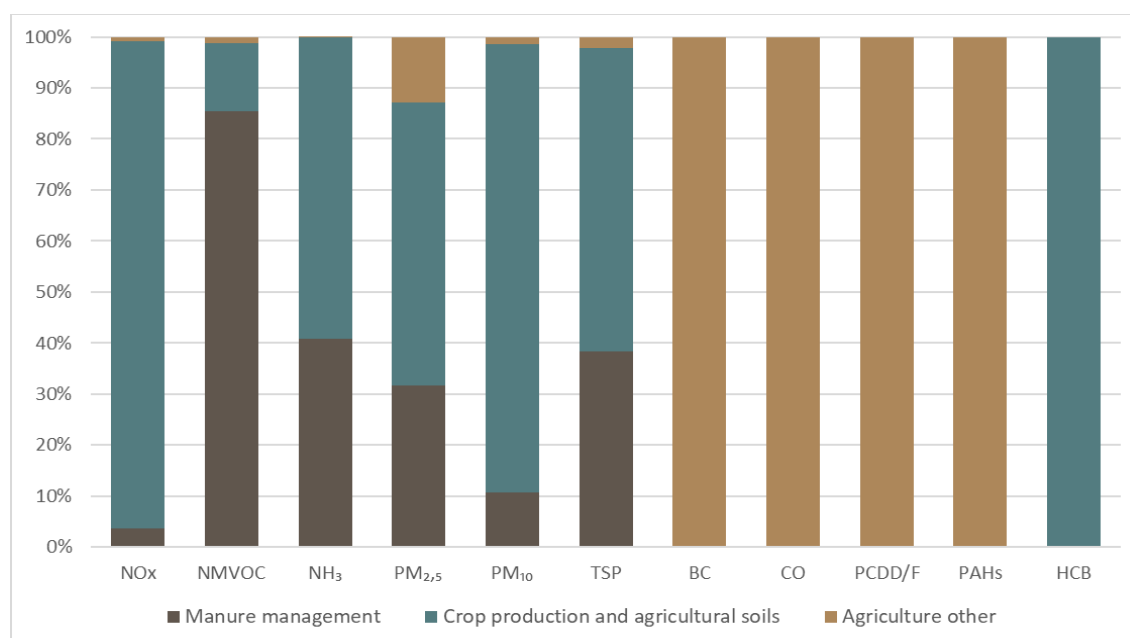


Figure 5.1 Distribution of emissions in Agriculture sector by subsectors in 2019, %

5.1.3 Trends in emissions

The NH₃ emissions from Agriculture have decreased by 51.65% over the period of 1990-2019 (Table 5.3). The general reason for this is transition to a market economy during 1991-1995, when the number of livestock in farms significantly decreased as well as the use of nitrogen fertilizers. In the recent years, it is possible to observe positive trends of mineral N fertilizer consumption due to increase of agriculture land use, expansion of crop production and number of livestock.

Table 5.3 Emissions from Agriculture sector in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Changes in 1990-2019, %
NO_x		9.27	2.28	2.28	3.01	3.74	4.50	4.54	4.47	4.32	4.58	-50.63
NMVOc		19.74	9.49	7.48	7.77	7.78	8.20	8.07	8.20	7.79	7.81	-60.46
NH₃		31.43	13.16	10.99	11.32	12.49	14.66	14.87	15.19	14.86	15.20	-51.65
PM_{2,5}	kt	0.46	0.24	0.23	0.23	0.25	0.29	0.26	0.26	0.27	0.29	-36.91
PM₁₀		3.59	2.02	1.93	2.14	2.48	2.94	3.03	2.97	2.98	3.21	-10.49
TSP		6.02	2.93	2.56	2.81	3.02	3.06	3.09	3.09	3.16	3.31	-45.04
BC		0.001	0.001	0.003	0.003	0.003	0.004	0.001	0.002	0.003	0.003	383.68
CO		0.21	0.20	0.84	0.76	0.93	1.21	0.25	0.46	0.75	1.00	383.68
PCDD/F	g i-Teq	0.004	0.004	0.018	0.016	0.019	0.025	0.005	0.010	0.016	0.021	383.68
PAHs	t	0.01	0.01	0.06	0.05	0.06	0.08	0.02	0.03	0.05	0.07	383.68
HCB	kg	5.46	0.00	0.00	0.01	0.06	0.16	0.22	0.20	0.20	0.20	-96.36

The amount of PM, NMVOc and NO_x emissions depend on the number of produced animals and crops. In the time period 1990-2019, PM emissions have decreased by 10-45%. Similarly, emissions of NO_x and NMVOc have decreased by 50.63% and 60.46%, respectively (Table 5.3).

Emissions from grassland burning were determined according to EMEP/EEA 2016 and 2006 IPCC Guidelines. In Latvia it occurs seasonally and emission amount depends on the burned area. Prohibition to burn grass and crop residues on fields has been defined as good agricultural and environmental condition under cross-compliance framework and has been respectively penalized in respect to beneficiaries of direct payment schemes and rural development area-related payments of the programming periods 2007-2014 and 2014-2020.

The area of grassland burning was taken from the State Fire and Rescue Service – SFRS. Under this system, SFRS sends reports on the recorded cases to the Rural Support Service who applies sanctions to the beneficiaries, such requirement under standards of good agricultural and environmental condition and respective sanctions will be continued onwards.

5.2 Manure management (NFR 3B)

5.2.1 Overview

In the NFR category 3B NO_x , NMVOC and NH_3 emissions from manure management are included. In 2019, the majority of NH_3 emissions from manure management in different livestock categories were related to production of the dairy cattle (57.43%), swine (15.08%), non-dairy cattle (9.01%), laying hens (5.00%) and broilers (5.00%) (Figure 5.2).

TSP, PM_{10} and $\text{PM}_{2.5}$ emissions include primary particles in the form of dust from housing. The main sources of PM emissions are livestock feeding and buildings of housing livestock. These emissions originate mainly from animal feed, bedding materials, feathers and manure. Emissions of PM occur also from free-range animals, but EMEP/EEA 2019 methodology has focused on housed animals.

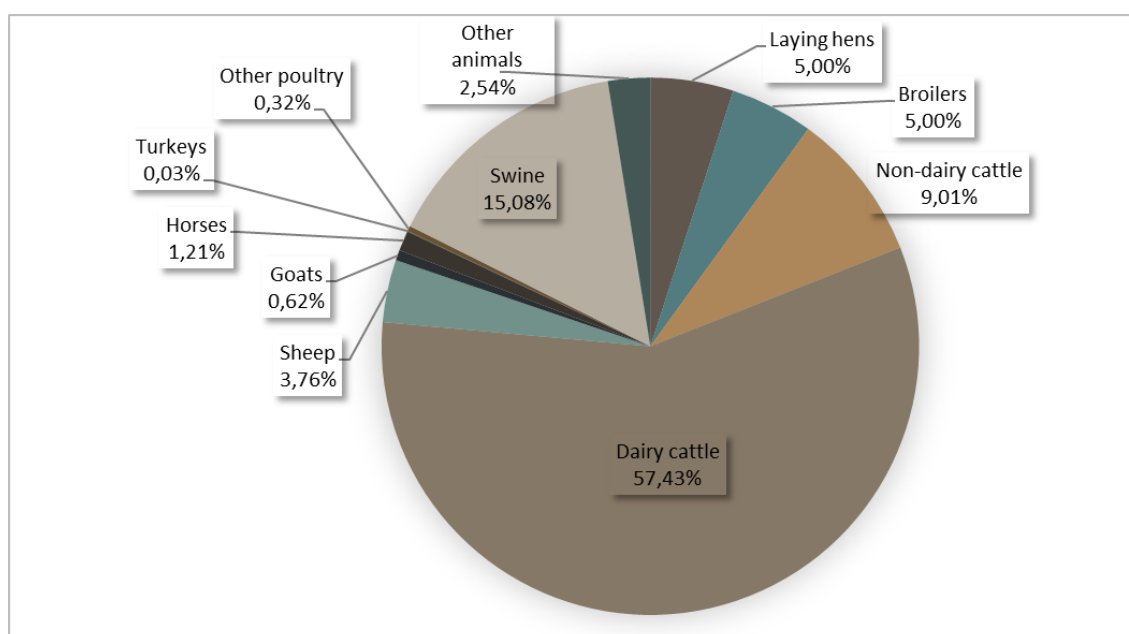


Figure 5.2 NH_3 emissions from manure management in 2019

5.2.2 Trends in emissions

Latvian livestock industry has been influenced by historical events and the changing economic situation²³. As seen in Table 5.4, emissions from manure management has noticeably decreased since the beginning of the 90's after the collapse of the Soviet Union and the restoration of independence of the Republic of Latvia. Significant changes in the livestock industry began in 1992 when most of the big farms went into liquidation. However, after Latvia joined the EU in 2004 it was possible to observe a slight increase of livestock numbers and related emissions. The NH_3 emissions from manure management have decreased by 64.2%, NO_x –

²³ Aina Dobele, Irina Pilvere, Edgars Ozols, Lasma Dobele Land Resources for Agricultural Production In Latvia. http://www.westeasinstitute.com/journals/wp-content/uploads/2013/02/ZG12-261-Aina-and-Lasma-Full-Paper_formatted-Land-Resources-For-Agricultural-Production-In-Latvia.pdf

78.0%, NMVOC – 63.6%, PM_{2.5} – 70.0%, PM₁₀ – 63.5%, TSP – 63.4% over the period of 1990-2019 (Table 5.4).

Table 5.4 Trends in emissions from Manure management in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Changes in 1990-2019, %
NOx		0.77	0.36	0.27	0.25	0.23	0.20	0.20	0.19	0.17	0.17	-78.0
NMVOC		18.33	8.67	6.65	6.84	6.75	7.08	6.98	7.11	6.68	6.67	-63.6
NH₃		17.36	8.32	6.46	6.54	6.48	6.69	6.62	6.64	6.21	6.22	-64.2
PM_{2.5}	kt	0.31	0.15	0.11	0.10	0.10	0.10	0.10	0.10	0.09	0.09	-70.0
PM₁₀		0.94	0.42	0.31	0.34	0.34	0.32	0.32	0.33	0.34	0.34	-63.5
TSP		3.46	1.46	1.12	1.20	1.24	1.15	1.14	1.16	1.22	1.27	-63.4

Predominant part of PM emissions is related to cattle, swine and poultry. The amount of emissions in the trend of PM emissions from 1990, depends on changes in the number of livestock due to significant changes in livestock industry (Figure 5.3).

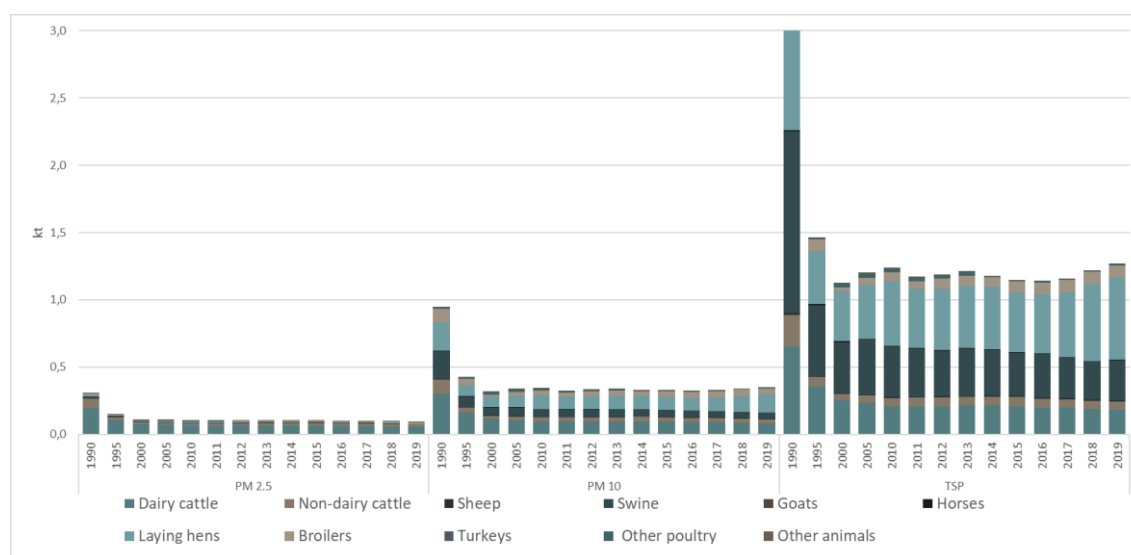


Figure 5.3 PM emissions from housing 1990-2019

In 2019, majority of PM emissions from manure management in different livestock categories were related to cattle, laying hens and swine. The biggest contributors for PM_{2.5} emissions were dairy cattle – 57.74% (0.05 kt), non-dairy cattle – 20.67% (0.02 kt) and laying hens 10.41% (0.01 kt). The biggest contributors for PM₁₀ emissions were laying hens – 37.24% (0.13 kt), dairy cattle – 23.81% (0.08 kt), broilers – 13.56% (0.05 kt) and swine– 13.44% (0.05 kt). Laying hens – 48.14% (0.61 kt), swine – 23.42% (0.30 kt) and dairy cattle – 14.19% (0.18 kt) constituted the major fraction of TSP emissions.

All emissions related to manure management were strongly related to the livestock numbers. At the end of 2019, agricultural holdings were breeding 138.4 thousand dairy cows, which were by 6.1 thousand lesser than the year before, according to the information from Central Statistical Bureau (CSB)²⁴ of Latvia. The number of non-dairy cattle rise by 6.0 thousand. Overall swine number increased over the year 2019: the numbers of fattening pigs increased by 16.8 thousand or 13.2%, sows, boars by 0.7 thousand or 3.0%, but number of pigs in age below 4 months decreased by 8.1 thousand or 5.2%. In 2019, the number of poultry continued to grow – by 287.3 thousand or 5.3%. The layer number increased by 7.1%. The number of fur animals continued to decrease by 13.8 thousand or 8.9% compared to 2018.

Trends in manure management of cattle time series show that the share of slurry-based systems increase. Small farms use predominantly solid manure management systems, while large farms mostly use

²⁴ The collection of statistics "Agriculture in Latvia" (2020). Available at <https://www.csb.gov.lv/en/statistika/db>

liquid/slurry management systems. The share of pasture tends to decrease for dairy cattle, however, for other all cattle categories the share of pasture show small changes in the time series. Trends in manure management of swine show significant increase of the manure share for slurry-based system and manure use for biogas production.

5.2.3 Methods

Emissions calculations are based on EMEP/EEA 2019. Estimation Tier 2 (mass flow approach) is used for NH₃ and NO_x emissions, which is described in the EMEP/EEA methodology. Calculations were done using MS Office Excel. Due to the N-flow calculation process, NH₃ emissions estimates were obtained from manure management systems from housing and storage (reported in 3B Manure management), on field application and grazing (reported in 3D Agricultural soils). In the same process, NO_x emissions from manure storage were calculated. Emissions estimates are done separately for each animal category (NFR 3B1a,b; 3B2; 3B4d,e,f,h and 3Bgi,ii,iii,iv). Emissions from manure spreading are not calculated for fur animals (3B4h Other animals) and from grazing poultry (3Bgi,iii,iv) due to emission factors not available. Calculated NO emissions were converted to NO₂ due to the reporting requirements.

Ammonia emissions from anaerobic digestion at biogas facilities from manure are estimated by Tier 2 approach described in EMEP/EEA Guidebook 2019 5.B.2 chapter and are reported under 5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities.

Total ammoniacal nitrogen (TAN) returned from biogas facilities to be used as fertilizers together with manure applied to soils is estimated by Tier 2 approach described in EMEP/EEA Guidebook 2019 5.B.2 chapter and are reported under 3Da2a Animal manure applied to soils. TAN and total-N in digested manures are calculated using equations 4, 5, 6 and 7 page 9 EMEP/EEA Guidebook 2019 5.B.2 chapter. Estimated TAN and total-N in digestate used in equations 35 and 36 page 27 EMEP/EEA Guidebook 2019 3B chapter. There is no national data available for relative share of organic N entering the digester that is mineralized to TAN in the digester (f_{min}), 0.32 kg kg⁻¹ is used as suggested in EMEP/EEA Guidebook 2019 5.B.2 chapter. TAN flow for digestion is calculated separately for the respective animal categories.

NMVOC emissions estimations for sheep, swine, goats, horses, poultry and other animal livestock categories, except cattle, are based on Tier 1 methodology described in the EMEP/EEA 2019. Also, PM and TSP emissions are estimated using Tier 1 methodology for all animal categories:

$$E_{pollutant_{animal}} = AAP_{animal} \times EF_{pollutant_{animal}}$$

where:

$EF_{pollutant_{animal}}$ - pollutant emissions for each livestock category;

AAP_{animal} - number of animals of a particular category that are present on average within the year;

$EF_{pollutant_{animal}}$ - EF of pollutant (kg a⁻¹).

For dairy and non-dairy cattle NMVOC emissions estimations were done by using Tier 2 methodology described in the EMEP/EEA 2019.

The example of N flow calculations for dairy cattle in 2019 is described in Annex III.

Values about annual N excretion (N_{ex}) per animal for dairy cattle and non-dairy cattle were calculated according to the 2006 IPCC Guidelines Tier 2 methodology (2006 IPCC Guidelines Equation 10.31, page 10.58):

$$N_{ex(T)} = N_{intake} * (1 - N_{retention})$$

where:

$N_{ex(T)}$ - annual N excretion rates, kg N animal⁻¹ yr⁻¹

$N_{intake(T)}$ - the annual N intake per head of animal of species/category T, kg N animal⁻¹ yr⁻¹

$N_{retention(T)}$ - fraction of annual N intake that is retained by animal of species/category T, dimensionless

$$N_{intake(T)} = \frac{GE}{18.45} * \left(\frac{CP\%}{6.25} \right)$$

where:

$N_{intake(T)}$ - daily N consumed per animal of category T, kg N animal⁻¹ day⁻¹

GE - gross energy intake of the animal, MJ animal⁻¹ day⁻¹

18.45 - conversion factor for dietary GE per kg of dry matter, MJ kg⁻¹

CP% - percent crude protein in diet, input

6.25 - conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg N-1)

The daily N retention per animal head of species/category is estimated as (2006 IPCC Guidelines Equation 10.33, page 10.60):

$$N_{retention(T)} = \left[\frac{Milk * \left(\frac{MilkPR\%}{100} \right)}{6.38} \right] + \left[\frac{WG * \left[268 - \left(\frac{7.03NE_g}{WG} \right) \right]}{\frac{1000}{6.25}} \right]$$

where:

$N_{retention(T)}$ - daily N retained per animal of category T, kg N animal⁻¹ day⁻¹

Milk - milk production, kg animal⁻¹ day⁻¹ (dairy cows only)

Milk PR% - percent of protein in milk, calculated as $[1.9 + 0.4 * \%Fat]$

6.38 - conversion from milk protein to milk N, kg Protein (kg N)⁻¹

WG - weight gain, input for each livestock category, kg day⁻¹

268 and 7.03 - constants

Neg - net energy for growth, MJ day⁻¹

6.25 - conversion from kg dietary protein to kg dietary N, kg Protein (kg N)⁻¹

Crude protein (CP) values are adopted from national studies regarding to feeding requirements for cattle²⁵ based on milk yield and milk fat content data, CP=14% (1990-1995) and CP=15% is set for dairy cows. For other cattle CP values ranging from 9% to 14%.

Annual N excretion rate for swine is derived from the 2006 IPCC Guidelines (2006 IPCC Guidelines Equation 10.30, page 10.57) by using typical animal mass (TAM) data:

The daily N intake per head of each cattle category is calculated as (2006 IPCC Guidelines Equation 10.32, page 10.58):

$$N_{ex(T)} = N_{rate} * \frac{TAM}{1000} * 365$$

where:

$N_{ex(T)}$ - annual N excretion rates, kg N animal⁻¹ yr⁻¹

$N_{rate(T)}$ - default N excretion rate, kg N (1000 kg mass)⁻¹ day⁻¹ (Market swine=0.52, Breeding swine=0.42 according to 2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.19, page 10.59)

TAM - typical animal mass, kg livestock⁻¹

5.2.4 Emission factors

The emission factors used to estimate NH₃ emissions from manure management are default Tier 2 from EMEP/EEA 2019, 3B Manure management (Table 5.5).

Table 5.5 Emission factors (EF) used for calculation of the NH₃-N emissions from manure management (proportion of TAN)

Animal type	Manure type	EF housing	EF storage	EF spreading	EF grazing
Dairy cattle	slurry	0.24	0.25	0.55	0.14

²⁵ Latvietis J. (1994) Govju ēdināšanas normas. Jelgava: LLU, p.102

	solid	0.08	0.32	0.79	
Other cattle	slurry	0.24	0.25	0.55	0.14
	solid	0.08	0.32	0.68	
Fattening pigs	slurry	0.27	0.11	0.40	-
	solid	0.23	0.29	0.45	
Sows	slurry	0.35	0.11	0.29	-
	solid	0.24	0.29	0.45	
Sheep, goats	solid	0.22	0.32	0.90	0.09
Horses	solid	0.22	0.28	0.90	0.09
Laying hens	solid	0.22	0.35	0.90	0.35
Broilers	solid	0.20	0.08	0.45	NA
Turkeys	solid	0.21	0.30	0.38	-
Ducks	solid	0.35	0.24	0.54	NA
Geese	solid	0.24	0.24	0.54	NA
Other poultry	solid	0.57	0.16	0.45	NA
Fur animals	solid	0.21	0.30	0.38	NA

Emission factors used to estimate NO_x emissions from manure management are the default values from EMEP/EEA 2019 (Table 5.6). Emission factors for pigs of age till 4 months are estimated as weighted mean from EF of fattening pigs and sow based on share of piglets of 8 kg²⁶ due to improve accuracy of calculations as statistical data of animal numbers and national Nex, manure management system is available for such livestock group.

Table 5.6 Emission factors (EF) used for calculation of the NO-N emissions from manure management (proportion of TAN)

EF Storage	
Slurry	Solid
0.0001	0.01

Emission factors which are used to estimate NMVOC from manure management are represented in Table 5.7.

Table 5.7 Emission factors (EF) used for calculation of the NMVOC emissions from manure management

Livestock	Tier 1 emission factors, kg AAP ⁻¹ a ⁻¹		Used EF
	EF, with silage feeding	EF, without silage feeding	
Fattening pigs (8-110 kg)	-	0.551	0.551
Sows (and piglets to 8kg, boars)	-	1.704	1.704
Sheep	0.279	0.169	0.224
Goats	0.624	0.542	0.583
Horses	7.781	4.275	4.275
Layers	-	0.165	0.165
Broilers	-	0.108	0.108
Turkeys	-	0.489	0.489
Ducks	-	0.489	0.489
Geese	-	0.489	0.489
Other poultry	-	0.108	0.108
Fur animals	-	1.941	1.941
Tier 2 emission factors, kg NMVOC kg/MJ feed intake			
Livestock	EF _{NMVOC, silage_feeding}	EF _{NMVOC, building}	EF _{NMVOC, graz}
Dairy cattle	0.0002002	0.0000353	0.0000069
Non-dairy cattle	0.0002002	0.0000353	0.0000069

Group of other poultry defined further is calculated using the same emission factors as for broilers, because of similar characteristics of quail and small chicks. Calculated emissions reported together with ducks and geese in 3B4giv Manure management - Other poultry.

²⁶ Lauksaimniecības datu centrs Publiskā datu bāze http://pub.ldc.gov.lv/pub_stat.php?lang=lv

The NH₃ emissions calculations also include evaluation of emissions reduction measures influence. Assumptions of emissions reduction are based on available statistical data and reliable national legal acts, defined to be respected by all farmers.

The base for implantation of abatement measures is law "On Pollution"²⁷ which entry into force in 2001 where it is stated that the best available technologies should be used. In the Law Regulations No. 531²⁸ clause 12.3. stated that "the liquid fertiliser and urines storage facilities shall be covered with a natural or artificially made covering layer that reduces and prevents any evaporation of ammonia and other volatile substances". In 2004 Cabinet Regulation No. 628²⁹ where adopted where in clause 9. stated "9.1. the storage facilities of slurry may be closed-type or covered with a permanent natural or artificial floating covering layer, which reduces evaporation. The floating covering layer or cover shall cover the surface of the storage facility at all times and, where appropriate, supplemented with a new material; and 9.2. slurry shall be infused in storage facilities under the level of manure in the storage facility in order to prevent the possibility of reverse flow. The filling system shall be established so that the floating covering layer would not be disturbed". At this point Regulations No 829³⁰ of the Cabinet of Ministers of Latvia are in force, all animal housings must have slurry storages with at least natural coverage. Therefore, NH₃ emissions reduction potential is included in the emissions calculation and based on the Guidance Document on Control Techniques for Preventing and Abating Emissions of Ammonia recommendations it is set as 40%³¹ for storage of slurry with natural crust or cover with straw, as implementation of it definitely occur in the largest farms, where is the biggest share of slurry based manure management. It is assumed dairy cow slurry is covered by natural crust and swine slurry is covered by chopped straw or other alternative cover. The biggest swine farms include more than 2000 places for fattening pigs and belongs to A category operators²⁹ (Table 5.8).

Table 5.8 Swine farm groups according to number of livestock

Parameter	Other pig farms										A category operators		
	1	2	3-4	5-9	10-19	20-49	50-99	100 -199	200 -399	400-999	1000 -1999	2000 -4999	>=5000
2001 Farms	14154	20897	10931	5658	2771	1375	292	91	58	37	6	7	11
Livestock	14154	41793	39592	39882	39746	41588	21281	13853	16498	21909	8026	19911	104220
2002 Farms	14117	21353	10948	5198	2822	1267	304	101	66	34	8	12	12
Livestock	14122	42706	37465	32700	37786	39171	22886	16075	19124	18828	10135	35395	124436
2003 Farms	12548	19050	8860	4300	1970	1184	286	131	67	34	13	11	13
Livestock	12548	38100	33881	27926	26775	35174	19275	18493	18692	19806	16527	37773	131501
2004 Farms	12310	16415	7854	3705	1854	955	277	151	70	31	11	10	14
Livestock	12310	32830	26521	23910	24041	28470	17879	20216	18866	20372	16023	34474	154863
2005 Farms	10405	15945	7085	3174	1400	855	257	161	64	24	10	12	16
Livestock	10405	31890	24176	19835	18501	26619	17756	23750	17806	15292	14328	38413	169147
2006 Farms	5975	9632	5486	2151	1138	676	199	112	60	29	15	13	20
Livestock	5975	19264	18544	13557	15160	20723	13294	15489	15445	17458	19416	43984	194274
2007 Farms	6155	10470	4496	1595	959	591	225	116	57	28	11	11	22
Livestock	6155	20940	15144	9737	12393	17336	15120	14742	15230	16898	16697	36890	213133
2008 Farms	3981	9635	6596	1104	642	365	99	69	38	16	14	12	18
Livestock	3981	19270	22703	7162	8895	11731	7338	9246	10479	9978	20514	46778	205649
2009 Farms	2895	8883	7335	1004	659	333	131	68	23	21	7	11	19
Livestock	2895	17766	24924	6529	8544	10139	8982	9260	6847	14214	10804	40788	214851
2010 Farms	5019	8538	4798	1110	609	386	106	57	28	14	15	11	21

²⁷ Law On Pollution <https://likumi.lv/ta/id/6075-par-piesarnojumu>

²⁸ Cabinet Regulation No. 531 Regulations regarding Protection of Water and Soil from Pollution with Nitrates Caused by Agricultural Sources <https://likumi.lv/ta/id/56960-noteikumi-par-udens-un-augsnes-aizsardzibu-no-lauksaimnieciskas-darbibas-izraisita-piesarnojuma-ar-nitratiem>

²⁹ Cabinet Regulation No. 628 Special Environmental Requirements for Performance of Polluting Activities in Animal Housing <https://likumi.lv/ta/id/91777-ipasas-vides-prasibas-piesarnojoso-darbibu-veiksana-dzivnieku-novietnes>

³⁰ National regulations No 829 Regarding Special Requirements for the Performance of Polluting Activities in Animal Housing <https://likumi.lv/ta/id/271374-ipasas-prasibas-piesarnojoso-darbibu-veiksana-dzivnieku-novietnes>

³¹ United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions, 24 March 2015 <https://undocs.org/ECE/EB.AIR/129>

Parameter	Other pig farms										A category operators		
	1	2	3-4	5-9	10-19	20-49	50-99	100 -199	200 -399	400-999	1000 -1999	2000 -4999	>=5000
2011 Livestock	5019	17076	16441	6970	8065	11939	7322	8072	8063	9139	20349	36378	234910
2011 Farms	3206	7549	2924	1659	636	402	192	75	26	18	8	12	17
2012 Livestock	3206	15098	10802	10936	7474	11358	13326	10173	7386	12047	12212	43793	217173
2012 Farms	2147	6548	3449	1471	551	243	136	68	18	13	8	10	18
2013 Livestock	2147	13095	12954	8902	6726	7370	8968	9553	4721	7729	12091	31796	229170
2013 Farms	2256	5718	2413	1287	528	166	135	49	19	16	7	10	18
2014 Livestock	2256	11437	8517	7861	6953	4579	9216	6907	5492	9815	9589	32832	252082
2014 Farms	2142	4086	1105	567	380	93	79	27	5	12	4	11	18
2015 Livestock	2142	8172	3838	3836	5160	2929	5248	4155	1317	7175	5440	34449	265571
2015 Farms	1569	2516	882	544	386	292	47	14	13	14	5	9	17
2016 Livestock	1569	5032	5099	5590	7858	8191	5747	1831	3026	8018	6599	33714	241885
2016 Farms	979	1322	1094	326	421	177	57	25	7	9	7	8	17
2017 Livestock	979	2644	3655	2168	5957	5434	3538	3639	2004	5396	10509	26351	264112
2017 Farms	895	1421	705	625	358	139	58	23	6	9	5	9	16
2018 Livestock	895	2842	2428	3742	4174	4329	3469	3190	1597	5395	7873	26072	254557
2018 Farms	499	1495	413	357	196	139	25	38	6	6	4	10	14
2019 Livestock	499	2990	1377	2230	2609	4366	1820	5342	1802	4264	6505	30823	240269
2019 Farms	931	697	468	323	146	111	42	14	5	6	3	11	15
2019 Livestock	931	1394	1628	2105	1707	3929	2859	1982	1414	4544	4393	30742	256576

For dairy cattle there are included farms with more than 100 cows according to research of animal breeding technology parameters. Research results show that for dairy cattle marginal size of the herds at which the transition from obtaining of solid manure to slurry takes place is close to 100³². The influence of techniques on emissions is estimated by statistical data of animal distribution in different scale farms³³ (Table 5.9).

Table 5.9 Dairy cattle farm groups according to number of livestock

Parameter	Small farms							Large farms			
	1	2	3-5	6-9	10-19	20-29	30-49	50-99	100-199	200-299	>=300
2002 Farms	39228	17984	9877	2442	1175	228	134	102	52	19	28
2002 Livestock	39228	35968	44470	19721	18240	6811	5697	7617	7730	4986	12656
2003 Farms	32469	15623	8793	2051	1376	377	190	124	53	20	32
2003 Livestock	32469	31246	36072	15419	18158	9022	7216	8565	7221	5040	13840
2004 Farms	32484	15246	8952	2273	1439	372	223	147	50	26	27
2004 Livestock	32484	30492	33978	16401	19112	8669	8220	9985	7021	6574	12288
2005 Farms	32185	14058	8268	2483	1704	396	240	148	51	28	33
2005 Livestock	32185	28116	29227	17557	21730	9263	8755	10065	6659	7006	14612
2006 Farms	22991	10655	5884	2038	1692	459	300	206	80	34	34
2006 Livestock	22991	21310	22991	15478	24171	11701	11898	14755	11077	8627	15786
2007 Farms	19939	7045	5769	2406	2122	680	427	278	97	32	30
2007 Livestock	19939	14090	19948	16446	26262	15159	14757	17767	12583	8166	14302
2008 Farms	18823	6782	4965	2055	1641	501	393	270	95	27	40
2008 Livestock	18823	13564	18267	14819	21911	11927	14630	18486	13278	6721	17971
2009 Farms	17506	6176	4454	1901	1535	518	383	276	103	27	40
2009 Livestock	17506	12352	16382	13802	20594	12308	14338	18800	14138	6668	18623
2010 Farms	15855	5543	3784	1857	1578	512	408	291	104	31	41
2010 Livestock	15855	11086	13894	13409	21176	12200	15332	19892	14397	7538	19281
2011 Farms	14037	4805	3440	1824	1593	533	406	308	113	34	44
2011 Livestock	14037	9610	12706	13199	21439	12729	15234	20966	15201	8283	20692
2012 Farms	12529	4425	3341	1759	1583	527	432	308	117	40	43
2012 Livestock	12529	8850	12422	12768	21457	12537	16117	21046	15795	9718	21325
2013 Farms	10978	3929	3227	1710	1563	532	457	315	125	35	46
2013 Livestock	10978	7858	11962	12499	21028	12482	17069	21617	17037	8576	23905
2014 Farms	9752	3605	3030	1675	1549	532	451	312	128	42	49
2014 Livestock	9752	7210	11232	12230	20805	12687	17098	21418	17252	10024	26163

³² Laurs A., Priekulis J., Markovics Z., Aboltins A. (2016) Research in farms animal breeding technological parameters. Engineering for rural development, Jelgava, 25. 27.05. 2016, pp 1054 -1058

³³ Agriculture, Forestry and Fishery. <http://data.csb.gov.lv/pxweb/en/lauks/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8>

Parameter	Small farms							Large farms				
	1	2	3-5	6-9	10-19	20-29	30-49	50-99	100-199	200-299	>=300	
2015 Farms	8775	3230	2796	1644	1467	540	417	313	137	37	52	
Livestock	8775	6460	10398	11963	19873	12838	15872	21200	18480	8906	27649	
2016 Farms	7643	2809	2437	1574	1432	463	400	306	131	41	50	
Livestock	7643	5618	9037	11419	19374	11075	15065	20758	17605	10016	26414	
2017 Farms	6594	2425	2199	1503	1354	436	375	315	124	42	49	
Livestock	6594	4850	8193	10963	18323	10449	14123	21536	16945	10207	28172	
2018 Farms	5603	2156	2006	1440	1276	404	379	294	128	34	50	
Livestock	5603	4312	7540	10526	17202	9603	14307	20046	17734	8361	29239	
2019 Farms	4833	1884	1916	1322	1222	390	361	283	126	37	50	
Livestock	4833	3768	7209	9688	16347	9280	13551	19172	17162	8726	28677	

Table 5.10 summarizes estimated reduction potential for dairy cattle and swine storage of slurry and used emission factors for calculations of NH₃ emissions from slurry storage for dairy cows and swine. Emission factors are estimated taking in to account described reduction potential.

Table 5.10 NH₃ reduction from storage of slurry, % and Emission factors (EF) used for calculation of the dairy cows and swine NH₃-N emissions from manure storage (proportion of TAN)

Year	NH ₃ reduction from storage of slurry, %		EF _{NH₃_storage_slurry, NH₃-N (kg TAN)⁻¹}	
	Dairy cows	Swine	Dairy cows	Swine
2001	-	22.3	default EF	0.085
2002	26.8	25.2	0.183	0.082
2003	29.2	25.4	0.177	0.082
2004	27.8	27.3	0.180	0.080
2005	29.5	28.9	0.176	0.078
2006	35.5	32.7	0.161	0.074
2007	32.0	33.3	0.170	0.073
2008	33.4	35.1	0.167	0.071
2009	32.9	35.1	0.168	0.071
2010	32.1	35.0	0.170	0.072
2011	32.0	34.0	0.170	0.073
2012	31.7	34.9	0.171	0.072
2013	31.6	35.9	0.171	0.070
2014	32.1	38.9	0.170	0.067
2015	29.7	36.4	0.176	0.070
2016	29.4	37.7	0.176	0.069
2017	29.5	37.8	0.176	0.068
2018	30.8	37.4	0.173	0.069
2019	31.0	38.1	0.172	0.068

It is stated that application of slurry has to be done within 12 h by national regulations No 834 of the Cabinet of Ministers of Latvia³⁴, but if used as additional fertilizer shall not be applied to land, therefore at this point it is not used in the calculations until more information on implementation of this measure is estimated. All solid manure has to be incorporated within 24 h, and reduction rate by this activity is set to be 30 %²⁷. Solid manure incorporation abatement measurement estimated starting from 2001 due to Law On Pollution²⁹ being in force at that time and Law Regulations No. 531³⁰.

The calculation of PM and TSP emissions is based on EMEP/EEA 2019 methodology. Emission factors by type are shown in the Table 5.11.

³⁴ National regulations No. 834 Regulation Regarding Protection of Water and Soil from Pollution with Nitrates Caused by Agricultural Activity <https://likumi.lv/ta/en/en/id/271376-regulation-regarding-protection-of-water-and-soil-from-pollution-with-nitrates-caused-by-agricultural-activity>

Table 5.11 PM and TSP emission factors, kg AAP⁻¹a⁻¹

	EF TSP	EF PM ₁₀	EF PM _{2.5}
Dairy cows	1.380	0.630	0.410
Other cattle	0.590	0.270	0.180
Calves	0.340	0.160	0.100
Fattening pigs	1.050	0.140	0.006
Sows	0.620	0.170	0.010
Sheep	0.140	0.060	0.020
Goats	0.140	0.060	0.020
Horses	0.480	0.220	0.140
Layers	0.190	0.040	0.003
Broilers	0.040	0.020	0.002
Turkeys	0.110	0.110	0.020
Ducks	0.140	0.140	0.020
Geese	0.240	0.240	0.030
Other poultry	0.040	0.020	0.002
Fur animals	0.018	0.008	0.004

5.2.5 Activity data

The number of cattle, sheep, swine, goats, horses, poultry and fur-bearing animal's population, as well as data on milk production and fat content in milk is obtained from the Database³⁵ of CSB of Latvia and statistical yearbooks³⁶. The distribution of different manure management systems (MMS) is adopted from national studies. Calculations of the distribution are made based on research results and developed methodology provided by Latvia University of Life Sciences and Technologies³⁷. MMS for all livestock categories 1990 – 2019 are summarized in Annex III.

Statistical information about the livestock number in Latvia is included in Table 5.12. The number of fur-bearing animals is not available for 1990-1992 and 1995 therefore interpolation and extrapolation are used to fill in the gaps of time series. The same activities have been done for turkeys, ducks and geese, because statistical data is not available for the period of 1990-1998. According to Central Statistical Bureau (CSB) not specified poultry or other poultry contains number of quail and small chicks from 1999 till 2014. Starting from 2014 other poultry group contains number of quails. Ostrich number is as well included in the group of other poultry from 2010 but the number is not significant.

Table 5.12 Number of livestock (thousand heads), 1990-2019

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	
Dairy cows	535.1	291.9	204.5	185.2	164.1	162.4	154.0	150.4	144.5	138.4	
Non-dairy cattle	Growing cattle	827.8	224.5	149.5	178.5	173.2	189.8	185.5	177.9	170.8	172.9
	Other mature cattle	76.4	20.7	12.7	21.5	42.2	66.9	72.8	77.5	80.1	84.1
Swine	Fattening pigs	759.2	287.7	191.7	175.7	156.3	155.4	141.7	135.7	127.3	144.1
	Sows, boars	146.5	75.8	35.3	37.7	36.0	25.0	27.1	25.7	23.1	23.8
	Pigs till 4 months	495.4	189.3	166.5	214.5	197.4	153.9	167.6	159.1	154.4	146.3
Sheep	164.6	72.2	28.6	41.6	76.8	102.3	106.6	112.2	107.3	99.8	
Goats	5.4	8.9	10.4	14.9	13.5	12.7	13.2	12.8	12.2	11.7	
Horses	30.9	27.2	19.9	13.9	12.0	9.6	9.3	8.9	8.4	8.3	
Layers	5160.6	2071.2	1980.5	2121.8	2549.5	2335.3	2310.3	2515.1	2996.9	3208.4	
Broilers	5089.3	2055.8	570.2	1365.0	1638.3	2035.9	2170.8	2303.5	2335.0	2336.0	

³⁵ Agriculture, Forestry and Fishery. <http://data.csb.gov.lv/pxweb/en/lauks/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8>

³⁶ The collection of statistics "Agriculture in Latvia" (2020). Available at <https://www.csb.gov.lv/en/statistika/db>

³⁷ Priekulis J., Ābolīņš A. (2015) Calculation Methodology for Cattle Manure Management Systems Based on the 2006 IPCC Guidelines. Proceedings of the 25th NJF Congress Nordic View to Sustainable Rural Development. Riga, pp.274-280

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Turkeys	10.1	10.1	12.5	15.1	1.0	3.1	18.1	3.3	3.6	4.1
Other poultry										
Ducks	48.6	48.6	51.0	38.4	2.9	6.6	6.2	6.1	6.1	6.9
Geese	12.6	12.6	14.4	16.2	1.6	3.3	3.3	2.9	3.0	3.2
Other poultry	-	-	476.0	535.8	755.4	147.8	203.0	112.9	58.5	131.8
Other animals										
Fur animals	260.2	213.5	97.2	140.8	166.1	272.2	243.3	298.4	154.1	140.3

The data of N excretion during the year per each livestock category used for the inventory are mainly country specific and is obtained from national studies. The research of country specific N excretion values is done according to outcomes of pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections" under 2009-2014 EEA Grants Programme National Climate Policy related to sub-project "Agricultural sector GHG emissions calculation methods and data analysis with the modelling tool development, integrating climate change". All N excretion values used in the inventory are represented in Table 5.13 and Table 5.14. Detailed description of country specific Nex is available at Latvia Inventory Report 2020 and in previous submissions³⁸.

Table 5.13 Average N excretions (N, kg year⁻¹) per head of animal

Livestock category	N, kg year ⁻¹	Source
Fattening pigs	14	National studies
Sows, boars	27.6	National studies
Pigs till 4 months	5.1	National studies
Sheep	15.3	National studies
Goats	15.8	National studies
Horses	44.0	National studies
Layers	0.55	National studies
Broilers	0.35	National studies
Turkeys	1.64	EMEP/EEA 2019
Ducks	0.58	National studies
Geese	1.12	National studies
Other poultry	0.35	National studies
Fur animals	4.60	EMEP/EEA 2019

Average N excretion data during the year for dairy cattle vary in all emissions reporting period depending on productivity indicators and age structure for non-dairy cattle (Table 5.14).

Table 5.14 Average N excretions for cattle (N, kg year⁻¹) per head of cattle

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dairy cows	85.8	84.7	99.6	104	106.6	107.1	108.2	109.6	110.5	108.8	112.2	114.4	115.0	117.0
Growing cattle	20.1	20.0	19.5	19.4	19.8	19.7	19.8	20.0	19.9	20.0	20.0	20.0	19.9	19.8
Other mature cattle	58.6	58.5	55.0	58.9	60.1	60.3	61.0	61.3	61.5	61.9	62.2	62.0	62.3	62.7

Calculations of MMS are done according to pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections" (2009-2014 EEA Grants Programme National Climate Policy) the most important outcomes in relation to sub-project "Agricultural sector GHG emissions calculation methods and data analysis with the modelling tool development, integrating climate change". Main differences caused by implementation of the new methodology to determine MMS should be tended to liquid manure system, which was found as not typical for non-dairy cattle in Latvia. Significantly, the share of pasture, range and paddock were reduced for all livestock groups, except beef cattle. Most of the large livestock farms refuse from grazing to keep high productivity of animals and arrange resources in economically feasible way. Table 5.15 represents the share of each manure management system in 2019.

³⁸ Latvia Inventory Report submissions <https://www.meteo.lv/lapas/sagatavotie-un-iesniegtie-zinojumi?&id=1153&nid=393>

Table 5.15 Share of each manure management system per animal type (%), 2019

	Pasture	Solid storage	Slurry	Anaerobic digester
Dairy cows	5.9	42.1	36.0	16.0
Growing cattle	29.6	61.8	0.0	8.7
Other mature cattle	78.7	21.3	0.0	0.0
Fattening pigs	0.0	4.5	50.1	45.4
Sows, boars	0.0	4.8	50.0	45.2
Pigs till 4 months	0.0	4.9	49.9	45.2
Sheep	34.7	65.3	0.0	0.0
Goats	9.8	90.2	0.0	0.0
Horses	29.9	70.1	0.0	0.0
Layers	3.5	19.9	0.0	76.6
Broilers	0.0	100.0	0.0	0.0
Turkeys	25.8	74.2	0.0	0.0
Ducks	29.1	70.9	0.0	0.0
Geese	27.0	73.0	0.0	0.0
Fur animals	0.0	100.0	0.0	0.0

The straw use is adjusted based on default values summarized EMEP/EEA 2019 Table 3.7. Used straw amount summarized in Table 5.16. N added in straw is estimated accordingly the use of the straw 4 g kg⁻¹.

Table 5.16 Annual use of straw, kg AAP-1 a-1

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019
Dairy cattle	2692	2700	2717	2750	2783	2842	2850	2858	2858	2858
Non-dairy cattle - growing cattle	611	693	752	743	772	719	711	716	713	714
Non-dairy cattle - mature cattle	217	217	217	217	217	217	217	217	217	217
Fattening pigs	200	200	200	200	200	200	200	200	200	200
Sows	600	600	600	600	600	600	600	600	600	600
Sheep	192	192	192	192	192	192	192	192	192	192
Goat	217	217	217	217	217	218	216	219	219	219
Horses	900	900	900	900	900	869	836	800	761	711

NMVOC emissions calculation for dairy and non-dairy cattle is based on Tier 2 approach of EMEP/EEA 2019. Feed intake values in MJ used for NMVOC emissions calculation are calculated using IPCC 2006 methodology (Table 5.17).

Table 5.17 Feed intake values in MJ per year

	Dairy cattle	Growing cattle	Other mature cattle
1990	88168	29330	55803
1995	86267	28699	55825
2000	96435	27745	53880
2005	102604	27789	61061
2010	107976	28277	63445
2011	108541	28171	64328
2012	110134	28436	65486
2013	112335	28883	65743
2014	113824	28741	66569
2015	113407	29050	67679
2016	118005	28999	68536
2017	121218	28966	68686
2018	122168	28831	69238
2019	125110	28742	70071

5.2.6 Uncertainties

The uncertainty associated with activity data was received from CSB of Latvia. Generally, the uncertainty of activity data provided by CSB of Latvia is set as 2%. Uncertainty of emission factors for NH₃ ranges is from ±14% to ±136%, for NO_x is from -50% to +100% according to EMEP/EEA 2019.

5.2.7 QA/QC and verification

Assessment of trends were performed by a sectorial expert. Statistical data were verified by CSB of Latvia.

5.2.8 Recalculations

Recalculations for the submission were mostly were done under implementation of EMEP/EEA air pollutant emission inventory guidebook 2019 methodology.

5.2.9 Planned improvements

It is planned to quantify and prepare detailed documentations of abatement strategies for ammonia emissions to provide implementation of them in the inventory by using data from Agricultural Data Center data base "Housing infrastructure and manure storage".

5.3 Agricultural soils (NFR 3D)

5.3.1 Overview

Under the category NFR 3D Latvia reports: ammonia (NH₃) and nitrous oxides (NO_x) emissions from inorganic N-fertilizers application, NH₃ and NO_x emissions from animal manure, sewage sludge and other organic fertilizers applied to soils, NH₃ and NO_x emissions from urine and dung deposited by grazing animals as well as volatile organic compounds (NMVOC) and particulate matter (PM_{2.5}, PM₁₀, TSP) emissions from crop production. Under 3.D.f Latvia reports HCB emissions from the use of pesticides.

5.3.2 Trends in emissions

Emissions from agricultural soils have noticeably decreased since the beginning of 90`s when agricultural production levels were significantly reduced (Table 5.18).

Table 5.18 Emissions from fertilizers, urine and dung deposited by grazing animals and crop production, 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Changes in 1990-2019, %
NO_x		8.50	1.92	1.99	2.73	3.48	4.26	4.33	4.27	4.12	4.37	-48.5
NMVOC		1.40	0.80	0.76	0.86	0.95	1.01	1.06	1.04	1.04	1.04	-25.7
NH₃	kt	14.07	4.83	4.52	4.77	6.00	7.97	8.24	8.55	8.64	8.97	-36.2
PM_{2.5}		0.15	0.09	0.09	0.10	0.12	0.15	0.15	0.15	0.15	0.16	10.5
PM₁₀		2.63	1.59	1.58	1.77	2.10	2.56	2.70	2.63	2.61	2.82	7.1
TSP		2.54	1.45	1.37	1.56	1.72	1.82	1.92	1.89	1.89	1.97	-22.4
HCB		kg	5.46	0.00	0.00	0.01	0.06	0.16	0.22	0.20	0.20	0.20

NH₃ emissions

In 2019, agricultural soils contributed 8.97 kt of NH₃. The main source of NH₃ emissions was animal manure applied to soils, contributing 53.3% or 4.79 kt of NH₃ emissions from agricultural soils. NH₃ emissions from application of inorganic N-fertilizers contributed 3.44 kt or 38.4%. NH₃ emissions from pastures had a share of 7.7% (0.69 kt). Application of sludge and other organic fertilizers emitted 0.05 kt of NH₃ or 0.6% of total NH₃ emissions from agricultural soils. In 2019, the total emission of NH₃ from agricultural soils increased by 3.8%, compared to 2018.

NO_x emissions

NO_x emissions from agricultural soils reached 4.37 kt in 2019. The main sources of NO_x emissions similarly to NH₃ emissions were application of inorganic N-fertilizers, manure, sludge and other organic fertilizers as well as pastures. 73.8% of NO_x emissions formed from the use of inorganic N-fertilizers, 19.4% from manure application, 6.3% from pastures, 2.8% from other organic fertilizers and 0.4% from sludge application. Comparing to previous submission year, NO_x emissions increased by 6.2%. The most important source of

emissions increase was application of inorganic N-fertilizers, application of other organic fertilizers and sludge.

NMVOG and PM emissions

In 2019, agricultural soils contributed 1.04 kt of NMVOG (the same as in 2018) emissions in Latvia. The only source for NMVOG was emissions from cultivated crops (3De). Agricultural soils also contributed 1.97 kt, 2.82 kt and 0.16 kt of the total agricultural TSP, PM₁₀ and PM_{2.5} emissions, respectively. These emissions were reported in category 3Dc (Farm-level agricultural operations including storage, handling and transport of agricultural products). Emissions of particulate matter increase by average 8.0% comparing to previous submission.

HCB emissions

In 2019, agriculture contributed 0.20 kg of HCB emission in Latvia. These emissions were reported in category 3Df (Use of pesticides). Emissions notably decrease by 96.4%, since 1990.

Trends of agricultural production

Emissions from agricultural soils are increasing since 2000. This could be explained by an increase of area covered by crops and fertilizer use. NH₃ emissions rapidly increased in relation to inorganic N-fertilizer application.

According to CSB information from Collection of Statistical Data the total sown area in 2019 was 1262.1 thousand ha, the number of total sown area increased by 4.4% compared to 2018. In 2019, according to Collection of Statistical Data of CSB, the highest harvested production of grain was recorded – 3.2 million t, which is 1.1 million t or 1.5 times more than a year ago. The average grain yield per one hectare reached 42.6 q/l, which is the second highest grain yield in the history of Latvia (44.9 q/l were harvested in 2015). The record-high harvested production was facilitated by both high yield and wider areas of cereals – cereal cropland covered 742.3 thousand ha, which is 51.4 thousand ha or 7.5 % more than year ago and the widest cereal area in the history of Latvian agriculture. Harvested production of grain was significantly influenced by the increase in share of winter cereal areas in the total cereal cropland – from 35.4 % in 2018 to 58.8 % in 2019 (50.4 % in 2015). In 2019, harvested production of winter cereals reached 2.2 million t (the highest indicator in the history of Latvia), and the average yield thereof constituted 50.7 q/l/ha. Higher yield of winter cereals was reached only in 2015 – 53.5 q/l/ha. In 2019, the highest harvested production of winter wheat was harvested – 2.0 million t or 62.0 % of the total harvested production of grain; the average yield thereof reached 51.8 q/l/ha, which is the second highest yield of winter wheat (55.3 q/l/ha in 2015).

In 2019, rape areas occupied 140.1 thousand ha, which is 16.5 thousand ha or 13.4 % more than a year ago and the widest rape area recorded in the history of Latvian agriculture. In 2019, areas of potato plantations rose slightly – only by 0.1 thousand ha or 0.7 %, while harvested production of potatoes grew by 17.6 %, reaching the average yield of 224 q/l/ha (191 q/l/ha in 2018).

2019 was favorable for open-field vegetables. Last year, 172.9 thousand t of vegetables were produced (including in greenhouses), and it is 33.8 thousand t or 24.3 % more than in 2018. The upturn was affected by a significant increase in the average yield of vegetables from one open field hectare – from 155 q/l/ha in 2018 to 192 q/l/ha in 2019.

According to CSB information in 2019, 139.2 thousand t of mineral fertilizers (expressed as 100 % of nutrients) were used on the sown area of agricultural crops – 6.3 % more than in 2018. The increase in the volume of mineral fertilizers used per hectare (from 108 kg in 2018 to 110 kg in 2019 or by 1.9 % over the year) was facilitated by the growth of winter cereal and winter rape sown areas – of 21 % and 57 %, respectively. Increase was recorded in the volume of mineral fertilizers used per hectare of all main agricultural crops – that used on cereals grew from 138 kg in 2018 to 139 kg in 2019 or by 0.7 %, on industrial crops from 190 to 195 kg (2.6 %), on open field vegetables from 110 to 112 kg (1.8 %), on potatoes from 95 to 96 kg (1.1 %). Use of nitrogen per hectare of sown area increased from 62 kg in 2018 to 64 kg in 2019 or

by 3.2 %. Share of straight nitrogen fertilizers in the total volume of mineral fertilizers (in physical weight) reduced from 42.8 % in 2018 to 41.4 % in 2019.

All statistical information is adopted from the collection of statistics "Agriculture in Latvia" (2020)³⁹ developed by the Agricultural Statistics Section, Agricultural and Environment Statistics Department of CSB of Latvia.

Emissions from animal manure applied to soils and urine and dung deposited by grazing animals are related to the total number of livestock in the country described in the Chapter 3B.

5.3.3 Methods

Emissions calculation of NH₃ from inorganic N-fertilizer is based on the consumption data of different fertilizer types and related emission factors. Emissions calculation of NO_x is based on the total consumption of N in inorganic N-fertilizer, manure or excreta, other organic fertilizers and related emission factor. NMVOC and PM, including TSP emissions were calculated using the data of the total sown area and respective emission factors. NH₃ emissions from animal manure applied to soils and urine and dung deposited by grazing animals were calculated under the category 3B.

NH₃, NO_x, NMVOC, PM and TSP emissions are calculated by methodology explained in EMEP/EEA 2019. NO_x emissions from crop production and agricultural soils are calculated using the following equation:

$$E_{pollutant} = AR_{nitrogen\ applied} \times EF_{pollutant}$$

where:

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

$AR_{nitrogen\ applied}$ = amount of N applied in fertilizer or organic waste (kg a⁻¹),

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

For calculation of NH₃ emissions from inorganic N-fertilizers in the country, the number of fertilizer consumption (expressed as mass of fertilizer-N used per year) is multiplied by the appropriate emission factor. NH₃ emissions from the application of inorganic fertilizers are calculated using the Tier 2 approach according to EMEP/EEA 2019 Crop production and agricultural soils 3D⁴⁰, distinguishing between various fertilizer types.

NMVOC and PM emissions from crop production and agricultural soils are calculated by using the following equation:

$$E_{pollutant} = AR_{area} \times EF_{pollutant}$$

where:

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

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

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

The emissions of HCB were calculated keeping methodology proposed in the EMEP/EEA 2019 (3Df/3I, chapter 3, Tier 1 approach)⁴¹. To estimate the emission of HCB which is present as an impurity, an impurity factor (IF) has to be considered in the calculation:

$$E_{pest} = \sum(m_{pest_i} \times IF_i)$$

³⁹ Agriculture in Latvia. Collection of Statistical Data. Riga (2020) 80 p. Available at: <https://www.csb.gov.lv/en/statistics/statistics-by-theme/agriculture/crop/search-in-theme/424-agriculture-latvia-2020>

⁴⁰ EMEP/EEA air pollutant emission inventory guidebook 2019. Available at <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/3-d-crop-production-and/view>

⁴¹ EMEP/EEA air pollutant emission inventory guidebook 2019. Available at: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/3-d-f-3-i/view>

where:

E_{pest} = total HCB emission of active substance (in mg a^{-1} , unit conversion reported in kg a^{-1}),

M_{pest_i} = mass of individual active substance applied (kg a^{-1}),

IF_i = impurity factor of the active substance (mg kg^{-1})

5.3.4 Emission factors

The default (Tier 1) emissions factors for NMVOC, TSP and NO_x were used for calculations as given in EMEP/EEA 2016 guidelines and the same emission factors are used for all years 1990-2019:

- 0.86 kg ha^{-1} for NMVOC;
- 1.56 kg ha^{-1} for TSP;
- 0.04 kg kg^{-1} fertilizer, manure or other waste applied for NO_2 .

NH_3 emissions from inorganic N-fertilizer are calculated on the basis of inorganic fertilizer types application data and suggested EF's according to EMEP/EEA 2019 Tier 2 methodology (EMEP/EEA 2019, 3.D Crop production and agricultural soils, Table 3.2 EFs for NH_3 emissions from fertilizers (in g NH_3 ($\text{kg N applied})^{-1}$)⁴². The emission factors used refer to cool climate and normal pH of soils. NH_3 emissions from sewage sludge applied to soils was estimated by the default emission factor of sewage sludge taken from (EMEP/EEA 2019, Table 3.1 Tier 1 EFs for source category 3.D) as 0.13 $\text{kg NH}_3 \text{ kg}^{-1}$ fertilizer N applied. Emissions of NO_x are calculated by Tier 1 methodology according to the EMEP/EEA 2019. For all fertilizer types the default emission factor of 4% (i.e. 0.04 kg NO_2 per kg applied fertilizer-N) is used. For 1990-2019, emissions of PM are estimated based on suggested Tier 2 EF's for agricultural crop operations in wet climate conditions. The implemented emission factors for PM emissions are represented in Table 5.19.

Table 5.19 PM emission factors (EF) for agricultural crop operations

Crop	Soil cultivation	EF, kg ha^{-1} for PM_{10}			EF, kg ha^{-1} $\text{PM}_{2.5}$			
		Harvesting	Cleaning	Drying	Soil cultivation	Harvesting	Cleaning	Drying
Wheat	0.25	2.7	0.19	0.56	0.015	0.02	0.009	0.168
Ray	0.25	2.0	0.16	0.37	0.015	0.015	0.008	0.111
Barley	0.25	2.3	0.16	0.43	0.015	0.016	0.008	0.129
Oat	0.25	3.4	0.25	0.66	0.015	0.025	0.0125	0.198
Other arable	0.25	NC	NC	NC	0.015	NC	NC	NC
Grass	0.25	0.25	0	0	0.015	0.01	0	0

NH_3 emissions from pasture grazed by livestock and animal manure applied to soils are derived by Tier 2 methodology that is implemented for NH_3 emissions calculation from manure management.

Proposed maximum HCB concentration (impurity factor) in active substances is used according to EMEP/EEA 2019 suggestions⁴³.

5.3.5 Activity data

Information regarding inorganic N-fertilizer use and the area covered by crops is provided by CSB of Latvia for the period of 1990-2019. The data about the use of nitrogen with inorganic fertilizers are included in Figure 5.4.

⁴² EMEP/EEA air pollutant emission inventory guidebook 2019. Table 3.2. Available at: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/3-d-crop-production-and/view>

⁴³ EMEP/EEA air pollutant emission inventory guidebook 2019. Table 4. Available at: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/3-d-f-3-i/view>

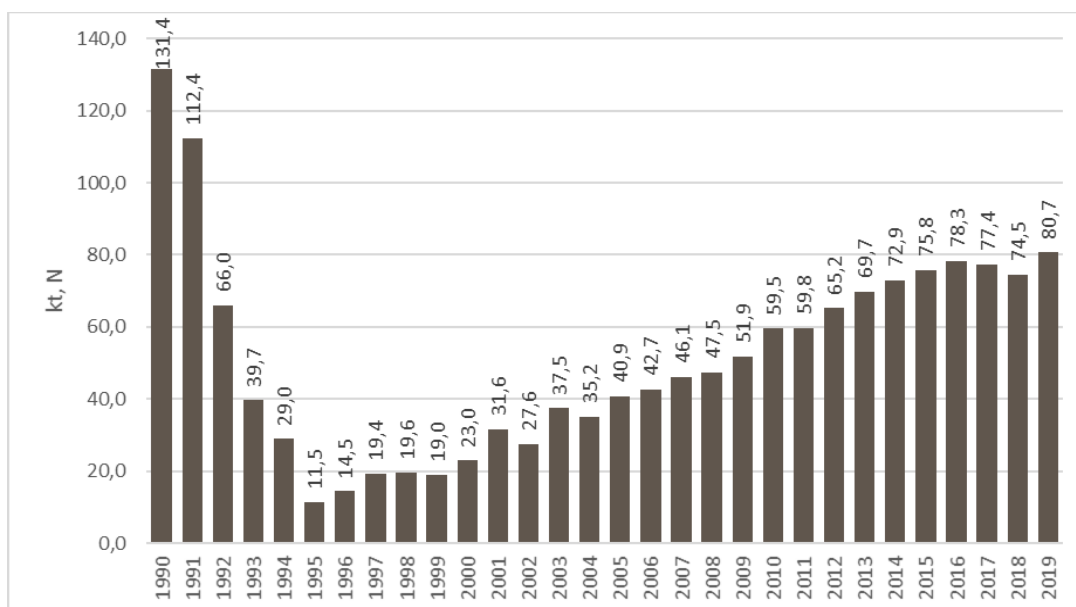


Figure 5.4 Used N with inorganic N-fertilizer 1990-2019, kt

The area covered by crops for period 1990-2019 is represented in Figure 5.5. Activity data source is CSB of Latvia.

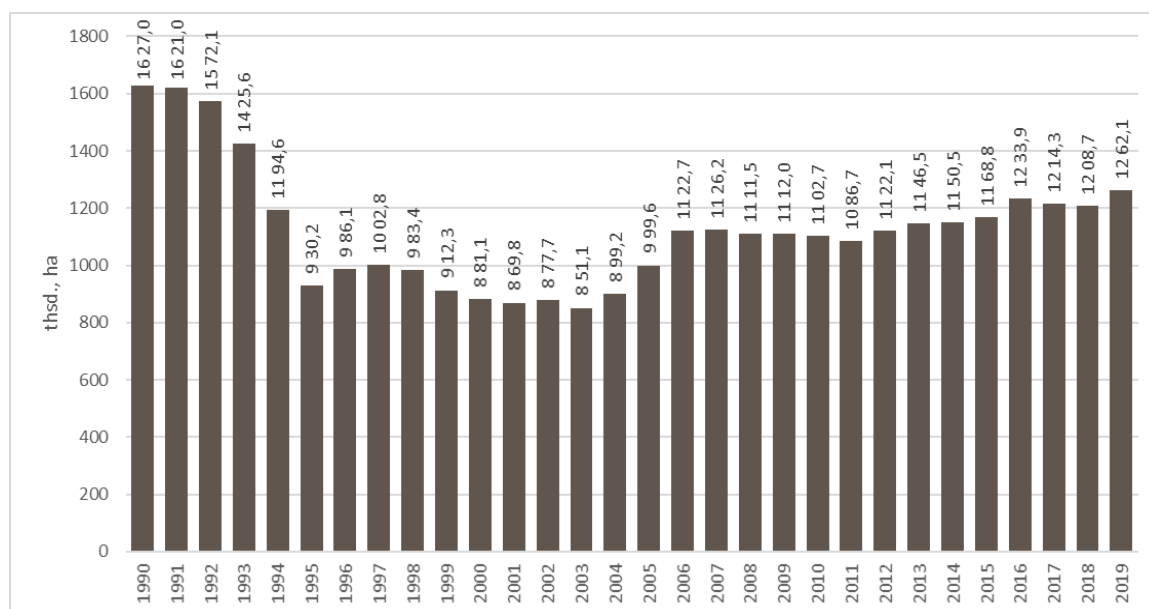


Figure 5.5 Area covered by crops 1990-2019, thsd. ha

Data on the amount of sewage sludge applied to agricultural soils are provided by State Ltd "Latvian Environment, Geology and Meteorology Centre" (LEGMC), other data of organic N fertilizer applied to soils are obtained from CSB of Latvia. The amount of nitrogen in sewage sludge and other organic fertilizers is calculated based on available research projects outcomes^{44;45}. Available data are represented in Figure 5.6.

⁴⁴ Gemste I., Vucāns A. (2010) Notekūdeņu dūņas. Jelgava, LLU, 276 lpp.

⁴⁵ Ličiņa I. (2013) Digestāta kā mēslošanas līdzekļa efektivitātes novērtējums kukurūzas sējuma. Zinātniski praktiskā konference LAUKSAIMNIECĪBAS ZINĀTNE VEIKSMĪGAI SAIMNIEKOŠANAI. Jelgava, LLU, 206-209 lpp.

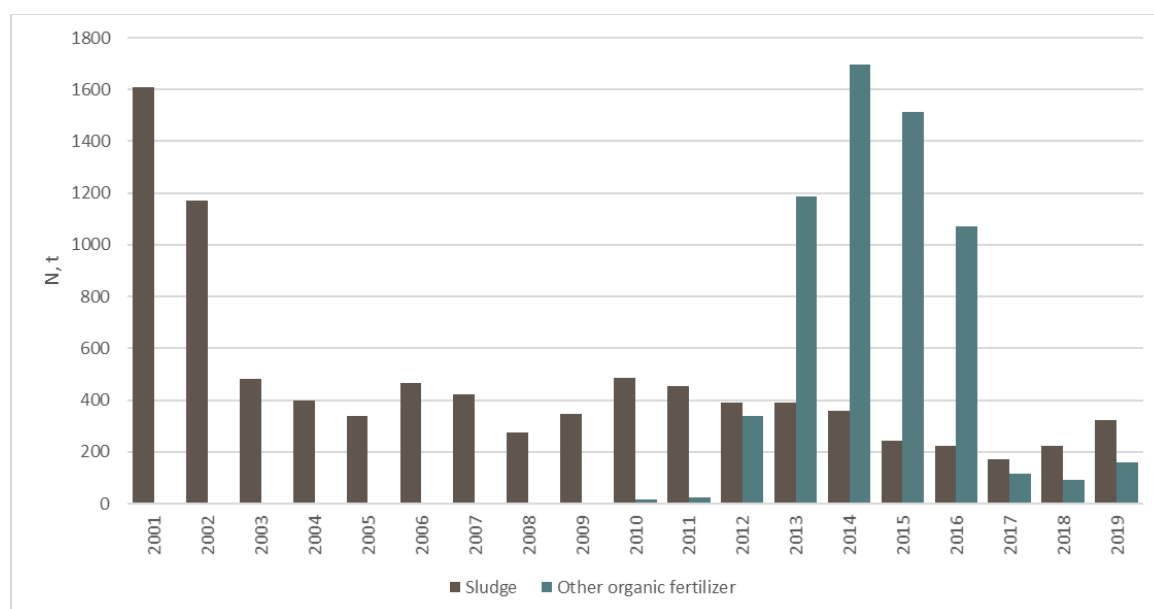


Figure 5.6 N in sewage sludge and other organic fertilizers applied to soils 2001-2019, t

Latvian statistics report the amount of fertilizers applied. Detailed statistics of the used amount of different fertilizer types in 2019 is available in Table 5.20.

Table 5.20 Activity data for the estimation of NH₃ emissions from application of inorganic fertilizers, t

Fertilizer type	2019
Ammonium nitrate (AN)	108090
Ammonium sulphate (AS)	38434
Calcium ammonium nitrate (CAN)	9852
Urea	13958
N solutions (UAN)	10697
Calcium nitrate	1002
Other N compounds	52496
NPK Mixtures	111647

The calculation results of NH₃ and NO_x emissions from application of sewage sludge is described in subcategory Da2b – Sewage sludge applied to soils. Nitrogen quantities from application of sewage sludge were calculated from data of LEGMC. NH₃ and NO_x emissions are calculated by multiplying the amounts of nitrogen in sewage sludge applied with the respective Tier 1 emission factors. To calculate nitrogen in sewage sludge, it is assumed that sewage sludge has a nitrogen content of 5.2% in the dry matter.

The subcategory 3Da2c – other organic fertilizers applied to soils describes Latvia's NH₃ and NO_x emissions from application of digestate and composts. Nitrogen quantities from application of digestate and composts were calculated from data of CSB of Latvia. It is assumed that digestate has nitrogen content of 5.85% in the dry matter and composts have around 2% of nitrogen in the dry matter.

Annual statistics on the quantities of plant protection products sold domestically and consumption are collected in limited amounts in Latvia. CSB of Latvia provides information on the total amounts of fungicides and bactericides, herbicides, insecticides and plant growth regulators use for cereals in 2014 and 2017, as well as for the use for vegetables and fruits in 2014 (on 1 ha of sown area as active substances, kg). Distributed quantities of active substances that cause HCB emissions during 2004-2018 are collected by State Plant Protection Service. Based on the available information from State Plant Protection Service data of pesticide use are estimated by expert for 1990-2003. Data of State Plant Protection Service have restricted access. For reporting C (confidential) is used for sources of pollutants.

5.3.6 Uncertainties

The uncertainty associated with activity data is received from CSB of Latvia. Generally, the uncertainty of activity data provided by CSB of Latvia is set as 2%. Uncertainty of emission factors is no less than 50% for NH₃ emissions.

5.3.7 QA/QC and verification

A sectorial expert performed assessment of trends. Statistical data are verified by CSB of Latvia.

5.3.8 Recalculations

Recalculations for the submission were mostly done under implementation of EMEP/EEA air pollutant emission inventory guidebook 2019 methodology. According to the new reporting guidelines, emission amount from digestate is determined under Manure management category, therefore to avoid double counting of emissions, reported amount of digestate used for fertilization by CSB is excluded from statistics used to calculate emissions under 3 D Crop production and agricultural soils.

Regarding to the TERT notes with reference to 3Da1 Inorganic N-fertilizers (includes also urea application) for NH₃ emissions the revised estimate is provided years 2005 and 2006 by used the Tier 2 EFs. Based on expert opinion, use of Tier 2 was investigate for the rest of the time series (1990-2004).

5.3.9 Planned improvements

Provide the more detailed investigation of Tier 2 use for 1990-2004 to calculate NH₃ emissions from 3Da1 Inorganic N-fertilizers.

5.4 Other (NFR 3I)

5.4.1 Overview

Under category 3I Other NO_x, NMVOC, SO₂, NH₃, PM_{2.5}, PM₁₀, BC, TSP, CO, PCDD/PCDF and PAHs emissions from grassland burning are included. Activities like this happen seasonally in Latvia.

5.4.2 Trends in emissions

Table 5.21 Emissions from grassland burning in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.007	0.007	0.029	0.026	0.032	0.042	0.009	0.016	0.026	0.035	384
NMVOC		0.019	0.018	0.077	0.069	0.085	0.111	0.023	0.042	0.069	0.091	384
SO₂		0.002	0.002	0.007	0.006	0.007	0.010	0.002	0.004	0.006	0.008	384
NH₃		0.002	0.002	0.007	0.006	0.007	0.010	0.002	0.004	0.006	0.008	384
PM_{2.5}	kt	0.008	0.007	0.032	0.028	0.035	0.046	0.010	0.017	0.028	0.038	384
PM₁₀		0.009	0.009	0.039	0.035	0.043	0.056	0.012	0.021	0.035	0.046	384
BC		0.001	0.001	0.003	0.003	0.003	0.004	0.001	0.002	0.003	0.003	384
TSP		0.015	0.014	0.060	0.054	0.066	0.086	0.018	0.033	0.053	0.071	384
CO		0.207	0.196	0.844	0.756	0.931	1.215	0.253	0.461	0.753	1.002	384
PCDD/F	g i-Teq	0.004	0.004	0.018	0.016	0.019	0.025	0.005	0.010	0.016	0.021	384
PAHs	t	0.014	0.014	0.058	0.052	0.064	0.084	0.017	0.032	0.052	0.069	384

Emission amount is directly dependent on the burned area of grassland (Table 5.21, Figure 5.7). The number of grassland fires and burned area of grassland is directly dependent on anthropogenic activities and meteorological conditions, especially during weekends in the spring. Wildfires in grasslands are more common in south eastern part of the country and around Riga. Concentration of wildfires in the south-east correlates with the area of abandoned farmlands. Decrease of the number of grassland fires and burned area of grassland is related to the rising awareness in society about dangers and negative ecological aspects of deliberate grassland burning. Moreover, grassland burning occurs unorganized and a fine may be applied

in accordance with the legislation in Latvia. Over the past 15 years, most (in numbers and area burned) grassland fires occurred in 2006.

5.4.3 Methods

Emissions from grassland burning were determined according to the EMEP/EEA 2019 and IPCC 2006. Emissions from wildfires in grassland were calculated using equation 2.27 of the IPCC 2006. Mass of available fuel in grassland's fires – 2.1 t DM ha⁻¹ (Table 2.4 of IPCC 2006), fraction of the biomass combusted 0.74 (Table 2.6 of IPCC 2006).

5.4.4 Emission factors

Emission factors for NO_x, CO, NMVOC, SO₂, NH₃, TSP, PM₁₀, PM_{2.5} and BC emission calculation regarding burning of grassland are shown in the Table 5.22 (EMEP/EEA 2019, 11.B Forest fires, Table 3-8). Information of condensable component inclusion in emission factors of PM is not provided by the EMEP/EEA 2019.

Table 5.22 Emission factors (EF) for grassland burning according to EMEP/EEA 2019

Pollutant	Value	Unit
NO _x	13	kg/ha area burned
CO	373	kg/ha area burned
NMVOC	34	kg/ha area burned
SO ₂	3	kg/ha area burned
NH ₃	3	kg/ha area burned
TSP	17	g/kg wood burned
PM ₁₀	11	g/kg wood burned
PM _{2.5}	9	g/kg wood burned
BC	9	% of PM _{2.5}

PAH emissions are calculated according to EMEP/CORINAIR Emission Inventory Guidebook, but DIOX emissions are calculated according to UNEP, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases. Emission factor is chosen as for Grassland and moor fires – 5 µg TEQ/t.

Currently used emission factors are the best available information. National researches on emission factors for grassland burning are not conducted.

5.4.5 Activity data

Area of grassland burning was taken from the SFRS and data is available starting from 1993 (Figure 5.7). For 1990-1992 no statistical information exists. However, an expert's assumption for years 1990-1992 was made, using extrapolation from burned areas of the following 5 years' period.

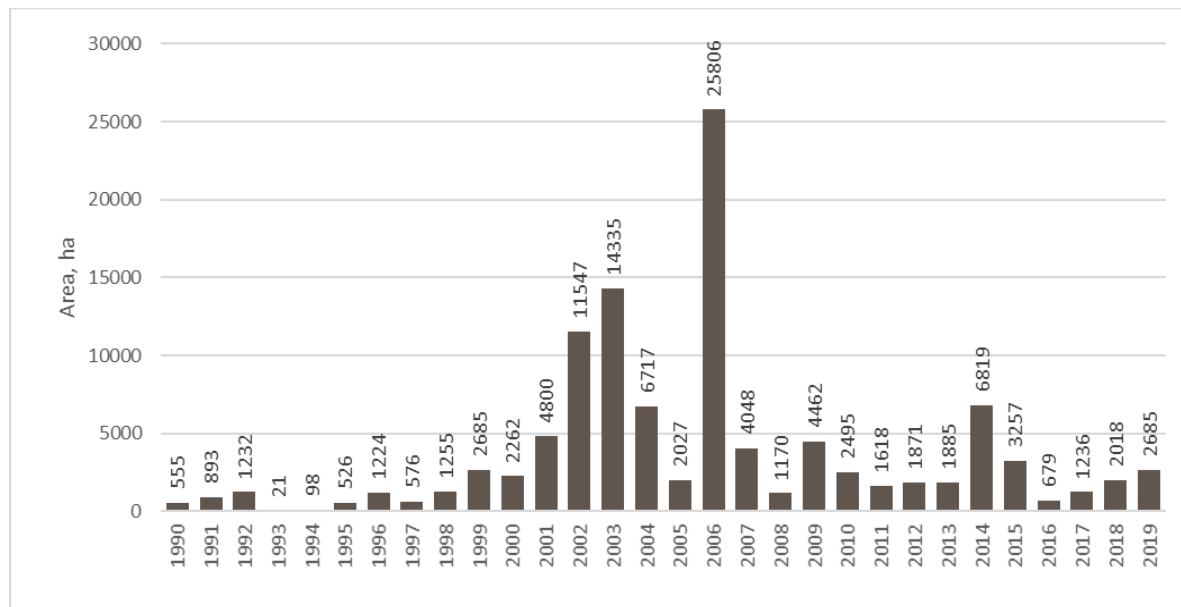


Figure 5.7 Area of last years grass burned (ha)

5.4.6 Uncertainties

Uncertainty of activity data (area) for biomass burning is estimated at $\pm 10\%$ based on expert judgement. Uncertainties in emission factors are based on the EMEP/EEA emission inventory guidebook 2019 (11.B Forest fires, Table 3-8) default values.

5.4.7 QA/QC and verification

Quality control procedures named in IPCC 2006 were done. Assessment of trends were performed. Land areas of wildfires burning were reviewed with latest statistics.

5.4.8 Recalculations

Recalculations are introduced due to improvement of activity data.

5.4.9 Planned improvements

No improvements are planned.

6 Waste (NFR 5)

6.1 Sector overview

6.1.1 Overview

Waste management has acquired prior significance in the environmental protection policy as one of the instruments for sustainable use of natural resources. The main directions in the waste management are the development of the construction of polygons and collecting system for non-hazardous municipal waste and the development of system for the collection and treatment of hazardous waste. Currently 11 non-hazardous waste polygons and 1 hazardous waste polygon have got A category permit according to IED directive 2010/75/EC. Biogas collection and use for energy production from biodegradable waste and sludge is set as one of the main priorities in Latvia.

Main activity data sources for emissions calculations in waste sector is the "3-Waste" data base, which is developed by LEGMC. According to the information from LEGMC the total generated volume of waste every year is shown in Table 6.1.

Table 6.1 Generated waste in Latvia, kt

	Municipal (all non-hazardous) waste	Hazardous waste	Total
2006	1420.46	54.37	1474.83
2007	1386.57	41.61	1428.18
2008	1368.79	46.40	1415.19
2009	1033.91	55.56	1089.47
2010	1131.40	55.09	1186.49
2011	1535.06	58.48	1593.53
2012	1799.44	85.12	1884.56
2013	1902.01	109.23	2011.24
2014	2013.70	80.98	2094.67
2015	2087.51	86.60	2174.11
2016	1980.28	63.66	2043.94
2017	2141.21	68.76	2209.97
2018	1587.74	118.14	1705.88
2019	1698.71	115.46	1814.17

Data of water abstraction and use, wastewater treatment and discharge has been collected since 1991 in the frame of the state statistical survey "2-Water". Data in the national database "2-Water" must be reported by all enterprises which have issued permits on water use, water resources use or mineral deposits quarry use, or IED permit.

Table 6.2 shows the methods and source for activity data and emission factors used for emission calculating in Waste sector. Table 6.3 shows list of pollutants which are produced in Waste sector.

Table 6.2 Source categories and methods for Waste sector

NFR code	Long name	Method	AD	EF
5A	Solid waste disposal on land	Tier 1	PS	D
5B1	Biological treatment of waste - Composting	Tier 1	PS	D
5B2	Biological treatment of waste – Anaerobic digestion	Tier1	CS	D
5C1bii	Hazardous waste incineration	Tier 1	PS	D
5C1biii	Clinical waste incineration	Tier 1	PS	D
5C1bv	Cremation	Tier 1	PS	D
5D	Waste-water handling	Tier 2	PS, CS	D
5E	Other (fires)	Tier2	CS	D

Table 6.3 Reported emissions in Waste sector in 2019

NFR code	Emissions
5A	NMVOC, PM _{2.5} , PM ₁₀ , TSP
5B1	NH ₃
5B2	NH ₃
5C1bii	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, BC, CO, Pb, Cd, Hg, As, Ni, PCDD/F, total PAHs, HCB
5C1biii	NO _x , NMVOC, SO ₂ , TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/F, total PAHs, HCB
5C1bv	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, total PAHs, HCB, PCBs
5D1	NMVOC, NH ₃
5D2	NMVOC
5D3	NMVOC
5E	PM _{2.5} , PM ₁₀ , TSP, Pb, Cd, Hg, As, Cr, Cu, PCDD/F

6.1.2 Key sources

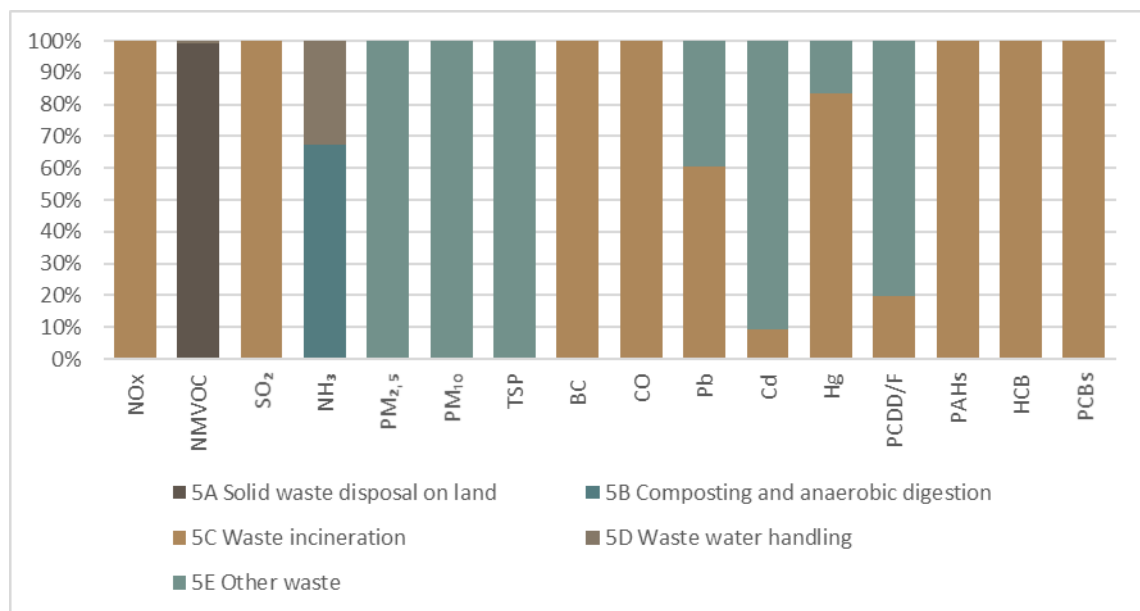


Figure 6.1 Distribution of emissions in Waste sector by subsectors in 2019, %

Almost all NMVOC emissions in Waste sector occur from solid waste disposal (NFR 5A), and largest part of NH₃ emissions are generated in anaerobic digestion process at biogas facilities as well as from composting (NFR 5B). All emissions of NO_x, SO₂, BC, CO, PAHs, HCB and PCB in Waste sector are caused by waste incineration (NFR 5C), and this subsector generates also the largest part of Pb and Hg emissions. Other waste subsector (fires; NFR 5E) produce almost all particulate matter emissions, as well as Cd and largest part of PCDD/F emissions. Wastewater handling (NFR 5D) produces a small part of NMVOC emissions and about one third of NH₃ emissions generated in Waste sector.

6.1.3 Trends in emissions

Emissions are increased since 1990 for NO_x and SO₂. It is due to cremation since 1994. NMVOC emission fluctuates through time series due to changes of disposed waste amounts. The main source for solid particles emission are fires (5E). As number of fires is estimated back till year 1990 there are no significant changes in emissions.

Table 6.4 Change in emissions from Waste sector between 1990-2019

Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019. %
NOx	0.00045	0.00100	0.00166	0.00168	0.00194	0.00202	0.00242	0.00303	0.00327	0.00337	639.7
NMVOC	0.220	0.257	0.299	0.267	0.307	0.274	0.274	0.269	0.272	0.280	27.2
SO2	0.00006	0.00013	0.00019	0.00024	0.00025	0.00028	0.00033	0.00041	0.00043	0.00046	685.7
NH3	0.227	0.214	0.209	0.218	0.244	0.252	0.269	0.254	0.291	0.271	19.5
PM2.5	0.22891	0.22891	0.22895	0.22896	0.22898	0.21678	0.20486	0.23689	0.21569	0.22905	0.1
PM10	0.22899	0.22901	0.22907	0.22908	0.22910	0.21689	0.20495	0.23699	0.21579	0.22914	0.1
TSP	0.23051	0.23078	0.23018	0.23097	0.22947	0.21739	0.20527	0.23762	0.21595	0.22952	-0.4
BC	3.24E-05	3.78E-05	2.22E-05	4.00E-05	5.05E-06	7.23E-06	3.99E-06	1.14E-05	5.73E-07	5.52E-06	-83.0
CO	0.00023	0.00035	0.00065	0.00038	0.00044	0.00034	0.00041	0.00058	0.00069	0.00057	151.0
Pb	0.0062	0.0071	0.0051	0.0073	0.0018	0.0018	0.0013	0.0028	0.0011	0.0017	-73.0
Cd	0.00202	0.00214	0.00186	0.00218	0.00146	0.00142	0.00128	0.00164	0.00130	0.00146	-27.6
Hg	0.0049	0.0063	0.0055	0.0080	0.0050	0.0056	0.0060	0.0078	0.0068	0.0079	61.9
PCDD/F	5.732	6.297	4.814	6.476	2.900	2.933	2.482	3.607	2.324	2.884	-49.7
PAHs	9.39E-09	3.00E-08	5.42E-08	6.01E-08	7.56E-08	8.18E-08	9.88E-08	2.83E-06	4.92E-06	3.37E-07	3486.9
HCB	0.0089	0.0104	0.0072	0.0109	0.0020	0.0022	0.0015	0.0034	0.0007	0.0020	-77.3
PCB	NA	0.00023	0.00046	0.00063	0.00086	0.00098	0.00119	0.00141	0.00152	0.00165	100.0

Emission estimates from the waste sector include:

- NMVOC, PM_{2.5}, PM₁₀, TSP emissions from solid waste disposal and fires (5E);
- NH₃ emissions from composting and anaerobic digestion;
- NMVOC, NH₃ emissions from waste water handling;
- Many pollutant emissions from incineration of hazardous and clinical waste and cremation. Emissions from waste incineration with energy recovery are counted under the Energy sector.

Data on hazardous waste in Latvia has been collected and compiled by LEGMC since 1997, but data on municipal waste since 2001. Since 2002 databases about hazardous and municipal waste are combined in one database - "3-Waste". Data in this database is taken from State Statistical survey about waste, which occurs every year. Statistical survey about waste must be filled by all enterprises, that have permits on pollutant activities (A and B category) and all enterprises, that have permits on waste management operations.

Data of wastewater treatment and discharge has been collected since 1991 in the frame of the state statistical survey "2-Water". State statistical survey "2-Water" must be reported by all enterprises which have issued permits on water use, water resources use or mineral deposits quarry use, or IED permit. CSB data is also used as activity data for emission calculation.

6.2 Solid waste disposal (NFR 5A)

6.2.1 Overview

Solid waste disposal is the main waste treatment operation in Latvia. Significant amount of landfill gas is emitted annually from waste disposal sites. NMVOC are part of landfill gas. NMVOC emissions relate to methane emissions from solid waste disposal.

6.2.2 Trends in emissions

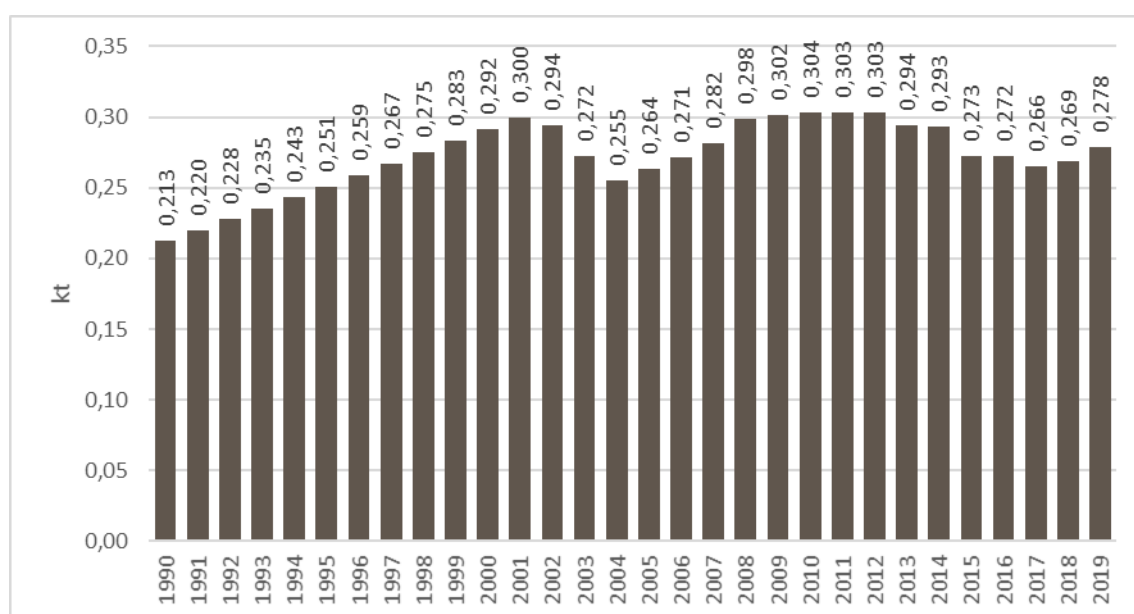


Figure 6.2 NMVOC emissions from Solid waste disposal, kt

Emissions of NMVOC from solid waste disposal (Figure 6.2) correlate with CH₄ emissions, which are calculated according to UNFCCC requirements. These emissions mostly relate to disposed waste amount in landfills. In years 2016 and 2017 emissions decrease due to lesser amount of disposed waste in landfills.

6.2.3 Methods

NMVOC, PM_{2.5}, PM₁₀, TSP emissions from solid waste disposal are calculated. EMEP/EEA 2016 is used for emission calculations. To estimate NMVOC, PM_{2.5}, PM₁₀, TSP emissions from solid waste disposal, disposed amount is multiplied with emission factors from "Table 3-1 Tier 1 emission factors for source category 5.A Biological treatment of waste - Solid waste disposal on land.

6.2.4 Emission factors

Table 6.5 Emission factors for disposed waste (EMEP/EEA 2016)

Pollutant	EF (unit/disposed waste)
NMVOC	5.65 g /1 m ³ landfill gas
PM _{2.5}	0.033 g/t
PM ₁₀	0.219 g/t
TSP	0.463 g/t

6.2.5 Activity data

To calculate PM_{2.5}, PM₁₀, TSP emissions - amount of disposed waste must be known.

Data about disposed amounts is taken from the waste statistical survey "3-Waste" (Figure 6.3).

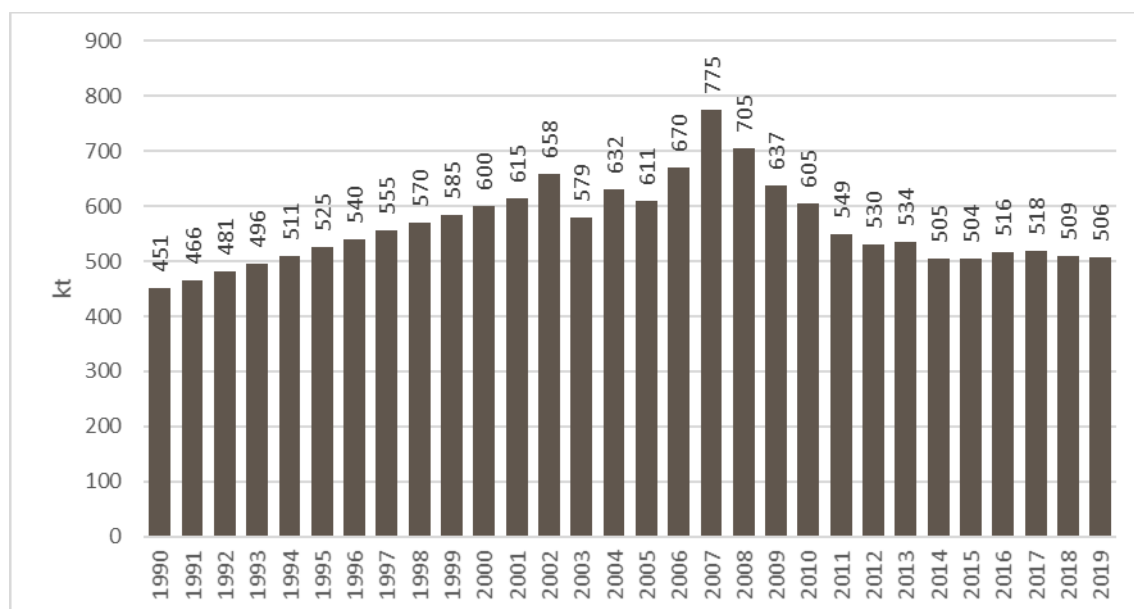


Figure 6.3 Disposed waste amounts in Latvia, kt

Disposed amounts for 1990-2001 are estimated according to equal growth between 1975 and 2002. The base year for disposed amount estimation is 1975. According to research about Latvia landfills (LEGMC, 2016) disposed amount in 1975 was 249 860 tonnes. Data about waste disposal on land for 2002-2019 is taken from the database “3-Waste”. Fluctuations in disposed waste amounts are due to economic growth in years 2007 and 2008. The disposed amount last year decreased due to waste recovery development.

To calculate NMVOC emissions - CH₄ emission from GHG inventory must be known. CH₄ emissions are calculated with IPCC 2006 waste model spreadsheet. Calculation are divided in two parts - for managed and unmanaged waste disposal sites.

6.2.6 Uncertainties

Uncertainty for activity data is estimated as 5.93%. The same uncertainty is used also for emission calculations in GHG inventory under UNFCCC.

6.2.7 QA/QC and verification

Disposed waste amounts are taken from waste database. Data in this database is checked and approved by Regional Environmental Boards. Check for emission calculations was done. Assessments of trends were performed.

6.2.8 Recalculations

NMVOC emissions are recalculated for all time series due to new estimation of CH₄ emissions from solid waste disposal. Disposed waste time series was prolonged till 1950.

6.2.9 Planned improvements

No planned improvements.

6.3 Composting and anaerobic digestion (NFR 5B)

6.3.1 Overview

NH₃ emissions from waste composting and manure anaerobic digestion are calculated under this category.

Composting is set as one of the priorities in waste treatment in Latvia. Composting biological degradable waste is useful. In Latvia that is mostly “park - garden” and “food production” waste.

Data about industrial composting became available 2003, when waste treatment companies started waste composting and got IPPC permits for this activity.

Composting in private households has been very popular for many years. Composted waste amount in households is estimated according household statistics from Central statistical bureau. To estimate composted amount research done by Waste Management Association of Latvia in 2015 about composting was taken into account.

6.3.2 Trends in emissions

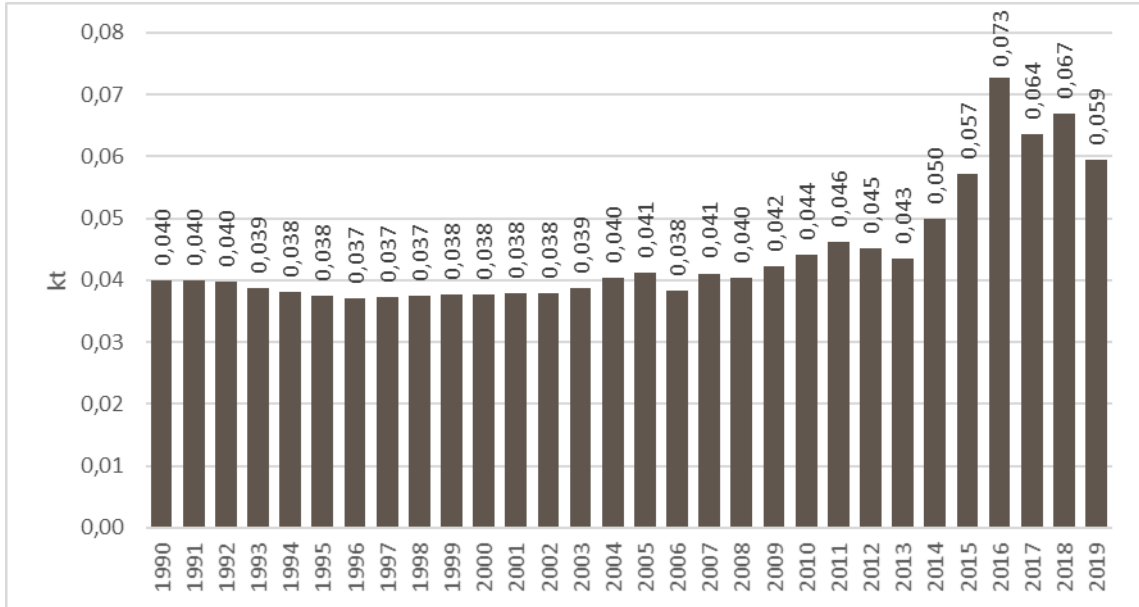


Figure 6.4 NH₃ emissions from composting, kt

Composting NH₃ emissions increase in 2016 was due to increase of industrial composting amounts.

Manure anaerobic digestion in biogas facilities starts in 2009. NH₃ emissions are calculated. Data is obtained from agriculture sector.

Table 6.6 Manure anaerobic digestion at biogas facilities

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AR feedstock, kt	0.01	0.60	0.77	1.64	2.24	2.56	2.29	2.41	2.95	3.69	3.69
NH ₃ emission, kt	0.00	0.02	0.03	0.05	0.07	0.09	0.08	0.08	0.10	0.12	0.12

6.3.3 Methods

Composted waste amount is multiplied by emission factor.

Ammonia emissions from anaerobic digestion at biogas facilities from manure are estimated by Tier 2 approach described in EMEP/EEA Guidebook 2019 5.B.2 chapter:

$$E_{NH_3} = AR_{feedstock} \cdot \sum_{stages} EF_{NH_3-N_i} \cdot 17/14$$

where AR feedstock - the total annual amount of N in feedstock estimated by EMEP/EEA Guidebook 2019 3.B-chapter Tier 2 approach section 3.4 in Step 8, kg N;

EF_{NH₃-N_i} - NH₃-N EF per stage: pre-storage – 0.0009 kg NH₃-N per kg N feedstock (Table 3.2), digester (considered negligible as described in section 2.3 EMEP/EEA Guidebook 2019 5.B.2 chapter), storage of digestate – 0.0266 kg NH₃-N per kg N feedstock (Table 3.3.).

Emissions associated with digestate application to the soil are described in chapter 5 AGRICULTURE (NFR3).

6.3.4 Emission factors

NH₃ emission factor (0.24 kg/t) for composting is taken from EMEP/EEA 2016.

For manure digestion in biogas facilities Tier 1 emission factor is 0.0286 kg NH₃-N per kg N in feedstock is used.

6.3.5 Activity data

Composted waste amount is taken from the "3-Waste" database, R3 - Recycling/reclamation of organic substances that are not used as solvents (including composting and other biological transformation processes), recovery operation for determination of composted amounts was used. Not all amounts, which classified under recovery as R3, are composted. To determine composted amount, each enterprise, which reports with recovery operations R3, working profile must be considered. Starting from 2013 separate R3A code for composting was implemented in legislation and reporting requirements of Latvia.

Table 6.7 Composted waste amounts, kt

	Industrial waste composted	Household waste composted	Total waste composted
1990	NO	166.89	166.89
1991	NO	166.26	166.26
1992	NO	165.31	165.31
1993	NO	161.73	161.73
1994	NO	158.93	158.93
1995	NO	156.41	156.41
1996	NO	154.46	154.46
1997	NO	155.34	155.34
1998	NO	155.98	155.98
1999	NO	157.37	157.37
2000	NO	157.14	157.14
2001	NO	158.18	158.18
2002	NO	158.18	158.18
2003	2.22	159.49	161.72
2004	7.91	160.05	167.96
2005	6.56	164.91	171.47
2006	11.70	148.18	159.88
2007	9.42	161.88	171.29
2008	9.28	159.23	168.51
2009	15.11	161.14	176.25
2010	18.55	165.19	183.74
2011	23.70	168.72	192.42
2012	17.62	170.79	188.41
2013	14.37	166.70	181.07
2014	40.04	168.25	208.29
2015	67.58	170.53	238.11
2016	135.22	167.82	303.04
2017	98.90	166.10	265.00
2018	112.25	166.17	278.42
2019	81.94	165.87	247.81

The share of manure used in anaerobic digestion is outcome of manure management system calculation algorithm developed according to pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections". Under the most important outcomes of 2009-2014 EEA Grants Programme National Climate Policy, based on national research results and provided by Latvia University of Life Sciences and Technologies.

Activity data of manure type and amount used for anaerobic digestion calculations is provided by Rural Support Service of Latvia.

6.3.6 Uncertainties

Uncertainty for activity data is estimated as 28%. The same uncertainty is used also for calculations in GHG inventory under UNFCCC.

Activity data uncertainty for anaerobic digestion of manure is 25%.

6.3.7 QA/QC and verification

Industrial composted waste amounts are taken from "3-Waste" data base. Data in this data base is checked and approved by Regional Environmental Boards. Assessments of trends have been performed.

6.3.8 Recalculations

No recalculations.

6.3.9 Planned improvements

No planned improvements.

6.4 Waste incineration (NFR 5C)

6.4.1 Overview

Currently there are no large amounts of waste being incinerated in Latvia without energy recovery. The main source of emissions is attributed to the hazardous and clinical waste incineration. The amounts of incinerated clinical waste are registered in the hazardous waste database (from 2002 in the "3-Waste" data base) as "Health service for humans and animals as well as related research waste" (European Waste catalogue class – 180103). The rest of the incinerated waste from hazardous waste database is considered as hazardous (industrial) waste.

Incinerated amounts for years 1990-1998 are extrapolated according to the average value of incinerated amount for years 2002-2013 what is attributed to disposed waste value.

In cremation sector 5C1bv emissions from human bodies and animal waste (carcasses) incineration are calculated.

6.4.2 Trends in emissions

Emissions are increased since 1990 for PM₁₀, PM_{2.5}, NO_x and SO₂. It is due to cremation emissions since 1994 and emissions from animal waste burning since 2011. NMVOC emission decreases till year 2016 due to decrease of incineration of hazardous waste. In years 2015 and 2016 hazardous waste was not incinerated in Latvia.

For clinical waste all 18 EWC (European Waste catalogue) group codes are counted. For clinical waste increase is in 2006 and 2007, when clinical waste was incinerated in hazardous waste incineration facility. From year 2008 facility was closed.

PM_{2.5}, PM₁₀, TSP emissions are calculated from animal (carcasses) waste burning. Data in the "3-Waste" data base is available from year 2011. Bird factory and cattle remains were burned in installation without energy recovery.

Table 6.8 Emissions in Waste incineration in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2017	2018	2019	Change in 1990-2019, %
NO_x		0.00045	0.00100	0.00166	0.00168	0.00194	0.00202	0.00303	0.00327	0.00337	639.7
NMVOC		0.00231	0.00270	0.00516	0.00168	0.00152	0.00004	0.00107	0.00182	0.00014	-94.1
SO₂	kt	0.00006	0.00013	0.00019	0.00024	0.00025	0.00028	0.00041	0.00043	0.00046	685.7
PM_{2.5}		0.00000	0.00000	0.00004	0.00005	0.00007	0.00018	0.00012	0.00013	0.00014	11394.8
PM₁₀		0.00000	0.00000	0.00004	0.00005	0.00007	0.00020	0.00012	0.00013	0.00014	6469.9

TSP		0.00141	0.00164	0.00101	0.00180	0.00030	0.00057	0.00063	0.00017	0.00040	-71.9
BC		0.00003	0.00004	0.00002	0.00004	0.00001	0.00001	0.00001	0.00000	0.00001	-83.0
CO		0.00023	0.00035	0.00065	0.00038	0.00044	0.00034	0.00058	0.00069	0.00057	151.0
Pb	t	0.00553	0.00646	0.00443	0.00666	0.00112	0.00122	0.00208	0.00051	0.00101	-81.7
Cd		0.00069	0.00081	0.00053	0.00085	0.00013	0.00016	0.00026	0.00005	0.00013	-80.6
Hg		0.00357	0.00501	0.00414	0.00668	0.00370	0.00436	0.00639	0.00560	0.00661	84.9
PCDD/F	g I-Teq	3.41614	3.98127	2.49803	4.16042	0.58378	0.73998	1.20989	0.13916	0.56845	-83.4
PAHs	t	9.4E-09	3.0E-08	5.4E-08	6.0E-08	7.6E-08	8.2E-08	2,8E-06	4,9E-06	3,4E-07	3486.9
HCB	kg	0.00888	0.01044	0.00719	0.01087	0.00200	0.00221	0.00342	0.00069	0.00202	-77.3
PCB		NA	0.00023	0.00046	0.00063	0.00086	0.00098	0.00141	0.00152	0.00165	100.0

6.4.3 Methods

For emissions calculation EMEP/EEA 2016 methodology was used. The amount of incinerated waste was multiplied with emission factors.

6.4.4 Emission factors

Table 6.9 Emission factors for waste incineration

	Units EF	Industrial EF	Clinical EF	Animal EF
NO_x	kg/t	0.87	2.3	-
NMVOG	kg/t	7.4	0.7	-
SO₂	kg/t	0.047	0.54	-
CO	kg/t	0.07	0.19	-
PM_{2.5}	kg/t	0.004	NE	0.538
PM₁₀	kg/t	0.007	NE	0.628
TSP	kg/t	0.01	17	0.897
Pb	g/t	1.3	62	-
Cd	g/t	0.1	8	-
Hg	g/t	0.056	43	-
As	g/t	0.016	0.2	-
Cr	g/t	NE	2	-
Cu	g/t	NE	98	-
Ni	g/t	0.14	2	-
Se	g/t	NE	NE	-
Zn	g/t	NE	NE	-
PCDD/PCDF	µg i-Teq/t	350	40	-
PAHs	g/t	0.02	0.04	-
HCB	g/t	0.002	0.1	-
PCBs	g/t	NE	NA	-

Emissions from cremation are calculated according to EMEP/EEA 2016.

Table 6.10 Emission factors from cremation

	EF	Units EF
NO_x	0.825	kg/body
NMVOG	0.013	kg/body
SO₂	0.113	kg/body
CO	0.14	kg/body
PM_{2.5}	34.70	g/body
PM₁₀	34.70	g/body
TSP	38.56	g/body
CO	0.14	kg/body
Pb	30.03	mg/body
Cd	5.03	mg/body
Hg	1.49	g/body
As	13.61	mg/body
Cr	13.56	mg/body

	EF	Units EF
Cu	12.43	mg/body
Ni	17.33	mg/body
Se	19.78	mg/body
Zn	160.12	mg/body
PCDD/ PCDF	0.027	µg/body
benzo(a) pyrene	13.2	µg/body
HCB	0.15	mg/body
PCBs	0.41	mg/body

6.4.5 Activity data

Table 6.11 Incinerated waste in Latvia, kt

	Hazardous waste	Clinical waste	Animal waste	Total
1990	0.429082	0.116729	NO	0.810708
1991	0.404964	0.110168	NO	0.765137
1992	0.380845	0.103606	NO	0.719567
1993	0.356726	0.097045	NO	0.673997
1994	0.332607	0.090484	NO	0.628427
1995	0.308488	0.083922	NO	0.582857
1996	0.321434	0.087444	NO	0.607317
1997	0.341924	0.093018	NO	0.646031
1998	0.362414	0.098592	NO	0.684744
1999	0.347210	0.201420	NO	0.750146
2000	0.690280	0.056410	NO	1.188603
2001	1.319270	0.213310	NO	2.364508
2002	0.165643	0.032247	NO	0.301688
2003	0.201813	0.040607	NO	0.368726
2004	0.210125	0.112325	NO	0.445552
2005	0.215127	0.102127	NO	0.444831
2006	0.786160	0.261890	NO	1.527627
2007	0.540500	0.350861	NO	1.200583
2008	0.299750	0.012361	NO	0.505465
2009	0.200000	0.011663	NO	0.340263
2010	0.200000	0.012843	NO	0.341302
2011	0.006300	0.012738	0.366092	0.343765
2012	NO	0.018049	0.348861	0.322881
2013	NO	0.005887	0.479833	0.427434
2014	0.166927	0.010341	0.316603	0.493301
2015	NO	0.018498	0.185480	0.203978
2016	NO	0.010198	0.186535	0.196733
2017	0.135432	0.02906	0.042067	0.206559
2018	0.2396	0.00138	NO	0.24098
2019	0.01	0.014121	NO	0.024121

Emissions from cremation are calculated according to EMEP/EEA 2016.

Data about burned bodies provided by operators of crematorium.

Table 6.12 Burned bodies in Riga and Valmiera crematoriums

Burned bodies	
1994	54
1995	564
1996	819
1997	817
1998	869
1999	982
2000	1127
2001	1297

Burned bodies	
2002	1293
2003	1389
2004	1391
2005	1529
2006	1630
2007	1959
2008	2227
2009	1977
2010	2102
2011	2158
2012	1970
2013	2150
2014	2222
2015	2395
2016	2396
2017	3343
2018	3708
2019	4029

6.4.6 Uncertainties

Uncertainty for cremation of bodies is not estimated, because it is correct figure from crematorium. Uncertainty of incinerated amount from the "3-Waste" database is 47%. The same uncertainty is also used for calculations in GHG inventory under UNFCCC.

6.4.7 QA/QC and verification

Incinerated waste amounts are taken from waste database. Data in this database is checked and approved by Regional Environmental Boards. Assessments of trends were performed.

QA/QC and verification included:

- Quality check of activity data in the period of reporting;
- Quality check in calculation of emissions for UNFCCC NIR.

6.4.8 Recalculations

No recalculations.

6.4.9 Planned improvements

No planned improvements.

6.5 Waste water handling (NFR 5D)

6.5.1 Overview

Data of LEGMC shows there were 177 million m³ of waste water discharged in Latvia, including 126 million m³ of treated wastewater (2019). Most of national population (82%, 2019) is served by centralized urban waste water collecting and treatment.

6.5.2 Trends in emissions

Table 6.13 NMVOC and ammonia emissions from Waste water handling, kt

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NMVOC	0.0053	0.0032	0.0023	0.0020	0.0020	0.0018	0.0017	0.0021	0.0019	0.0019	-64.5
NH₃	0.1867	0.1762	0.1709	0.1767	0.1798	0.1181	0.1160	0.0920	0.1005	0.0882	-58.2

NH₃ emissions are slightly decreasing over entire period (Table 6.13) due to factors as slow decrease of national population, increase of collection and treatment of waste water. Emissions of NMOVC are stable around 0.002 kt/a in the period of last 20 years.

Domestic waste water handling is main source of NMVOC emissions in waste water handling sector, contributing on average 77% of sector emissions (75% in 2019). Industrial and other waste water handling subsectors have less significance, contributing on average 10% and 13% of emissions, correspondingly (or 3% and 22% correspondingly in 2019).

6.5.3 Methods

For emission calculation, EMEP/EEA 2016 was used as methodology source (Table 6.14). According to methodology, activity data is multiplied by according emission factors to calculate emissions, and for both substances emitted methodologies are considered to be Tier 2 methods.

Amount of treated waste water (i.e. activity data to estimate NMVOC emissions) were divided into three flows: domestic (municipal waste water collection and treatment), industrial (manufacturing industry) and other (agriculture, fisheries, services etc.), and NMVOC emissions were calculated separately for each flow, and reported correspondingly as NFR 5D1 (domestic), NFR 5D2 (industrial) and NFR 5D3 (other).

Emissions of NH₃, originating only from latrines, are reported under sector NFR 5D1 (domestic waste water).

6.5.4 Emission factors

Table 6.14 Activity data and emission factors for calculation of NH₃ and NMVOC emission from NFR 5D

	Activity data	Emission factor value	Emission factor unit
NH ₃	Population using latrines	1.6	kg/person/year
NMVOC	Amount of waste water produced	15	mg/m ³ waste water

Default EMEP emission factors for both NH₃ and NMVOC were used.

6.5.5 Activity data

Activity data was taken from water use, treatment and discharge national statistics (data base of the state statistical survey "2-Water").

Table 6.15 Activity data type and value example

	Source of activity data	Activity data value (2019)
NH ₃	Population using latrines	55 (thousands of people)
NMVOC	Amount of waste water treated and discharged	126 (millions of m ³)

Population using latrines was estimated through rate of urbanization (data of World Bank and CSB of Latvia) and degree of treatment and discharge pathway or method for national population not connected to waste water collecting system (IPCC Guidelines 2006). Part of national population, not connected to centralized waste water collecting and treatment system, are served with septic tanks, which, according to EMEP/EEA 2016, is not a source of NH₃ emissions.

Statistical data on number of national population served or not served by waste water collecting and treatment services is available since 2000. Extrapolation was used to obtain part of population not served for period 1990-1999. Extrapolation and change in reporting procedure implemented in 2008 and again in 2011 can lead to some inconsistency of statistical data results.

Extrapolation was also used to divide amount of treated waste water between flows of domestic, industrial and other waste water for period 1990-1999, when exact statistical data were not available.

Table 6.16 Activity data and result of emission (NH₃, NMVOC) calculations from NFR 5D 1990-2019

	Population using latrines	Emission of NH ₃ , kt	Amount of domestic waste water treated and discharged, mio m ³	Amount of industrial waste water treated and discharged, mio m ³	Amount of other waste water treated and discharged, mio m ³	Emission of NMVOC, kt
1990	116 677	0.187	246	63.6	45.6	0.00533
1991	116 116	0.186	237	58.8	43.4	0.00508
1992	115 787	0.185	221	52.6	40.0	0.00470
1993	114 275	0.183	182	41.9	32.5	0.00384
1994	111 525	0.178	173	38.2	30.5	0.00362
1995	110 136	0.176	155	32.8	27.1	0.00323
1996	108 987	0.174	146	29.5	25.2	0.00301
1997	108 060	0.173	145	28.1	24.8	0.00297
1998	107 052	0.171	144	26.5	24.3	0.00292
1999	106 560	0.170	129	22.6	21.5	0.00259
2000	106 820	0.171	117	19.5	17.4	0.00230
2001	123 355	0.197	115	18.2	17.6	0.00226
2002	115 184	0.184	116	18.1	17.1	0.00226
2003	95 618	0.153	104	15.8	16.3	0.00204
2004	112 632	0.180	105	11.4	16.1	0.00199
2005	110 467	0.177	104	12.2	16.2	0.00199
2006	106 278	0.170	99	11.1	16.1	0.00189
2007	104 270	0.167	112	9.7	15.5	0.00205
2008	121 969	0.195	103	8.3	13.6	0.00187
2009	112 388	0.180	94	8.8	9.73	0.00168
2010	112 364	0.180	104	6.3	21.9	0.00198
2011	80 555	0.129	105	8.7	14.1	0.00192
2012	82 693	0.132	101	8.7	9.58	0.00179
2013	79 108	0.127	103	9.7	14.3	0.00191
2014	79 484	0.127	98	9.4	17.0	0.00186
2015	73 801	0.118	98	9.7	14.2	0.00183
2016	72 530	0.116	100	4.6	9.57	0.00171
2017	57529	0.092	105	4.5	33.0	0.00214
2018	62 841	0.101	93	4.2	26.8	0.00185
2019	55 098	0.088	95	4.1	27.4	0.00189

Considerable increase of amount of treated other waste water in the last years are due to emerging of rather large amount of treated waste water from fisheries un quarrying facilities.

6.5.6 Uncertainties

The following uncertainties have been calculated for Wastewater Handling sector for activity data and emission factors. Uncertainties were estimated, using similar methodology as in the UNFCCC NIR.

Table 6.17 Uncertainties for Waste Water handling sector

Emission	Activity data	Emission factor
NH ₃	10%	200%
NMVOC, combined	7%	150%
NMVOC, 5D1 (domestic waste water handling)	8%	150%
NMVOC, 5D2 (industrial waste water handling)	21%	
NMVOC, 5D3 (other waste water handling)	12%	

6.5.7 QA/QC and verification

QA/QC and verification included:

- Quality check of activity data in the period of annual reporting, when water using enterprises are submitting their annual water data (including both number of national population served by waste water collection and/or certain type and level of treatment, and amount of total waste water discharged); data is submitted electronically in the water statistics data base "2-Water", and only

after a quality check, performed by an inspector of Regional Environment Board of State Environment Service, the particular report is included in national statistics.

- Quality check in calculation of emissions for UNFCCC NIR;
- Trend analysis;
- Additional data checks were performed to increase the quality of waste water statistics itself.

6.5.8 Recalculations

NMVOC emissions were recalculated for reporting period 2000-2018 due to update of activity data. However, significant changes in emissions it caused only for year 2012.

6.5.9 Planned improvements

No improvements are planned.

6.6 Other waste (NFR 5E)

6.6.1 Overview

Emissions from various types of fires are estimated since 1990.

To estimate emissions from fires, data from Fire and Rescue service was used. Data from Fire and Rescue service is available since 2011. Every year Fire and Rescue service publishes a report on number of fires in the country. According to EMEP/EEA 2016 guidelines number of industrial, undetached house and car fires are used for emissions calculations. For years 1990-2010 average number of fires from years 2011 to 2018 are used as activity data.

6.6.2 Trends in emissions

Table 6.18 Emissions in Other waste in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2017	2018	2019	Change in 1990-2019, %	
PM_{2.5}	kt	0.2289	0.2289	0.2289	0.2289	0.2289	0.2166	0.2368	0.2155	0.197326	-13.8	
PM₁₀		0.2289	0.2289	0.2289	0.2289	0.2289	0.2166	0.2368	0.2155	0.197326	-13.8	
TSP		0.2289	0.2289	0.2289	0.2289	0.2289	0.2166	0.2368	0.2155	0.197326	-13.8	
Pb	t	0.0007	0.0007	0.0007	0.0007	0.0007	0.0006	0.0007	0.0006	0.000572	-14.0	
Cd		0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0013	0.001144	-14.0	
Hg		0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0014	0.0013	0.001144	-14.0	
As		0.0021	0.0021	0.0021	0.0021	0.0021	0.0020	0.0022	0.0020	0.001842	-14.0	
Cr		0.0020	0.0020	0.0020	0.0020	0.0020	0.0019	0.0021	0.0019	0.001747	-14.0	
Cu		0.0047	0.0047	0.0047	0.0047	0.0047	0.0045	0.0049	0.0044	0.004068	-14.0	
PCDD/F		g I-Teq	2.3158	2.3158	2.3158	2.3158	2.3158	2.1934	2.3969	2.1844	2.001362	-13.6

6.6.3 Methods

Number of fires multiplied with emissions factors from EMEP/EEA Guidebook 2016.

6.6.4 Emission factors

Table 6.19 Emission factors from fires

	Unit	Industrial	Undetached	Car
PM_{2.5}	kg/fire	27.23	61.62	2.3
PM₁₀	kg/fire	27.23	61.62	2.3
TSP	kg/fire	27.23	61.62	2.3
Pb	g/fire	0.08	0.18	-
Cd	g/fire	0.16	0.36	-
Hg	g/fire	0.16	0.36	-
As	g/fire	0.25	0.58	-
Cr	g/fire	0.24	0.55	-
Cu	g/fire	0.57	1.28	-

	Unit	Industrial	Undetached	Car
PCDD/F	mg/fire	0.27	0.62	0.048

6.6.5 Activity data

Table 6.20 Number of fires

	Industrial	Undetached	Car
2011	282	3678	449
2012	252	3770	468
2013	263	3647	566
2014	271	3804	633
2015	300	3359	621
2016	269	3181	610
2017	208	3727	624
2018	258	3359	670
2019	175	3100	669

Statistics show that there are 200-300 events of industrial fires and 3100-3800 fires of undetached houses per annum with a fluctuating trend between years.

6.6.6 Uncertainties

Not estimated.

6.6.7 QA/QC and verification

Activity data taken from Fire and Rescue service annual report. This data is verified by the responsible persons for data publications.

6.6.8 Recalculations

No recalculation.

6.6.9 Planned improvements

No planned improvements.

7 Other and Natural emissions (NFR 6A, 11B)

7.1 Biomass burning on - site in the forest (NFR 6A)

7.1.1 Sectoral overview

This category (NFR 6A) comprises NO_x, CO, PM_{2.5}, PM₁₀, TSP, PCDD/PCDF and PAHs emissions arising from burning on site in forest (Table 7.1).

Table 7.1 Emissions from on – site burning in the forest in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.163	0.225	0.350	0.072	0.048	0.049	0.050	0.050	0.051	0.050	
PM_{2.5}		1.336	1.840	2.864	0.590	0.394	0.403	0.411	0.410	0.420	0.411	
PM₁₀	kt	1.633	2.248	3.500	0.721	0.482	0.492	0.503	0.501	0.513	0.502	
TSP		2.523	3.475	5.409	1.115	0.745	0.761	0.777	0.775	0.793	0.776	
BC		0.120	0.166	0.258	0.053	0.036	0.036	0.037	0.037	0.038	0.037	-69
CO		11.577	15.943	24.819	5.114	3.419	3.492	3.563	3.555	3.637	3.560	
PCDD/F	g i-Teq	0.742	1.022	1.591	0.328	0.219	0.224	0.228	0.228	0.233	0.228	
PAHs	t	2.458	3.385	5.269	1.086	0.726	0.741	0.756	0.755	0.772	0.756	

Variation of the emissions depends from the annual felling stock and the approach used to utilize harvesting residues. Since 2005 it is becoming more common to use harvesting residues from final felling in forest biofuel production, therefore, incineration and other types of utilization of residues are not used widely anymore in final felling. In thinning harvesting residues are used to improve soils bearing capacity during forwarding. The study on the actual utilization practice was implemented by LSFRI Silava in 2012 and 2014. The results demonstrated that no harvesting residues are incinerated in state forests and in 15 % of the clear-felling sites (by area) harvesting residues are incinerated in private forests⁴⁶. Due to lack of information about transition between previous practice and correct figures of incineration of harvesting residues, it is assumed that incineration of harvesting residues is reduced in 2011, but earlier studies⁴⁷ are used for previous years.

7.1.2 Methodological issues

2006 IPCC Guidelines, EMEP/EEA 2019 and EMEP/CORINAIR simpler methodologies were used. Emissions were estimated as follows: emission factor multiplied by activity data provided by National forest inventory, State forest service and Fire and Rescue Service.

7.1.3 Emission factors and other parameters

For CO and NO_x emission calculation from burning on - site in the forest default emission factors according to 2006 IPCC Guidelines, Volume 4, Chapter 2, Table 2.5 were used. For PM_{2.5}, PM₁₀, TSP and BC emission calculation from burning on - site in the forest default emission factors according to EMEP/EEA 2019, 11.B Forest fires, Table 3-1 (Table 7.2) were used. Information of condensable component inclusion in emission factors of PM is not provided by the EMEP/EEA 2019.

Table 7.2 Emission factors for open burning of forests

	Value	Unit
CO	78 ± 31	g kg ⁻¹ dry matter burnt
NO_x	1.1 ± 0.6	g kg ⁻¹ dry matter burnt
TSP	17	g kg ⁻¹ wood burned

⁴⁶ Lazdiņš, A., Zariņš, J., 2013. Meža ugunsgrēku un mežizstrādes atlieku dedzināšanas radītās siltumnīcefekta gāzu emisijas Latvijā (Greenhouse gas emissions due to forest fires and incineration of harvesting residues in Latvia), in: Referātu tēzes. Presented at the Latvijas Universitātes 71. zinātniskā konference "Ģeogrāfija, ģeoloģija, vides zinātne", Latvijas Universitāte, Rīga, pp. 133–137.

⁴⁷ Līpiņš, L., 2004. Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums).

	Value	Unit
PM ₁₀	11	g kg ⁻¹ wood burned
PM _{2.5}	9	g kg ⁻¹ wood burned
BC	9	% of PM _{2.5}

Emission factors for PAHs were estimated by multiplying the benz[a]pyrene emission factor by the appropriate ratios (Table 7.3).

Table 7.3 PAHs emission factors for open burning of forests

PAH	Default emission factor (best estimate), g t ⁻¹	Ratio	Emission factor, g t ⁻¹
Benzo [b] fluoranthene	7.2	0.6	4.32
Benzo [k] fluoranthene	7.2	0.3	2.16
Benz [a] pyrene	7.2	1.0	7.20
Indeno [123cd] pyrene	7.2	0.4	2.88

Dioxins (PCDD/ PCDF) are calculated according to the UNEP methodology (97. pp.), emission factor – 5 micrograms TEQ/t incinerated material.

The following assumptions were made for burnt harvesting residues calculation (Source: State Forest Service, private forest owners questionnaires):

- 1990 to 2000 – 50 % of harvesting residues left for incineration and 67 % incinerated, the rest left to decay;
- 2001 to 2004 – 30 % of harvesting residues left for incineration and 67 % incinerated and 70 % left to decay;
- 2005 to 2009 – 7 % of harvesting residues left for incineration and 100 % burned on-site, the rest left for decay or extracted for bioenergy production.
- starting from 2010 – 4 % of harvesting residues left for incineration and 100 % burned on-site, the rest left for decay or extracted for bioenergy production.

7.1.4 Activity data

Emissions from controlled fires were calculated considering average stock of harvesting residues (BEFs for conversion of stem biomass to above-ground biomass). Emissions increased due to increase of estimates of harvesting stock (Figure 7.1).

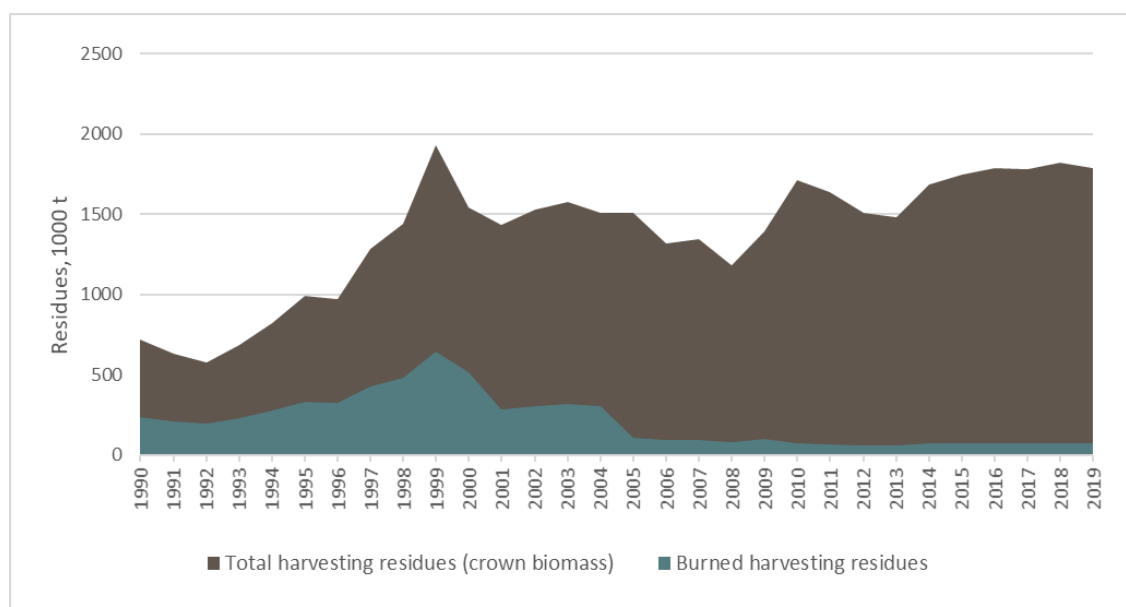


Figure 7.1 Harvesting residues, 1000 tons

7.1.5 Uncertainties

Combined activity data uncertainty is $\pm 92.6\%$. Uncertainties of emission factors are based on the 2006 IPCC Guidelines' and EMEP/EEA 2019 default values.

7.1.6 Recalculations

Recalculations are introduced due to improvement of activity data.

7.1.7 Planned improvements

No improvements are planned.

7.2 Forest wildfires (NFR 11B)

7.2.1 Sector overview

This source category (NFR 11B) includes NO_x , NMVOC, SO_x , NH_3 , CO, $\text{PM}_{2.5}$, PM_{10} , TSP, BC, PCDD/PCDF and PAHs emission from wildfires in forest land (Table 7.4).

Table 7.4 Emissions from forest wildfires in 1990-2019

	Unit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	Change in 1990-2019, %
NO_x		0.049	0.102	0.250	0.023	0.060	0.083	0.078	0.050	0.544	0.156	219
NMVOC		0.129	0.268	0.658	0.060	0.159	0.218	0.206	0.133	1.432	0.411	219
SO₂		0.010	0.020	0.050	0.005	0.012	0.017	0.016	0.010	0.109	0.031	219
NH₃		0.011	0.023	0.057	0.005	0.014	0.019	0.018	0.011	0.123	0.035	219
PM_{2.5}	kt	0.141	0.330	0.902	0.089	0.247	0.351	0.332	0.217	2.334	0.677	379
PM₁₀		0.173	0.404	1.103	0.109	0.302	0.428	0.405	0.265	2.853	0.827	379
TSP		0.267	0.624	1.705	0.169	0.466	0.662	0.627	0.409	4.409	1.279	379
BC		0.013	0.030	0.081	0.008	0.022	0.032	0.030	0.019	0.210	0.061	379
CO		1.393	2.889	7.106	0.648	1.712	2.360	2.227	1.431	15.465	4.439	219
PCDD/F	g i-Teq	0.079	0.183	0.501	0.050	0.137	0.195	0.184	0.120	1.297	0.376	379
PAHs	t	0.260	0.608	1.660	0.165	0.454	0.645	0.610	0.399	4.294	1.245	379

7.2.2 Methodological issues

EMEP/EEA 2019, 2006 IPCC Guidelines and EMEP/CORINAIR simpler methodologies were used. Emissions were estimated as follows: emission factor multiplied by activity data provided by National forest inventory, State forest service and Fire and Rescue Service. Dioxins (PCDD/ PCDF) were calculated according to the UNEP methodology (97. pp), emission factor – 5 micrograms TEQ/t incinerated material.

Amount of burned biomass was considered according to the average growing stock of living biomass, dead wood and litter in the particular year. Combustion efficiency or fraction of biomass combusted (dimensionless) was considered 0.45 according to Table 2.6 of 2006 IPCC Guidelines⁴⁸.

7.2.3 Emission factors and other parameters

For NO_x , NMVOC, SO_x , NH_3 , CO, $\text{PM}_{2.5}$, PM_{10} , BC and TSP emission calculations from forest wildfires were used default emission factors according to EMEP/EEA 2019, 11.B Forest fires, Table 3-5 (Table 7.5). Information of condensable component inclusion in emission factors of PM is not provided by the EMEP/EEA 2019.

Table 7.5 Emission factors for forests wildfires

	Value	Unit
NO_x	190	kg ha ⁻¹ area burned
CO	5400	kg ha ⁻¹ area burned

⁴⁸ Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types.

	Value	Unit
NMVO	500	kg ha ⁻¹ area burned
SO_x	38	kg ha ⁻¹ area burned
NH₃	43	kg ha ⁻¹ area burned
TSP	17	g kg ⁻¹ wood burned
PM₁₀	11	g kg ⁻¹ wood burned
PM_{2.5}	9	g kg ⁻¹ wood burned
BC	9	% of PM _{2.5}

Emission factors for PAHs were estimated by multiplying the benz[a]pyrene emission factor by the appropriate ratios (Table 7.3).

7.2.4 Activity data

The statistics on forest wildfire areas are compiled by the State forest service and they are based on information given by the local units. Area of forest fires and biomass in burned area is shown in Figure 7.2.

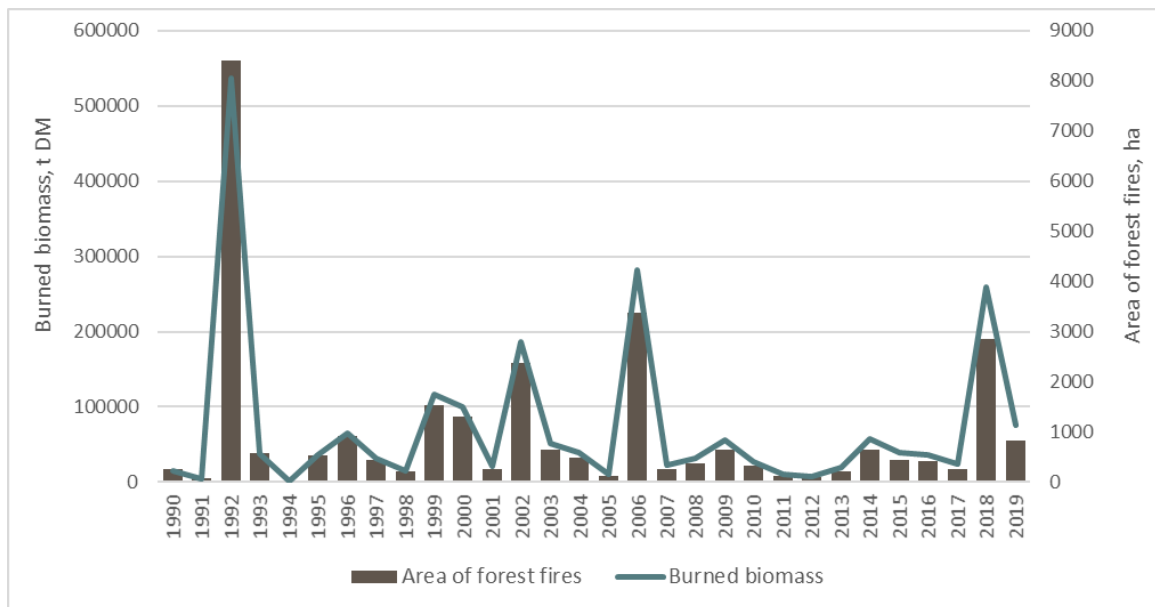


Figure 7.2 Area of forest fires and biomass in burned area

7.2.5 Uncertainties

Combined activity data uncertainty is $\pm 37.4\%$. Uncertainties of emission factors are based on the EMEP/EEA 2019 default values.

7.2.6 Recalculations

Recalculations are introduced due to improvement of activity data.

7.2.7 Planned improvements

No improvements are planned.

8 Recalculations, improvements and recommendations from the TERT

8.1 Recalculations

Recalculations made in Submission 2021 can be seen in Figure 8.1.

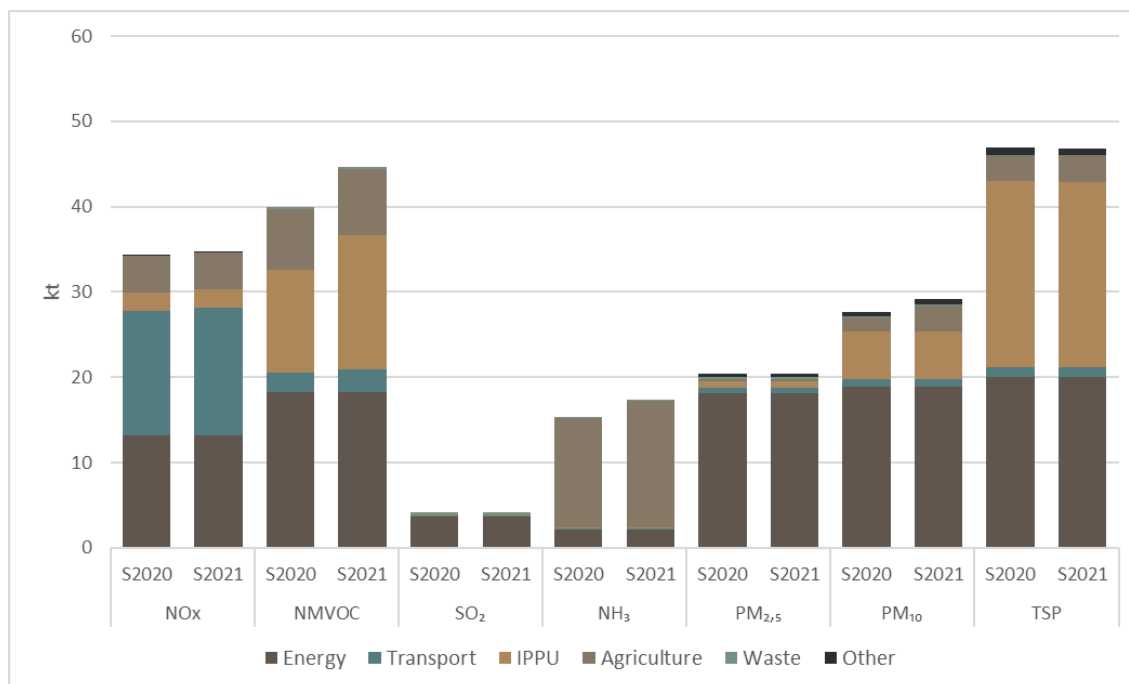


Figure 8.1 Emission comparison for 2018 between Submission 2020 and Submission 2021

Comparing reported emissions of 2018 in Submission 2020 and Submission 2021, NO_x emissions have increased by 1.2%. NMVOC emissions have increased by 11.8% mainly due to the recalculations in Solvent use (IPPU) sector. NH₃ emissions have increased by 13.1%. SO₂ emissions have decreased by 0.1%. Total PM_{2.5} emissions have decreased by 0.1%. Total PM₁₀ emissions have increased by 5.1% and TSP decreased by 0.1%.

Detailed information about recalculations done in each sector is described in appropriate chapter.

8.2 Planned improvements

Planned improvements are:

Energy sector

- Calculate emissions using a Tier 2 methodology for category 1A1a (1990 – 2004);
- Work on developing Tier 2 calculation methodology for biomass combustion in sector NFR 1A4a;
- Work on developing Tier 2 calculation methodology for sector NFR 1A4ciii Fishing.

IPPU sector

- It is planned to improve NMVOC emission estimation under 2D3a subsector according to EMEP 2019 guidelines.

Agriculture sector

- It is planned to quantify and prepare detailed documentations of abatement strategies for ammonia emissions to provide implementation of them in the inventory by using data from Agricultural Data Center data base "Housing infrastructure and manure storage";

- Provide the more detailed investigation of Tier 2 use for 1990-2004 to calculate NH₃ emissions from 3Da1 Inorganic N-fertilizers.

Waste sector

- No improvements planned.

8.3 Recommendations from the TERT

Table 1. All recommendations, revised estimates, technical corrections and unquantified potential technical corrections including those additionally made during the NECD Review 2020 and those not implemented from previous reviews, for NO_x, NMVOC, SO₂, NH₃, PM_{2.5}

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)	Chapter in the IIR
LV-1A4ciii-2019-0001	Yes	1A4ciii Agriculture/Forestry/Fishing: National Fishing, NOX, 1990-2018	For category 1A4ciii Agriculture/Forestry/Fishing: National fishing, liquid fuels, NOX for all years, the TERT noted, with reference to the NFR tables and IIR page 68, that there is a lack of transparency regarding the improvement plan about changing Tier methodology. This does not relate to an over- or under-estimate of emissions that is above the threshold of significance. This was raised during the 2019 NECD review. In response to a question raised during the review, Latvia explained that steps to gather information necessary to switch from Tier 1 to Tier 2 calculation methodology will be taken this year to try to implement higher Tier methodology in the next submission. The TERT recommends that Latvia calculate 1A4ciii NOX emission by using a higher Tier methodology in its next submission.	Included as planned improvement.	3.2.7.8
LV-3B-2019-0001	Yes	3B Manure Management, NOX, NH3, 2000-2018	For 3B Manure Management and NH3 and NOX emissions for all years, the TERT noted that there is a lack of transparency regarding the parameters used to complete the N-flow. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia provided the parameters used and an example of implementation of the N-flow for dairy cows for 2018 which was really clear. The TERT recommends that Latvia includes in its IIR a detailed example of the N-flow implemented for dairy cows for one year, underlining in particular how emissions related to anaerobic digestion are treated and reported in order to increase transparency.	N – flow example is given for dairy cow for 2019 in Annex III.	Annex III
LV-3B-2020-0002	Yes	3B Manure Management, NOX, NH3, NMVOC, PM2.5, 2000-2018	For 3B Manure Management, for NH3 emissions, for all years, the TERT noted that there is a lack of transparency regarding the methodology applied to estimate emissions from animals with manure handled in anaerobic digesters. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia explained that the total annual amount of N in feedstock (estimated in Tier 2 step 8 according to the 2016 EMEP/EEA Guidebook 3.B Manure	More explanations are given in description of methodology and also in N – flow example for dairy cows in Annex III.	Annex III, Chapter 5.2.3 and 6.3.3.

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)	Chapter in the IIR
			management) is used, with the Tier 1 approach described in chapter 5.B.2 Biological treatment of waste. The TERT recommends that Latvia includes more explanations in its IIR regarding the calculation and reporting of emissions from anaerobic digestion for the next submission.		
LV-3B-2020-0003	Yes	3B Manure Management, NOX, NH3, NMVOC, PM2.5, 2000-2018	For 3B Manure Management for all pollutants for all years, the TERT noted that there is a lack of transparency regarding the allocation of animals per MMS over time. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia provided the allocation of animals per MMS over time in a very clear document. The TERT recommends that Latvia includes the information provided during the review in its IIR for the next submission.	The information of MMS per livestock categories for 1990 – 2019 is provided.	Annex III
LV-3B1a-2020-0002	Yes	3B1a Manure Management - Dairy Cattle, NOX, NH3, 2000-2018	For 3B1a Manure Management - Dairy Cattle and 3B1b Manure Management - Other Cattle for NH3 and NOX emissions, for all years, the TERT noted that there is a lack of transparency regarding the methodology applied to estimate the N excreted. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia provided the information on the methodology applied, which is the one described in the 2006 IPCC Guidelines. The TERT recommends that Latvia includes the information provided during the review in its IIR for the next submission, including also the values of the different parameters used (e.g. gross energy intake, milk yield, net energy for growth, weight gain).	More information on N _{ex} estimation is provided in report. Gross energy intake, milk yield and milk fat content are provided for improvement of transparency.	Chapter 5.2.3., Annex III
LV-3Da1-2019-0001	Yes	3Da1 Inorganic N-fertilisers (includes also urea application), NH3, 1990-2018	The TERT notes with reference to 3Da1 Inorganic N-fertilizers (includes also urea application) for NH3 emissions for 2005 that a Tier 1 method is used for a key category. The TERT notes that using a Tier 1 method is not best practice and could result in an over- or under-estimate of emissions. This over- or under-estimate may have an impact on total emissions that is above the threshold of significance. Latvia has provided a revised estimate but the TERT do not agree with the number provided. In the revised estimate provided, Latvia used the oldest mix per fertiliser form known (year 2007), applied it to the total amount of N (national statistical data) and used the Tier 2 EF as it is done for 2007-2018. The TERT wants to commend Latvia for the effort done to provide the revised estimate. However,	More information on recalculations is provided in the report. 3Da1 Inorganic N-fertilizers (includes also urea application) for NH ₃ emissions the revised estimate is provided years 2005 and 2006 by used the Tier 2 EFs.	Chapter 5.3.8 and 5.3.9

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)	Chapter in the IIR
			<p>Latvia expressed its interest for other options to improve the estimates. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 2 method, and therefore the issue will be flagged as Potential Technical Correction and will be assessed as a high priority item in future reviews. The TERT recommends that Latvia further explore the possibility of using the available data on urea for 2005. Indeed, Latvia knows the amount of N from urea that is spread in 2005 : this amount should be kept for the calculation. In the revised estimate suggested, there is less urea than the real amount (which is provided also). For the N left (Total N – Urea N), Latvia could apply the mix between other fertiliser forms, estimated without taking urea into account. This estimated mix without urea would be applied to the N left. Another suggestion would be to estimate the mix of the N from fertilisers other than urea according to expert opinion, or to further explore the possibility to access these data.</p> <p>The TERT recommends that Latvia calculates NH₃ emissions from 3Da1 Inorganic N-fertilizers (includes also urea application) using a Tier 2 or Tier 3 method for inclusion in next years' inventory submission for the years 2005 and 2006, and recommends Latvia to investigate relevant proxies to enable a Tier 2 estimate for the rest of the time series (1990-2004).</p>	Based on expert opinion, use of Tier 2 was investigate for the rest of the time series (1990-2004).	
LV-3Da2a-2019-0001	Yes	3Da2a Animal Manure Applied to Soils, NOX, NH ₃ , 2000-2017	<p>For category 3Da2a Animal Manure Applied to Soils, for pollutants NH₃ and NOX, the TERT noted that there is a lack of transparency with regard to the emission associated with the application of digestates from the anaerobic digestion of manures to agricultural soils. This was raised during the 2019 NECD review. Latvia explained that it has been done to avoid double counting. This is due to use of statistical data on digestate application provided by the Central Statistical Bureau (CSB) which is not available by feed stock type used for anaerobic digestion. Thus, reported amount includes also digestate from manure. The 2020 review noted that the IIR states that the issue has been included in the list of improvements and that the recommendation will be addressed in the next submission.</p> <p>The TERT reiterates the recommendation that Latvia includes the explanation provided during the 2019 NECD review in its IIR and further explore the possibility to report those emissions in 3Da2a.</p>	Emissions from digestate from manure are reported in 3Da2a. More information on is included in the report.	Chapter 5.2.3 and 5.3.8., Annex III

Table 2. All recommendations, revised estimates, technical corrections and unquantified potential technical corrections including those additionally made during the NECD Review 2020 and those not implemented from previous reviews, for heavy metals and POPs

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)	Chapter in the IIR
LV-1A1a-2019-0001	Yes	1A1a Public Electricity and Heat Production, NOX, PM2.5, PCBs, HCB, Hg, Pb, 1990 - 2017	<p>The TERT confirmed that Latvia implemented the previous revised estimate for category 1A1a Public Electricity and Heat Production for the years 2005 - 2018 (IIR section 8.3, table 3). The TERT noted that it is good practice to use a consistent methodology throughout the time series. The TERT noted that category 1A1a is a key category for pollutant Hg in 1990, but that the potential over- or under-estimate is below the threshold of significance for a technical correction. In response to a question raised during the review, Latvia explained that information from the national database "2-Air" and LCP was gathered to perform the calculations using Tier 2 methodology, but that prior to 2005 information from these sources are not available.</p> <p>The TERT recommends that Latvia attempts to find additional data sources that could help to perform a Tier 2 emission estimate for category 1A1a for the years 1990 - 2004 in the next submission.</p>	Work in progress	3.2.4.9
LV-1A2gviii-2019-0002	Yes	1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other, NOX, NH3, NMVOC, PM2.5, HCB, Cd, Hg, Pb, PCDD/F, 1990 - 2017	<p>The TERT noted that the Revised estimate for category 1A2gviii Stationary combustion in manufacturing industries and construction: other and pollutants NOX, NH3, NMVOC, PM2.5, HCB, Cd, Hg, Pb and PCDD/F that was provided by Latvia at the end of the 2019 review has been implemented in the 2020 inventory (see IIR 3.2.5.8). The TERT noted that the Revised estimate only included gaseous fuels and that a Tier 1 methodology is still being used for other fuel types. The TERT noted that the use of a Tier 1 methodology for a key category is not best practice. In response to a question raised during the review, Latvia provided a partial revised estimate, calculating emissions of Pb, Cd, Hg, NMVOC, NOX and PM2.5 from solid fuels using emission factors from the 2016 EMEP/EEA Guidebook. The TERT notes that the revised estimate does not cover emissions of NH3, HCB or PCDD/F and does not cover emissions from biomass altogether. Therefore, the TERT does not fully agree with the revised estimate provided. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 2 method, and therefore the issue will be flagged as Potential Technical Correction and will be assessed as a high priority item in future reviews.</p>	Tier 2 method used to calculate emissions from solid fuel in 1A2gviii	3.2.5.3

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)	Chapter in the IIR
			The TERT recommends that Latvia calculates emissions from 1A2gviii using a Tier 2 or Tier 3 method for all fuels and pollutants NOX, NH3, NMVOC, PM2.5, HCB, Cd, Hg, Pb and PCDD/F, for inclusion in next years' inventory submission.		
LV-1A4ai-2019-0002	Yes	1A4ai Commercial/Institutional: Stationary, NMVOC, PM2.5, PCBs, Cd, Hg, 1990 - 2017	<p>The TERT noted that the Revised estimate for category 1A4ai Commercial/Institutional: stationary and pollutants NMVOC, PM2.5, Cd, Hg and PCBs that was provided by the Member State at the end of the 2019 review has been implemented in the 2020 inventory (see IIR 3.2.7.8). The TERT noted that the Revised estimate only included gaseous fuels and that a Tier 1 methodology is still being used for other fuel types. The TERT noted that the use of a Tier 1 methodology for a key category is not best practice. In response to a question raised during the review, Latvia provided a partial revised estimate, calculating emissions of NMVOC, PM2.5, PCBs, Cd and Hg from solid fuels using emission factors from the 2016 EMEP/EEA Guidebook. The TERT notes that the revised estimate does not cover emissions from biomass altogether. Therefore, the TERT does not fully agree with the revised estimate provided. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 2 method, and therefore the issue will be flagged as Potential Technical Correction and will be assessed as a high priority item in future reviews.</p> <p>The TERT recommends that Latvia calculates emissions from 1A4ai using a Tier 2 or Tier 3 method for all fuels and pollutants NMVOC, PM2.5, Cd, Hg and PCBs, for inclusion in next years' inventory submission.</p>	Work in progress	3.2.7.9
LV-2A3-2020-0001	Yes	2A3 Glass Production, Pb, 2016, 2017	<p>For 2A3 glass production and emissions of Pb for the years 2016-2018, the TERT noted that in response to a question raised during the review Latvia explained that from 2007 onwards only glass fibre has been produced in Latvia, for which no Pb emissions are to be expected, but did not provide a revised estimate. The TERT decided to calculate a technical correction for the years 2007-2018, which was accepted by Latvia. The estimates demonstrate that the issue is above the threshold of significance.</p> <p>The TERT recommends that Latvia includes a revised estimate in its next submission.</p>	Revised estimates and additional information are included in this IIR submission.	Chapter 4.2.4.1 and 4.2.4.8

Table 3. All recommendations, revised estimates and unquantified potential technical corrections made during the NECD Review 2020 for LPS data

Observation	GNFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)
LV-LPS-GEN-2020-0002	General, 2015	For the LPS reporting, the TERT noted that two facilities reported under the PRTR had not been included in the LPS reporting. In response to a question raised during the review Latvia provided information on the two facilities not reported in the LPS submission. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Latvia includes all relevant LPS in the next submission.	Recommendation included as Planned improvement due to the unavailable PRTR report.
LV-LPS-GEN-2020-0003	General, SO ₂ , NO _x , NH ₃ , NMVOC, PM _{2.5} , BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, PM ₁₀ , CO, BC, 2015	For the LPS reporting, the TERT noted that there is a lack of transparency regarding the LPS emissions and the links to the national inventory. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia explained that the documentation will be improved in the 2021 submission. The TERT recommends that Latvia includes more documentation of the LPS emissions in the next submission, e.g. by including information on whether the LPS emissions are used directly in the inventory, the share of national emissions covered by LPS emissions and any differences between the LPS reporting and the reporting under PRTR.	Information included in Chapter 10.2 Large Point Sources (LPS).
LV-LPS-B-2-2020-0002	B-2 Industry, NO _x , 2015	For LPS IDs 953592 Kronospan and Latvijas Finieris AS, Lignums and Granuul Invest Sia and AKZ SIA and emissions of NO _x in 2015, the TERT noted that there is a lack of transparency regarding their exact IDs and thus differences in reporting between EPRTR and LPS. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Latvia explained that these are four separate enterprises that are located very close to each other, and not all of them fall under EPRTR reporting obligations. The TERT recommends that Latvia provide a thorough description of differences between LPS and EPRTR reporting in their next IIR.	Recommendation included as Planned improvement due to the unavailable PRTR report.
LV-LPS-E-2020-0001	E Solvents, 2015	For GNFR code E_Solvents the TERT noted that no emissions are reported under LPS, whilst emissions are reported for NFR code 2D3g Chemical Products in the national inventory. In response to a question raised during the review Latvia informed the TERT that estimates for GNFR code E_Solvents will be included in the 2021 submission. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Latvia includes information on emissions for E_Solvents in their 2021 LPS submission.	In 2021 LPS submission there is no facility that meets the E_Solvents criterion.

Table 4. All recommendations and unquantified potential technical corrections made during the NECD Review 2020 for gridded data

Observation	GNFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)
LV-GRID-GEN-2020-0002	General, NOX, NH3, PM2.5, Cd, Pb, PM10, CO, 2015	<p>For the pollutants NOX, NH3, PM2.5, Cd, Pb, PM10 and CO, the TERT noted that there are a number of locations (grid cells) where gridded and LPS data are inconsistent. The TERT had compared gridded emissions for each grid cell with LPS emissions (allocated to the respective grid cell), where several inconsistencies were found where LPS emissions exceed gridded emissions. In response to a question raised during the review Latvia explained that the LPS values are not taken into account for the preparation of the national inventory, and as such the gridded data (derived from the national inventory) are not consistent with the Large Point Sources.</p> <p>The TERT recommends that for the next submission, Latvia improves the consistency between gridded and LPS data to the extent possible and reports in the IIR on the level of consistency between these two datasets, and what attempts have been undertaken to improve consistency.</p>	<p>When comparing national total gridded and LPS data results - 16 inconsistencies were found. After reviewing them, as many recommendations to improve data consistency was performed as possible at the given moment.</p> <p>For NH₃ issues - consistency was improved for K_AgriLivestock (NFR code: 3B3 and 3B4g) by detailing in territorial units and identifying LPS as points in these units, so units value could fall in the correct grid not dispersed in many.</p> <p>For other LPS pollutants weight in emission proportion was reviewed and adjusted to represent the emissions in national level: NMVOC and SO_x in C_Other Stationary (NFR code: 1A4ai), SO_x in A_Public Power (NFR code: 1A1a), PM_{2.5} and PM₁₀ in B_Industry (NFR code: 1A2gviii). Still, it was not possible to correctly adjust allocation methodology for three inconsistencies.</p> <p>For LPS consistency with national total gridding following improvements are considered:</p> <ol style="list-style-type: none"> 1) review location of large pollution sources; 2) review applied proportion for ABC pollution categories to improve data consistency for gridded and LPS data correctly; 3) improved approach for LPS weight in NFR sector recalculations could be considered.
LV-GRID-F-2020-0001	F Road Transport, NOX, 2015	<p>For the pollutant NOX and GNFR category F_RoadTransport, the TERT noted a geographical allocation issue. This does not relate to an over- or under-estimate of emissions. The TERT found that the emissions are centred in Riga, with very little emissions in other areas compared to other countries. In response to a question raised during the review, Latvia explained that road transport emissions are</p>	<p>Changes in methodology for spatial scatter were made according to expert judgement and after discussion about available spatial data. For regional spatial dispersion motorways ("A category" roads) were</p>

Observation	GNFR, Pollutant(s), Year(s)	Recommendation	LV Response (status of implementation)
		<p>geographically disaggregated using traffic and road intensities provided by Latvian State Roads. When looking in more detail, the TERT found that the emissions in Riga are very high compared to other cities in Latvia and other countries, when considering emissions per capita. While the TERT cannot provide conclusive evidence, the TERT believes the distribution methodology may be over allocating emissions to Riga. One reason could be that the “maximum road load” have been used to distribute emissions in Riga for smaller roads, which may partly explain this over-estimate.</p> <p>The TERT recommends that for the next submission, Latvia checks the methodology used for distributing emissions from road transport, with a focus on potential over-allocation of emissions in Riga, and where appropriate uses an updated methodology for the next submission. The TERT also recommends Latvia to report on the findings in the next submission of the IIR.</p>	<p>mapped with added traffic intensity data per different intervals and for urban spatial dispersion densely populated territories with value above 10 000 were identified. For Riga city population data agglomeration value was included in proportion rather than the one in the administrative unit. For all types of road transport urban and rural proportions were applied by expert judgement.</p> <p>For gridding Road transport emissions following improvements are considered:</p> <ol style="list-style-type: none"> 1) review if local “P category” roads should be applied and weighted in emission allocation; 2) review if densely populated territories with value above 5 000 have to be taken in consideration when allocating emissions.

9 Projections

9.1 Overview of emissions projections

As a member of the European Union, Latvia is obliged to report to the European Commission emission projections according to Article 8 of Directive (EU) 2016/2284 of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC or NEC directive.

The year 2018 (base year) and the Informative inventory report submitted under the Convention on Long-Range Transboundary Air Pollution on 15.03.2020 has been used as a starting point for the projections.

Emissions are projected for the scenario with current policies and existing measures (WEM) and the scenario with additional measures (WAM). The emission projection is done using the macroeconomic indicators forecast for the year 2050 elaborated by the Ministry of Economics (Gross Domestic Product (GDP), Value Added (VA), private consumption and the number of population). The projections are calculated for NO_x, NMVOC, SO₂, NH₃, PM_{2,5} and BC emissions.

The submission contains:

1. Report on Projections of National Emissions in Latvia;
2. Emission projections reporting template (Annex IV).

9.2 Emission reduction targets for 2020 and 2030

On 31 December 2016, Directive (EU) 2016/2284 of the European Parliament and the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC or NEC directive entered into force. The Directive sets out new emission reduction commitments for Latvia (see Table 9.1).

To ensure the legal framework for meeting the requirements for reaching the target of emission reduction, on 12 April 2018 amendments to the Law on Pollution⁴⁹ were adopted. The given amendments stipulate that Latvia shall have to reduce total emissions of NO_x, NMVOC, SO₂, NH₃, PM_{2,5} in the period 2020-2029 and the year 2030 onwards. The targets for reducing the mentioned emissions for the stated period and 2030 onwards were laid down in Cabinet Regulations No 614 of 2 October 2018 "Emissions reduction and accounting rules of gross air pollutants"⁵⁰ (hereinafter – Cabinet Regulations No 614).

Table 9.1 Emission reduction commitments for Latvia

Emission	For any year from 2020 to 2029	For any year from 2030
SO₂	8 %	46 %
NO_x	32 %	34 %
NMVOC	27%	38 %
NH₃	1 %	1 %
PM_{2.5}	16 %	43 %

Note: The reduction commitments have the year 2005 as base year

⁴⁹ Latvijas Republikas Saeima. Grozījumi Likumā "Par piesārņojumu". Pieņemti 2018.gada 12.aprīlī, stājās spēkā 2018.gada 10.maijā, <https://likumi.lv/ta/id/298653>

⁵⁰ MK 2018.gada 2.oktobra noteikumi Nr. 614 "Kopējo gaisu piesārņojošo vielu emisiju samazināšanas un uzskaites noteikumi"

9.3 Projected emissions with existing measures (WEM) and with additional measures (WAM)

The scenarios underlying the emission projections in the 2021 submission incorporate new insights with regard to economic and demographic developments, sector developments, fossil fuel prices and policies when compared with the projection of 2019 submission.

The Ministry of Economics has prepared a base scenario for economic growth and a corresponding macroeconomic forecast. The scenario was developed in line with the settings of the structural policy of Latvia, as set out in the policy documents – “Sustainable Development Strategy of Latvia until 2030”, “Latvia's National Development Plan for 2021-2027”. It also takes into account the impacts of the Covid-19 pandemic and analyses the processes that drive the development of the global economy. The baseline scenario expects the economy return to growth in 2021, following the fall due to Covid-19 crisis in 2020, as the global pandemic will gradually end and government measures will be effective for economic recovery. The new population forecast (2020) foresees a population of about 10% higher in 2030 than the previous (2018) forecast.

Comparing these economic development forecasts with the macroeconomic forecasts used in the previous projection report (2019), it can be noted that the latest forecasts foresee a slower population decline (population in 2030 is about 10% higher than in previous forecasts) and slightly lower average GDP growth rates over the period 2020-2030.

National emission projections have been made for the years 2020, 2025 and 2030. The projections are based on the policies and measures approved by the Parliament of Latvia and government before the year 2021, which means that it is a projection “with measures” (WEM).

The WEM scenario also incorporates all policies and measures that are included in the scenario (WEM) for reporting on Policies and Measures under Article 18 of Regulation (EU) No. 2018/1999 of the European Parliament and of the Council.

In addition to this scenario, there are also projected emissions with planned policies and measures. They are principally announced by high-level strategic development documents but still their implementation has not been elaborated in detail yet and legal regulations have not been adopted either but are expected to be adopted and implemented from the specific future year onwards. This is the “scenario with additional measures” (WAM).

In both the above scenarios the same indicators of macroeconomic projection are used for calculation of emissions.

In addition, sensitivity analysis regarding emissions projections has been carried out. GDP and population assumptions impacts on projected emissions (NO_x, NMVOC, SO₂, PM_{2,5}) have been analysed in 1A1; 1A2; 1A3 and 1A4 NFR sectors.

9.3.1 NO_x

The gross NO_x emission projections for 2030 reveal reduction against 2018 and are by 17.0% lower than those in 2018. The major emission sources in 2030 are transport sector (33.2%), service sector and households (20.4%), energy industries sector (13.3%), agriculture (17.7%), industrial processes (8.6%) and fuel combustion in the industry sector (6.7%).

Analysing trends in changes of emission projections in different sectors in the period 2018-2030 it can be noted that increase in 2030 is projected for emissions from industrial processes (14.4%). The main reason for the increase is the assumed future growth rate in the manufacturing industry. In the transport sector, as the major NO_x emission source, the projected emissions in 2030 against 2018 are going to reduce by 35.5%. The greatest reduction is projected in road transport due to replacement of existing fossil fuel vehicles by more effective ones and a wider entry of vehicles that use alternative fuels (compressed natural gas (CNG), *plug-in hybrid electric* vehicles (PHEV) and battery *electric* vehicles (BEV)). It should be noted that the emission projections in the road transport sector is based on the information about currently available technologies and the respective environmental quality requirements (e.g., EURO 6 and EURO6+, PEV, BEV, CNG).

The other greatest emissions reduction in 2030 against 2018 is projected from fuel combustion in the manufacturing industry sector (22.4%). The main reasons for this trend are the reduction in fuel consumption in the sector and the replacement of existing combustion plants with new ones.

NO_x emission reduction (14.2%) is also projected for the service sector and households where the energy efficiency measures in residential and public buildings will provide reduction of energy consumption required for heating.

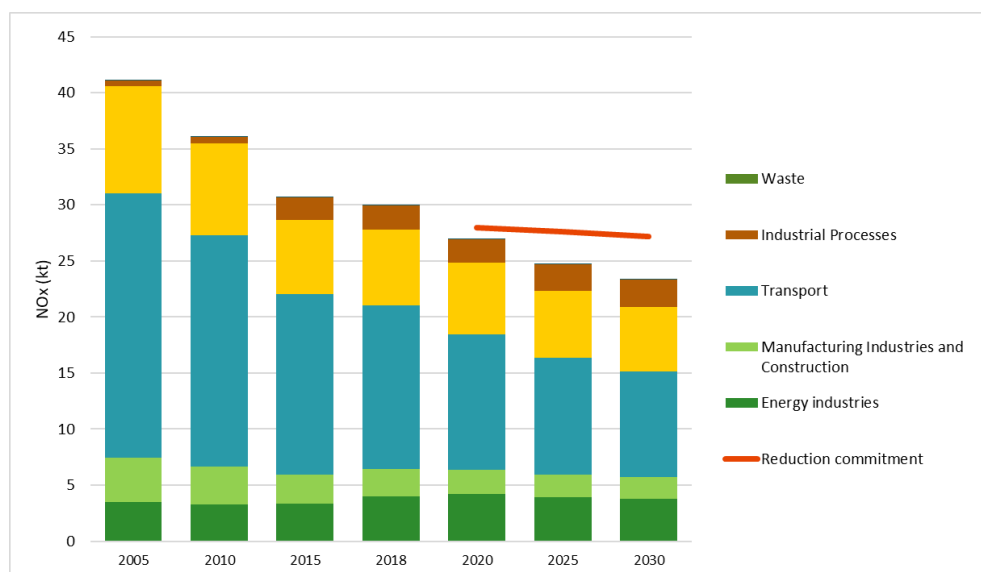


Figure 9.1 NO_x emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

Note. Complying with Directive 2016/2284, Article 4, the projected emissions reduction does not include emissions from manure management and agricultural soils.

Figure 9.1 reveals that the projected NO_x emission in the WEM scenario for 2020 and 2030 are about 3.6% and 13.8% lower than the set target, respectively.

It should be noted that the calculated emissions projections for 2020 depend to a large extent on the impact of the Covid-19 pandemic on fuel consumption, particularly in the transport sector.

WAM scenario

In addition to the measures in the WEM scenario, the WAM scenario encompasses three groups of measures for the projected emissions reduction from fuel combustion. Group 1 addresses energy consumption reduction by implementing energy efficiency measures. They are planned basically for the service sector and households. Group 2 refers to replacing the used combustion equipment by such that corresponds to the requirements of higher emission limit values. Group 3 is associated with transport sector. In road transport, WAM scenario involves a higher number of electric cars than in WEM scenario thanks to planned support programmes. WAM scenario envisages railway electrification planned under the national Development Program 2021-2027.

In the WAM scenario the impact of the mentioned groups of measures is estimated not only for NO_x emissions, but also for NMVOC, SO₂ and PM_{2.5} emissions.

When implementing all three groups of measures, the projected NO_x emissions (without emissions from manure management and agricultural soils) in the WAM scenario for 2030 are by about 9.9% lower than in the WEM scenario and as a result they are by 22.4% lower than the set target.

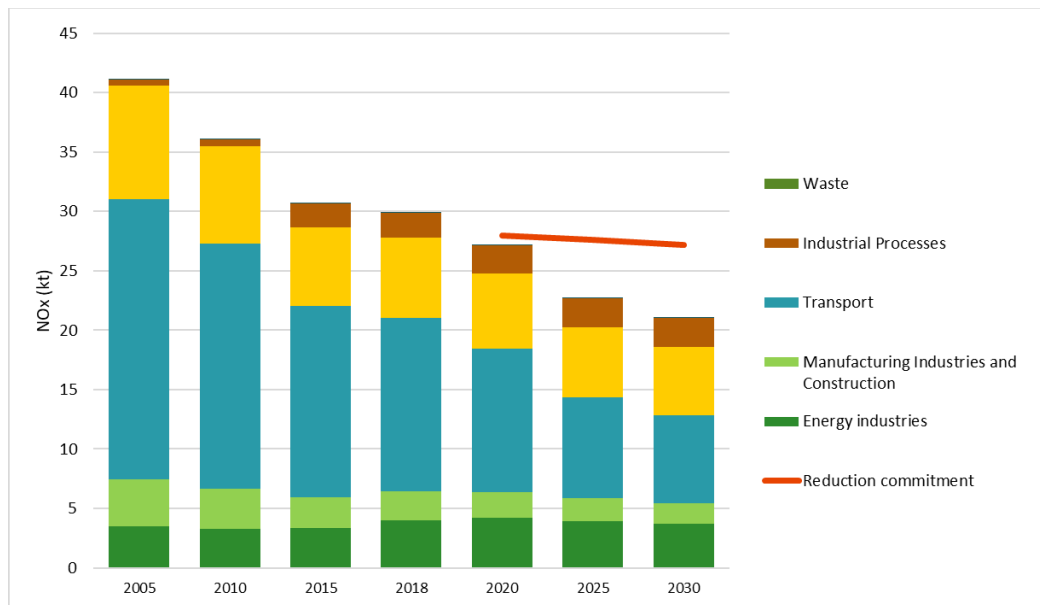


Figure 9.2 NO_x emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

The largest reduction in projected emissions in 2030, in the WAM scenario compared to the WEM scenario, is in the transport sector (21.7%) and manufacturing industries (6.8%).

9.3.2 SO₂

While in the period 2005-2018 the trend in SO₂ emissions revealed essential reduction, the WEM scenario projects a moderate reduction in emissions between 2020 and 2030. Projected emissions in the energy conversion sector (energy industries) depend on the imported electricity and locally produced electricity in CHPs shares in electricity supply.

Forecasted emissions trends depend to a large extent on assumptions about future fuel prices and their competitiveness among others. In industry and the energy transformation sector, natural gas and biomass compete with each other. Consequently, the estimated SO₂ emissions projections may increase or decrease depending on the type of fuel used in these sectors.

The major emission sources in 2030 are the service sector and households (49.0%), the energy conversion sector (25.7%) and fuel combustion in industry (19.1%). Figure 9.3 below shows that according to the WEM scenario SO₂ emissions are by 22.8% lower in 2030 than in the year 2018.

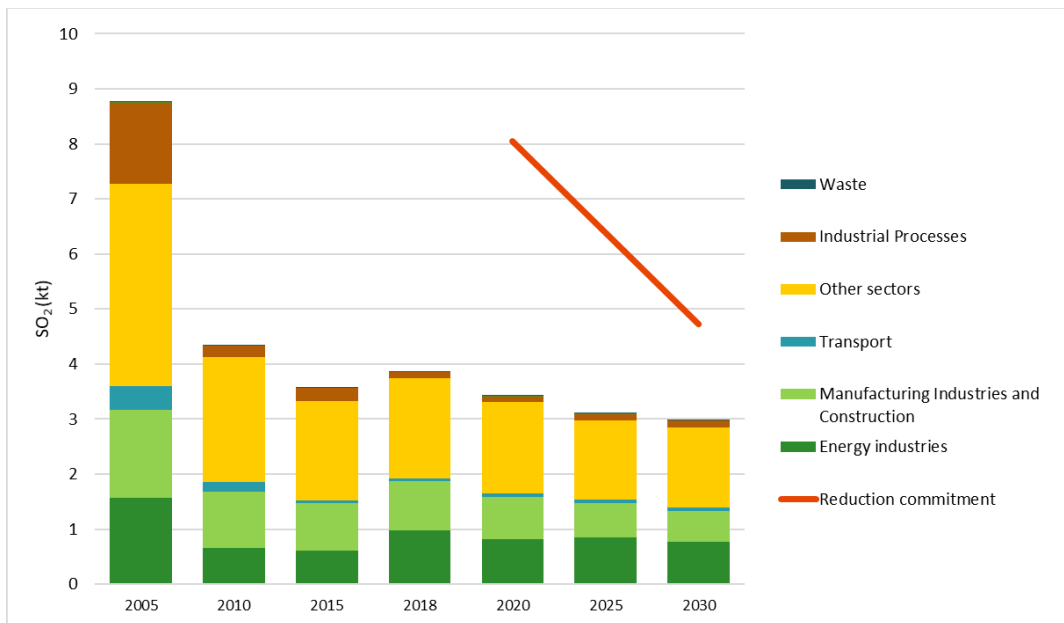


Figure 9.3 SO₂ emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

Such emission trends provide reaching the set targets for the years 2020 and 2030. Emission projections for 2030 are by about 37.0% lower than the set emission target for 2030.

WAM scenario

In the WAM scenario, on the one hand, additional energy efficiency measures are implemented in residential, tertiary and manufacturing sectors, while on the other, the manufacturing sector is expected to replace natural gas with biomass for heat energy production. As a result, in the WAM scenario total SO₂ emissions remain almost unchanged compared to the WEM scenario.

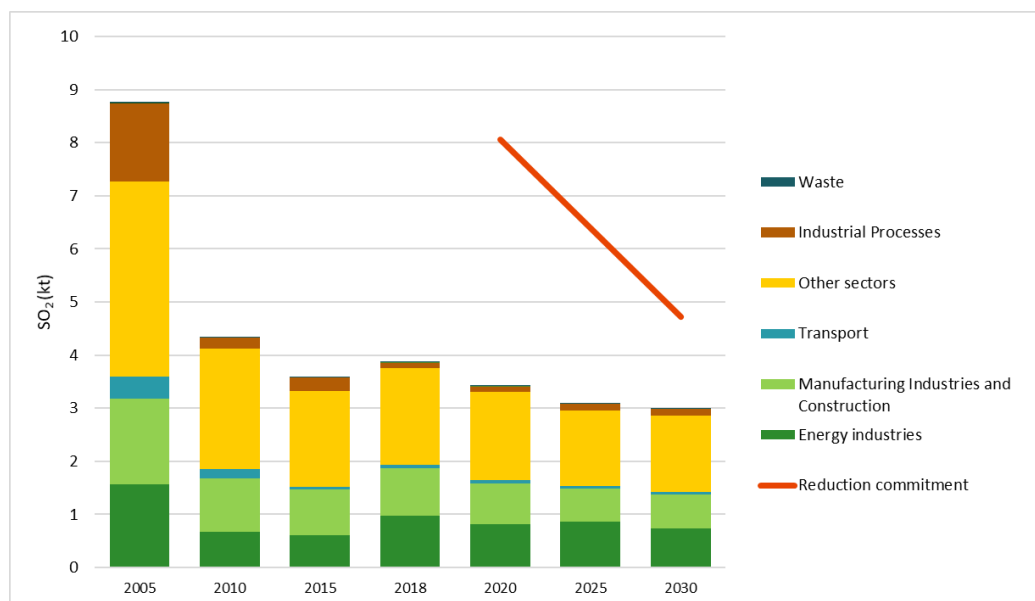


Figure 9.4 SO₂ emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

Such emission trends provide reaching the set targets for the years 2020 and 2030.

9.3.3 NMVOC

The results of the projected NMVOC emissions reveal that in the period up to 2030 emissions might be reduced by 4.5% in comparison with 2018. The major emission sources in 2030 are use of solvents and other products (32.8%), fuel combustion in the service sector and households (25.6%), agriculture (20.3%) and fuel combustion in manufacturing industries (10.1%).

In comparison with 2018 the projected NMVOC emissions in 2030 are lower by 58.8% in the road transport sector as fuel consumption, petrol including, is reduced in the road transport, and household and commercial and service sector emissions decrease by 21.5% due to the implementation of energy efficiency measures in heating public and residential buildings. Emissions decrease is forecasted also in manufacturing (23.2%). Emissions from the use of solvents and other products increase by 17.7%.

The figure below shows the projected NMVOC emissions up to 2030 considering, as stipulated by Directive 2016/2284, Article 4, that the gross emission reduction does not include emissions from manure management and agricultural soils. Figure 9.5 reveals that the projected emissions trajectory ensures reaching the targets in 2020 and 2025.

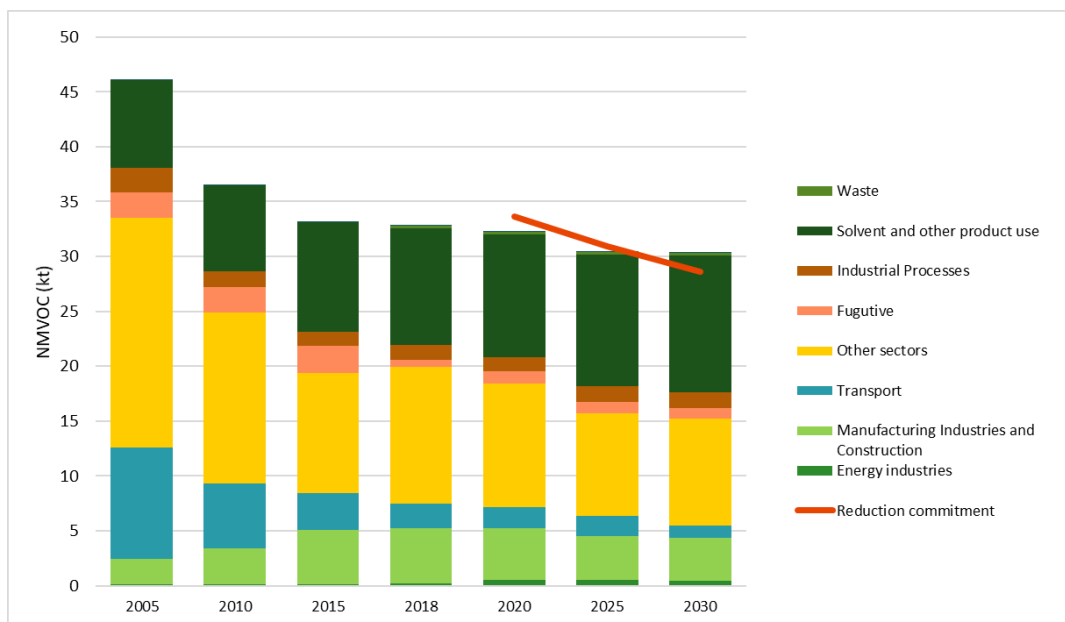


Figure 9.5 NMVOC emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

The calculated NMVOC emissions are by about 6.3% higher than the set emissions reduction trajectory for the year 2030.

WAM scenario

As mentioned above, the WAM scenario foresees the implementation of energy efficiency measures in residential, tertiary and manufacturing sectors. In addition, the WAM scenario foresees a more rapid replacement of existing combustion equipment, including small combustion installations.

As a result of the implementation of these measures, emissions in the WAM scenario are lower than in the WEM scenario in 2030 by 12.9% and the projected emissions are by 7.4% lower than the set target.

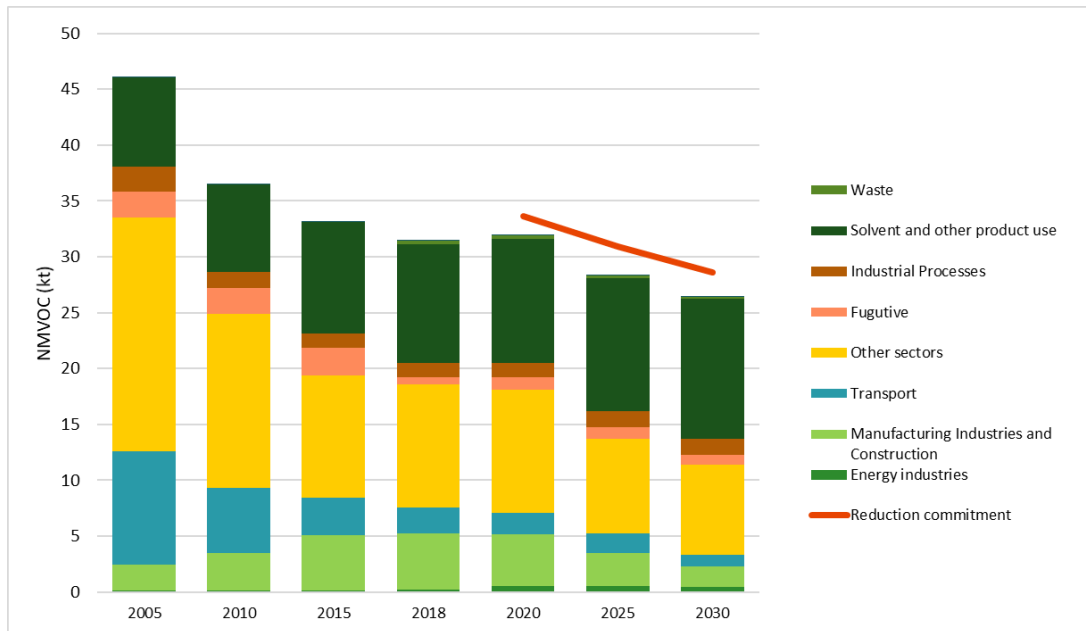


Figure 9.6 NMVOC emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

9.3.4 NH₃

The largest source of NH₃ emissions is agriculture and its share in the gross projected emissions for 2030 make about 88.6%. The projected gross ammonia emissions are by 15.5% higher in 2030 than in 2018 and by 23.4% than in 2005. The major NH₃ emission sources in agriculture are manure management and use of synthetic fertilizers. The calculated emission projections predict increase in the share of NH₃ emissions from the use of synthetic ammonium fertilizers and manure in 2030 by about 5.4% points in comparison with 2018, making 55.6% in 2020 and 54.4% in 2030 from gross NH₃ emissions in agriculture.

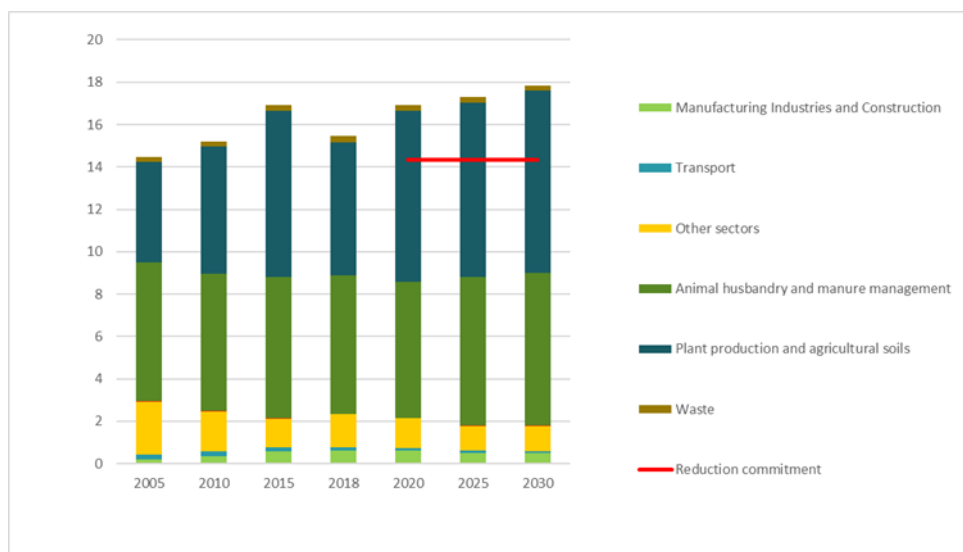


Figure 9.7 NH₃ emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

Such emission projections exceed the national targets for 2020 and 2030 by 18% and 24.6% respectively. In the WEM scenario ammonia emission projections for 2030 indicate that without essential changes in the current practice of manure management and use of synthetic fertilizers ammonia emissions will increase.

WAM scenario

Implementation of additional policies and measures in agriculture plays a decisive role in the reduction of ammonia emissions in the WAM scenario. In order to identify potential of additional ammonia emissions abatement measures in Latvia, the following measures were evaluated according to the Air Pollution Reduction Action Plan 2020-2030:

- promotion of organic dairy farming (low emission dairy farming);
- support for fertilisation planning;
- promote inclusion of leguminous plants in crop rotation for nitrogen fixation;
- promote and support for precision application of inorganic nitrogen fertilisers;
- promote and support for direct incorporation of organic fertilisers into the soil;
- promote feed ration planning and improvement of feed quality;
- promote and support for coverage of manure storages with less permeable cover.

The results of the agricultural emission projections under the WAM scenario indicate that ammonia emissions in the agricultural sector could be decreased by 4.8% till 2030 compared to 2018, or around 22.8% of emissions reduction potential is determined in relation to the WEM scenario.

Implementing the measures in the WAM scenario, the projected gross ammonia emissions are by 7.6% lower in 2030 than in 2018 and by 20.0% lower than in the WEM scenario. Wherewith, the projected emissions are by 0.3% lower than the set target.

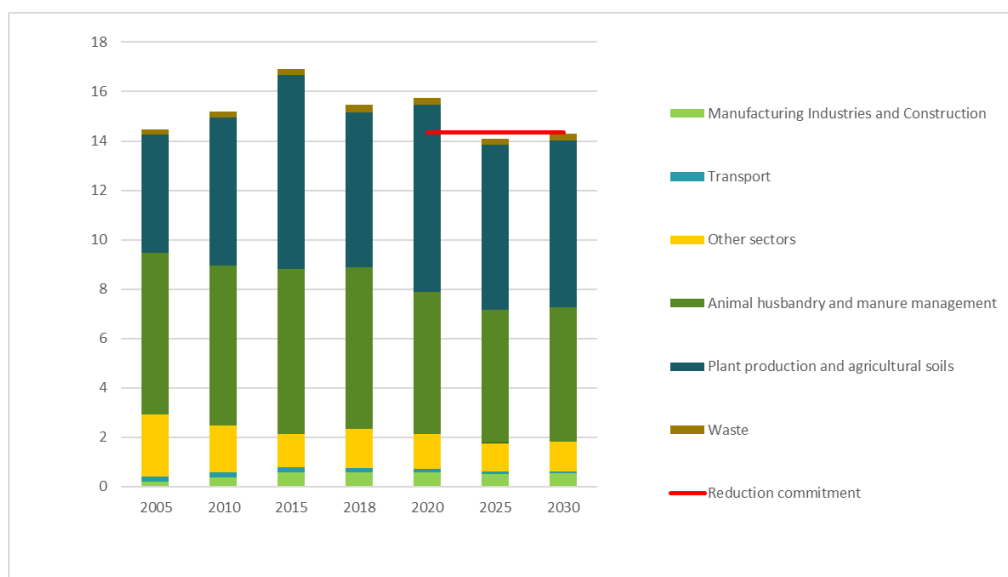


Figure 9.8 NH₃ emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

9.3.5 PM_{2.5}

Emissions projections of fine particulate matter PM_{2.5} for 2030 reveal possible emission reduction by 22.3% in comparison with the 2018 level. The major PM_{2.5} emission sources in 2030 are the service sector and households (62.2%) which widely use biomass combustion equipment, the energy industries (energy conversion sector) (10.8%) with extensive use of biomass in central district heating plants and combined heat power plants, fuel combustion in the manufacturing sector (10.8%) and the transport sector (2.5%).

Emissions reduction in the transport sector and service sector and households is forecasted. In the transport sector, due to the increasing number of cars using alternative fuels and more environmentally friendly fossil fuels emissions will reduce by 40.7% in 2030, compared with 2018. In the service sector and household's energy efficiency measures in public and residential buildings will enable reduction of fuel consumption, leading to the emission levels by 25.3% lower in 2030 than in 2018. In view of the expected growth in industrial production, including in the non-mineral branch, calculated projections foresee a 47.4% increase in emissions in industrial processes for 2030 compared to 2018. As a result, industrial processes emissions will account for 2.2% of total emissions in 2030.

In energy transformation sector, natural gas and biomass compete with each other. Consequently, there is uncertainty regarding trends in calculated emissions.

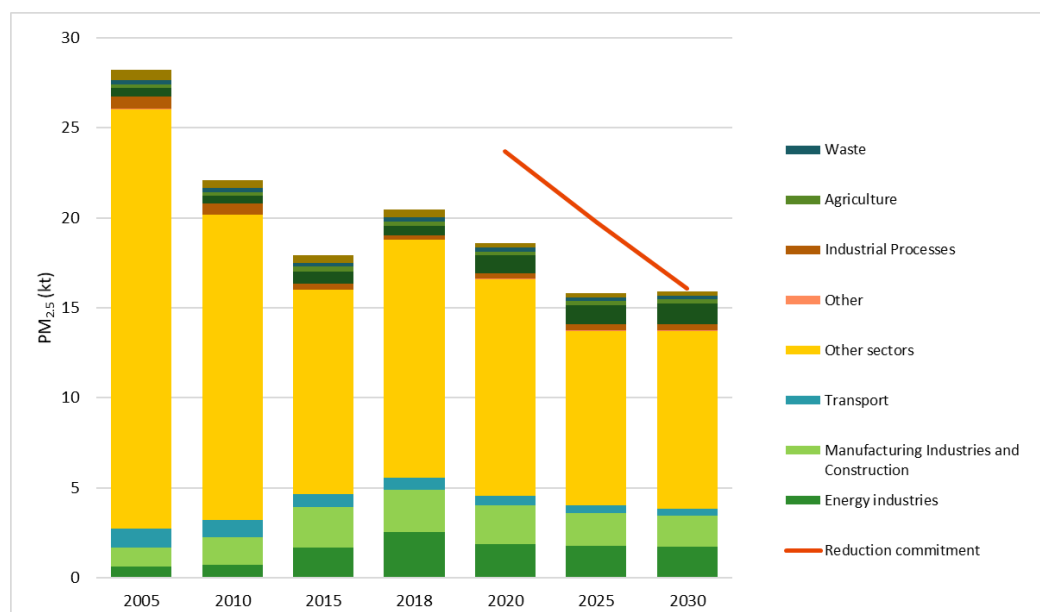


Figure 9.9 PM_{2.5} emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

Such emission trends provide reaching the set targets for the years 2020, 2025 and 2030. Emission projections for 2030 are by about 1.2% lower than the set emission target for 2030.

WAM scenario

In the WAM scenario, a group of measures is aimed at reducing energy consumption by executing energy efficiency measures, resulting in reduction of emissions from fuel combustion. These mainly refer to renovation of public and residential buildings in the service sector and households. The second group relates to replacing the used combustion equipment (manufacturing, tertiary and residential sector) by such that corresponds to the requirements of higher emission limit values.

The major impact upon PM_{2.5} emission reduction is from replacing the used combustion equipment by such that corresponds to the requirements of higher emission limit values. Implementation of energy efficiency measures results in lower emission reduction.

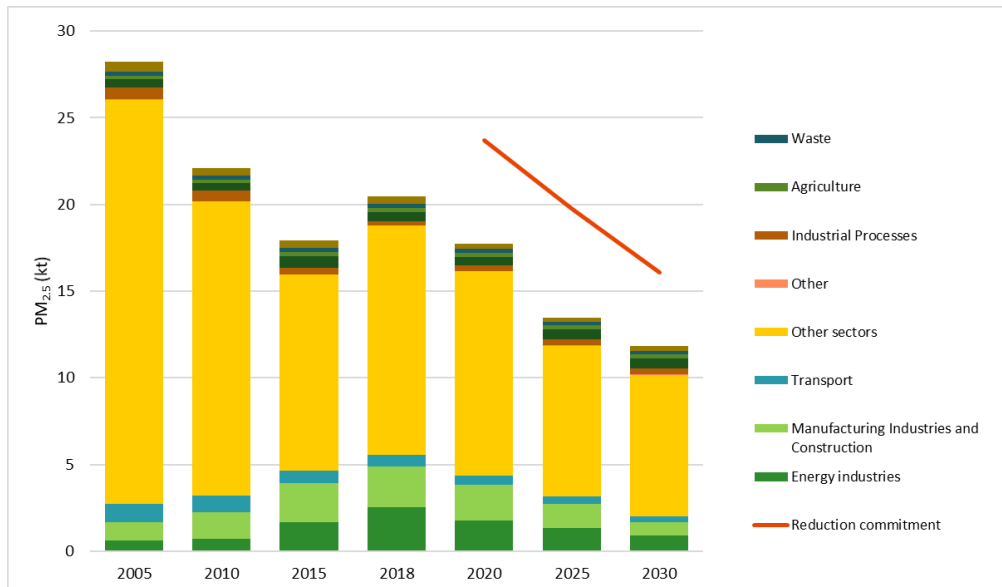


Figure 9.10 PM_{2.5} emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

Implementation of the above two groups of measures enables PM_{2.5} emission reduction according to the WAM scenario by about 23% against the WEM scenario. It results in PM_{2.5} emissions in 2030 lower by 23.3% than the set target.

9.3.6 BC

Black carbon emissions depend directly upon PM_{2.5} emissions volume. Thus, the calculated projections have the same main development trends. The projected emissions according to the WEM scenario are by 26.5% lower in 2030 compared with 2018 and by 44% lower than in 2005. The major emission sources in 2030 are the service sector and households (63.6%), fuel combustion in the manufacturing sector (23.2%) and transport (4.9%).

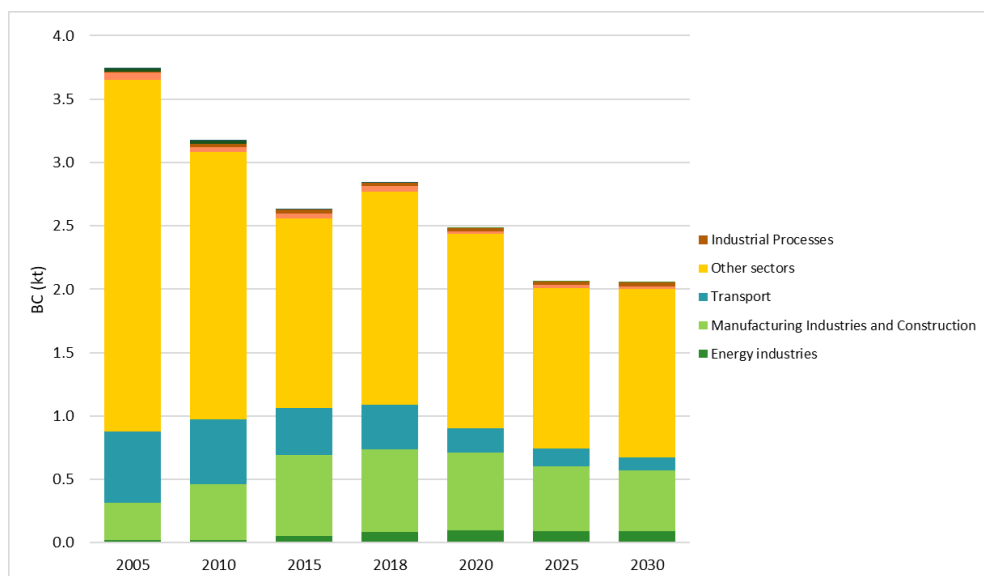


Figure 9.11 BC emissions according to the latest inventory (2005-2018) and the WEM projections (up to 2030)

The estimated emissions projections for 2030 are almost unchanged in the WAM scenario compared to the WEM scenario.

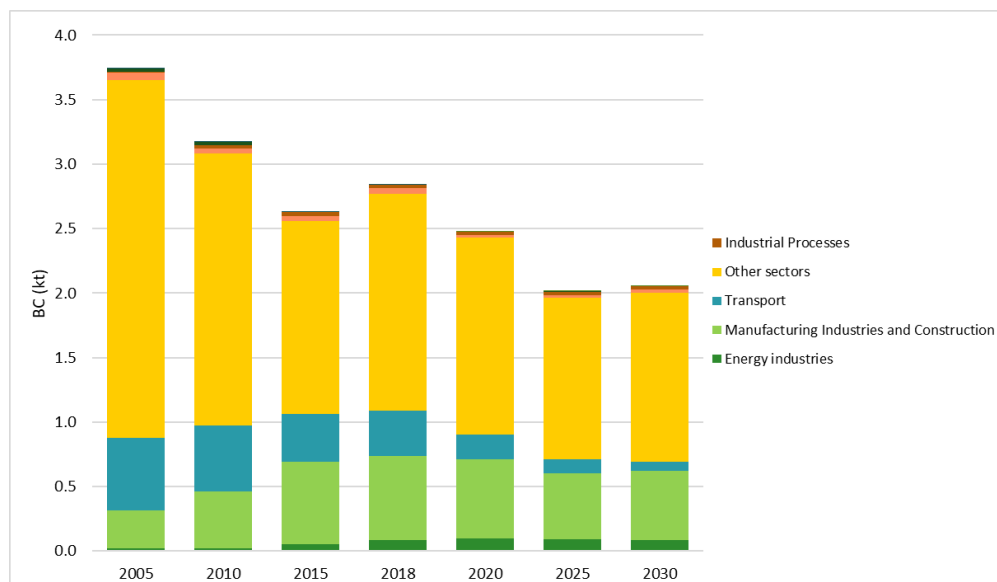


Figure 9.12 BC emissions according to the latest inventory (2005-2018) and the WAM projections (up to 2030)

9.4 Sensitivity analysis

As underlined above, assumptions on the future change of macroeconomic's indices are one of the most important factors when projecting emissions in Energy sector. To evaluate the impact of macroeconomic's indices on emissions volume in the Energy sector, the emissions are calculated for the alternative scenario (WEM_HD), for constructing of which the indices (GDP, number of population, value added) of the "optimistic scenario", developed by the Ministry of Economics, are used.

The alternative scenario (WEM_HD) assumes in 2030 the higher GDP per about 15% and higher number of population (per about 0.9%) against the WEM scenario level at 2030. At the end of the period (2050), this gap in the WEM_HD scenario against the WEM scenario increases, respectively GDP by 23% and population by 5%. The projected higher GDP growth rates and higher population in the WEM_HD scenario affect parameters such as floor area in residential sector, passenger kilometres and freight transportation (tkm) in transport, value added in manufacturing and other parameters.

As shown by the figure below, the assumptions on more rapid GDP growth rate and on stabilisation of population number result in 2030 in the increase of calculated FEC per 6.3% against the WEM scenario level in 2030. This increase of FEC varies in different sectors, being in 2030 in the range 3-10% against WEM scenario levels. The highest impact is seen in the industry, in which the higher Value Added in the WEM_HD scenario causes per 10.4% higher FEC in 2030 against the WEM scenario level. High impact is seen also in transport and residential sector in which in 2030 FEC in the alternative WEM_HD scenario increases per 7% and 5.2% respectively against the WEM scenario level.

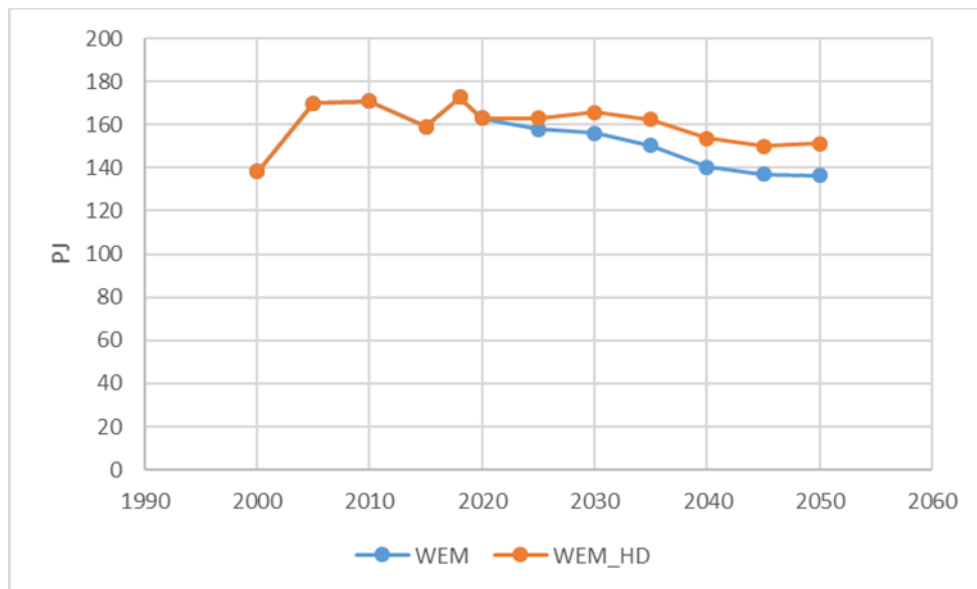


Figure 9.13 Projected final energy consumption in the WEM and alternative scenarios

Greater final energy consumption results in emissions growth under the provision of not implementing additional policies aimed at emission reduction.

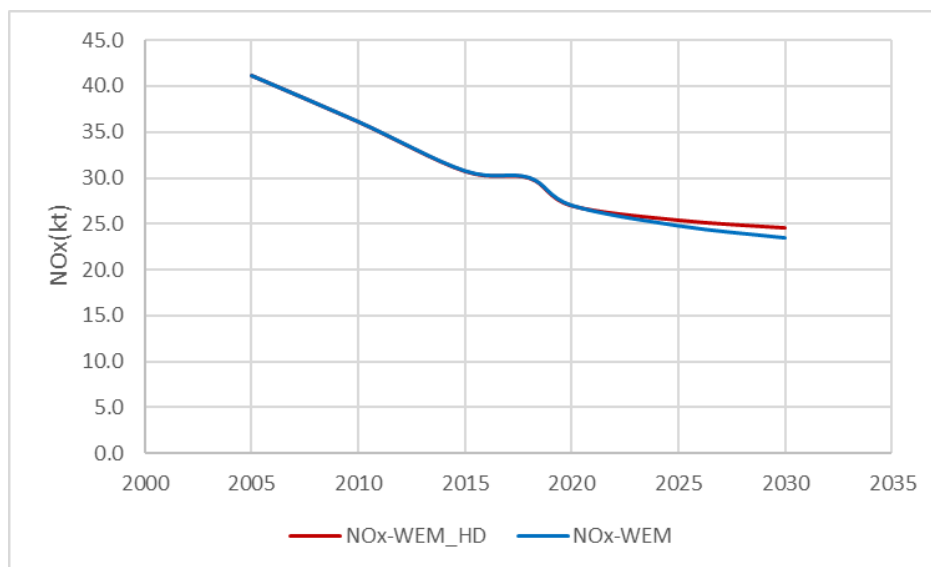


Figure 9.14 Projected NO_x emissions in the WEM and alternative scenarios

Growth of final energy consumption and, thus, of gross primary energy consumption results in higher NO_x emissions. In the alternative scenario, the projected NO_x emissions in 2030 are by 5% higher than in the WEM scenario. The greatest emissions increase compared with the WEM scenario affects the energy conversion sector (4.9%) manufacturing industry (9.4%) and transport (5.9%).

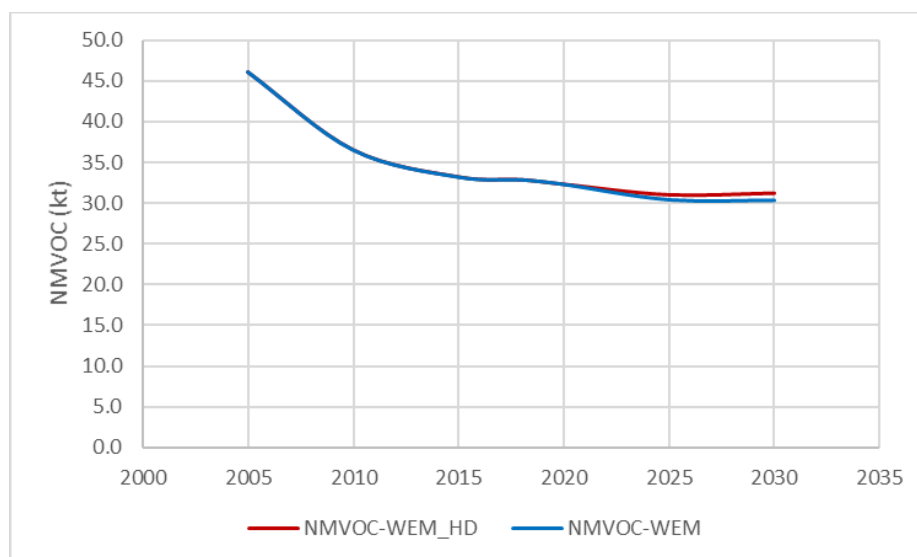


Figure 9.15 Projected NMVOC emissions in the WEM and alternative scenarios

As combustion of solid fuels used for heating and different types of motor fuels is the cause of about 53% of gross NMVOC emissions, their impact is smaller than that of other pollutants upon the projected gross NMVOC emissions in the alternative scenario, compared with the WEM scenario. In the alternative scenario, emission level in 2030 is by 2.8% higher than in the WEM scenario. The greatest growth, compared the WEM scenario, is in the energy conversion sector (10.9%) and manufacturing sector (9.8%), also in the service and residential sector (3.3%) and transport sector (5.6%).

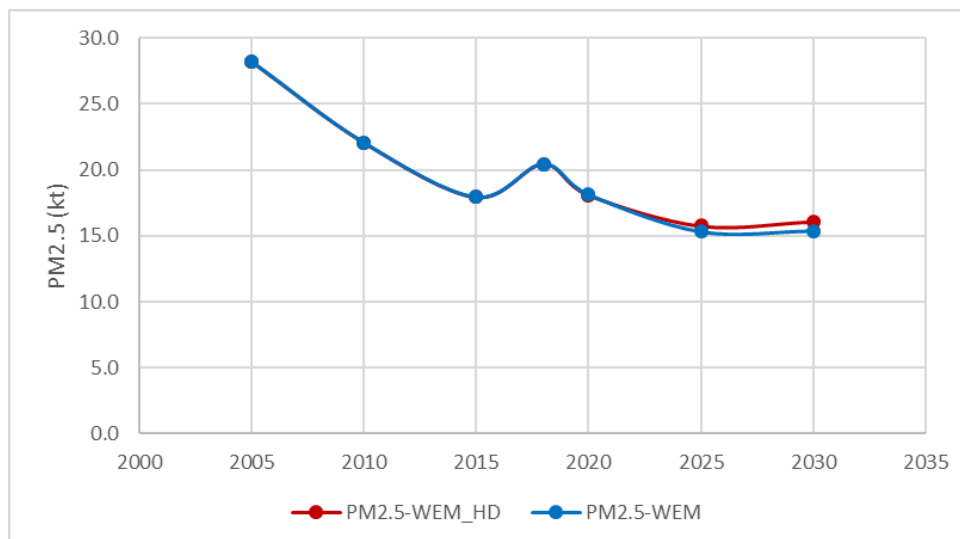


Figure 9.16 Projected PM_{2.5} emissions in the WEM and alternative scenarios

As combustion of solid fuels used for heating and different types of motor fuels causes about 90% of gross PM_{2.5} emissions and biomass has a considerable share of the consumed fuels, in the alternative scenario, which is characterized by greater FEC and GPEC, emissions increase in 2030, in comparison with the WEM scenario is by 4.7%. The greatest growth, compared with the WEM scenario, is in manufacturing sector (9.7%), energy conversion sector (13.5%) and transport sector (7.2%).

Agriculture

The sensitivity analysis is used to determine how different projection approaches of milk yield can impact the total ammonia emissions outcome of agriculture sector. The aim of sensitivity analysis is assessment of

the impact of dairy cow productivity projections. In the baseline scenario, milk yield is predicted with a logarithmic function by setting the milk yield target value of 10 tonnes from one dairy cow in 2050. The milk target value is based on expert judgment, assuming findings that the intensity and size of farms will increase. In addition to assessing the impact of economic factors, projections of milk yield should include information on the average herd size, the proportion cow breeds, the number of organic dairy farms, feeding strategies and other biological features. In the sensitivity analysis version of the milk yield, milk yield projection is based on the milk yield models approved and used in animal sciences. Results of the sensitivity analysis show that agricultural ammonia emissions could be 0.75% lower in 2030 than in the base scenario.

All other parameters of projections for both scenarios are similar to inputs for the WEM scenario projections.

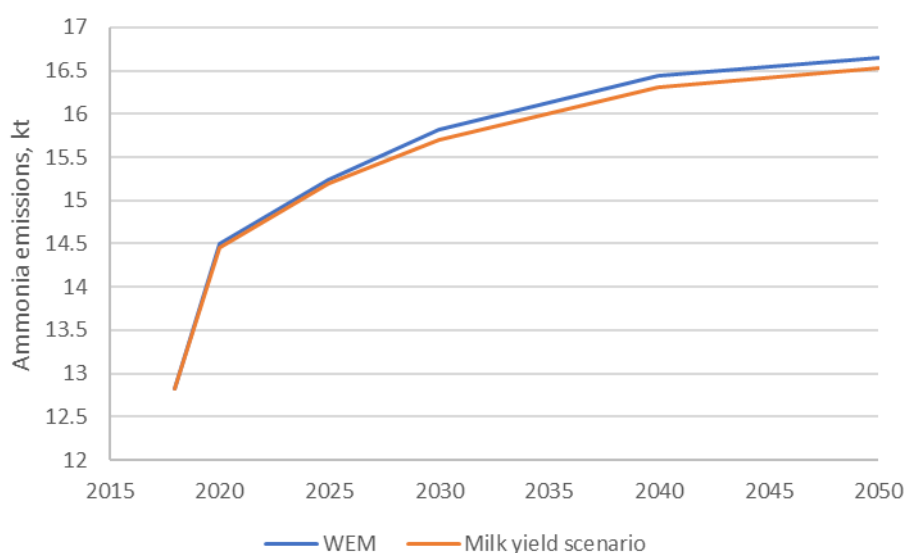


Figure 9.17 Sensitivity analysis of ammonia emission projections for agricultural sector

9.5 Methodology

9.5.1 Energy

Macroeconomic framework

Emissions projections are calculated taking as basis long-term macroeconomic forecasts for the year 2050, developed by the Ministry of Economics in 2020. The projected macroeconomic indicators are based on conservative assumptions and by assessing internal and external risks. The major growth drive is revenue from export and export capacity expansion. The development rate of economy in the baseline scenario is also affected by negative demographic trends.

In the medium term (2021-2027), the baseline scenario projects GDP growth of an average of 2.8% annually, a prerequisite for which is the benefits of economic competitiveness based on technological improvements, production efficiency, innovation. In the long term (from 2028 to 2050), the annual growth rates of the economy will be slower and limited up to 2%.

Trends in sectoral development

On average, manufacturing industry maintains a faster growth rate both in the medium and long term compared with the average of national economy, growth will be synchronously linked to the use of the latest technological processes, digitalisation, process optimisation, etc. More rapid development due to the

above factors is expected in high and medium-sized high-tech industries such as chemicals, pharmaceuticals, electronics, etc. Relatively rapid growth is also expected in the largest manufacturing sector — wood processing. The development of sectors that tend to be focused on the internal market (e.g. food industry, printing) will primarily be affected by domestic demand. Non-metallic mineral production will be closely linked to construction trends. No considerable decrease in any of national economy sectors or significant growth of any other sector are expected in the period until 2030.

The baseline scenario does not forecast essential changes in the sectoral structure of economy up to 2030, if compared with the current situation. It will remain close to the present one. The ratio of commercial services might increase by 1 percentage point up to 2030 alongside with increase also in such sectors as IT, the construction industry and different industrial sectors while the ratio of agriculture, the transport industry, financial services and communal services might slightly decrease.

Table 9.2 The main macroeconomic indices applied for projecting emissions

	2018	2020	2025	2030
Population, millions	1.934	1.904	1.850	1.799
Private consumption, constant (2015) prices, billions EUR	16.0	15.5	18.5	20.8
GDP, constant (2015) prices, billions EUR	26.9	25.3	30.5	34.3

The energy – economy – climate model MARKAL-Latvia (Institute of Physical Energetics) is used for calculating emission projections in energy industries (power and heat generation), transport, fuel consumption in the manufacturing, commercial sectors and households; it enables linking the economy development with energy consumption, generation and emission calculation.

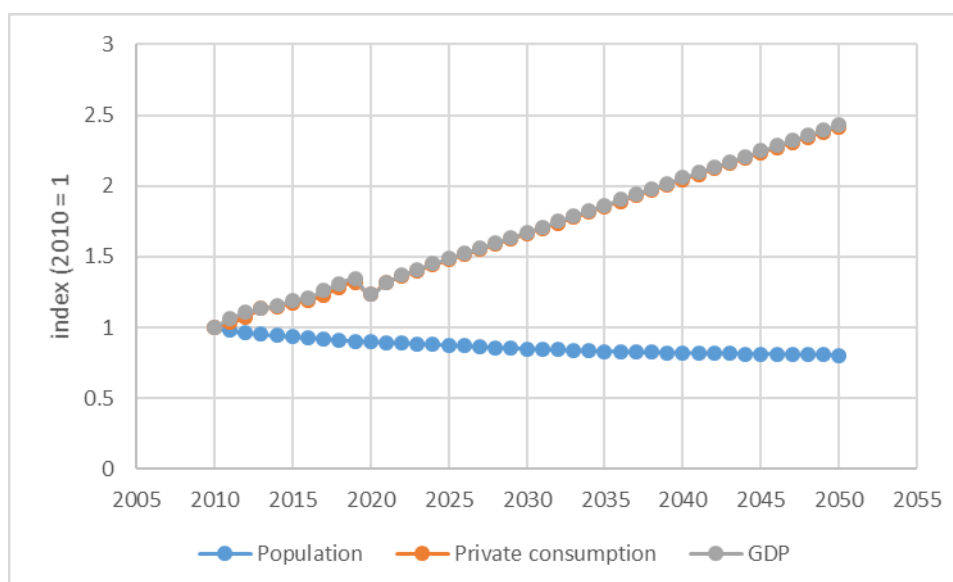


Figure 9.18 Used macroeconomic indices in the WEM and WAM scenarios

The basic parameters determining emissions amount in the energy sector are changes in Final Energy Consumption (FEC) and Gross Primary Energy Consumption (GPEC) over certain time period and the fuel mix in energy production and implemented technologies. FEC has been calculated based on the projections of macroeconomic indicators (Gross Domestic Product, Value Added by branches, private consumption, the number of population, etc.). Parameters, characterizing each separate sector of FEC, are used additionally to calculate FEC in the relevant sector, e.g. the total floor area of dwellings in residential sector, the number of households, number of vehicles, number of vehicle kilometres travelled, etc.

By applying the macroeconomic forecast and the above modelling method for the energy sector final energy consumption up to 2050 has been projected (see Figure below). The major impacting policies upon

the energy scenario are energy efficiency policy and renewable energy (RES) policy. The WEM scenario forecasts the implementation of a set of measures for repealing the component of the mandatory procurement and development of electricity market, promotion of using local RES in district heating and execution of different support instruments for raising energy efficiency in the process of implementing the said measures.

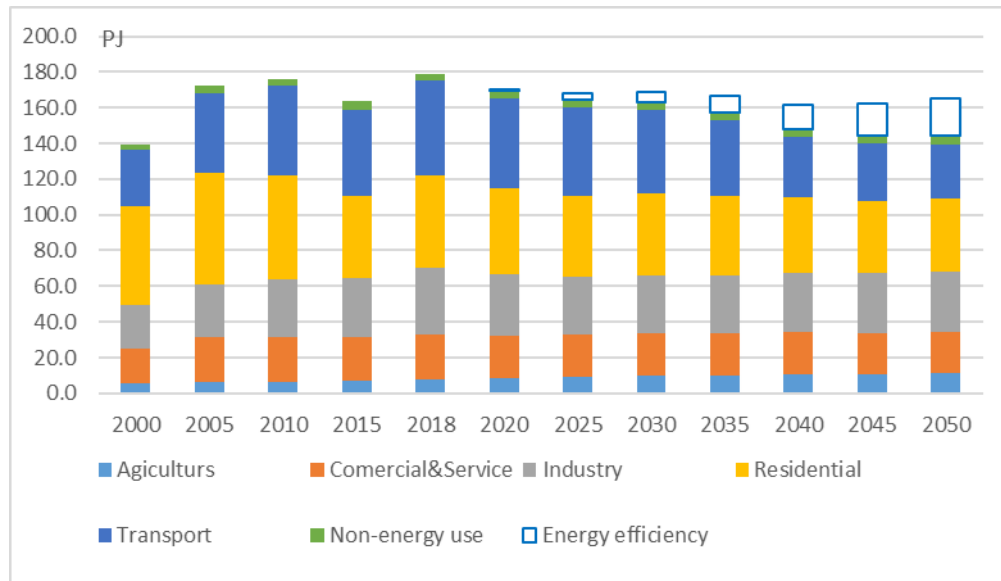


Figure 9.19 Final energy consumption development in sectors under the WM scenario

The calculated FEC projections anticipate that in 2030 Residential and Transport) will be the main FEC sectors consuming respectively 29.5% and 25.6% of total FEC. In its turn, Industry will consume 20.6% and Commercial&Service sector 15.1% of total FEC. The rest will be consumed in agriculture sector and for the non-energy consumption needs.

The both the assumption about the economic growth rate and change in population number and policies and measures included in the WEM scenario result the FEC in 2030 will be per 9.7% lower, compared to 2018. As seen in Figure 9.19, the implemented energy efficiency policy allows to save about 5.9 PJ in energy end-use in 2030 (meaning that without implementation of energy efficiency measures the FEC in 2030 will be per 5.9 PJ higher). Energy efficiency measures mainly focus on energy efficiency improvements in buildings (both residential and public buildings), but also in industry and transport sector energy efficiency is improved as well.

WEM scenario envisages transition to more energy efficient vehicles and widened use of alternative fuels (electricity (BEV, PHEV), CNG and LNG) in the road transport.

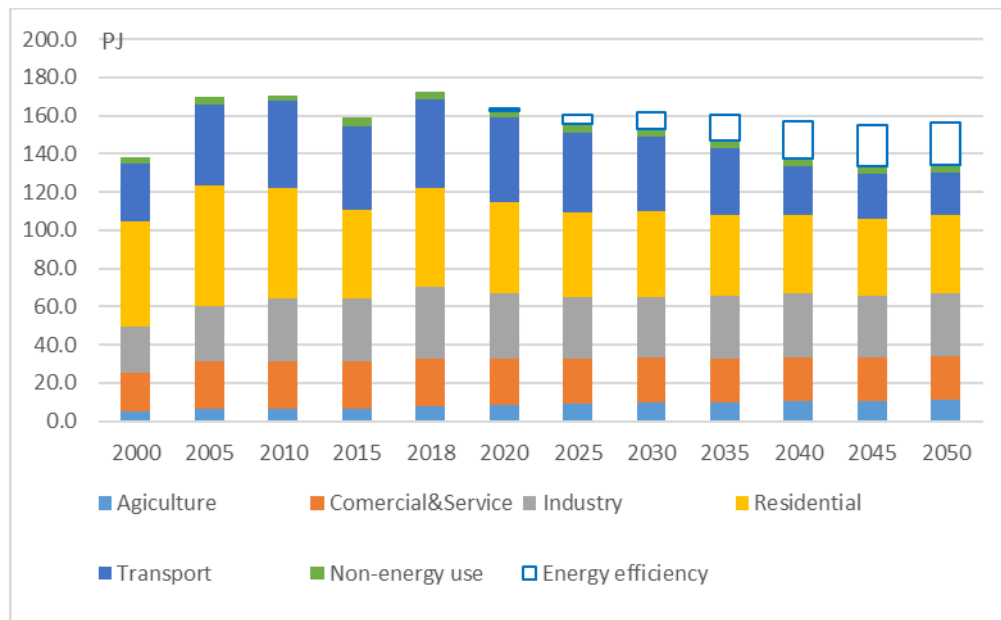


Figure 9.20 FEC development in sectors under the WAM scenario

WAM scenario envisages additional energy efficiency measures, namely, the financial support programmes for energy efficient renovation of both residential buildings and state central administration buildings and energy efficiency improvement for manufacturing. These measures provide around 2.3 PJ additional energy savings in 2030, compared to WEM scenario. Thus, the FEC in the WAM scenario is per about 1,7% lower, compared to WEM scenario.

WAM scenario involves a higher number of electric cars than in WEM scenario thanks to planned support programmes.

WAM scenario envisages promotion of biomethane production and utilisation in road transport. The target group of this particular measure is biomethane producers and users. WAM scenario envisages the construction of the 1st phase of the Electrification project of the railway network.

In addition, the WAM scenario foresees a more rapid replacement of fuel combustion technologies in all sectors (energy industry, manufacturing, commercial and residential). The technology changes will be affected by the planned support programmes and the legislation adopted on stricter environmental requirements for the equipment used.

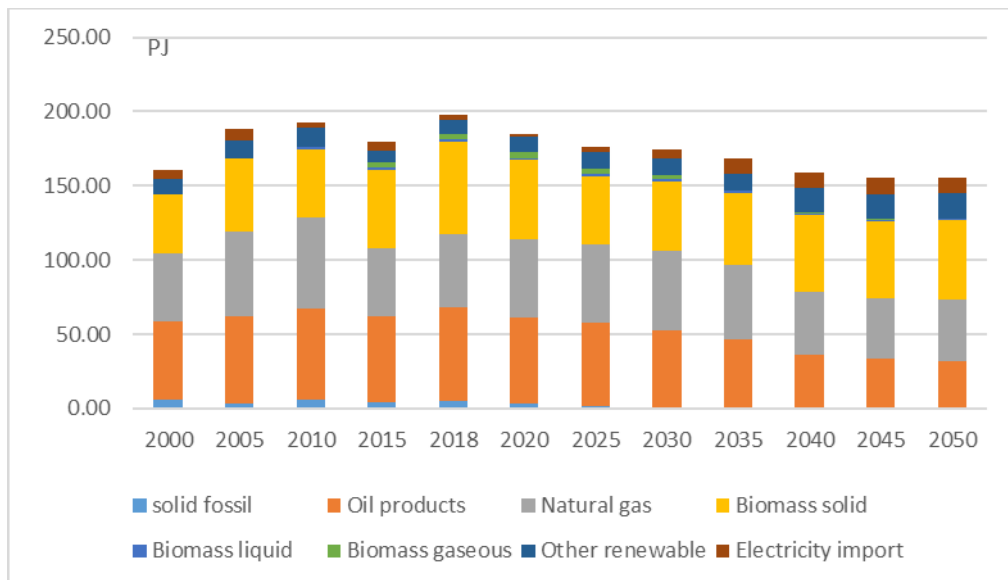


Figure 9.21 Gross primary energy consumption development under the WEM scenario

To ensure the projected final energy demand, the following Gross Primary Energy Consumption (GPEC) under the WEM and WAM scenarios has been calculated (Figure 9.21 and Figure 9.22). The main characteristics of GPEC in the WEM scenario are as follows:

- calculated GPEC in 2030 is per about 11,9% lower, compared to 2018. This GPEC decrease is caused by final energy consumption decrease in residential, services and commercial sector and transport sectors, as well as decrease in energy losses in energy transmission and distribution system;
- the RES share is around 37% over the entire time period;
- WEM scenario does not result in the substantial change of the primary energy resources structure. In the total GPEC in 2030 the share of oil products and solid fossil fuel will decrease per about 2 percent points each, in its turn, consumption of natural gas will increase per about 4 percent points.

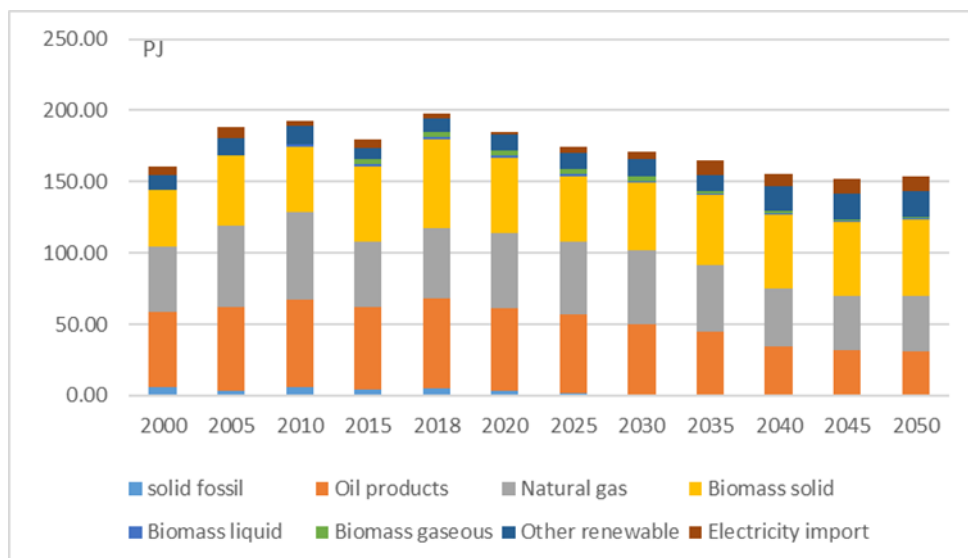


Figure 9.22 Gross primary energy consumption development under the WAM scenario

In the WAM scenario, the GPEC in 2030 is per 1,7% lower, compared to the WEM scenario, however the primary energy resources mix, if comparing WAM and WEM scenarios, change only minor. Implementation

of additional energy efficiency policies will have the highest impact on the energy efficiency of those buildings, which are connected to the district heating systems due to this factor the largest decrease in the WAM scenario undergoes biomass consumption in district heating sector. The RES share under the WAM scenario constitutes 38% in 2030.

Based on the projected activity data and considering the valid policies, emission projections in the WEM and WAM scenario have been calculated using the year 2018 as the base year. The calculation rests on the latest available emission factors in the national inventory. Appendix contains the numeric values of parameters used for emission projections.

9.5.1.1 Description of implemented Policies and Measures

9.5.1.1.1 Energy

Programmes for DH Systems

In *EU Funds planning period of 2014-2020* the co-financing of investment is provided by Cohesion Fund (CF) within the framework of the National Operational Programme (NOP) "*Growth and Employment*". The support is provided for: (i) new RES utilising heat production sources (both additional RES capacities to supply new DH consumers and replacement of existing fossil fuel capacities); reconstruction for increase of energy efficiency of existing heat production sources utilising RES (renovation of heat boilers, construction of heat accumulation units), (ii) construction (widening) and renovation of DH pipeline systems aimed at reducing heat losses. RES-utilising technologies include both combustible (biomass) and solar heat ones. The implementation of the projects will be finished in 2022. The measure is included in the WEM scenario.

Programmes for Household sector: Energy Efficiency in Apartment Buildings

In *EU Funds planning period of 2014-2020* increasing of energy efficiency in multi-apartment buildings is co-financed by EU Regional Development Fund (ERDF) within the framework of the NOP "*Growth and Employment*". The financial assistance is provided in the following forms: (1) subsidy (grant), up to 50% of cost of energy efficiency improvement project, (2) repayable low-interest loan, (3) guarantee for the loan. The annual heat energy consumption for heating after renovation of the apartment building shall not exceed 90 kWh per m². The measure is included in the WEM scenario.

In *EU Funds planning period of 2021-2027* the support for energy efficiency improvement of apartment buildings is planned to be continued. The National Development Plan (NDP) 2021-2027 envisages to improve energy efficiency in at least 40 thousand households (including flats). The measure is included in the WAM scenario.

In *EU Funds planning period of 2021-2027* the support for measures to improve air quality is planned. The National Development Plan (NDP) 2021-2027 envisages 1) the replacement of inefficient and polluting heating equipment used in individual heating by more modern and efficient; 2) replacement of fuel combustion plants with more efficient and installation of emission purification system. The support is planned for: households, municipalities and SMS.

Programmes for Industrial Buildings and Technologies

Efficient use of energy resources, reduction of energy consumption and transfer to RES in manufacturing industry: 2014-2020 EU Funds planning period. Investment for new, innovative energy-saving technology, measures increasing energy efficiency and share of RES is co-financed by CF within the framework of the NOP "*Growth and Employment*". The general intensity of support is 30%. The implementation of the projects will be finished in 2023. The measure is included in WEM scenario.

Investments Support Programme to Improve Energy Efficiency in Food Processing Enterprises. In 2014-2020 EU Funds planning period (implementation 2017-2022 including) the support is provided within the framework of the Measure 04.2 "*Investments*" of the national Rural Development Programme (RDP) 2014-2020, co-financed by EAFRD. The measure is included in the WEM scenario.

In *EU Funds planning period of 2021-2027* the support for energy efficiency improvement of manufacturing industry is planned to be continued. The financial support is envisaged by NDP 2021-2027. The measure is included in the WAM scenario.

Programmes for Public Sector

Increasing Energy Efficiency in Municipal Buildings: EU Funds planning period 2014-2020. Investment to increase energy efficiency in public buildings of local governments is co-financed by ERDF within the framework of the NOP "Growth and Employment". Implementation of the projects will be finished in 2022.

Increasing Energy Efficiency in State Public Buildings: EU Funds planning period of 2014-2020. Increasing of energy efficiency in state public buildings is co-financed by ERDF within the framework of the NOP "Growth and Employment". Implementation of the projects will be finished in 2022. At least 30% of heat energy (or heat energy plus electricity) savings should be reached in the building as a result of the implementation of the energy efficiency project.

Increasing Energy Efficiency in General and Vocational Education Institutions: EU Funds planning period of 2014-2020. The NOP "Growth and Employment" provides complex support, based on strategies of municipalities or associations of municipalities, concentrating resources and improving the learning environment in general educational institutions established by municipalities. This complex support includes different eligible activities aimed both to buildings (both buildings of school and dormitories) and their engineering systems and lighting themselves and to learning environment infrastructure (renovation of classrooms for natural sciences, laboratories, libraries and upgrading of related learning tools and equipment, implementation of innovative ICT solutions). Thus, the support includes also energy efficiency and RES related measures. The implementation of projects will be finished in 2023.

Investment Support Programmes to reduce GHG emissions: national Emission Allowances Auction Instrument (EAAI). The revenues due to the auctioning of Latvia's allocated EU ETS GHG emission allowances are used for co-financing the energy efficiency measures which have high demonstration value. Several EAAI programmes are currently under implementation focused to nearly zero energy public buildings (construction of new buildings as well as reconstruction of existing ones) comprising smart technologies as well as use of smart technologies for energy efficiency (efficient outdoor lighting) in urban environment. Implementation of projects are finishing in 2018-2021, few projects will be finished in 2022 as well.

The above measures in Public sector are included in the WEM scenario.

In turn, the following measures below are included in the WAM scenario. The financial support (co-financing) is envisaged by NDP 2021-2027.

In EU Funds planning period of 2021-2027 the support for energy efficiency improvement of state public buildings is planned to be continued.

In EU Funds planning period of 2021-2027 the support is planned to be continued also for energy efficiency improvement of municipal buildings and public buildings with special purpose of use.

Programme for Solar (PV) Energy. In 2021-2027 EU Funds planning period the particular measure which focuses on the implementation of solar PV technologies in both commercial and public (municipalities) sectors is planned as well.

9.5.1.1.2 Transport

All the measures of Transport sector, except two economic measures – (1) Biomethane production and (2) Electrification of Latvia's Railway - are included in the WEM scenario.

The Biomethane production and Electrification of Railway are included in the WAM scenario.

Electromobility Development

EV charging Infrastructure Development: EU Funds Planning Period of 2014-2020

In April 2017 the Alternative Fuels Development Plan 2017-2020 has been approved which includes EV charging infrastructure development as one of the measures. Development of country-wide EV charging infrastructure is supported by the ERDF within the framework of the NOP "*Growth and Employment*". The implementation of a single national level fast charging infrastructure coverage (139 EV direct current fast charging points with capacity at least 50 kW) will be finished in 2022 promoting the development of EV market and increase of EVs in road transport.

Development of the infrastructure of environmentally friendly public transport in cities

In EU Funds planning Period of 2014-2020 the development of the infrastructure of public transport (PT) is co-financed by CF within the framework of the NOP "*Growth and Employment*". Thus, more effective urban transport infrastructure will be developed promoting the use of PT. Investments are made in accordance with city development plans. These investments result in at least 20 km new and improved tram lines and purchase or upgrade of 85 environmentally friendly buses. The implementation of new tram lines projects is planned to be finished in 2023.

Electrification of the Latvia's railway network (WAM scenario)

The policy of low-emission and zero-emission transport development, including railway, is included in the NDP for 2021-2027. Railway electrification is stated as one of the indicative investment projects of the NDP 2021-2027.

Biomethane production and utilisation (WAM scenario). The target groups of this particular measure are both biomethane producers (particularly upgrade to biomethane quality of biogas produced by processing agriculture sector raw materials) and biomethane consumers. The NDP 2021-2027 envisages to support investment for the biogas upgrade equipment and the infrastructure ensure utilisation of biomethane in Transport sector⁵¹. The support will be provided as the grant in the combination with financial instrument.

9.5.1.2 *Methods and model*

To model the complex development of the Latvian energy system and perform calculation of emission projections there is used internationally widely-applied partial equilibrium, bottom-up, dynamic, linear programming optimisation model MARKAL code for the energy-environmental system optimisation which we have adapted to Latvia's circumstances since 1995 by creating the MARKAL-Latvia country model and applying it for the national level studies.

The MARKAL model is driven by useful energy demands, expressed in energy units or energy demands expressed as energy services in other units (e.g., lumen hours for lighting). The model integrates the end-use sectors and the supply side, holding descriptions of different energy sources and carriers that pass through the energy system's stages – transformation and distribution processes, energy end-use processes in all economic sectors, including a set of technological and energy efficiency options as well as associated emissions. The model is based on the minimization of the long-term discounted cost of all modelled energy-environmental system. The system's cost includes investment and operation, and maintenance costs for all technologies, plus costs of all fuels, minus the revenue from exported fuels, minus the salvage value of all residual technologies at the end of the modelled horizon. The model covers 11 periods of 5 years each, so that the modelled horizon covers 2000 to 2050, inclusive.

⁵¹ Latvia National Development Plan 2021-2027. The list of indicative investment projects, the project No.87: <https://www.pkc.gov.lv/lv/nap2027>.

In the MARKAL-Latvia model the energy demand is divided in five main sectors – industry, residential, agriculture, commercial & service and transport – and further divided in subgroups or subsectors, e.g., energy consumption in the residential sector is divided into space heating and hot water in single or multifamily houses, the use of particular electrical appliances. The projection is calculated for each of these subsectors by linking directly or indirectly via elasticities and/or other indicators (e.g., energy intensities or specific consumption and changes in them, the number of households, persons per households, household area, etc.) to the economic development scenario (GDP, value added, private consumption, population). In the years 2000, 2005, 2010, 2015 and 2016, the actual installed capacities and activity levels of technologies (energy balance and emissions) are imposed, thus providing that the model results exactly represent the real system being modelled.

Additionally, the road transport model COPERT 5 is applied for the calculation of the used in the MARKAL model average emissions factors for road transport forecasting and technology distribution in the future.

MARKAL determines future investments and activity of technologies in each period, while ensuring demands, emission caps and sets of other different constraints.

Projection on prices of energy resources, as well as useful energy demand (energy service demand) or other secondary parameters, like the area of heated premises of buildings or mileage of cars that reflect the required amount of energy are needed as the input data in the MARKAL model. Consumption of electricity and district heating is calculated internally within the model.

The model structure is adapted so that emissions can be calculated not only by the type of fuel, but also by sector and corresponding type of technologies.

Demand for energy is directly linked with economic development, thus, the projected changes of consumption of useful energy are related to the long-term macroeconomic projections. For developing the energy demand scenario, the long-term macroeconomic projection up to the year 2030 developed by the MoE, has been used. This projection has been applied in projecting electricity consumption, heat consumption, as well as fuel consumption in individual sectors.

Price projection of imported energy resources (oil products, natural gas, coal) have been developed based upon information from the International Energy Agency World Energy Outlook (IEA WEO 2020, Existing Policy scenario). Prices of local energy resources depend on the geographical location of usage; therefore, the price may differ. Projection of average prices of these fuels have been developed based upon available statistics, various studies, taking into account the projection price trends of imported energy resources. Solid biomass (wood) is split into four price groups with different available amounts of sources. Actual prices of energy resources are projected without taking into account taxes. All implemented taxes in Latvia are further added in the model.

9.5.2 Agriculture

9.5.2.1 Description of implemented Policies and Measures

Implementation of the Nitrates Directive (ND) 91/676/EEC and Water Framework Directive (WFD) 2000/60/EEC in to national legislation indirectly affected ammonia emissions set in the National Emission Ceilings Directive 2001/81/EC. Legal norms arising from Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources have been included in Law "On Pollution"⁵² that set base to regulation on protection of water and soil from pollution with nitrates caused by agricultural activity.

Law "On Pollution" also classifying polluting activities into Categories A, B, and C, considering the quantity and effect or the risk of pollution caused to human health and the environment. In agriculture sector polluting activities requiring a Category A permit are farms for the intensive rearing of pigs and poultry with

⁵² Law On Pollution <https://likumi.lv/ta/id/6075-par-piesarnojumu>

more than 40 000 places for poultry or with more than 2 000 places for production pigs with weight over 30 kg (with more than 750 places for sows). These farms shall apply the best available techniques to prevent pollution.

The purpose of Law on Environmental Impact Assessment⁵³ is to prevent or reduce the negative impact of the implementation of the activities of a planning document thereof on the environment. Objects requiring Impact Assessment in agriculture sector are installations for the intensive rearing of pigs or poultry with more than 85000 places for broilers; 60000 places for hens; 3000 places for production pigs (over 30 kilograms); and 900 places for sows.

According to Law "On Pollution" several requirements regarding agricultural practice and manure spreading were introduced in the Regulations of the Cabinet of Ministers No. 834⁵⁴ adopted on 23 December 2014 "Requirements Regarding the Protection of Water, Soil and Air from Pollution Caused by Agricultural Activity Regulations on protections of water and soil from pollution caused by nitrates from agricultural activities" and Regulations of the Cabinet of Ministers No. 829⁵⁵ adopted on 23 December 2014 "Special Requirements for the Performance of Polluting Activities in Animal Housing Specific requirements for carrying of polluting activities in animal sheds".

Ammonia emission reduction measures arise from previously described requirements are:

- crop fertilisation plans based on the knowledge of physical and chemical properties of soil and involves performing soil tests, designing a fertilisation plan and its practical implementation as well as calculating the balance of nitrogen (N), which plays an important role in efficient farming, required also under Cabinet Regulation No. 1056 Requirements for Integrated Cultivation, Storage and Labelling of Agricultural Products and the Procedures for Control Thereof (2009)⁵⁶;
- management of nitrates in vulnerable territories and requirements for pollution decrease caused by nitrates from agricultural sources, limit of nitrogen usage is 170 kg of nitrogen from manure and digesters per hectare in a year or 1.7 AU;
- the storage facilities of liquid manure, semi-liquid manure and urine need to be closed type or have a permanent natural or artificial floating covering layer, which reduces evaporation. The floating covering layer continuously covers the surface of the storage facility. Where necessary, the natural covering layer need to be supplemented;
- basic requirements for application of manure to the soil are to incorporate solid manure within 24 hours and slurry – within 12 hours if it is used as basic fertilizer.

A Law on Agriculture and Rural Development⁵⁷ (1 May, 2004) provides a legal basis for agricultural development and to specify sustainable agricultural and rural development policy in accordance with the CAP of the European Union. Regulations of the Cabinet of Ministers No. 126⁵⁸ adopted on 10 March 2015 sets procedure for awarding of direct payments to farmers. The procedure is based on EU Regulation No. 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No. 637/2008 of 23 June 2008 and Council Regulation (EC) No. 73/2009 of 19 January 2009, as well as Commission Delegated Regulation

⁵³ Law on Environmental Impact Assessment <https://likumi.lv/doc.php?id=51522>

⁵⁴ National regulations No. 834 Regulation Regarding Protection of Water and Soil from Pollution with Nitrates Caused by Agricultural Activity <https://likumi.lv/ta/en/en/id/271376-regulation-regarding-protection-of-water-and-soil-from-pollution-with-nitrates-caused-by-agricultural-activity>

⁵⁵ National regulations No 829 Regarding Special Requirements for the Performance of Polluting Activities in Animal Housing <https://likumi.lv/ta/id/271374-ipasas-prasibas-piesarnojoso-darbibu-veiksmai-dzivnieku-novietnes>

⁵⁶ Cabinet Regulation No. 1056 Requirements for Integrated Cultivation, Storage and Labelling of Agricultural Products and the Procedures for Control Thereof <https://likumi.lv/ta/en/en/id/197883>

⁵⁷ Law on Agriculture and Rural Development <https://likumi.lv/ta/id/87480-lauksaimniecibas-un-lauku-attistibas-likums>

⁵⁸ Regulations of the Cabinet of Ministers No. 126 Procedures for Granting of Direct Payments to Farmers <https://likumi.lv/ta/id/273050-tiesos-maksajumu-pieskirsanas-kartiba-lauksaimniekiem>

(EU) No. 639/2014 of 11 March 2014 supplementing Regulation (EU) No. 1307/2013 of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy, and Commission Implementing Regulation No. 641/2014 of 16 June 2014 laying down rules for the application of Regulation (EU) No. 1307/2013 of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy. According to the law and resulting regulations – Regulations of the Cabinet of Ministers No. 126 (10.03.2015), Regulations of the Cabinet of Ministers No. 598⁵⁹ (30.09.2014) and Regulations of the Cabinet of Ministers No. 600⁶⁰ (30.09.2014) following mitigation measures which affects ammonia emissions are implemented in Latvia:

- growing leguminous plants that considerably increase the accumulation of symbiotically fixed atmospheric nitrogen in soil;
- organic farming that includes environmentally friendly farming methods with no influence on nature, improved cropland management and reduction of synthetic fertiliser use;
- precision fertiliser application that leads to fertiliser savings because of planning fertiliser application rates and in fertiliser spreading;
- feed planning is a set of concerted activities: acquiring information about livestock needs (productivity tests), designing feed recipes, doing feed tests and preparing the feed that influence the pace of production of N in manure.

9.5.2.2 Projected emissions per sector

Projections of emissions from agriculture sector with existing measures (WEM) are based on projected livestock population, main harvested crops and area harvested, consumption of inorganic and organic N fertilizers.

All emissions from the manure management projected under WEM scenario are represented in Table 9.3. NH₃ emissions will increase by 10.28% in 2030 comparing to 2018. NO_x emissions will increase by 3.00% in 2030 comparing to 2018. NMVOC emissions will increase by 10.41% in 2030 comparing to 2018. PM_{2.5} emissions will decrease by 11.59% in 2030 comparing to 2018.

Table 9.3 Projected emissions from manure management in WEM scenario

	Unit	2018	2020	2025	2030	2040	2050
NO _x	kt	0.15	0.17	0.16	0.15	0.12	0.12
NMVOC		6.06	6.61	6.65	6.69	6.45	6.37
NH ₃		6.54	6.43	7.02	7.21	7.36	7.35
PM _{2.5}		0.09	0.09	0.08	0.08	0.08	0.08

All emissions from the plant production and agricultural soils projected under WEM scenario are represented in Table 9.4. NH₃ emissions will increase by 28.22% in 2020 and by 36.94% in 2030 comparing to 2018. NO_x emissions will increase by 10.78% in 2020 and by 18.90% in 2030 comparing to 2018. NMVOC emissions will increase by 2.79% in 2020 and by 3.43% in 2030 comparing to 2018. PM_{2.5} emissions will decrease by 1.80% in 2020 and by 3.43% in 2030 comparing to 2018.

Table 9.4 Projected emissions from plant production and agricultural soils in WEM scenario

	Unit	2018	2020	2025	2030	2040	2050
NO _x	kt	4.07	4.51	4.62	4.84	5.03	5.24

⁵⁹ Regulations of the Cabinet of Ministers No. 598 <https://likumi.lv/ta/id/269553-noteikumi-par-valsts-un-eiropas-savienibas-atbalsta-pieskirsanu-administresanu-un-uzraudzibu-lauku-un-zivsaimniecibas-attistiba...>

⁶⁰ Regulations of the Cabinet of Ministers No. 600 <https://likumi.lv/ta/id/269868-kartiba-kada-pieskir-valsts-un-eiropas-savienibas-atbalstu-atklatu-projektu-konkursu-veida-pasakumam-ieguldijumi-materialajos>

NMVOC	1.04	1.07	1.06	1.08	1.09	1.10
NH₃	6.29	8.06	8.21	8.61	9.08	9.30
PM_{2.5}	0.15	0.15	0.15	0.15	0.16	0.16

In order to identify potential of additional ammonia emissions abatement measures in Latvia, the following measures were evaluated according to the Air Pollution Reduction Action Plan 2020-2030:

- promotion of organic dairy farming (low emission dairy farming);
- support for fertilisation planning;
- promote inclusion of leguminous plants in crop rotation for nitrogen fixation;
- promote and support for precision application of inorganic nitrogen fertilisers;
- promote and support for direct incorporation of organic fertilisers into the soil;
- promote feed ration planning and improvement of feed quality;
- promote and support for coverage of manure storages with less permeable cover.

The results of the agricultural emission projections under additional measures scenario indicate that ammonia emissions in the agricultural sector could be decreased by 4.81% till 2030 compared to 2018, or around 23% of emissions reduction potential is determined in relation to the baseline assumptions (Figure 9.23).

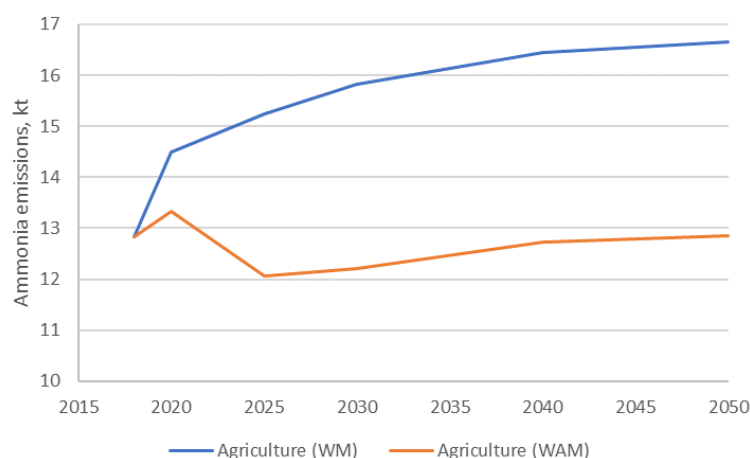


Figure 9.23 Ammonia emissions by agricultural sector under WEM and WAM scenarios, 2018 - 2050

All emissions from the manure management projected under WAM scenario are represented in Table 9.5. NH₃ emissions will decrease by 16.70% in 2030 comparing to 2018. NO_x emissions will decrease by 4.52% in 2030 comparing to 2018. NMVOC emissions will increase by 4.96% in 2030 comparing to 2018. There is no difference in PM_{2.5} emissions in WEM and WAM scenario.

Table 9.5 Projected emissions from manure management in WAM scenario

	Unit	2018	2020	2025	2030	2040	2050
NO_x		0.15	0.16	0.14	0.14	0.12	0.12
NMVOC	kt	6.06	6.57	6.34	6.36	6.16	6.08
NH₃		6.54	5.74	5.38	5.45	5.50	5.50
PM_{2.5}		0.09	0.09	0.08	0.08	0.08	0.08

All emissions from the plant production and agricultural soils projected under WAM scenario are represented in Table 9.6. It is projected that there will be an increasing trend of manure management ammonia and NMVOC emissions during period 2020-2040. NH₃ emissions will increase by 20.91% in 2020 and by 7.56% in 2030 comparing to 2018. NO_x emissions will increase by 9.76% in 2020 but will decrease by 0.08% in 2030 comparing to 2018. NMVOC emissions will increase by 2.79% in 2020 and by 3.43% in 2030 comparing to 2018. There is no difference in PM_{2.5} emissions in WEM and WAM scenario.

Table 9.6 Projected emissions from plant production and agricultural soils in WAM scenario

	Unit	2018	2020	2025	2030	2040	2050
NOx	kt	4.07	4.47	4.16	4.07	4.27	4.23
NMVOC		1.04	1.07	1.06	1.08	1.09	1.10
NH₃		6.29	7.60	6.68	6.76	7.22	7.35
PM_{2.5}		0.15	0.15	0.15	0.15	0.16	0.16

9.5.2.3 Methodology

Projections of emissions are based on primary activity data provided by the Ministry of Agriculture in collaboration with the Latvia University of Life Science and Technologies (LULST). The econometric scenario-based model Latvian Agricultural Sector Analysis Model (LASAM) is used for the activity data generation of Latvian agriculture. LASAM provides an outlook for animal husbandry, producing forecasts in dairy, beef, sheep, goat, pig, poultry and horse farming and crop farming based on regression analysis principles. LASAM estimates a forecast of the utilised agricultural area (UAA) and the structure of UAA enables calculation of the use of fertilisers in the agriculture sector. The source data for the calculations within the model are gathered from CSB, EUROSTAT, domestic use balance sheets and the Farm Accountancy Data Network (FADN). The exogenous price forecasts until 2025 are gathered from the DG AGRI of the European Commission and Food and Agriculture Organization of the United Nations, further projected by the team of Latvia University of Life Science and Technologies. The macroeconomic forecasts are integrated from the forecasted values of the Ministry of Economics of Latvia.

Secondary data projections including manure management system distribution, nitrogen excretion of livestock, use of organic nitrogen fertilizers and nitrogen content in crop residues are made by experts of Latvia University of Life Science and Technologies based on the results of the pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections" under 2009–2014 EEA Grants Programme National Climate Policy. Methodological approach used for manure management distribution projections are available in scientific literature⁶¹.

EMEP/EEA 2019 Guidebook has been used for the calculation of emission forecasts, which is in line with the methodology used for preparing the latest inventory report. NH₃ and NOx emission calculation for the category of manure management was done corresponding to Tier 2 methodology with estimation of impact of abatement measures based on reduction factor and a proportional reduction in the emission estimate for the unabated situation, together with the proportion of the source to which the abatement technique is applied. NMVOC emissions estimated using Tier 1 and Tier2 methodological approach, PM_{2.5} – Tier 1, plant production emissions – Tier 1 and Tier 2.

Impact of addition measures to reduce ammonia emissions are based on relative implementation rates described in On the Air Pollution Reduction Action Plan 2020-2030⁶². The proportion of the source to which the abatement technique applied for manure management is estimated according Reduction Action Plan 2020-2030 Table 26 where target animal share by abatement measure is defined .

⁶¹ Priekulis J., Aboltins A., Laurs A., Melece L. Research in manure management in Latvia / 14th International scientific conference "Engineering for rural development" : proceedings, Jelgava, Latvia, May 20 - 22, 2015 Latvia University of Life Sciences and Technologies. Faculty of Engineering. - Jelgava, 2015. - Vol.14, p.88-93. Available: http://tf.ltu.lv/conference/proceedings2015/Papers/015_Laurs.pdf

⁶² On the Air Pollution Reduction Action Plan 2020-2030 <https://likumi.lv/ta/id/314078-par-gaisa-piesarnojuma-samazinasanas-ricibas-planu-2020-2030-gadam>

9.5.3 Industrial processes and solvent use

Emission projections calculation is based on MS Excel top-down accounting model. The structure and emission calculation is performed according to EMEP/EEA 2019 Guidebook and adjusted for projection estimation incorporating parameters according to macroeconomic forecast.

Solvent use

9.5.3.1 Description of implemented Policies and Measures

Law "On Pollution" laying down the procedures by which emission of volatile organic compounds from installations, in which organic solvents are used, shall be limited. Legal norms arising from the following directives have been included in this Law:

- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control);
- Directive 2004/42/EC of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC;
- Regulations of the Cabinet of Ministers No. 186⁶³ adopted on 2 April 2013 "Regulations to limit emission of volatile organic compounds from installations, in which organic solvents are used" contains legal norms arising from Directive 2010/75/EU and Regulations of the Cabinet of Ministers No. 231 adopted on 3 April 2007 "Regulations Regarding the Limitation of Emissions of Volatile Organic Compounds From Certain Products" contains legal norms arising from Directive 2004/42/EC.

9.5.3.2 Projected emissions per sector

NM VOC emissions projections in the solvent use sector are based on two parts. For Domestic solvent use subsector projections are based on number of inhabitant development scenario and private consumption development scenario. Emissions from other subsectors are based on gross domestic product development scenario.

NM VOC emissions projections are projected to increase during the period 2020-2030. Respectively, NM VOC emissions are projected to increase by 10.6% in 2030 compared to 2019.

Table 9.7 Projected NM VOC emissions, kt

	2018	2019	2020	2025	2030	2035	2040	2045	2050
NM VOC	10.64	11.28	11.13	11.95	12.48	13.01	13.54	14.06	14.54

9.5.3.3 Methodology

NM VOC emissions projections in the solvent use sector are based on two parts. For Domestic solvent use subsector projections are based on number of inhabitant development scenario and private consumption development scenario. Emissions from other subsectors are based on gross domestic product development scenario. The structure and emission calculation is performed according to EMEP/EEA 2019 Guidebook.

⁶³ Cabinet of Ministers Regulation No.186 (2013) "Regulations to limit emission of volatile organic compounds from installations, in which organic solvents are used": <https://likumi.lv/doc.php?id=256096>

9.5.4 Waste

9.5.4.1 Description of implemented Policies and Measures

The most important document that describes the Latvian progress and planned policies on **waste management** is "Waste management plan 2021 - 2028", approved by the Cabinet of Ministers. The waste management system is one of the most important directions of the EU and Latvian legislation on environmental protection. In general, this is governed by the Latvian more than 40 laws and regulations, including the Waste Management Law, the Law on Regulators of Public Utilities, the Municipalities Law and the Natural Resources Tax Law. The Regulations of the Cabinet of Ministers, which have an effect on GHG emissions within the waste sector:

- Regulations of the Cabinet of Ministers No. 1032 adopted on 27 December 2011 "Regulations Regarding the Construction of Landfill Sites, the Management, Closure and Re-cultivation of Landfill Sites and Waste Dumps";
- Regulations of the Cabinet of Ministers No. 184 adopted on 2 April 2013 "Regulations Regarding Separate Waste Collection, Preparation for Re-use, Recycling and Material Recovery";
- Regulations of the Cabinet of Ministers No. 485 adopted on 21 June 2011 "Procedures for the Management of Certain Types of Hazardous Waste";
- Regulations of the Cabinet of Ministers No. 401 adopted on 24 May 2011 "Requirements for Incineration of Waste and Operation of Waste Incineration Plants";
- Regulations of the Cabinet of Ministers No. 470 adopted on 21 June 2011 "Mining waste management procedures".

In order to promote recycling and reuse of natural resources tax law sets the rate for waste disposal (Table 9.8)

Table 9.8 The tax rates for waste disposal from January 1, 2020

No.	Waste type	Unit	The tax rate for the period 01.01.2020. – 31.12.2020. (Euro)	The tax rate for the period 01.01.2021. – 31.12.2021. (Euro)	The tax rate for the period 01.01.2022. – 31.12.2022. (Euro)	The tax rate for the period 01.01.2023 (Euro)
1.	Municipal and industrial waste, which are not hazardous	tonne	50.00	65.00	80.00	95.00
2.	Hazardous waste (also industrial hazardous waste)	tonne	60.00	70.00	85.00	100.00

Main policies and measures, regulating **waste water handling sector**, are listed below:

- Urban Waste Water Directive 271/91/EEC (UWWTD) requires to implement at least secondary treatment (which means "well managed biological treatment" in the terms of IPCC 2006 Guidelines) in all agglomerations, larger than 2000 population equivalents (p.e.) not later than 31st December of 2015. Although there is no requirement for 100% connection rate for population, living within the border of agglomeration, total number of population living in these agglomerations constitutes a major proportion of national population. Full implementation of UWWTD means that up to 75% or even more of national population will be served by well managed

biological treatment of urban waste water and thus be very small or even not at all source of CH₄ emissions. However, UWWTD requires as well, that all agglomerations, larger than 10 000 p.e., must be served by more stringent treatment (significantly decreasing in the effluent content of total nitrogen and/or total phosphorus as well) not later than 31st December of 2011. This requirement, while aimed at protection of water environment from eutrophication, in accordance with IPCC 2006 Guidelines leads to increase of N₂O emissions from modern, centralized treatment plants.

Regulations of the Cabinet of Ministers No. 403 adopted on 21 June 2016 “The Implementing Rules of Specific Aid Objective 5.3.1. “Developing and Improving of the Water Supply and Sewerage Systems and the Quality of Services to Provide Connectivity” of Operational Program “Growth and Jobs”, designated targets and financial resources (~126 million euro from Cohesion Fund of Europe Union) to increase number of population, connected to a centralized waste water collection and treatment system in a certain agglomerations. Part of national population, not connected to a waste water collection system and treatment plant, but using septic tanks and latrines instead, is one of the main sources of CH₄ emissions from the domestic waste water handling sector. This measure should be fully implemented until 31st December of 2022

9.5.4.2 Projected emissions per sector

NMVOC emissions are projected from solid waste disposal (SWD) and waste water handling (WWH) subsectors. Biggest impact on NMVOC emissions gives SWD subsector. NMVOC emission amount depends on CH₄ emissions from SWD.

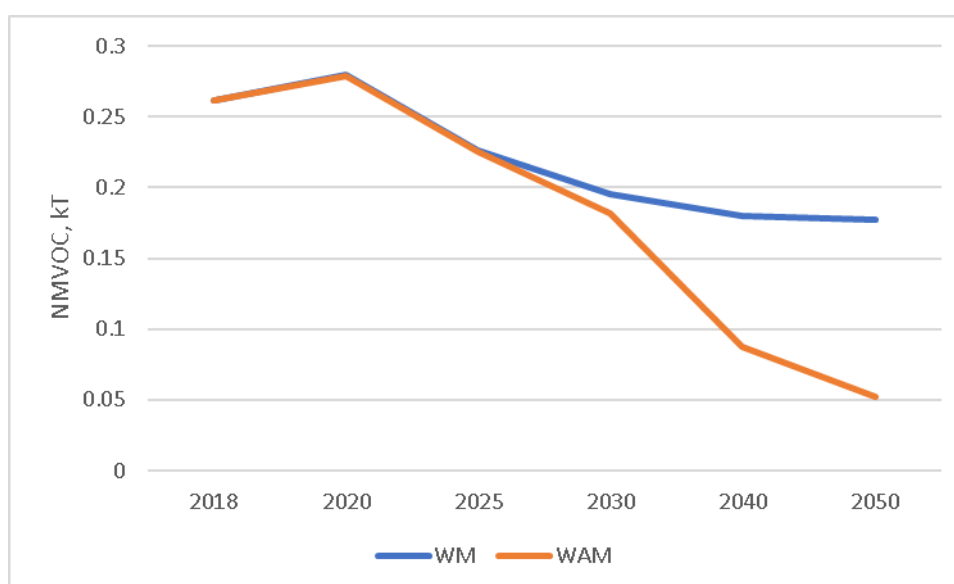


Figure 9.24 Projected NMVOC emissions, kt

In scenario with additional measures higher CH₄ emissions reduction from SWD is taken into account due to decrease of waste disposing.

NH₃ emissions are projected from waste composting, biogas collection from manure and WWH subsectors. Difference between WM and WAM is due to waste composting increase in WAM scenario comparing to WM scenario and decrease of NH₃ emissions from biogas collection in WAM comparing to WM scenario. Composting increases in WAM scenario due to waste disposal decrease.

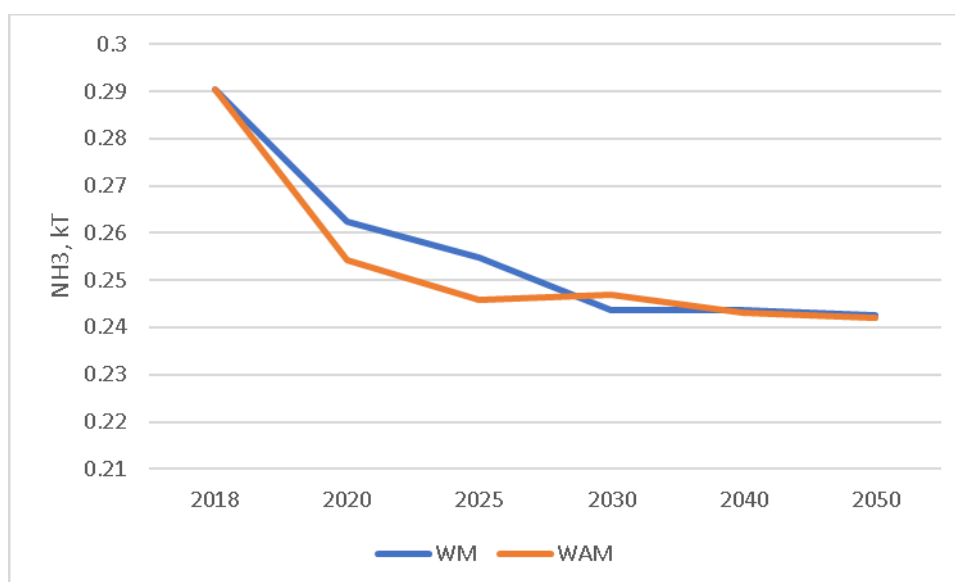


Figure 9.25 Projected NH₃ emissions, kt

9.5.4.3 Methodology

NM VOC and particulate matters emissions from waste disposal are calculated according to EMEP/EEA guidelines 2016. Disposed amount multiplied with EF. Projected amount of disposed waste is estimated according to Latvia "Waste management plan 2013-2020".

Projected NH₃ emissions from composting are calculated according to EMEP/EEA guidelines 2016. Emission factors are multiplied with composted waste amounts. Composted waste amount in households is projected according to changes in population, but industrially composted amounts are projected according to time series from 2003 till 2019.

Projected NH₃ and NM VOC emissions from waste water handling are calculated according to EMEP/EEA guidelines 2016. Activity data (population using latrines and amount of treated waste water) are multiplied with corresponding emission factors. Activity data for projections are estimated according to existing trends in a sector.

9.5.5 Other (Biomass burning on - site in the forest)

9.5.5.1 Projected emissions per sector

Projections of NO_x, PM_{2.5} and BC emissions from biomass burning on - site in the forest for 2020, 2025 and 2030 reveal reduction against 2018 and are by, respectively, 38%, 43%, and 42% lower than those in 2018 (Figure 9.26). The main reason for the decrease is assumed elimination of this practice in forestry due to high costs and broader use of harvesting residues in energy sector.

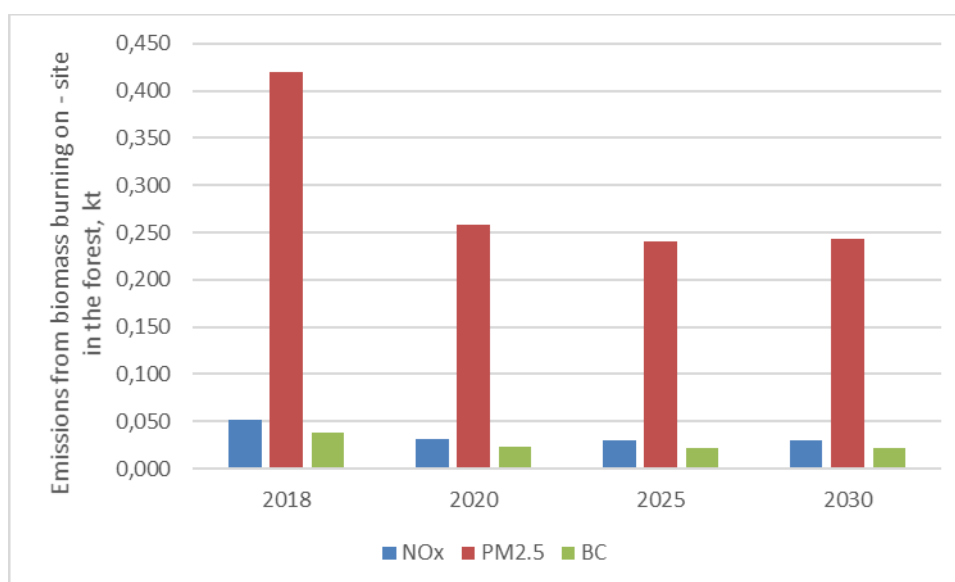


Figure 9.26 Projections of NO_x, PM_{2.5} and BC emissions from biomass burning on - site in the forest

9.5.5.2 Methodology

Projections of emissions were calculated using 2006 IPCC Guidelines⁶⁴ and EMEP/EEA 2019⁶⁵ simpler methodologies. Emissions were estimated as follows: emission factor (Table 9.9) multiplied by projected activity data - average stock of burned harvesting residues (BEFs were used for conversion of stem biomass to above-ground biomass). Slight decrease in projected stock of burned harvesting residues is based on assumption that harvesting residues will be used in forest biofuel production instead of on-site incineration and environmental pressure insisting on elimination of this practice in forestry.

Table 9.9 Emission factors for open burning of forests

Main pollutants and particulate matter	Value	Unit	Reference
NO _x	1.1 ± 0.6	g kg ⁻¹ dry matter burnt	2006 IPCC Guidelines, Volume 4, Chapter 2, Table 2.5
PM _{2.5}	9	g kg ⁻¹ wood burned	EMEP/EEA 2019, 11.B Forest fires, Table 3-1
BC	9	% of PM _{2.5}	EMEP/EEA 2019, 11.B Forest fires, Table 3-1

⁶⁴ 2006 IPCC Guidelines for National Greenhouse Gas Inventories

⁶⁵ EMEP/EEA air pollutant emission inventory guidebook 2019

10 Submission of Latvia's LPS and gridded emissions data

10.1 Gridded emissions

10.1.1 Overview of gridded emissions

According to the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125) and the revised NEC Directive (2016/2284/EC), Latvia is required to report four-yearly its gridded emissions for the year x-2, starting from 2017.

The emission spatial distribution is done for the year 2019. The mandatory reporting of gridded emissions of 2019 includes the following 15 pollutants: NO_x, NMVOC, SO₂, NH₃, PM_{2.5}, PM₁₀, BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB and PCBs.

According to the 36th EMEP Steering Body decision on gridded data, Latvia uses the EMEP grid with a spatial resolution of 0.1° x 0.1°. EMEP grid" refers to a 0.1° x 0.1° latitude-longitude projection in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84. The number of grid cells for Latvia are 1 074 (0.1° x 0.1°).

In Table 10.1 the NFR sectors are listed which were used for reporting of gridded emission data based on the Latvian Air Emission Inventory submitted on March 15, 2021.

Table 10.1 GNFR categories and corresponding NFR categories

GNFR sector	NFR code	Pollutants	Main data
A_PublicPower	1A1a	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Power and heat suppliers
B_Industry	1A1c, 1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f, 1A2gviii, 2A1, 2A3, 2A5a, 2A5b, 2A5c, 2D3b, 2D3c, 2H2	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Manufacturing enterprises, other statistical data representing extraction, manufacturing and construction activities
C_OtherStationary Comb	1A4ai, 1A4bi, 1A4ci	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Commercial, institutional, agriculture, forestry related enterprises, population data
D_Fugitive	1B1a, 1B2av, 1B2b, 1B2c	NMVOC, PM _{2.5} , PM ₁₀	Various gas sector data and coal handling data
E_Solvents	2D3a, 2D3d, 2D3e, 2D3f, 2D3g, 2D3h, 2D3i, 2G	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs	Manufacturing enterprises, population data
F_RoadTransport	1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3bv, 1A3bvi, 1A3bvii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Traffic intensity measurements per intervals on motorways and urban territories
G_Shipping	1A3dii	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Cd, PAHs, HCB, PCBs	Harbour locations and cargo turnover
H_Aviation	1A3ai(i), 1A3aii(i)	NO _x , NMVOC, SO ₂ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg	Airport locations and expert data proportions
I_Offroad	1A2gvii, 1A3c, 1A4aii, 1A4bii, 1A4cii, 1A4ciii, 1A5b,	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Manufacturing, commercial, institutional, agriculture, forestry related enterprises, forests and agricultural lands, coastal haul and population data
J_Waste	5A, 5B1, 5B2, 5C1bii, 5C1biii, 5C1bv, 5D1, 5D2, 5D3, 5E	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, PCBs	Operator and enterprise data related to water and waste', population data and State Fire and Rescue Service statistics
K_AgriLivestock	3B1a, 3B1b, 3B2, 3B3, 3B4d, 3B4e, 3B4gi,	NO _x , NMVOC, NH ₃ , PM _{2.5} , PM ₁₀	Number of various livestock per territorial units

GNFR sector	NFR code	Pollutants	Main data
	3B4gii, 3B4giii, 3B4giv, 3B4h		
L_AgriOther	3Da1, 3Da2a, 3Da2b, 3Da2c, 3Da3, 3Dc, 3Dd, 3De, 3Df, 3I	NO _x , NMVOC, SO ₂ , NH ₃ , PM _{2.5} , PM ₁₀ , BC, CO, PCDD/PCDF, PAHs, HCB	Corine Land Cover 2018 data of agricultural lands and State Fire and Rescue Service data of grass burning area per municipal unit
M_Other	6A	NO _x , PM _{2.5} , PM ₁₀ , BC, CO, PCDD/PCDF, PAHs	Private property forest territories

10.1.2 Data

Information about the main proxy data is listed in Table 10.2. These data are the basis for the disaggregation of the national emissions, which was carried out on NFR level. In a final step the results were aggregated to the GNFR sectors as it is required in the CLRTAP reporting template for the gridded emissions (Annex V).

It is useful to mention that there are various polygon types used in gridding: parishes and towns (territorial units), counties and republic cities (municipal units) and planning regions (regional NUTS-3 units).

For some sources data from year 2015 have been reviewed and improved as they have higher spatial detailing (finer territorial units) and precision (more subtle data for emission, omitting territories which are not considered as places/sources for emission dispersion) to improve accuracy level. For NFR sectors gridded for the first time additional data sets have been reviewed and detected

Table 10.2 Overview of proxy data

Data set	Data description	Data source	Year	Resolution/ Specification	Tier level
Ortophoto WMS	Orthophotographic data from years 2016-2018	SJSC "Latvian State forests" platform "LVM GEO"	2016 2018	Raster data	Tier 1
Spatial units	Administrative units, territorial units, regional NUTS-3 units	"Envirotech" Ltd. GISLatvija 10.2	2019	Vector data	Tier 1
Agricultural lands	Agricultural lands from Corine Land Cover (code: 211, 222, 231, 242,243)	Copernicus Land Monitoring Service	2018	Vector data	Tier 2
Forests	Forests from Corine Land Cover (code: 311,312, 313)	Copernicus Land Monitoring Service	2018	Vector data	Tier 2
Population	Population grid cells 1 km ² x 1km ²	Central Statistical Bureau	2019	Vector data	Tier 2
Population	Population per various spatial units - territorial, municipal, regional	Central Statistical Bureau	2019	Excel data	Tier 1
Road and railway network	Vector data for classified road and railway network	"Envirotech" Ltd. GISLatvija 10.2	2019	Vector data	Tier 3
Gas pipeline network	Vector data for gas pipeline network	JSC "Gasol", "Envirotech" Ltd. GISLatvija 10.2	2019	Vector data	Tier 2
Gas districts	Georeferenced map of gas districts in Latvia	JSC "Gasol"	2019	Vector data	Tier 2
Traffic intensity census	Information on traffic census on motorways per intervals	SOE "Latvian State Roads"	2019	Excel data	Tier 3
Road works	Georeferenced map of road works on motorways, which includes asphalt change	SOE "Latvian State Roads"	2019	Vector data	Tier 3
Buildings and dwellings finished	Data from register of buildings and dwellings accepted for exploitation - constructions considered with asphalt roofing in particular	Building Information System	2018 2019	Excel data Regional level	Tier 1
New building	Data of building permissions given	Central Statistical Bureau	2019	Excel data Regional level	Tier 1

Data set	Data description	Data source	Year	Resolution/ Specification	Tier level
Animal livestock numbers	Data of number of various livestock per parish	Agricultural Data Centre	2019	Excel data Territorial level	Tier 2
Haul limitations	Data of haul limitations in coastal parishes. Limitations describe maximum activity in the coastal zone.	Ministry of Agriculture	2019	Excel data Territorial level	Tier 1
Coal data	Cargo turnover in Latvian ports (coal)	Ministry of Transport	2019	Excel data	Tier 2
Military bases	Data of military bases according to National Armed Forces	Expert judgement National Armed Forces	2019	Vector data	Tier 2
Large Point Sources (LPS)	Point data of Large Point Sources from 2-Air database	LEGMC	2019	Excel data Coordinate data	Tier 3
National databases: 2-Air 2-Water	Facility data: 2-Air (coordinates, NACE code, category) 2-Water (amount of waste waters, coordinates)	LEGMC	2019	Excel data Coordinate data	Tier 3
Solid waste disposed on land	List of solid waste disposal sites by parishes	LEGMC	2019	Excel data Municipal level	Tier 2
Biogas facilities	List of biogas facilities in Latvia	LEGMC	2019	Excel data	Tier 3
Incinerated waste	Hazardous waste, clinical waste, cremation - list of incineration sites	LEGMC	2019	Excel data	Tier 3
Fires	Industrial fires, fires in undetached houses and cars	State Fire and Rescue Service	2019	Excel data	Tier 1
Last year's grass fires	Data of burned areas of last year's grass	State Fire and Rescue Service	2019	Excel data Municipal level	Tier 2
Active quarries in Latvia	Data about active quarries areas in Latvia	LEGMC	2019	Vector data	Tier 2
Natura 2000 territories	Data of Natura 2000 territories in Latvia	European Environment Agency	2019	Vector data	Tier 1
Forests	Data of State JSC "Latvian State forests" managed forest territories	SJSC "Latvian State forests" platform "LVM GEO"	2019	Vector data	Tier 2
Airports	Data of airports from State-Owned Limited Liability Company "Latvian Air Traffic Control Centre" Latvian airspace data platform	SJSC "Latvian Air Traffic Control Centre"	2019	Vector data	Tier 3
Harbours	Data from Orthophoto WMS remote sense process	Expert judgement	2019	Vector data	Tier 3

10.1.3 Methodology

For gridding procedure the methodology of spatial emissions mapping guidelines in the 2019 EMEP/EEA emission inventory guidebook was used wherever it was applicable. The overall approach aims to allocate the national total emissions to the geographical location where they occur as accurately as possible. Point and line data are considered the most accurate.

The concept of Tier mapping is divided in three levels:

Tier 3 methods are based on closely related spatial emission or activity data, e.g. data points for pollutants and industries, road traffic flows by vehicle type derived from measured intervals. This means, when point sources were known, they were chosen to map the emissions.

Tier 2 methods are based on the use of surrogate statistics related to the NFR sector, for example, agricultural animal statistics, haul limitations per territorial unit. In the cases where the emissions can be linked to statistical data, the emissions are spatialized using finest territorial unit level as possible.

Tier 1 methods are based on loosely related surrogate statistics, e.g., population density and land use data. For sectors, where limited information is available for emission allocation, more general information is used to generate spatial correlation such as population.

Data collection from databases

Data (location and NACE code of a facility) were taken from national databases "2-Air" and "2-Water". Data selection from the "2-Air" database was made using NACE codes and dividing them into corresponding NFR categories for more accurate emission distribution. For the Energy sector, NACE code distribution by particular subsectors was taken from Energy balance.

Data selection from the "2-Water" database was made using expert assumptions regarding particular NFR subcategories.

Appropriate processing and recalculations if needed in MS Excel environment to create data ready for spatial joins.

Data processing in GIS environment

GIS based method and the proxy data, which was used for the allocation of national emissions to the EMEP Grid. The data was processed in ArcGIS 10.8 environment.

Emissions from point sources were directly allocated to the coordinates (function "Display XY") of the individual emitters. Line based emissions and emissions from area sources were disaggregated from the national total emissions to the described proxy data (see Table 2). All data were reviewed if territorial unit detailing could be adapted or improved to point geometry type.

Produced data sets were intersected with the EMEP grid and weighted within ArcGIS software. "Intersect" function is a basic geoprocessing tool, where according to available statistical data joined to the most suitable spatial data geometry spatial data is divided between EMEP grids creating new spatial elements.

Field calculator was used to calculate target values from base data layers in EMEP grid layer and summarizing function methods to allocate emission proportions correctly. Data quality control was applied after every manipulation to test if base value remains the same. Formula applied to calculations:

$$value_new = value_base \times \frac{area_new}{area_base}$$

where:

value_new - target value or proportional value;
 value_base - base value of data feature;
 area_new - area/length of feature after intersect;
 area_base - original/base area length of feature.

Join table functions were applied in GIS from MS Excel data and other GIS functionalities as digitizing and selection, then export data was used.

Afterwards, further recalculations in MS Excel environment were made.

10.1.4 Changes and improvements in 2019

After the previous EMEP gridding year in 2017 the approach for spatial allocation of the current Inventory had to be adapted accordingly to ensure data consistency and improvements, also taking in consideration TERT recommendations. There was a need to adjust the available base data and the statistical background to the latest available databases and updated higher resolution GIS data.

Main improvements:

- 1) improved data detailing, but keeping consistency, e.g. Agricultural Data Centre data about livestock numbers;
- 2) added spatial aspects in gridding procedure - to focus on exact territories where emissions could be found;
- 3) changed data sources and recalculations;
- 4) more effective interaction with experts to aim for detailed and improved results.

New sources were added to the inventory for disaggregating emissions in following NFR sectors for the first time, see Table 10.3 below.

Table 10.3 First time gridded NFR sectors

NFR code	NFR code - long name
2A5a	Quarrying and mining of minerals other than coal
2A5b	Construction and demolition
2A5c	Storage, handling and transport of mineral products
3Df	Use of pesticides
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities (emission distribution by biogas facilities; list of facilities given by waste expert)
5C1bii	Hazardous waste incineration
5E	Other waste (fires)

Data sets and sources for first-time gridded NFR sectors are displayed in Table 10.2 in Chapter 10.1.2, methodology applied for sector was developed in cooperation with sectoral expert using available spatial and statistical data. Methodology and emission allocation is explained in Chapter 10.1.3 Methodology.

10.1.5 Quality control

Quality control was performed at several levels during the allocation process. For **geospatial manipulations quality control** - control of base value during geoprocessing and other required manipulations in the GIS environment was applied. Afterwards in MS Excel environment **recalculation control** of proportions and emission sums consistency and their match with Annex V emission data was monitored. For final data consistency and quality control National total (annual data submitted to NECD and LRTAP) was used to compare to gridded data total. If inconsistencies were recognized, they were corrected.

For **LPS quality control** national total values in grid cells were checked if they are higher than LPS values in grid. If there is data inconsistency, then changes in grid data have been made based on:

- 1) Agricultural data center numbers of big farms in territorial uni level have been reviewed and divided according to their coordinate data more precisely where it was an issue;
- 2) LPS that could be detected in NFR level, could be integrated in gridding dispersion, other LPS, where its count or category value was an issue, LPS weight was raised to 10 to display pollutants emitted.

Additionally, an explanation was given to all inconsistencies that could not be solved using approaches mentioned above.

10.1.6 Results

The following figures show the spatial allocation of national totals for NO_x, NMVOC, SO₂, NH₃ and PM_{2.5} and CO emissions. In general, the largest parts of the emissions are located in the most densely populated region of Riga and its agglomeration, there are hot spots in largest cities due to their industrial, urban and traffic activities compared to rural areas and towns. For NH₃, the greatest source is agriculture, with a large activity in the central part of Latvia.

Dispersion of NO_x shows spatial correlations with densely populated territories and motorway and railway networks, specifically, cargo from transit transportation is visible in Figure 10.1. Also, it can be seen that LPS stands out (i.e., "Schwenk" emissions in cell 468).

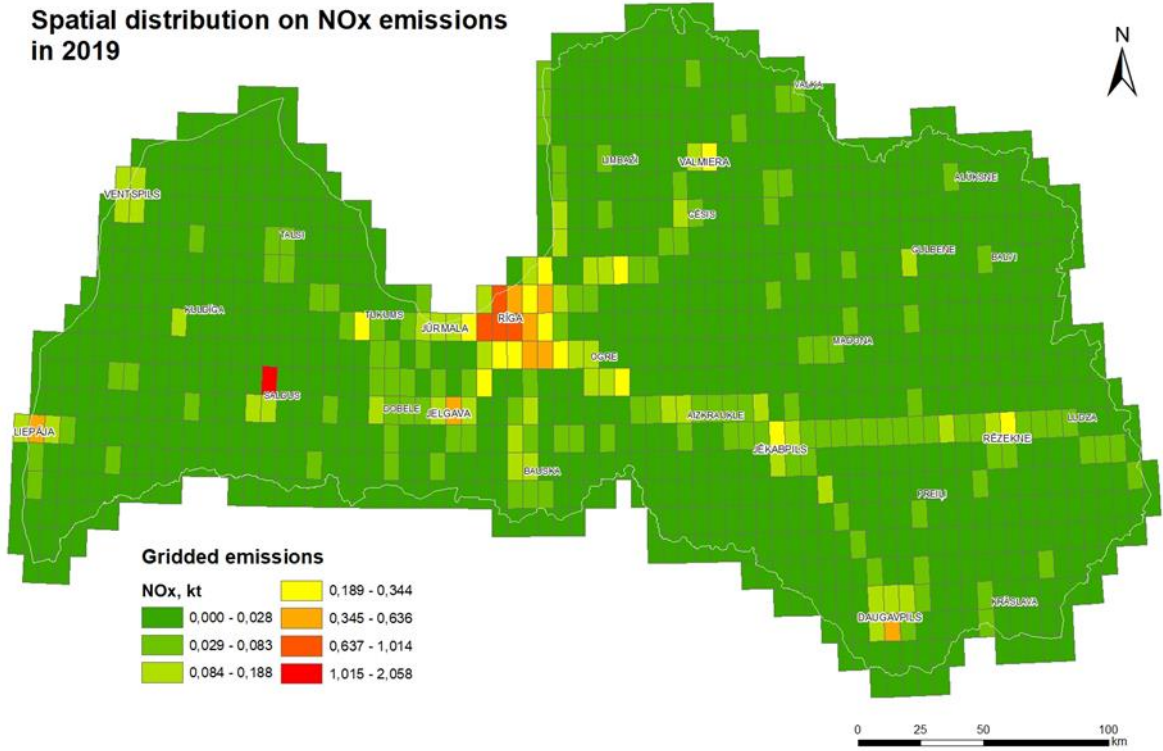


Figure 10.1 Spatial distribution on NOx emissions in 2019

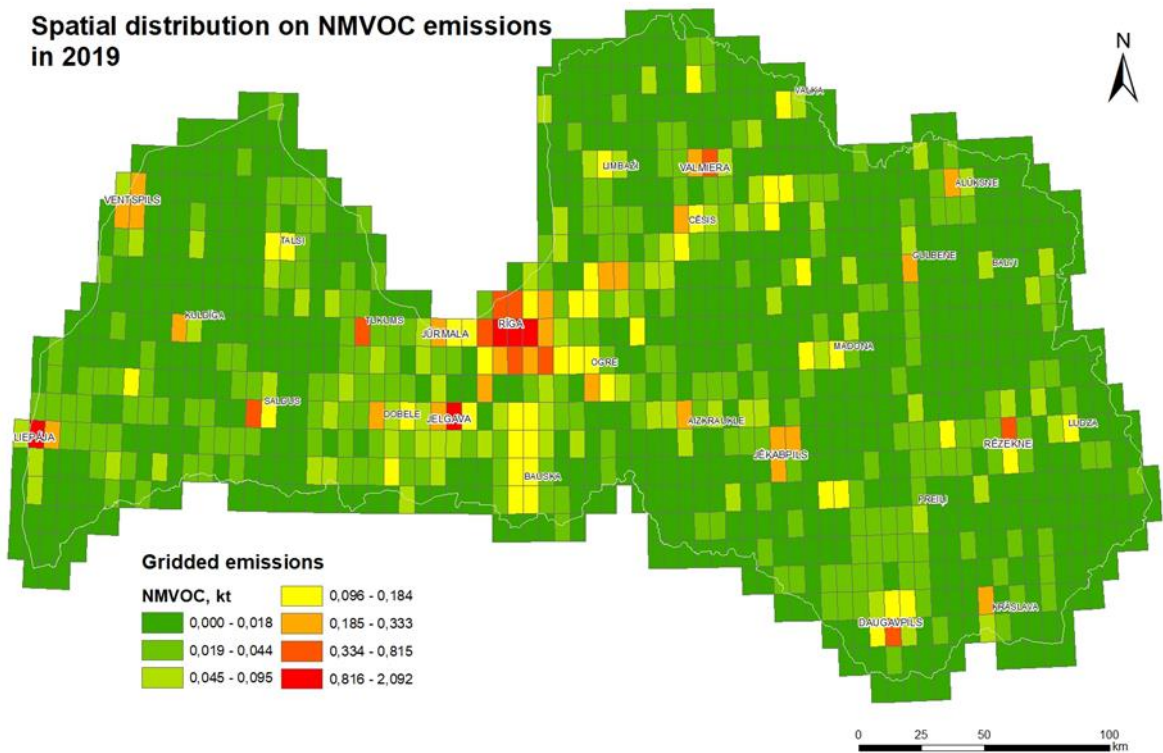


Figure 10.2 Spatial distribution on NMVOC emissions in 2019

As it can be seen in Figure 10.2, NMVOC spatial dispersion highlights impacts from densely populated areas around 5 000 inhabitants and larger. Also SO_x distribution in Figure 10.3 correlates with the same tendency.

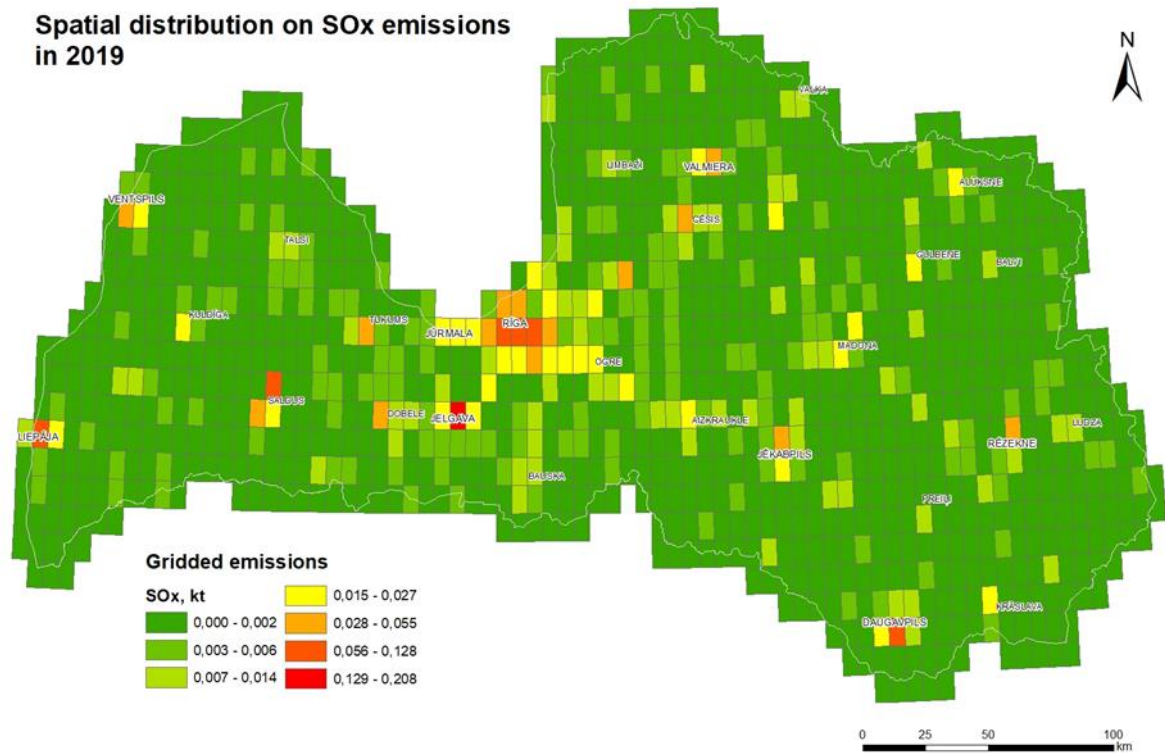


Figure 10.3 Spatial distribution on SO_x emissions in 2019

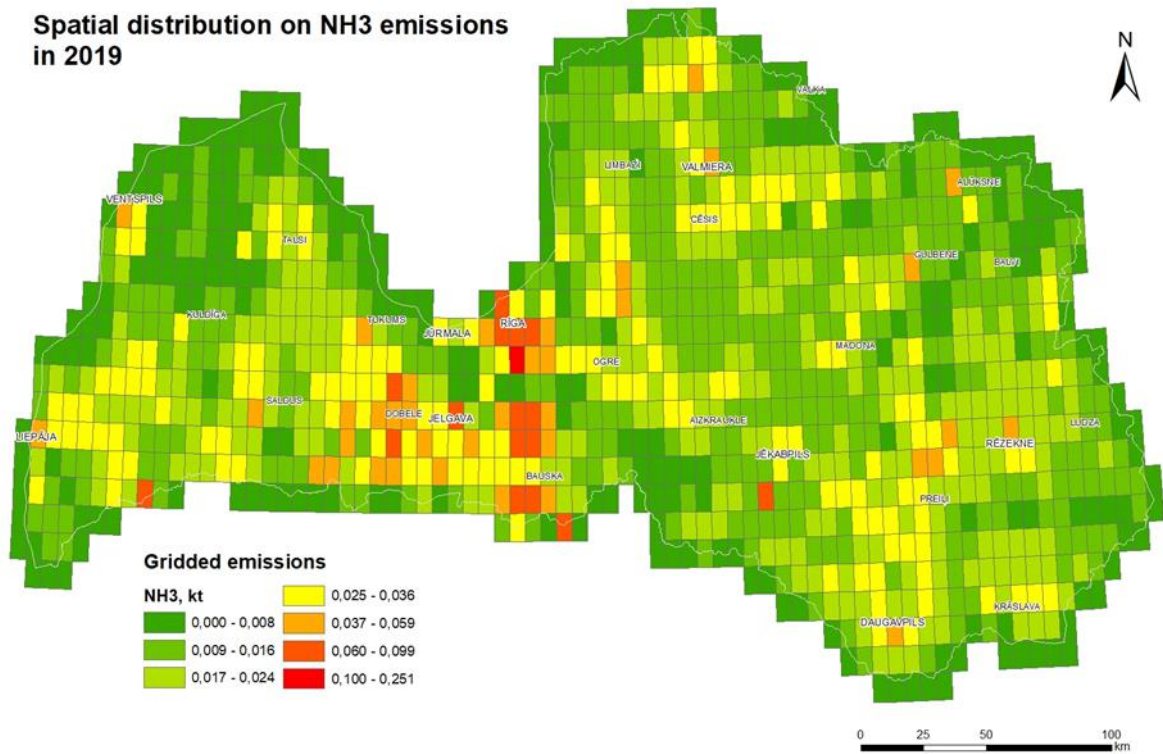


Figure 10.4 Spatial distribution on NH₃ emissions in 2019

The highest ammonia emissions occur in rural areas which is represented in Figure 10.4. Figure 10.5 shows correlation where PM_{2.5} stands out in urban territories with more than 10 000 inhabitants with noticeable economic activity in manufacturing and industry.

In Figure 10.6 carbon monoxide dispersion is correlated to densely populated territories and general activities related to housing and other domestic aspects.

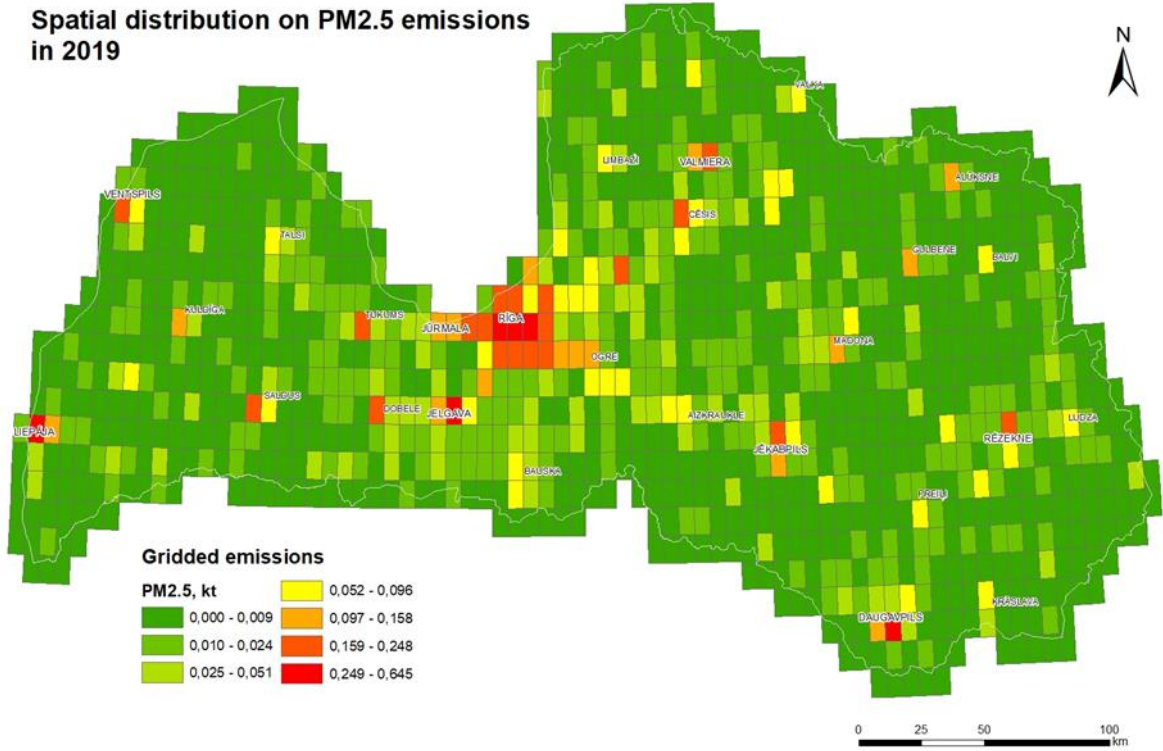


Figure 10.5 Spatial distribution on PM_{2.5} emissions in 2019

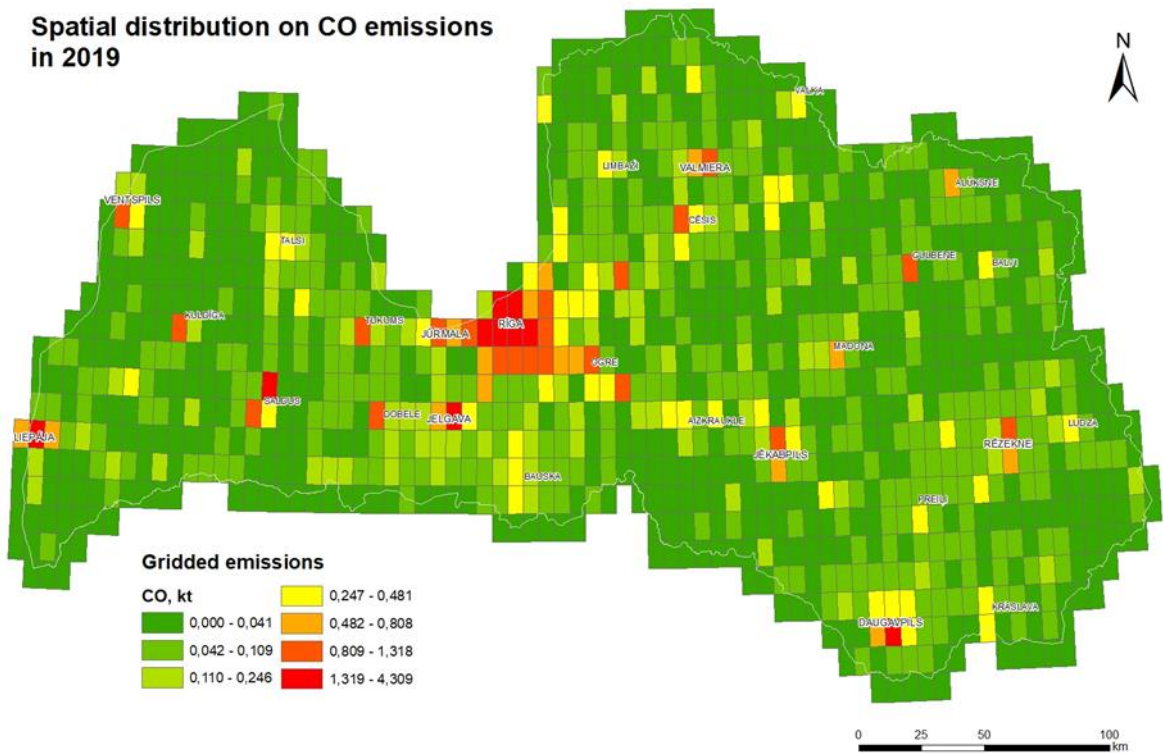


Figure 10.6 Spatial distribution on CO emissions in 2019

10.1.7 Planned improvements

After finalising gridding perspective improvements for procedure in year 2023 were found:

- 1) review LPS coordinate data for high resolution accuracy when detecting pollution source;
- 2) review applied ABC pollution category proportions for all pollutants and not only LPS;
- 3) improvements in data precision and detailed information including State level information systems, so higher Tier level methods can be adapted with data representing more focused gridding technique. For example, a quarry database (LEGMC) is set for system-level improvements - not only area but amount of extraction can be used for emission spatial distribution calculations. In solid waste treatment instead of using territorial units process coordinate data and amount of deposited waste for emission distribution, etc.;
- 4) review data sources and where it is possible find more accurate surrogate data, which represent emission dispersion;
- 5) consider improvements for statistics in more detailed spatial units if point data are not available. For example, construction and demolition sectors could be applied in municipal units not at the regional level

10.2 Large Point Sources (LPS)

10.2.1 Overview of LPS emissions

According to the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125) and the revised NEC Directive (2016/2284/EC), Latvia is required to report four-yearly its emissions from LPS for the year x-2, starting from 2017.

Large Point Sources are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed at least one of the threshold values for the 14 pollutants identified in Reporting Guidelines.

The Table 10.4 and Figure 10.7 shows LPS in 2019 by GNFR sectors - reported pollutants, stack height class categories and location. Each LPS emission has been aggregated by GNFR sectors and the stack height class categories. In 2019 40 facilities were identified and reported in Latvia. Emission data is reported in NFR 2014-1 format ANNEX VI: Template for LPS data for each relevant aggregated Gridding NFR sectors (GNFR).

LPS data was obtained from the national database "2-Air" (The Report on Air Protection). Data in the database is submitted by companies which have or in the reference year had a valid permit for the pollutive activities. Information in database is reviewed and verified by State environmental services.

Table 10.4 Activities and pollutants under LPS in 2019

GNFR	Emissions reported	Number of LPS facilities	Height class
A_PublicPower	NO _x (as NO ₂), SO _x (as SO ₂), PM _{2.5} , PM ₁₀ , CO	5	1, 2,3
B_Industry	NO _x (as NO ₂), NMVOC, SO _x (as SO ₂), NH ₃ , PM _{2.5} , PM ₁₀ , CO, Pb, Cd, Hg	11	1, 2,3
C_OtherStationaryComb	NO _x (as NO ₂), NMVOC, NH ₃ , PM ₁₀ , CO	3	1, 2
K_AgriLivestock	NO _x (as NO ₂), SO _x (as SO ₂), PM _{2.5} , PM ₁₀ , CO	21	1, 2

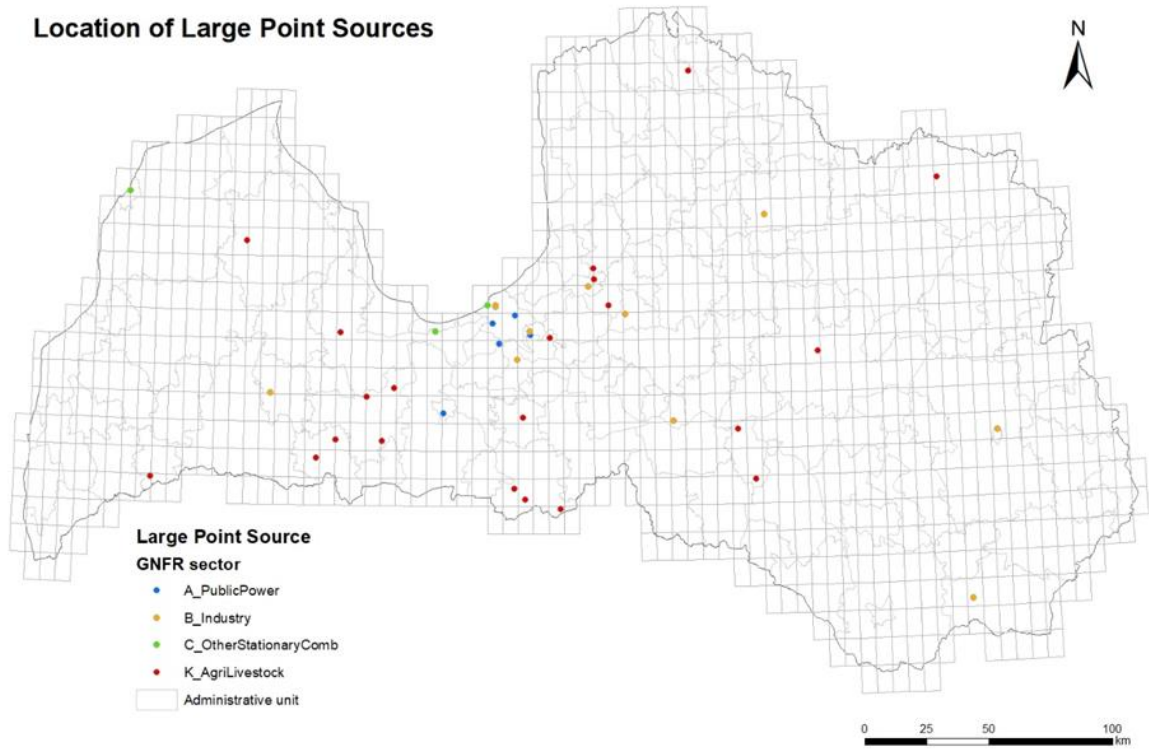


Figure 10.7 Location of LPS in 2019

Figure 10.8 shows comparison between LPS and submitted National Total emissions in 2019. LPS NO_x emissions contributes 12.3% from total emissions, NMVOC – 1.4%, SO_x – 6.8%, NH₃ – 4.8%, PM_{2.5} – 1.4% and CO – 3.6%.

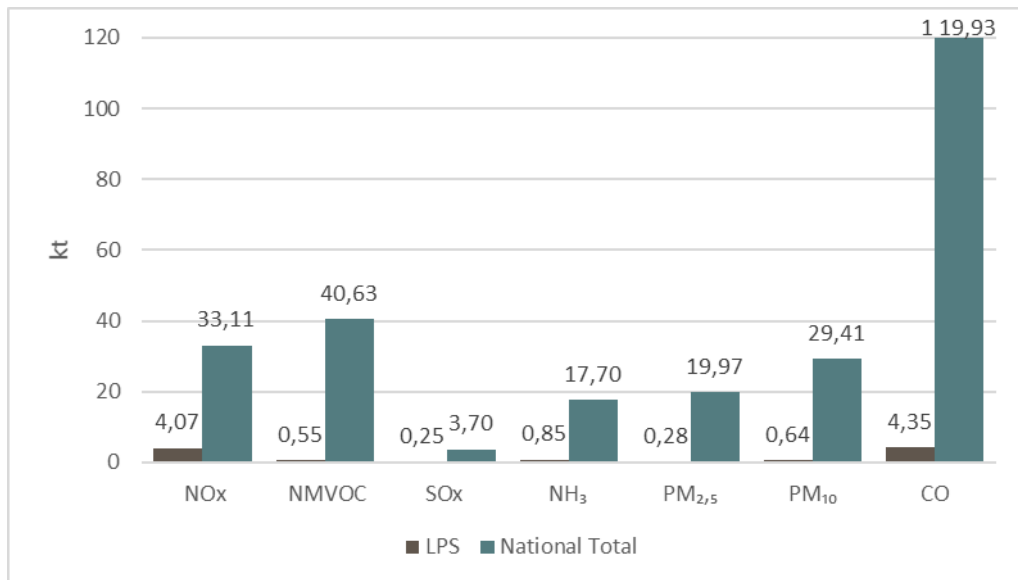


Figure 10.8 LPS and National total emissions in 2019, kt

Figure 10.9 and Figure 10.10 shows LPS contribution into K_AgriLivestock and B_Industry.

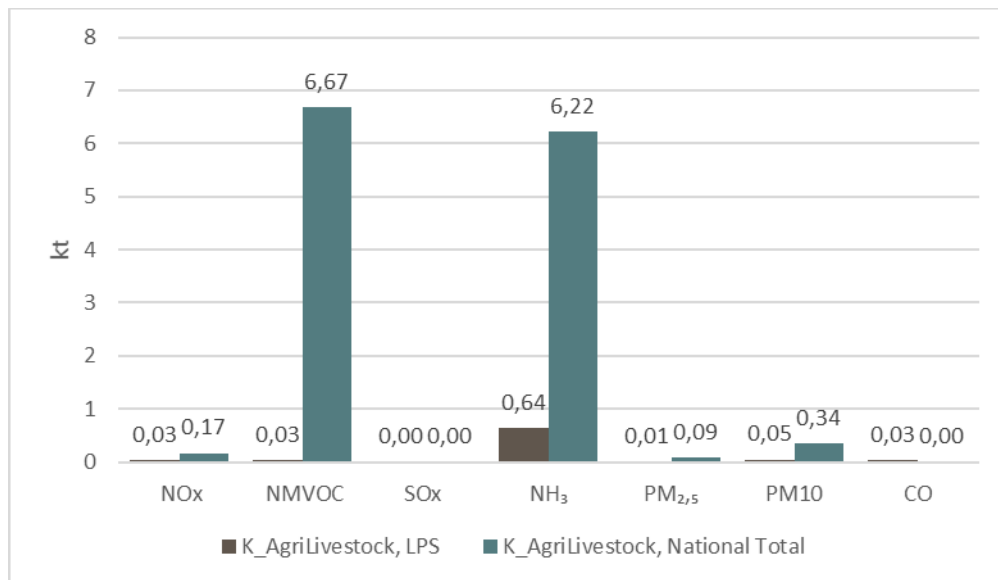


Figure 10.9 K_AgriLivestock LPS and National total, kt

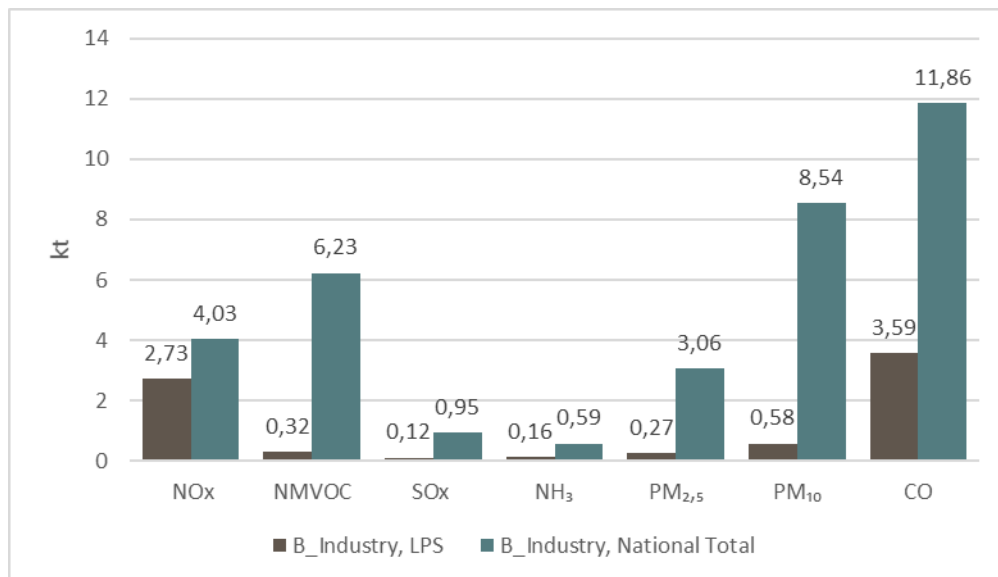


Figure 10.10 B_Industry LPS and National total, kt

Figure 10.11 shows a comparison between LPS emissions data from 2015 and 2019. NMVOC, SOx, PM_{2,5} and PM₁₀ emissions have decreased but NOx and CO emissions have increased.

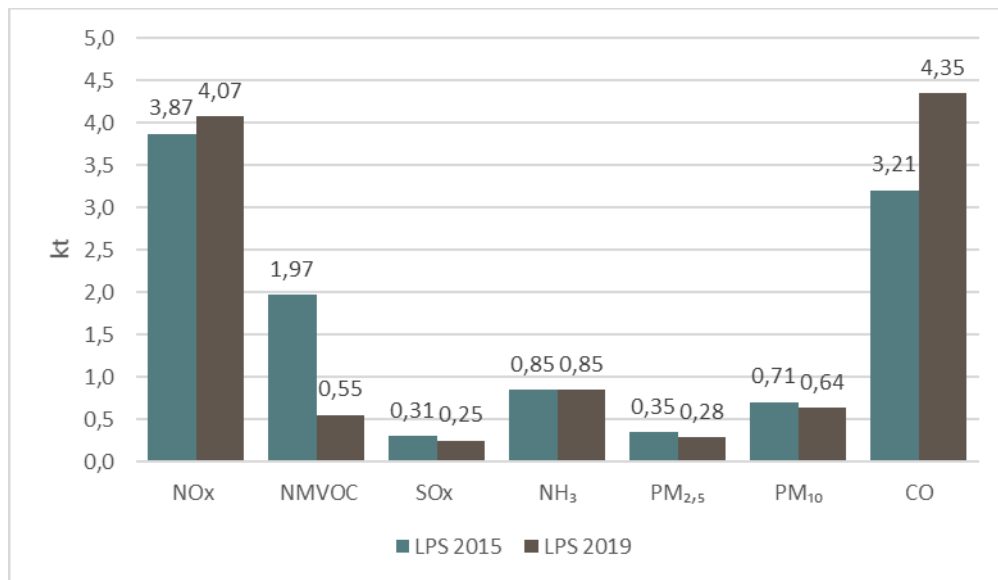


Figure 10.11 Pollutant emissions from LPSs in the period 2015-2019

10.2.2 Planned improvements

In the next report include LPS emissions data comparison with submitted PRTR/LCP: E-PRTR and LCP integrated data reporting and EU Registry on Industrial Sites report.

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Annex I: Detailed methodological descriptions

Table 1 Emission factors for Energy Industries (NFR 1A1)

	NOx	CO	NM VOC	NH ₃	TSP	PM ₁₀	PM _{2.5}	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCBs	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	Reference	
Unit	g/GJ							% of PM _{2.5}	mg/GJ									µg/GJ	ng/GJ	mg/GJ			µg/GJ	Reference		
Shale Oil	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	
LPG	89	39	2.6	NE	0.89	0.89	0.89	2.5	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015	NE	0.5	0.56	0.84	0.84	0.84	NE	EMEP/EEA 2019 - 1A1 - Table 3-4	
Jet Kerosene	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	
Diesel Oil	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	
RFO	142	15.1	2.3	NE	35.4	25.2	19.3	5.6	4.56	1.2	0.341	3.98	2.55	5.31	255	2.06	87.8	NE	2.5	NE	4.5	4.5	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-5	
Other Oil Products	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	
Coal	209	8.7	1	NE	11.4	7.7	3.4	2.2	7.3	0.9	1.4	7.1	4.5	7.8	4.9	23	19	3.3	10	0.7	37	29	1.1	6.7	EMEP/EEA 2019 - 1A1 - Table 3-2	
Peat	247	8.7	1.4	NE	11.7	7.9	3.2	1	15	1.8	2.9	14.3	9.1	1	9.7	45	8.8	3.3	10	1.3	37	29	2.1	6.7	EMEP/EEA 2019 - 1A1 - table 3-3	
Natural Gas	Tier 1	89	39	2.6	NE	0.89	0.89	0.89	2.5	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015	NE	0.5	0.56	0.84	0.84	0.84	NE	EMEP/EEA 2019 - 1A1 - Table 3-4
	Dry bottom boilers	89	39	2.6	NE	0.89	0.89	0.89	2.5	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015	NE	0.5	0.56	0.84	0.84	0.84	NE	EMEP/EEA 2019 - 1A1 - Table 3-12
	Gas turbine	48	4.8	1.6	NE	0.2	0.2	0.2	2.5	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015	NE	NE	0.56	1.58	1.11	8.36	NE	EMEP/EEA 2019 - 1A1 - Table 3-17
Wood	81	90	7.31	NE	172	155	133	3.3	20.6	1.76	1.51	9.46	9.03	21.1	14.2	1.2	181	3.5	50	1.12	0.043	0.0155	0.0374	5	EMEP/EEA 2019 - 1A1 - Table 3-7	
Straws	81	90	7.31	NE	172	155	133	3.3	20.6	1.76	1.51	9.46	9.03	21.1	14.2	1.2	181	3.5	50	1.12	0.043	0.0155	0.0374	5	EMEP/EEA 2019 - 1A1 - Table 3-7	
Biofuel	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	
Biogas	89	39	2.6	NE	0.89	0.89	0.89	2.5	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.0112	0.0015	NE	0.5	0.56	0.84	0.84	0.84	NE	EMEP/EEA 2019 - 1A1 - Table 3-4	
Waste Oil	65	16.2	0.8	NE	6.5	3.2	0.8	33.5	4.07	1.36	1.36	1.81	1.36	2.72	1.36	6.79	1.81	NE	0.5	NE	NE	NE	6.92	NE	EMEP/EEA 2019 - 1A1 - Table 3-6	

Table 2 Emission factors for Manufacturing Industries and Construction (NFR 1A2)

	NO _x	CO	NMVOC	NH ₃	TSP	PM ₁₀	PM _{2.5}	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCBs	PCDD/ F	B(a)j	B(b)f	B(k)f	I(1,2,3- cd)p	HC B	Reference	
Unit	g/GJ							% of PM _{2.5}	mg/GJ									µg/GJ	ng/GJ	mg/GJ			µg /GJ			
Shale Oil	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
LPG	74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.54	0.1	0.013	0.0026	0.013	0.058	0.73	NE	0.52	0.72	2.9	1.1	1.08	NE	EMEP/EEA 2019 - 1A2 - Table 3-3	
Jet Kerosene	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
Other Kerosene	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
Diesel Oil	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
RFO	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
Petroleum Coke	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
Other Oil Products	513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4	
Anthracite	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.6 2	EMEP/EEA 2019 - 1A2 - Table 3-2	
Coal	Tier 1	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.6 2	EMEP/EEA 2019 - 1A2 - Table 3-2
	> 50 kWth to ≤ 1 MWth	160	2000	200	NE	200	190	170	6.4	200	3	7	5	1578	30	20	2	300	170	400	100	130	50	40	0.6 2	EMEP/EEA 2019 - 1A4ai -Table 3-20
	> 1 MWth to ≤ 50 MWth	180	200	90	NE	80	76	72	6.4	100	1	9	4	15	10	10	2	150	170	100	13	17	9	6	0.6 2	EMEP/EEA 2019 - 1A4ai -Table 3-21
Coke	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.6 2	EMEP/EEA 2019 - 1A2 - Table 3-2	
Oil Shale	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.6 2	EMEP/EEA 2019 - 1A2 - Table 3-2	
Peat	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.6 2	EMEP/EEA 2019 - 1A2 - Table 3-2	
Natural Gas	Tier 1	74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.54	0.1	0.013	0.0026	0.013	0.058	0.73	NE	0.52	0.72	2.9	1.1	1.08	NE	EMEP/EEA 2019 - 1A2 - Table 3-3
	> 50 kWth	73	24	0.36	NE	0.45	0.45	0.45	5.4	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	NA	0.5	0.56	0.84	0.84	0.84	NA	EMEP/EEA 2019 - 1A4ai - Table 3-26

	NO _x	CO	NM VOC	NH ₃	TSP	PM ₁₀	PM _{2.5}	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCBs	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HC B	Reference	
Unit	g/GJ								% of PM _{2.5}	mg/GJ										µg/GJ	ng/GJ	mg/GJ			µg/GJ	
	to ≤ 1 MWth																									
	> 1 MWth to ≤ 50 MWth	40	30	2	NE	0.45	0.45	0.45	5.4	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	NA	0.5	0.56	0.84	0.84	0.84	NA	EMEP/EEA 2019 - 1A4ai - Table 3-27
Wood		91	570	300	37	150	143	140	28	27	13	0.56	0.19	23	6	2	0.5	512	0.06	100	10	16	5	4	5	EMEP/EEA 2019 - 1A2 - Table 3-5
Straws		91	570	300	37	150	143	140	28	27	13	0.56	0.19	23	6	2	0.5	512	0.06	100	10	16	5	4	5	EMEP/EEA 2019 - 1A2 - Table 3-5
Biofuel		513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4
Biogas		74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.54	0.1	0.013	0.0026	0.013	0.058	0.73	NE	0.52	0.72	2.9	1.1	1.08	NE	EMEP/EEA 2019 - 1A2 - Table 3-3
Waste Oil		513	66	25	NE	20	20	20	56	0.08	0.006	0.12	0.03	0.2	0.22	0.008	0.11	29	NE	1.4	1.9	15	1.7	1.5	NE	EMEP/EEA 2019 - 1A2 - Table 3-4

Table 3 Emission factors for Small combustion (NFR 1A4ai, 1A4ci)

	NO _x	CO	NM VOC	NH ₃	TSP	PM ₁₀	PM _{2.5}	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCBs	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	Reference	
Unit	g/GJ								% of PM _{2.5}	mg/GJ										µg WHO-TEG/GJ	ng I-TEQ/GJ	mg/GJ			µg/GJ	
Shale Oil	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
LPG	74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.1	0.1	0.013	0.0026	0.013	0.058	0.73	NA	0.52	0.72	2.9	1.1	1.08	NA	EMEP/EEA 2019 - 1A4 - Table 3-8	
Other Kerosene	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
Diesel Oil	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
RFO	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
Other Oil Products	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
Anthracite	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.62	EMEP/EEA 2019 - 1A4 - Table 3-7	
Coal	Tier 1	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.62	EMEP/EEA 2019 - 1A4 - Table 3-7
	> 50 kWth	160	2000	200	NE	200	190	170	6.4	200	3	7	5	1578	30	20	2	300	170	400	100	130	50	40	0.62	EMEP/EEA 2019 - 1A4ai - Table 3-20

	NOx	CO	NM VOC	NH ₃	TSP	PM ₁₀	PM _{2.5}	BC	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCBs	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	Reference	
Unit	g/GJ							% of PM _{2.5}	mg/GJ									µg WHO-TEG/GJ	ng I-TEQ/GJ	mg/GJ				µg/GJ	Reference	
	to ≤ 1 MWth																									
	> 1 MWth to ≤ 50 MWth	180	200	90	NE	80	76	72	6.4	100	1	9	4	15	10	10	2	150	170	100	13	17	9	6	0.62	EMEP/EEA 2019 – 1A4ai - Table 3-21
Peat	173	931	88.8	NE	124	117	108	6.4	134	1.8	7.9	4	13.5	17.5	13	1.8	200	170	203	45.5	58.9	23.7	18.5	0.62	EMEP/EEA 2019 - 1A4 - Table 3-7	
Natural Gas	Tier 1	74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.1	0.1	0.013	0.0026	0.013	0.058	0.73	NA	0.52	0.72	2.9	1.1	1.08	NA	EMEP/EEA 2019 - 1A4 - Table 3-8
	> 50 kWth to ≤ 1 MWth	73	24	0.36	NE	0.45	0.45	0.45	5.4	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	NA	0.5	0.56	0.84	0.84	0.84	NA	EMEP/EEA 2019 - 1A4ai - Table 3-26
	> 1 MWth to ≤ 50 MWth	40	30	2	NE	0.45	0.45	0.45	5.4	0.0015	0.00025	0.1	0.12	0.00076	0.000076	0.00051	0.011	0.0015	NA	0.5	0.56	0.84	0.84	0.84	NA	EMEP/EEA 2019 - 1A4ai - Table 3-27
Wood	91	570	300	37	170	163	160	28	27	13	0.56	0.19	23	6	2	0.5	512	0.06	100	10	16	5	4	5	EMEP/EEA 2019 - 1A4 - Table 3-10	
Straws	91	570	300	37	170	163	160	28	27	13	0.56	0.19	23	6	2	0.5	512	0.06	100	10	16	5	4	5	EMEP/EEA 2019 - 1A4 - Table 3-10	
Biofuel	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	
Biogas	74	29	23	NE	0.78	0.78	0.78	4	0.011	0.0009	0.1	0.1	0.013	0.0026	0.013	0.058	0.73	NA	0.52	0.72	2.9	1.1	1.08	NA	EMEP/EEA 2019 - 1A4 - Table 3-8	
Waste Oil	306	93	20	NE	21	21	18	56	8	0.15	0.1	0.5	10	3	125	0.1	18	0.13	6	1.9	15	1.7	1.5	0.22	EMEP/EEA 2019 - 1A4 - Table 3-9	

Table 4 Emission factors for Off-road transport

		NOx	NM VOC	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	PCB	Reference
		IEF for 2018, g/tonnes fuel									mg/kg									ng/kg	µg/kg				Reference	
1.A.2.gvii	Gasoline: 2-stroke	2495	113157	4	4299	4299	4299	215	695237	1990-1998 - 0.00015 1999-2015 - 5.05391	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.2.gvii Non-road mobile sources and machinery Table 3-1, Table 3-2
	Gasoline: 4-stroke	6676	16126	4	159	159	159	8	804157		0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.2.gvii Non-road mobile sources

		NO _x	NM _{VOC}	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/ F	B(a)p	B(b)f	B(k)f	I(1,2,3- cd)P	HCB	PCB	Reference	
		IEF for 2018, g/tonnes fuel								mg/kg									ng/kg				µg/kg				
																											and machinery Table 3-1, Table 3-2
	Diesel	13871	1270	8	697	697	697	524	6931	NE	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	30	50	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.2.g.vii Non-road mobile sources and machinery Table 3-1, Table 3-2	
1.A.4.a.ii	Gasoline: 2- stroke	2495	113157	4	4299	4299	4299	215	695237	1990-1998 - 0.00015 1999-2015 - 5.05391	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.a.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
	Gasoline: 4- stroke	6676	16126	4	159	159	159	8	80157		0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.a.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
	Diesel	13871	1270	8	697	697	697	524	6931	NE	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	30	50	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.a.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
1.A.4.b.ii	Gasoline: 2- stroke	2765	227289	3	3762	3762	3762	188	620793	1990-1998 - 0.00015 1999-2015 - 5.05391	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.b.ii Non-road mobile sources and machinery Table 3-1	
	Gasoline: 4- stroke	7117	18893	4	157	157	157	8	770368		0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.b.ii Non-road mobile sources and machinery Table 3-1	
	Diesel	32629	3377	8	2104	2014	2014	1306	10774	NE	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	30	50	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.b.ii Non-road mobile sources and machinery Table 3-1	
1.A.4.c.ii	Gasoline: 2- stroke	2495	113157	4	4299	4299	4299	215	695237	1990-1998 - 0.00015 1999-2015 - 5.05391	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.c.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
	Gasoline: 4- stroke	6676	16126	4	159	159	159	8	804157		0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	40	40	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.c.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
	Diesel Agriculture	15421	1432	8	612	612	612	388	6892	NE	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	30	50	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.c.ii Non-road mobile sources and machinery Table 3-1, Table 3-2	
	Diesel Forestry	10533	1103	8	387	387	387	240	6940	NE	0.01	NE	NE	0.05	1.7	0.07	0.01	1	NE	30	50	NE	NE	NE	NE	EMEP/EEA 2019 - 1.A.4.c.ii Non-road mobile sources	

		NOx	NM VOC	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)P	HCB	PCB	Reference
		IEF for 2018, g/tonnes fuel									mg/kg									ng/kg	µg/kg					
																										and machinery Table 3-1, Table 3-2
1.A.4.c.iii	RFO	79300	7400	NE	5600	6200	6200	NE	7400	0.18	0.02	0.02	0.68	0.72	1.25	32	0.21	1.2	0.47	NE	NE	NE	NE	0.14	0.57	EMEP/EEA 2019 - 1.A.4.c.iii National fishing Table 3-1
	Diesel	78500	2800	NE	1400	1500	1500	NE	7400	NE	0.01	0.03	0.04	0.05	0.88	1	0.1	1.2	0.13	NE	NE	NE	NE	0.08	0.038	EMEP/EEA 2019 - 1.A.4.c.iii National fishing Table 3-2
1.A.5.b	Aviation gasoline	4000	19000	NE	0	0	0	NE	1200	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NE	EMEP/EEA 2019 - 1.A.5.b Aviation Table 3.3
	Jet Kerosene	4000	19000	NE	0	0	0	NE	1200	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NE	EMEP/EEA 2019 - 1.A.5.b Aviation Table 3.3
	Diesel oil	78500	2800	NE	1400	1500	1500	NE	7400	0.13	0.01	0.03	0.04	0.05	0.88	1	0.1	1.2	0.13	NE	NE	NE	NE	0.08	0.038	EMEP/EEA 2019 - 1.A.4.c.iii National fishing Table 3-2

Table 5 Emission factors in Residential wood burning appliances

		Fireplaces	Conventional stoves	High-efficiency stoves	Advanced/ecolabelled stoves	Conventional boiler <50kW	Pellet stoves	
NOx	g/GJ	50	50	80	95	80	80	
		CO	4000	4000	4000	2000	4000	300
		NM VOC	600	600	350	250	350	10
		NH ₃	74	70	37	37	74	12
		TSP	880	800	400	100	500	62
		PM ₁₀	840	760	380	95	480	60
		PM _{2.5}	820	740	370	93	470	60
		BC	57.4	74	59.2	26.04	75.2	9
Pb	mg/GJ	27	27	27	27	27	27	
		Cd	13	13	13	13	13	13
		Hg	0.56	0.56	0.56	0.56	0.56	0.56
		As	0.19	0.19	0.19	0.19	0.19	0.19
		Cr	23	23	23	23	23	23
		Cu	6	6	6	6	6	6
		Ni	2	2	2	2	2	2
		Se	0.5	0.5	0.5	0.5	0.5	0.5
		Zn	512	512	512	512	512	512
		PCBs	µg/GJ	0.06	0.06	0.03	0.007	0.06
PCDD/F	ng I-TEQ/GJ	800	800	250	100	550	100	
benzo(a)pyrene	mg/GJ	121	121	121	10	121	10	

		Fireplaces	Conventional stoves	High-efficiency stoves	Advanced/ecolabelled stoves	Conventional boiler <50kW	Pellet stoves
benzo(b)fluoranthene		111	111	111	16	111	16
benzo(k)fluoranthene		42	42	42	5	42	5
indeno(1,2,3-cd)pyrene		71	71	71	4	71	4
HCB	µg/GJ	5	5	5	5	5	5
<i>Reference</i>		<i>EMEP/EEA 2019 - 1A4bi - Table 3.39</i>	<i>EMEP/EEA 2019 - 1A4bi - Table 3.40</i>	<i>EMEP/EEA 2019 - 1A4bi - Table 3.41</i>	<i>EMEP/EEA 2019 - 1A4bi - Table 3.42</i>	<i>EMEP/EEA 2019 - 1A4bi - Table 3.43</i>	<i>EMEP/EEA 2019 - 1A4bi - Table 3.44</i>

Table 6 Sulphur content and SO₂ emission factors used in Energy sector

Fuel	NCV	Sulphur content (%)																
		1990-95	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel	42.49	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
RFO	40.60	2.00	2.08	1.23	0.99	1.21	0.91	0.79	0.91	0.97	0.94	0.80	0.84	0.79	0.66	0.60	0.51	0.64
Gasoline	43.97	0.015	0.02	0.02	0.01	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Jet fuel	43.21	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Other liquid fuel	41.86	0.65	0.56	0.50	0.48	0.47	0.46	0.45	0.44	0.42	0.41	0.40	0.39	0.40	0.42	0.45	0.41	0.64
LPG	45.54	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029
Shale oil	39.35	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Coal	23.91	1.80	0.90	0.72	0.66	0.52	0.45	0.46	0.39	0.41	0.50	0.44	0.48	0.57	0.49	0.53	0.55	0.48
Coke	26.79	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Oil shale	9.20	1.60	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	10.05	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
RFO (marine)	40.60	2.00	1.50	1.50	1.50	1.50	1.50	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wood	6.70	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Natural gas	<i>Changes annually</i>	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029
		EF (kt/PJ)																
Diesel		0.094	0.094	0.094	0.094	0.094	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
RFO		0.966	1.003	0.596	0.479	0.583	0.441	0.382	0.442	0.467	0.456	0.389	0.405	0.384	0.318	0.288	0.247	0.308
Gasoline		0.0068	0.0068	0.0068	0.0023	0.0023	0.0023	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Jet fuel		0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Other liquid fuel		0.311	0.267	0.237	0.231	0.225	0.220	0.214	0.208	0.202	0.196	0.190	0.184	0.190	0.202	0.216	0.196	0.305
LPG		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Shale oil		0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407
Coal		1.138	0.567	0.498	0.454	0.357	0.308	0.318	0.266	0.280	0.342	0.328	0.359	0.431	0.370	0.398	0.406	0.352
Coke		0.410	0.410	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403
Oil shale		3.130	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat		0.508	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507
RFO (marine)		0.966	0.724	0.724	0.724	0.724	0.724	0.724	0.483	0.483	0.483	0.483	0.483	0.483	0.483	0.483	0.483	0.483
Wood		0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Natural gas		0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

Notes:

Gasoline, diesel oil – EU legislation

RFO – EU legislation, average value from database Nr.2-Air

Other liquids – average value from database Nr.2-Air

Coal – average value from database Nr.2-Air

Shale oil – Luik, H. "Coal, oil shale, natural bitumen, heavy oil and peat" Vol. II *Chemicals and Other products from Shale Oil*

Oil shale – Gavrilova, O., Randla, T., Vallner, L., Strandberg, M., Vilu, R. 2005. "Life Cycle Analysis of the Estonian Oil Shale Industry"

Peat, peat briquettes – Latvian Peat Producers Association

Wood – Zandersons, J, Zūriņš, A., Rižikovs, J., Dobeļe, G., Latvian Institute of Wood chemistry "Feasibility of processing and utilisation of used up railway sleepers"

Natural gas – allowed content of mercaptan (3 mg/m³)

Table 7 Distribution of road transport fleet by subsectors and layers, year 2019

Category	Fuel	Segment	Euro Standard	Population	Average mileage per car
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 1</i>	550	6 192
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 2</i>	4 134	7 076
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 3</i>	9 071	7 843
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 4</i>	11 799	9 688
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 5</i>	7 749	11 278
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 6 a/b/c</i>	6 728	13 724
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Small</i>	<i>Euro 6 d-temp</i>	6 168	13 724
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 1</i>	16 292	7 949
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 2</i>	36 410	9 199
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 3</i>	23 765	10 065
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 4</i>	26 732	12 004
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 5</i>	11 396	12 595
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 6 a/b/c</i>	6 191	14 790
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Medium</i>	<i>Euro 6 d-temp</i>	5 872	14 790
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 1</i>	200	9 612
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 2</i>	7 127	10 053
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 3</i>	8 359	11 813
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 4</i>	8 063	12 693
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 5</i>	2 638	13 763
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 6 a/b/c</i>	1 856	14 910
<i>Passenger Cars</i>	<i>Petrol</i>	<i>Large-SUV-Executive</i>	<i>Euro 6 d-temp</i>	1 203	15 671
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 2</i>	45	6 816
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 3</i>	2 082	7 555
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 4</i>	2 189	8 986
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 5</i>	1 848	10 490
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 6 a/b/c</i>	994	11 775
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Small</i>	<i>Euro 6 d-temp</i>	642	11 775
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 1</i>	15 970	7 525
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 2</i>	28 429	10 061
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 3</i>	82 900	11 379
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 4</i>	58 868	12 436
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 5</i>	35 861	15 607
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 6 a/b/c</i>	13 883	16 430
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Medium</i>	<i>Euro 6 d-temp</i>	10 905	16 430
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 1</i>	8 330	8 797
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 2</i>	14 947	10 595
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 3</i>	77 237	12 366
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 4</i>	34 402	13 939
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 5</i>	19 386	16 211
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 6 a/b/c</i>	7 468	17 394

Category	Fuel	Segment	Euro Standard	Population	Average mileage per car
<i>Passenger Cars</i>	<i>Diesel</i>	<i>Large-SUV-Executive</i>	<i>Euro 6 d-temp</i>	1 479	17 394
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Conventional</i>	363	8 682
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 1</i>	8 002	11 318
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 2</i>	9 673	13 825
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 3</i>	10 612	15 657
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 4</i>	10 172	17 916
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 5</i>	3 147	18 785
<i>Passenger Cars</i>	<i>LPG Bifuel</i>	<i>Small</i>	<i>Euro 6 a/b/c</i>	522	18 785
<i>Passenger Cars</i>	<i>CNG Bifuel</i>	<i>Small</i>	<i>Euro 4</i>	14	7 141
<i>Passenger Cars</i>	<i>CNG Bifuel</i>	<i>Small</i>	<i>Euro 5</i>	20	7 141
<i>Passenger Cars</i>	<i>CNG Bifuel</i>	<i>Small</i>	<i>Euro 6 a/b/c</i>	29	7 141
<i>Passenger Cars</i>	<i>BEV</i>	<i>Medium</i>		658	12 000
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Conventional</i>	20	10 733
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 1</i>	124	11 782
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 2</i>	161	14 387
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 3</i>	327	16 183
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 4</i>	468	18 789
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 5</i>	397	20 924
<i>Light Commercial Vehicles</i>	<i>Petrol</i>	<i>N1-II</i>	<i>Euro 6 a/b/c</i>	199	22 772
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Conventional</i>	161	12 463
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 1</i>	1 437	12 700
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 2</i>	4 056	13 390
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 3</i>	10 796	16 827
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 4</i>	15 414	22 029
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 5</i>	12 942	25 049
<i>Light Commercial Vehicles</i>	<i>Diesel</i>	<i>N1-II</i>	<i>Euro 6 a/b/c</i>	6 113	25 446
<i>Light Commercial Vehicles</i>	<i>LPG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 1</i>	238	18 309
<i>Light Commercial Vehicles</i>	<i>LPG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 2</i>	290	20 186
<i>Light Commercial Vehicles</i>	<i>LPG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 3</i>	236	21 914
<i>Light Commercial Vehicles</i>	<i>LPG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 4</i>	287	26 848

Category	Fuel	Segment	Euro Standard	Population	Average mileage per car
Light Commercial Vehicles	LPG Bifuel	Large-SUV-Executive	Euro 5	189	29 218
Light Commercial Vehicles	LPG Bifuel	Large-SUV-Executive	Euro 6 a/b/c	44	31 823
Light Commercial Vehicles	CNG Bifuel	Medium	Euro 4	5	10 711
Light Commercial Vehicles	CNG Bifuel	Medium	Euro 5	4	10 711
Light Commercial Vehicles	CNG Bifuel	Medium	Euro 6 a/b/c	8	10 711
Heavy Duty Trucks	Petrol	>3,5 t	Conventional	650	28 860
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro I	462	13 954
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro II	506	15 811
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro III	498	19 707
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro IV	445	22 741
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro V	622	25 989
Heavy Duty Trucks	Diesel	Rigid <=7,5 t	Euro VI A/B/C	419	29 607
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro I	60	21 873
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro II	230	24 221
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro III	450	27 638
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro IV	511	29 046
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro V	231	31 561
Heavy Duty Trucks	Diesel	Rigid 7,5 - 12 t	Euro VI A/B/C	208	33 263
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro I	17	13 954
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro II	38	15 811
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro III	68	19 707
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro IV	139	22 741
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro V	29	25 989
Heavy Duty Trucks	Diesel	Rigid 12 - 14 t	Euro VI A/B/C	25	29 607
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro I	717	27 098
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro II	548	30 132
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro III	715	40 771
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro IV	699	44 466
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro V	636	46 605
Heavy Duty Trucks	Diesel	Rigid 14 - 20 t	Euro VI A/B/C	360	48 083
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro I	170	30 724
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro II	617	41 811
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro III	588	44 461
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro IV	697	48 157
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro V	788	59 370
Heavy Duty Trucks	Diesel	Rigid 20 - 26 t	Euro VI A/B/C	469	63 805
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	Euro I	32	30 724
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	Euro II	80	41 811
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	Euro III	227	44 461
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	Euro IV	76	48 157
Heavy Duty Trucks	Diesel	Rigid 26 - 28 t	Euro V	151	59 370

Category	Fuel	Segment	Euro Standard	Population	Average mileage per car
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 26 - 28 t</i>	<i>Euro VI A/B/C</i>	155	63 805
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro I</i>	38	30 724
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro II</i>	124	41 811
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro III</i>	227	44 461
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro IV</i>	149	48 157
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro V</i>	243	59 370
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid 28 - 32 t</i>	<i>Euro VI A/B/C</i>	287	63 805
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro I</i>	22	30 724
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro II</i>	68	41 811
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro III</i>	221	44 461
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro IV</i>	190	48 157
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro V</i>	98	59 370
Heavy Duty Trucks	<i>Diesel</i>	<i>Rigid >32 t</i>	<i>Euro VI A/B/C</i>	63	63 805
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro I</i>	72	33 642
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro II</i>	553	44 209
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro III</i>	1 630	48 720
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro IV</i>	1 597	60 014
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro V</i>	4 034	65 722
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 14 - 20 t</i>	<i>Euro VI A/B/C</i>	3 078	71 747
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro I</i>	5	33 642
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro II</i>	55	44 209
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro III</i>	237	48 720
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro IV</i>	154	60 014
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro V</i>	1 173	65 722
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 20 - 28 t</i>	<i>Euro VI A/B/C</i>	1 048	71 747
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 28 - 34 t</i>	<i>Euro II</i>	4	44 209
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 28 - 34 t</i>	<i>Euro III</i>	22	48 720
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 28 - 34 t</i>	<i>Euro IV</i>	12	60 014
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 28 - 34 t</i>	<i>Euro V</i>	17	65 722
Heavy Duty Trucks	<i>Diesel</i>	<i>Articulated 28 - 34 t</i>	<i>Euro VI A/B/C</i>	32	71 747
Heavy Duty Trucks	<i>CNG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 4</i>	8	17 851
Heavy Duty Trucks	<i>CNG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 5</i>	3	17 851
Heavy Duty Trucks	<i>CNG Bifuel</i>	<i>Large-SUV-Executive</i>	<i>Euro 6 a/b/c</i>	4	17 851
Buses	<i>Petrol</i>	<i>N1-III</i>	<i>Euro 2</i>	6	22 365
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro I</i>	89	18 120
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro II</i>	157	21 009
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro III</i>	358	21 009
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro IV</i>	283	30 953
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro V</i>	655	36 342
Buses	<i>Diesel</i>	<i>Urban Buses Midi <=15 t</i>	<i>Euro VI A/B/C</i>	550	36 342
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro I</i>	126	23 340
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro II</i>	131	27 015
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro III</i>	250	33 994
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro IV</i>	67	38 050
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro V</i>	178	47 774

Category	Fuel	Segment	Euro Standard	Population	Average mileage per car
Buses	<i>Diesel</i>	<i>Coaches Standard <=18 t</i>	<i>Euro VI A/B/C</i>	72	47 774
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro I</i>	62	23 340
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro II</i>	90	27 015
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro III</i>	366	33 994
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro IV</i>	119	38 050
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro V</i>	30	47 774
Buses	<i>Diesel</i>	<i>Coaches Articulated >18 t</i>	<i>Euro VI A/B/C</i>	220	47 774
Buses	<i>CNG</i>	<i>Urban CNG Buses</i>	<i>EEV</i>	7	22 191
L-Category	<i>Petrol</i>	<i>Mopeds 2-stroke <50 cm³</i>	<i>Euro 1</i>	426	929
L-Category	<i>Petrol</i>	<i>Mopeds 2-stroke <50 cm³</i>	<i>Euro 2</i>	4 709	1 101
L-Category	<i>Petrol</i>	<i>Mopeds 2-stroke <50 cm³</i>	<i>Euro 3</i>	10 168	1 168
L-Category	<i>Petrol</i>	<i>Mopeds 2-stroke <50 cm³</i>	<i>Euro 4</i>	2 019	1 168
L-Category	<i>Petrol</i>	<i>Motorcycles 2-stroke >50 cm³</i>	<i>Conventional</i>	1 100	853
L-Category	<i>Petrol</i>	<i>Motorcycles 2-stroke >50 cm³</i>	<i>Euro 1</i>	911	996
L-Category	<i>Petrol</i>	<i>Motorcycles 2-stroke >50 cm³</i>	<i>Euro 2</i>	926	1 097
L-Category	<i>Petrol</i>	<i>Motorcycles 2-stroke >50 cm³</i>	<i>Euro 3</i>	1 766	1 269
L-Category	<i>Petrol</i>	<i>Motorcycles 2-stroke >50 cm³</i>	<i>Euro 4</i>	894	1 357
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke 250 - 750 cm³</i>	<i>Conventional</i>	1 943	1 118
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke 250 - 750 cm³</i>	<i>Euro 1</i>	1 642	1 277
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke 250 - 750 cm³</i>	<i>Euro 2</i>	1 262	1 591
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke 250 - 750 cm³</i>	<i>Euro 3</i>	1 503	2 135
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke 250 - 750 cm³</i>	<i>Euro 4</i>	780	2 764
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke >750 cm³</i>	<i>Conventional</i>	1 781	1 118
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke >750 cm³</i>	<i>Euro 1</i>	2 197	1 277
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke >750 cm³</i>	<i>Euro 2</i>	1 762	1 591
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke >750 cm³</i>	<i>Euro 3</i>	2 276	2 135
L-Category	<i>Petrol</i>	<i>Motorcycles 4-stroke >750 cm³</i>	<i>Euro 4</i>	990	2 808
L-Category	<i>Petrol</i>	<i>Quad & ATVs</i>	<i>Euro 4</i>	993	313

	Oil products - total	Shale oil	Liquefied petroleum gas	Motor and aviation petrol	Petrol type jet fuel	Kerosene type jet fuel	Kerosene	Diesel oil	Residual (heavy) fuel oils	White spirit	Lubricants	Oil bitumen	Paraffin waxes	Petroleum coke	Other oil products	Used oils	Coal	Peat	Peat briquettes	Coke oven coke	Oil shale	Natural gas	Firewood	Wood wastes	Wood chips	Wood briquettes	Pelleted wood	Used rubber tyres and other rubber products	Municipal waste for heating	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sewage sludge gas	Other biogas	Straw		
Losses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	624	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Final consumption	66178	9	3424	7637	-	6631	1	44658	67	47	1118	2205	368	0	-	13	1497	19	18	1	-	13581	22999	7501	5803	722	2953	363	2356	87	306	1329	127	-	210	433		
Transport	52142	-	2028	7315	-	6631	-	35091	-	-	1077	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	306	1244	-	-	-	-	-	
International air transport	6612	-	-	0	-	6612	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Domestic air transport	23	-	-	4	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Road transport	43510	-	2028	7307	-	-	-	33123	-	-	1052	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	306	1190	-	-	-	-	-	
Rail transport	1861	-	-	-	-	-	-	1836	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54	-	-	-	-	-	
Inland shipping	136	-	-	4	-	-	-	132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pipeline transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Industry and construction	4701	9	462	43	-	-	0	1520	45	47	-	2205	368	-	-	2	1212	-	14	1	-	4085	2611	6558	5503	220	417	363	2356	-	-	2	-	-	2	309		
Manufacture of metals	0	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	3	0	-	-	-	-	-	-	-	-	-	-	
Manufacture of chemicals and chemical products	222	-	163	0	-	-	-	12	-	47	-	-	-	-	-	0	-	-	-	-	-	297	4	1	150	1	1	-	-	-	-	-	-	-	-	-	-	
Manufacture of other fabricated metal products	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Manufacture of other non-metallic mineral products	332	-	6	0	-	-	0	326	-	-	-	-	-	-	-	1183	-	-	-	-	-	1250	12	0	20	-	2	363	2356	-	-	2	-	-	-	-	261	
Manufacture of transport equipment	45	-	18	0	-	-	0	27	-	-	-	-	-	-	-	0	-	-	1	-	-	39	0	-	-	-	2	-	-	-	-	-	-	-	-	-	-	
Machinery	34	-	17	3	-	-	-	14	-	-	-	-	-	-	-	0	-	1	-	-	-	172	35	14	31	4	23	-	-	-	-	-	-	-	-	-	-	

	Oil products - total	Shale oil	Liquefied petroleum gas	Motor and aviation petrol	Petrol type jet fuel	Kerosene type jet fuel	Kerosene	Diesel oil	Residual (heavy) fuel oils	White spirit	Lubricants	Oil bitumen	Paraffin waxes	Petroleum coke	Other oil products	Used oils	Coal	Peat	Peat briquettes	Coke oven coke	Oil shale	Natural gas	Firewood	Wood wastes	Wood chips	Wood briquettes	Pelleted wood	Used rubber tyres and other rubber products	Municipal waste for heating	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sewage sludge gas	Other biogas	Straw	
Mining and quarrying	295	-	-	0	-	-	-	295	-	-	-	-	-	-	-	-	-	-	-	-	-	33	3	-	1	-	3	-	-	-	-	-	-	-	-	-	-
Manufacture of food products, beverages and tobacco	285	9	141	1	-	-	-	87	45	-	-	-	-	-	-	2	14	-	-	-	-	1254	130	65	157	13	37	-	-	-	-	-	-	-	2	48	
Manufacture of paper and paper products	4	-	4	0	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	95	1	-	12	-	4	-	-	-	-	-	-	-	-	-	
Manufacture of wood and of products of wood and cork	657	-	36	7	-	-	-	385	-	-	-	-	229	-	-	-	-	-	13	-	-	438	2226	5829	5113	196	307	-	-	-	-	-	-	-	-	-	
Construction	2666	-	69	32	-	-	-	360	-	-	-	2205	-	-	-	-	7	-	-	-	-	274	14	0	0	1	31	-	-	-	-	-	-	-	-	-	
Manufacture of textiles	5	-	4	0	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	168	4	-	-	0	3	-	-	-	-	-	-	-	-	-	
Manufacture of other products	156	-	4	0	-	-	-	13	-	-	-	-	139	-	-	-	7	-	-	-	-	42	181	649	19	2	4	-	-	-	-	-	-	-	-	-	
Other sectors	9335	-	934	279	-	-	1	8047	22	-	41	-	-	0	-	11	285	19	4	-	-	9488	20388	943	300	502	2536	-	-	87	-	83	127	-	208	124	
Other consumers - commercial and public sector	1159	-	215	30	-	-	1	909	2	-	-	-	-	0	-	2	90	19	4	-	-	4624	1440	12	257	27	571	-	-	-	-	0	127	-	-	4	
Households	2218	-	621	220	-	-	-	1377	-	-	-	-	-	-	-	195	-	-	-	-	-	4647	18625	261	-	470	1929	-	-	87	-	-	-	-	-	-	
Crop and animal production, hunting and related service activities; forestry and logging	5721	-	98	29	-	-	-	5546	-	-	39	-	-	-	-	9	0	-	0	-	-	214	322	670	43	5	36	-	-	-	-	83	-	-	208	120	
Fishing	237	-	-	0	-	-	-	215	20	-	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	0	-	-	-	-	-	-	-	-	-	

Table 2 Fuel consumption in Energy sector (stationary combustion), TJ

1.A.1 Energy Industries

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.A.1. Energy Industries																				
Total	95424	89290	74201	58345	53160	50516	51326	52637	54187	48325	42657	44355	43268	43796	41000	40407	41915	39400	38929	37897
Liquid Fuels	40437	33253	28441	27170	30859	20519	27333	17437	20662	17491	7900	5235	5033	3576	3055	2365	1511	1389	905	1194
Solid Fuels	2305	1736	1935	2106	1366	1395	740	541	455	398	371	398	285	209	210	183	105	341	446	472
Peat	2089	2343	2814	3007	2841	3432	2974	3083	2157	1275	2351	1230	1005	663	70	60	30	29	20	10
Gaseous Fuels	50115	51368	40338	25200	16770	24107	18644	28165	26802	25464	28803	33510	32497	34074	32371	33306	35181	32613	32650	31236
Biomass	436	590	673	862	1324	1063	1634	3412	4111	3697	3232	3940	4406	5245	5206	4464	5088	5028	4908	4956
Other Fossil Fuels	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29
1.A.1.a. Public Electricity and Heat Production																				
Total	92473	86689	71901	55946	51496	48590	48499	51233	50453	44329	39919	42931	41998	42183	39348	39061	40482	38378	37639	36780
Liquid Fuels	40098	33002	28190	26919	30426	20266	26110	17107	18116	14486	6350	5065	4821	3406	2843	2153	1299	1219	693	1031
Solid Fuels	2305	1736	1935	2106	1366	1395	740	541	427	370	371	398	285	209	210	183	105	341	446	472
Peat	1378	1703	1945	2437	2246	2703	2403	2600	1764	1046	1970	1125	995	653	60	40	20	20	20	10
Gaseous Fuels	48214	49658	39158	23622	16134	23163	17612	27599	26069	24831	27996	32633	31691	33199	31499	32434	34242	32043	31845	30739
Biomass	436	590	673	862	1324	1063	1634	3386	4077	3596	3232	3668	4164	4687	4648	4222	4816	4755	4635	4499
Other Fossil Fuels	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29
Shale oil	NO	NO	NO	NO	NO	39	NO	NO	NO	394	944	472	354	157	NO	NO	39	39	NO	NO
LPG	46	46	46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	5524	5226	3824	935	382	85	42	297	85	85	127	42	42	42	42	42	42	43	43	16
RFO	32561	26147	23183	24563	30044	20016	25984	16768	17905	14007	5279	4425	4425	3207	2801	2111	1218	1137	650	1015
Other liquid	1967	1583	1137	1421	NO	126	84	42	126	NO	NO	126	NO	NO	NO	NO	NO	NO	NO	NO
Coal	2305	1736	1935	2106	1366	1395	740	541	427	370	371	398	285	209	210	183	105	341	446	472
Peat	1347	1688	1930	2422	2231	2626	2341	2523	1749	1046	1970	1125	995	653	60	40	20	20	20	10
Peat briquettes	31	15	15	15	15	77	62	77	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	48214	49658	39158	23622	16134	23163	17612	27599	26069	24831	27996	32633	31691	33199	31499	32434	34242	32043	31845	30739
Wood	436	590	673	831	1300	1045	1595	3363	4060	3558	3191	3617	4097	4644	4570	4132	4740	4675	4556	4390
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	9
Sludge gas	NO	NO	NO	31	24	18	39	23	17	38	41	51	67	43	78	90	76	80	79	100
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries																				
Total	2951	2601	2300	2399	1664	1926	2826	1405	3734	3996	2738	1424	1270	1613	1652	1346	1433	1022	1290	1117

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Liquid Fuels	339	251	251	251	433	253	1223	330	2546	3005	1550	170	212	170	212	212	212	170	212	163
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	711	640	869	570	595	729	571	483	393	229	381	105	10	10	10	20	10	9	NO	NO
Gaseous Fuels	1901	1710	1180	1578	636	944	1032	566	733	633	807	877	806	875	872	872	939	570	805	497
Biomass	NO	NO	NO	NO	NO	NO	NO	26	34	101	NO	272	242	558	558	242	272	273	273	457
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	46	NO	NO	NO	182	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	216	346	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	212	170	170	170	170	212	127	127	127	212	127	170	212	170	212	212	212	170	212	163
RFO	81	81	81	81	81	41	1096	203	487	731	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	1716	1716	1423	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	711	640	869	570	595	729	571	483	393	229	381	105	10	10	10	20	10	9	NO	NO
Natural gas	1901	1710	1180	1578	636	944	1032	566	733	633	807	877	806	875	872	872	939	570	805	497
Wood	NO	NO	NO	NO	NO	NO	NO	26	34	101	NO	272	242	558	558	242	272	273	273	457

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.1. Energy Industries										
Total	45600	42403	40450	46116	43891	46768	51075	48148	55235	54249
Liquid Fuels	918	848	662	466	319	283	295	281	360	416
Solid Fuels	419	419	513	424	175	105	152	107	112	104
Peat	11	9	NO	40	NO	NO	NO	29	102	35
Gaseous Fuels	38687	35607	31872	33926	29870	31395	32108	26556	33211	31283
Biomass	5536	5517	7403	11260	13527	14985	18520	21175	21450	22411
Other Fossil Fuels	29	3	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.a. Public Electricity and Heat Production										
Total	44279	40875	39074	44636	42381	45456	49929	46879	54057	52883
Liquid Fuels	705	593	492	211	33	28	30	37	80	39
Solid Fuels	419	419	513	424	175	105	152	107	112	104
Peat	11	9	NO	40	NO	NO	NO	NO	85	NO
Gaseous Fuels	37812	34664	30895	32997	29040	30712	31595	26116	32691	30713
Biomass	5303	5187	7174	10964	13133	14611	18152	20619	21089	22027
Other Fossil Fuels	29	3	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	4	1	1	1	1	1	2
Diesel oil	15	25	127	94	22	14	11	14	49	9

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
RFO	690	568	365	113	10	13	18	22	30	28
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	419	419	513	424	175	105	152	107	112	104
Peat	10	9	NO	40	NO	NO	NO	NO	85	NO
Peat briquettes	1	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	37812	34664	30895	32997	29040	30712	31595	26116	32691	30713
Wood	5120	4635	5793	9198	11184	12286	15662	18003	18751	19948
Straws	1	NO	NO	NO	NO	NO	NO	18	66	NO
Biofuel	8	52	39	NO	NO	NO	NO	NO	1	NO
Landfill gas	18	22	22	14	16	13	13	14	14	14
Sludge gas	114	100	105	97	91	99	107	106	87	98
Other biogas	42	378	1215	1655	1842	2213	2370	2478	2170	1968
Waste oils	29	3	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries										
Total	1321	1528	1376	1480	1510	1312	1146	1269	1178	1366
Liquid Fuels	213	255	170	255	286	255	265	244	280	377
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	29	17	35
Gaseous Fuels	875	943	977	929	830	683	513	440	520	570
Biomass	233	330	229	296	394	374	368	556	361	384
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	213	255	170	255	286	255	265	244	280	377
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	29	17	35
Natural gas	875	943	977	929	830	683	513	440	520	570
Wood	233	330	229	296	394	374	368	556	361	384

1.A.2 Manufacturing Industries and Construction

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.A.2 Manufacturing Industries and Construction																				
Total	58640	45567	38083	32982	29888	29837	29430	28709	26228	24129	20526	20910	21411	21329	22992	24018	25618	24376	23172	22367
Liquid Fuels	29747	20311	17430	17082	16545	16745	16344	16010	12910	11400	7575	4681	3966	4417	4277	2866	4075	3843	3076	2936
Solid Fuels	1545	882	968	1639	1444	650	592	450	393	421	252	252	253	262	236	971	1394	1967	1993	1363

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Peat	NO	20	10	NO	15	15	15	25	25	15	NO	NO	NO	NO	10	NO	NO	NO	NO	NO
Gaseous Fuels	25894	23752	19059	12482	9783	10014	9815	9484	9712	9080	9873	11583	12838	12729	13157	13680	13395	12881	11836	9261
Biomass	617	603	616	1779	2101	2414	2664	2740	3188	3186	2733	3926	3487	3391	4795	5588	6464	5415	5895	8675
Other Fossil Fuels	837	NO	NO	NO	NO	NO	NO	NO	NO	26	94	469	866	530	517	914	290	270	372	132
1.A.2.a. Iron and Steel																				
Total	6304	4622	4130	3651	3992	3065	3282	5079	5083	4991	5049	5142	4861	4932	5016	4777	5059	5081	4738	4187
Liquid Fuels	1192	989	705	731	885	705	785	1162	1088	1130	1145	1042	963	963	963	99	963	963	917	792
Solid Fuels	NO	NO	NO	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	27	27	5	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	4275	3633	3425	2892	3107	2360	2497	3917	3995	3861	3904	4058	3898	3969	4026	4125	4091	4118	3821	3395
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	526	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	15	15	15	NO	15	NO	NO	NO	NO	NO	15	NO	NO	NO	NO	15	NO	NO	NO	NO
RFO	1177	974	690	284	284	203	325	325	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	122	81
Other liquid	NO	NO	NO	447	586	502	460	837	1088	1130	1130	963	963	963	963	84	963	963	795	711
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	27	27	5	NO	NO	NO
Natural gas	4275	3633	3425	2892	3107	2360	2497	3917	3995	3861	3904	4058	3898	3969	4026	4125	4091	4118	3821	3395
Wood	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	526	NO	NO	NO	NO
1.A.2.b. Non-Ferrous Metals																				
Total	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	190	269	302	269	203	204	201	134	101
Liquid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	190	269	302	269	203	204	201	134	101
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	190	269	302	269	203	204	201	134	101

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.c. Chemicals																				
Total	3943	2515	2013	3638	3935	5645	4160	3529	643	538	486	479	469	449	452	472	540	455	811	679
Liquid Fuels	3516	1932	1599	2963	3207	4547	3451	3207	325	122	122	164	162	122	NO	NO	NO	NO	81	31
Solid Fuels	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	427	584	414	643	693	1090	696	302	298	362	317	269	278	308	405	442	480	381	513	518
Biomass	NO	NO	NO	4	7	7	13	20	20	54	47	46	29	19	47	30	60	74	188	130
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	29	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	389	389	259	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	3127	1543	1340	2963	3207	4547	3451	3207	325	122	122	122	162	122	NO	NO	NO	NO	81	31
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	427	584	414	643	693	1090	696	302	298	362	317	269	278	308	405	442	480	381	513	518
Wood	NO	NO	NO	4	7	7	13	20	20	54	47	46	29	19	47	30	57	72	187	127
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	2	1	3
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	29	NO
1.A.2.d. Pulp, Paper and Print																				
Total	2956	2827	2562	953	330	326	194	181	142	168	124	176	182	214	213	255	281	217	208	264
Liquid Fuels	203	162	122	122	41	81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	28	28	28	113	56	56	56	57	28	28	NO	28	28	26	26	26	26	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	2724	2637	2412	653	45	101	118	104	94	100	101	135	134	168	167	202	235	201	201	101
Biomass	NO	NO	NO	65	188	87	20	20	20	40	23	13	20	20	20	27	20	16	7	163
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	203	162	122	122	41	81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	28	28	28	113	56	56	56	57	28	28	NO	28	28	26	26	26	26	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Natural gas	2724	2637	2412	653	45	101	118	104	94	100	101	135	134	168	167	202	235	201	201	101
Wood	NO	NO	NO	65	188	87	20	20	20	40	23	13	20	20	20	27	20	16	7	163
1.A.2.e. Food Processing, Beverages and Tobacco																				
Total	11791	8021	7340	7910	7380	7842	8807	8002	7721	6747	5615	4899	5112	4423	4879	5019	4876	4037	3139	2874
Liquid Fuels	7318	4471	3944	3578	3654	4141	4919	4398	4516	3581	2418	1184	1102	694	533	615	661	456	208	374
Solid Fuels	1069	598	655	594	565	309	309	252	168	224	140	140	141	158	105	132	106	79	79	52
Peat	NO	NO	NO	NO	15	NO	NO	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	3177	2722	2511	3500	2829	3065	3250	3013	2694	2578	2607	2775	2985	2764	3238	3149	3249	2684	2370	1930
Biomass	228	231	230	238	316	327	330	325	328	349	450	800	842	719	916	1035	772	701	394	488
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	88	88	88	88	117	88	30
Shale oil	NO	NO	NO	NO	NO	39	NO	NO	NO	NO	630	79	79	39	39	79	39	40	40	39
LPG	46	46	46	46	NO	NO	NO	46	46	46	NO	46	46	46	46	46	91	91	46	91
Jet fuel	NO	NO	NO	NO	NO	NO	43	86	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	43	43	43	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	7105	4425	3898	3532	3654	4060	4791	4223	4384	3492	1745	975	893	609	406	406	447	325	122	244
Other liquid	167	NO	NO	NO	NO	42	42	NO	NO	NO	NO	84	84	NO	42	84	84	NO	NO	NO
Coal	911	598	655	541	512	256	256	199	142	171	114	114	114	131	105	105	79	79	79	52
Coke	158	NO	NO	53	53	53	53	53	26	53	26	26	27	27	NO	27	27	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	15	NO	NO	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	3177	2722	2511	3500	2829	3065	3250	3013	2694	2578	2607	2775	2985	2764	3238	3149	3249	2684	2370	1930
Wood	228	231	230	238	316	327	330	325	328	349	450	800	842	719	916	1035	772	701	394	483
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	5
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	88	88	88	88	117	88	30
1.A.2.f. Non-metallic minerals																				
Total	9369	5784	5542	2920	3829	3968	3899	3103	2960	2986	2470	2755	3631	3861	3606	4016	4085	4357	4180	2566
Liquid Fuels	3458	1180	1259	1218	2888	2478	2477	2354	1827	2189	1479	440	316	1325	1167	509	708	252	80	165
Solid Fuels	170	85	114	199	171	114	57	85	28	28	28	28	28	26	26	682	1127	1809	1888	1285
Peat	NO	NO	NO	NO	NO	NO	NO	10	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	5734	4513	4163	1476	750	1282	1345	634	1066	698	808	1821	2352	1884	1845	2381	1878	1979	1782	942
Biomass	7	6	6	27	20	94	20	20	29	44	61	82	111	184	139	144	170	165	175	101

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	94	385	824	442	429	300	202	153	255	73
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	118	748	236	118	118	79	39	39	39	39	NO
LPG	NO	NO	NO	NO	46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	3289	1137	1259	1218	2842	2436	2477	2354	1827	2071	731	162	NO	NO	NO	41	NO	81	41	NO
Petroleum coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	198	956	1088	429	627	132	NO	165
Other liquid	126	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	42	NO	251	NO	NO	42	NO	NO	NO
Coal	142	85	114	199	171	114	57	85	28	28	28	28	28	26	26	682	1127	1809	1888	1285
Oil shale	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	10	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	5734	4513	4163	1476	750	1282	1345	634	1066	698	808	1821	2352	1884	1845	2381	1878	1979	1782	942
Wood	7	6	6	27	20	94	20	20	29	34	24	12	17	102	50	95	136	139	77	67
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Municipal wastes (biomass fraction)	NO	NO	NO	NO	NO	NO	NO	NO	NO	10	37	70	94	82	89	49	34	26	98	34
Municipal wastes (fossil fraction)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	80	29
Industrial wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	94	176	238	208	224	125	85	65	58	15
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	209	586	234	205	175	117	88	117	29
1.A.2.g. Other																				
Total	24278	21798	16497	13910	10424	8992	9088	8814	9626	8599	6615	7269	6886	7148	8557	9276	10573	10028	9962	11697
Liquid Fuels	14061	11578	9802	8470	5871	4793	4712	4888	5154	4378	2411	1851	1423	1313	1615	1643	1743	2172	1790	1574
Solid Fuels	278	171	171	677	623	170	169	56	169	141	84	56	56	52	52	104	130	79	26	26
Peat	NO	20	10	NO	NO	15	15	NO	NO	NO	NO	NO	NO	NO	10	NO	NO	NO	NO	NO
Gaseous Fuels	9557	9664	6134	3318	2360	2115	1910	1515	1512	1380	1968	2335	2922	3334	3208	3177	3258	3318	3014	2275
Biomass	382	366	380	1445	1570	1899	2281	2355	2791	2699	2152	2985	2485	2449	3673	4352	5442	4459	5132	7793
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	29

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	39	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	91	137	91	NO	46	46	NO	NO	NO	46	46	46	46	45	NO
Gasoline	880	220	220	220	132	44	132	88	88	44	44	44	69	44	88	88	88	88	88	44
Other kerosene	NO	NO	NO	86	43	86	43	86	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	5549	5591	4019	3779	1597	1485	1315	1740	1655	1527	1469	1357	1231	1187	1357	1385	1527	1997	1657	1530
RFO	7632	5766	5563	4385	4099	3086	3085	2883	3411	2761	813	366	123	82	82	82	82	41	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	84	NO	NO	42	42	NO	NO	NO	NO
Coal	199	171	171	625	597	170	169	56	169	141	84	56	56	52	52	104	130	79	26	26
Coke	79	NO	NO	52	26	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	20	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	10	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	9557	9664	6134	3318	2360	2115	1910	1515	1512	1380	1968	2335	2922	3334	3208	3177	3258	3318	3014	2275
Wood	382	366	380	1445	1570	1899	2281	2355	2791	2699	2152	2985	2485	2449	3673	4352	5442	4459	5132	7793
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	29

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.2 Manufacturing Industries and Construction										
Total	26693	25237	27823	26084	26820	26271	23655	24234	27505	26182
Liquid Fuels	3500	2298	2649	2576	2254	2014	2193	2282	2326	2079
Solid Fuels	1861	2229	2149	1406	1336	1014	727	974	1341	1213
Peat	14	2	2	24	24	11	34	NO	1	14
Gaseous Fuels	10537	7578	7952	6259	5258	5262	4755	4689	4936	4258
Biomass	10319	12381	14194	14703	16670	16722	15034	15124	17319	17211
Other Fossil Fuels	462	749	877	1115	1279	1248	913	1166	1582	1407
1.A.2.a. Iron and Steel										
Total	4869	1207	1633	583	13	406	46	6	5	4
Liquid Fuels	1005	NO	NO	NO	NO	NO	NO	0	0	NO
Solid Fuels	26	27	184	32	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	3838	1180	1449	551	13	406	46	6	4	NO
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	1	4
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel oil	0	NO	NO	NO	NO	NO	NO	0	0	NO
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	1005	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	NO	NO	82	27	NO	NO	NO	NO	NO	NO
Coal	26	27	102	5	NO	NO	NO	NO	NO	NO
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	3838	1180	1449	551	13	406	46	6	4	NO
Wood	NO	NO	NO	NO	NO	NO	NO	NO	1	4
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.b. Non-Ferrous Metals										
Total	135	170	170	138	72	61	37	26	26	24
Liquid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	NO	2	1	NO	NO	1	1	NO	1	1
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	135	168	168	138	72	60	36	26	25	23
Biomass	NO	NO	1	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	2	1	NO	NO	1	1	NO	1	1
Natural gas	135	168	168	138	72	60	36	26	25	23
Biofuel	NO	NO	1	NO	NO	NO	NO	NO	NO	NO
1.A.2.c. Chemicals										
Total	803	621	737	756	780	720	718	810	816	618
Liquid Fuels	9	46	137	137	144	139	127	142	182	163
Solid Fuels	NO	1	NO	NO	NO	NO	NO	NO	2	NO
Peat	NO	NO	NO	20	11	NO	NO	NO	1	NO
Gaseous Fuels	606	404	371	385	316	330	390	452	480	297
Biomass	188	170	229	214	309	251	201	216	151	158
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	46	137	137	144	139	127	142	182	163
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	9	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	1	NO	NO	NO	NO	NO	NO	2	NO
Peat	NO	NO	NO	20	10	NO	NO	NO	1	NO
Peat briquettes	NO	NO	NO	NO	1	NO	NO	NO	NO	NO
Natural gas	606	404	371	385	316	330	390	452	480	297
Wood	187	169	210	208	278	221	179	188	151	158
Biofuel	1	1	NO	NO	1	1	NO	6	NO	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Other biogas	NO	NO	19	6	30	29	22	22	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.d. Pulp, Paper and Print										
Total	257	209	170	200	104	104	102	118	118	116
Liquid Fuels	NO	NO	NO	NO	4	4	4	4	3	4
Solid Fuels	NO	NO	NO	NO	NO	NO	1	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	101	101	68	103	97	95	86	105	107	95
Biomass	156	108	102	97	3	5	11	9	8	17
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	4	4	4	4	3	4
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	1	NO	NO	NO
Natural gas	101	101	68	103	97	95	86	105	107	95
Wood	156	108	102	97	3	5	11	9	8	17
1.A.2.e. Food Processing, Beverages and Tobacco										
Total	2738	2609	2790	2616	2477	2097	2144	1984	2086	2042
Liquid Fuels	396	291	379	305	226	156	197	200	170	195
Solid Fuels	52	16	27	25	24	24	46	40	17	14
Peat	3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	1919	1886	1819	1808	1729	1627	1476	1303	1378	1336
Biomass	339	360	536	449	469	261	404	417	492	495
Other Fossil Fuels	29	56	29	29	29	29	21	24	29	2
Shale oil	39	79	39	NO	NO	NO	NO	NO	8	9
LPG	72	91	137	182	160	148	190	191	153	141
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	285	121	203	81	31	8	7	9	9	45
Other liquid	NO	NO	NO	42	35	NO	NO	NO	NO	NO
Coal	52	16	27	25	24	24	46	40	17	14
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	1919	1886	1819	1808	1729	1627	1476	1303	1378	1336
Wood	333	360	535	449	467	230	361	371	442	445
Straws	NO	NO	NO	NO	NO	29	41	45	49	48
Biofuel	6	NO	1	NO	NO	NO	NO	NO	NO	NO
Other biogas	NO	NO	NO	NO	2	2	2	1	1	2
Waste oils	29	56	29	29	29	29	21	24	29	2

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.2.f. Non-metallic minerals										
Total	4318	4973	5282	4765	5125	4521	3686	4347	5570	5466
Liquid Fuels	627	NO	NO	NO	NO	1	124	45	21	6
Solid Fuels	1757	2136	1910	1299	1254	957	650	899	1292	1183
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	1010	977	1280	1344	1353	1208	1186	1286	1239	1251
Biomass	520	1196	1273	1035	1269	1136	835	976	1465	1621
Other Fossil Fuels	404	664	819	1086	1250	1219	892	1142	1553	1405
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	1	NO	1	16	6
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Petroleum coke	627	NO	NO	NO	NO	NO	124	44	5	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	1757	2136	1910	1299	1254	957	650	899	1292	1183
Oil shale	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	1010	977	1280	1344	1353	1208	1186	1286	1239	1251
Wood	10	3	23	NO	NO	3	25	6	5	34
Straws	NO	NO	NO	NO	NO	NO	NO	NO	211	261
Biofuel	NO	NO	NO	NO	3	2	2	2	2	2
Municipal wastes (biomass fraction)	510	1193	1250	1035	1266	1131	808	968	1247	1324
Municipal wastes (fossil fraction)	320	332	577	707	892	934	736	962	1215	1086
Industrial wastes	84	331	242	379	358	284	155	180	338	320
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.g. Other										
Total	13573	15448	17041	17026	18249	18362	16922	16943	18884	17912
Liquid Fuels	1463	1961	2133	2134	1880	1714	1741	1891	1950	1711
Solid Fuels	26	47	27	50	58	32	29	35	29	15
Peat	11	2	2	4	13	11	34	NO	NO	14
Gaseous Fuels	2928	2862	2797	1930	1678	1536	1535	1511	1703	1256
Biomass	9116	10547	12053	12908	14620	15069	13583	13506	15202	14916
Other Fossil Fuels	29	29	29	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	1	NO	NO
LPG	19	91	92	94	115	114	137	194	189	148
Gasoline	44	44	44	44	43	48	41	36	37	43

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	1359	1785	1997	1996	1722	1547	1560	1657	1722	1520
RFO	41	41	NO	NO	NO	5	3	3	2	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	26	47	27	50	58	32	29	32	28	14
Coke	NO	NO	NO	NO	NO	NO	NO	3	1	1
Peat	10	2	2	NO	10	10	34	NO	NO	NO
Peat briquettes	1	NO	NO	4	3	1	NO	NO	NO	14
Natural gas	2928	2862	2797	1930	1678	1536	1535	1511	1703	1256
Wood	9115	10547	12051	12906	14620	15069	13583	13506	15202	14916
Biofuel	1	NO	2	2	NO	NO	NO	NO	NO	NO
Waste oils	29	29	29	NO	NO	NO	NO	NO	NO	NO

1.A.4 Other Sectors

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.A.4 Other Sectors																				
Total	101006	107881	83180	76877	64625	60095	61217	56087	52424	51957	49115	54027	53754	57204	59271	58976	58737	59294	55356	58765
Liquid Fuels	27829	32499	24223	21319	14008	8731	8715	7674	6901	7307	6886	7360	6844	7817	7779	7728	8334	7849	7067	7720
Solid Fuels	22398	19894	15853	13347	9363	5180	5521	4639	3330	2817	2162	2988	2390	2203	2150	2045	1940	1940	1783	1574
Peat	1128	880	1030	617	515	390	506	357	266	66	41	15	NO	10	NO	20	40	61	31	16
Gaseous Fuels	23203	23548	11201	8384	7002	7150	6732	5434	5670	5865	6218	7061	8098	8795	9651	9632	9983	11027	10959	10241
Biomass	26448	31060	30873	33210	33737	38643	39743	37983	36257	35902	33808	36561	36295	38321	39574	39523	38382	38388	35487	39215
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO
1.A.4.a. Commercial/Institutional																				
Total	39260	39062	33600	26832	17464	16430	16535	14620	12251	12993	11354	12363	13105	13786	14985	14213	14844	15946	13201	12520
Liquid Fuels	13453	16642	11910	10556	5308	2804	2712	2285	1971	2214	1713	1926	1743	2138	2010	1781	2167	1863	1549	1528
Solid Fuels	14913	11413	10872	7854	4297	2903	3272	2732	2419	2049	1565	1536	1423	1338	1285	1049	1075	1075	918	735
Peat	672	517	620	288	326	113	250	163	71	15	31	15	NO	10	NO	20	40	61	31	16
Gaseous Fuels	5004	5328	4916	2625	1903	2328	2271	1805	2175	2536	3054	3347	4103	4278	4680	4598	4851	5676	5679	5415
Biomass	5218	5162	5282	5508	5630	8282	8029	7636	5615	6179	4991	5497	5709	5965	6894	6737	6652	7242	4995	4826
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79	NO	NO	NO	39	NO	NO	NO	NO
LPG	46	NO	NO	182	137	91	137	182	410	91	NO	91	46	182	137	137	137	137	91	91
Gasoline	44	44	44	44	220	NO	85	87	41	86	86	75	46	39	41	42	38	43	39	43
Other kerosene	43	130	86	173	173	346	43	43	43	86	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	8116	11515	7436	7478	1529	1189	1147	552	340	935	1020	1190	1242	1465	1546	1198	1627	1643	1339	1344
RFO	4953	4953	4344	2679	3248	1177	1300	1421	1137	974	528	528	325	284	244	365	365	40	80	50

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Other liquid	251	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	42	84	167	42	NO	NO	NO	NO	NO
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	14913	11413	10872	7854	4297	2903	3272	2732	2419	2049	1565	1536	1423	1338	1285	1049	1075	1075	918	735
Peat	161	161	171	40	171	51	110	70	40	NO	NO	NO	NO	10	NO	20	40	60	30	10
Peat briquettes	511	356	449	248	155	62	139	93	31	15	31	15	NO	NO	NO	NO	NO	1	1	6
Natural gas	5004	5328	4916	2625	1903	2328	2271	1805	2175	2536	3054	3347	4103	4278	4680	4598	4851	5676	5679	5415
Wood	5218	5162	5282	5508	5630	8282	8029	7636	5615	6179	4991	5497	5663	5803	6652	6485	6382	6955	4691	4482
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	11	16	14	29
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	162	242	251	259	271	290	314
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO
1.A.4.b. Residential																				
Total	35751	42489	39047	40790	38562	37659	38588	36043	35336	34027	32851	36298	35666	37702	38261	38948	37955	37271	37067	40809
Liquid Fuels	4908	5671	5003	4010	2848	1402	1272	1363	1454	1406	1443	1441	1441	1398	1443	1577	1621	1438	1393	2025
Solid Fuels	6404	7542	4440	5037	4411	1821	1964	1708	797	683	512	1338	854	787	787	944	813	813	813	813
Peat	425	332	379	258	144	252	241	179	195	51	10	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	4004	4275	4905	5089	4359	4181	3762	3063	2896	2829	2659	3001	3293	3667	3958	4193	4326	4587	4693	4304
Biomass	20010	24669	24320	26396	26800	30003	31349	29730	29994	29058	28227	30518	30078	31850	32073	32234	31195	30433	30168	33667
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	2869	2823	2368	2140	1913	1275	1230	1321	1412	1321	1184	1139	1139	1139	1184	1230	1230	1047	1002	911
Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	132	132	132	132	132	220	264	264	264	264
Other kerosene	86	86	43	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	1912	2762	2592	1827	892	127	42	42	42	85	127	170	170	127	127	127	127	127	127	850
RFO	41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	6404	7542	4440	5037	4411	1821	1964	1708	797	683	512	1338	854	787	787	944	813	813	813	813
Peat	131	131	131	10	20	20	40	40	40	20	10	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	294	201	248	248	124	232	201	139	155	31	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	4004	4275	4905	5089	4359	4181	3762	3063	2896	2829	2659	3001	3293	3667	3958	4193	4326	4587	4693	4304
Wood	20010	24669	24320	26396	26800	30003	31349	29730	29994	29058	28227	30518	30078	31850	32043	32174	31165	30388	30108	33607
Charcoal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	30	60	30	45	60	60
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.4.c. Agriculture/Forestry/Fisheries																				
Total	25995	26331	10533	9255	8599	6005	6094	5424	4837	4937	4910	5365	4983	5716	6025	5815	5939	6077	5088	5436
Liquid Fuels	9468	10186	7310	6752	5852	4526	4731	4027	3476	3687	3730	3994	3660	4282	4326	4370	4546	4548	4125	4167
Solid Fuels	1081	939	541	456	655	456	285	199	114	85	85	113	113	78	78	52	52	52	52	26
Peat	31	31	31	71	45	25	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	14195	13945	1380	670	739	641	699	566	599	500	505	712	702	850	1014	841	806	764	587	521

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Biomass	1220	1229	1271	1306	1307	358	365	617	648	665	590	546	508	506	607	552	535	713	324	722
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	46	46	NO	91	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	45
Gasoline	1628	132	132	132	132	88	88	88	44	44	44	11	17	44	44	44	44	44	NO	NO
Other kerosene	86	86	43	43	43	NO	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	6161	8583	6161	5269	4419	3951	3909	3654	3229	3399	3442	3739	3399	3994	4079	4164	4461	4504	4079	4122
RFO	1421	1339	974	1217	1258	487	691	285	203	244	244	244	244	244	203	162	41	NO	NO	NO
Other liquid	126	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	1081	939	541	456	655	456	285	199	114	85	85	113	113	78	78	52	52	52	52	26
Peat	NO	NO	NO	40	30	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	31	31	31	31	15	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	14195	13945	1380	670	739	641	699	566	599	500	505	712	702	850	1014	841	806	764	587	521
Wood	1220	1229	1271	1306	1307	358	365	617	648	665	590	546	508	506	607	552	535	713	324	722
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biofuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.4 Other Sectors										
Total	52858	51546	53990	50171	49303	44409	44492	47841	48529	46905
Liquid Fuels	8230	8269	8268	8413	8648	8775	8504	9140	9041	9033
Solid Fuels	2098	1861	983	1075	962	831	799	608	441	327
Peat	21	32	32	NO	11	NO	NO	11	32	23
Gaseous Fuels	11819	10343	10477	9809	9670	9101	9888	9948	10345	10131
Biomass	30682	31042	34230	30874	30012	25701	25297	28132	28666	27381
Other Fossil Fuels	8	NO	NO	NO	NO	NO	4	3	4	11
1.A.4.a. Commercial/Institutional										
Total	13247	11743	13020	12833	12495	12380	11863	11967	11535	10588
Liquid Fuels	1515	1315	1777	1876	2024	2131	1451	1405	1346	904
Solid Fuels	1023	891	354	519	407	323	292	197	165	132
Peat	1	32	32	NO	11	NO	NO	11	31	23
Gaseous Fuels	5623	5055	4952	4477	4401	4166	4514	4651	4837	5027
Biomass	5077	4451	5905	5961	5652	5759	5604	5701	5152	4501
Other Fossil Fuels	8	NO	NO	NO	NO	NO	2	3	4	2
Shale oil	NO	NO	NO	NO	NO	NO	7	NO	NO	NO

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LPG	99	54	98	96	161	144	249	332	281	218
Gasoline	44	88	44	88	44	44	33	43	36	29
Other kerosene	NO	NO	NO	NO	NO	NO	6	4	4	1
Diesel oil	1331	1171	1635	1692	1819	1942	1152	1022	1023	654
RFO	41	2	NO	NO	NO	1	4	4	2	2
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	NO	NO	NO	NO	NO	NO	27	7	NO	NO
Coal	1023	891	354	519	407	323	265	190	165	132
Peat	NO	29	28	NO	10	NO	NO	NO	16	19
Peat briquettes	1	3	4	NO	1	NO	NO	11	15	4
Natural gas	5623	5055	4952	4477	4401	4166	4514	4651	4837	5027
Wood	4679	3997	5163	5087	4603	4512	4455	4509	3876	3333
Straws	57	43	24	44	53	30	15	10	23	24
Biofuel	4	31	34	54	12	15	NO	NO	NO	NO
Landfill gas	314	327	325	357	353	407	396	408	391	352
Other biogas	23	53	359	419	631	795	738	774	862	792
Waste oils	8	NO	NO	NO	NO	NO	2	3	4	2
1.A.4.b. Residential										
Total	33561	33797	35117	31228	30846	25862	26012	28556	30002	28432
Liquid Fuels	2237	2229	2236	2237	2283	2055	2140	2314	2277	2218
Solid Fuels	1049	944	577	530	531	501	498	410	276	195
Peat	20	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	5219	4480	4481	4266	4252	4116	4510	4673	4998	4647
Biomass	25036	26144	27823	24195	23780	19190	18864	21159	22451	21372
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	911	903	911	911	957	773	766	794	679	621
Gasoline	264	264	263	264	264	220	220	220	220	220
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	1062	1062	1062	1062	1062	1062	1154	1300	1378	1377
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	1049	944	577	530	531	501	498	410	276	195
Peat	20	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	5219	4480	4481	4266	4252	4116	4510	4673	4998	4647
Wood	24974	26084	27764	24105	23690	19130	18799	21093	22383	21285
Charcoal	60	60	59	90	90	60	65	66	68	87
Straws	2	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.4.c. Agriculture/Forestry/Fisheries										

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total	6050	6006	5853	6110	5962	6167	6617	7318	6992	7885
Liquid Fuels	4478	4725	4255	4300	4341	4589	4913	5421	5418	5911
Solid Fuels	26	26	52	26	24	7	9	1	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	1	NO
Gaseous Fuels	977	808	1044	1066	1017	819	864	624	510	457
Biomass	569	447	502	718	580	752	829	1272	1063	1508
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	2	NO	NO	9
LPG	13	45	46	48	47	92	109	127	76	101
Gasoline	NO	88	88	88	46	25	82	22	27	29
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	4462	4589	4121	4164	4248	4472	4722	5272	5223	5761
RFO	3	3	NO	NO	NO	NO	NO	NO	92	20
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	26	26	52	26	24	7	9	1	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	1	NO
Natural gas	977	808	1044	1066	1017	819	864	624	510	457
Wood	568	361	299	460	292	401	462	877	710	1093
Straws	NO	NO	14	14	46	76	105	150	65	124
Biofuel	1	48	56	54	59	75	66	57	79	83
Other biogas	NO	38	133	190	183	200	196	188	209	208
Waste oils	NO	NO	NO	NO	NO	NO	2	NO	NO	9

1.A.5 Other

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1.A.5 Other (Not elsewhere specified)																				
Total	NO	NO	NO	NO	NO	86	46	174	46	132	2	2	92	87	157	104	122	39	47	73
Liquid Fuels	NO	NO	NO	NO	NO	86	46	174	46	132	2	2	92	87	157	104	122	39	47	73
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	NO	NO	NO	NO	NO	NO	3	1	3	2	2	2	NO	5	3	2	6	1	5	1
Jet fuel	NO	NO	NO	NO	NO	86	43	173	43	130	NO	NO	17	17	43	24	43	24	21	23
Diesel oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	75	65	111	77	73	14	21	49

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.A.5 Other (Not elsewhere specified)										
Total	107	98	100	88	128	130	155	178	269	322
Liquid Fuels	107	98	100	88	128	130	155	178	269	322
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	0.2	NO	NO	NO	NO	NO	NO	0.04	1	1
Jet fuel	20	18	21	24	23	18	34	10	35	57
Diesel oil	87	80	79	63	105	112	121	168	233	264

Annex III: Additional methodological description – Manure management

Example of the N-flow implemented for dairy cattle for 2019

Step 1

Number of dairy cattle in Latvia in 2019 is 138,400

Step 2

The total annual excretion of N by the animals (N_{ex} ; kg AAP⁻¹ a⁻¹) is calculated according the 2006 IPCC Guidelines Tier 2 methodology described also in Methodology chapter. In 2019 N_{ex} for dairy cattle was 116.99 kg N head⁻¹year⁻¹.

Step 3

Housed period = 343 d a⁻¹

Proportion of N excreted as TAN = 0.60

Proportion of N excreted on yards = 0.00

$$m_{graz_N} = x_{graz} \cdot N_{ex} = 975,901.08 \text{ kg N}$$

$$m_{hous_N} = x_{hous} \cdot N_{ex} = 15,215,185.10 \text{ kg N}$$

Step 4

$$m_{graz_TAN} = x_{TAN} \cdot m_{graz_N} = 585,540.65 \text{ kg N}$$

$$m_{hous_TAN} = x_{TAN} \cdot m_{hous_N} = 9,129,111.06 \text{ kg N}$$

Step 5

$x_{house_slurry} = 0.5$

$$m_{hous_slurry_TAN} = x_{slurry} \cdot m_{hous_TAN} = 4,747,137.75 \text{ kg N}$$

$$m_{hous_slurry_N} = x_{slurry} \cdot m_{hous_N} = 7,911,896.25 \text{ kg N}$$

$$m_{hous_solid_TAN} = (1 - x_{slurry}) \cdot m_{hous_TAN} = 4,381,973.31 \text{ kg N}$$

$$m_{hous_solid_N} = (1 - x_{slurry}) \cdot m_{hous_N} = 7,303,288.85 \text{ kg N}$$

Step 6

$$EF_{\text{NH}_3\text{ house_slurry}} = 0.24 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$EF_{\text{NH}_3\text{ house_solid}} = 0.08 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$E_{\text{hous_slurry}} = m_{\text{hous_slurry_TAN}} \cdot EF_{\text{hous_slurry}} = 1,139,313.06 \text{ kg NH}_3\text{-N}$$

$$E_{\text{hous_solid}} = m_{\text{hous_solid_TAN}} \cdot EF_{\text{hous_solid}} = 350,557.86 \text{ kg NH}_3\text{-N}$$

Step 7

$$\text{Straw} = 189,884,800.00 \text{ kg yr}^{-1}$$

$$N_{\text{added_in_straw}} = 11.43 \text{ kg a}^{-1} \text{ yr}^{-1}$$

$$m_{\text{bedding}} = 759,539.20 \text{ kg N}$$

$$f_{\text{imm}} = 0.0067 \text{ kg N (kg straw)}^{-1}$$

$$m_{\text{ex-hous_solid_TAN}} = m_{\text{hous_solid_TAN}} - (E_{\text{hous_solid}} + (m_{\text{bedding}} \cdot f_{\text{imm}})) = 2,759,187.28 \text{ kg N}$$

$$m_{\text{ex-hous_solid_N}} = m_{\text{hous_solid_N}} + m_{\text{bedding_N}} - E_{\text{hous_solid}} = 7,712,270.18 \text{ kg N}$$

Step 8

$$x_{\text{store_slurry}} = 0.84$$

$$x_{\text{store_solid}} = 1.00$$

$$x_{\text{biogas_slurry}} = 0.16$$

$$x_{\text{biogas_solid}} = 0.00$$

For slurry:

$$m_{\text{storage_slurry_TAN}} = (m_{\text{hous_slurry_TAN}} - E_{\text{hous_slurry}}) \cdot x_{\text{store_slurry}} = 3,030,572.74 \text{ kg N}$$

$$m_{\text{storage_slurry_N}} = (m_{\text{hous_slurry_N}} - E_{\text{hous_slurry}}) \cdot x_{\text{store_slurry}} = 5,688,969.88 \text{ kg N}$$

$$m_{\text{biogas_slurry_TAN}} = (m_{\text{hous_slurry_TAN}} - E_{\text{hous_slurry}}) \cdot x_{\text{biogas_slurry}} = 577,251.95 \text{ kg N}$$

$$m_{\text{biogas_slurry_N}} = (m_{\text{hous_slurry_N}} - E_{\text{hous_slurry}}) \cdot x_{\text{biogas_slurry}} = 1,083,613.31 \text{ kg N}$$

For solid:

$$m_{\text{storage_solid_TAN}} = m_{\text{ex-hous_solid_TAN}} \cdot x_{\text{store_solid}} = 2,759,187.28 \text{ kg N}$$

$$m_{storage_solid_N} = m_{ex-hous_solid_N} \cdot x_{store_solid} = 7,712,270.18 \text{ kg N}$$

$$m_{biogas_solid_TAN} = m_{ex-hous_solid_TAN} \cdot x_{biogas_solid} = 0.00 \text{ kg N}$$

$$m_{biogas_solid_N} = m_{ex-hous_solid_N} \cdot x_{biogas_solid} = 0.00 \text{ kg N}$$

Step 9

$$f_{min} = 0.1 \text{ kg N kg}^{-1}$$

$$mm_{storage_slurry_TAN} = m_{storage_slurry_TAN} + \left((m_{storage_slurry_N} - m_{storage_slurry_TAN}) \times f_{min} \right) = 3,296,412.4534 \text{ kg N}$$

Step 10

$$EF_{NH3_storage_slurry} = 0.172 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$EF_{N2O_storage_slurry_with_natural_crust} = 0.01 \text{ N}_2\text{O-N (kg TAN)}^{-1}$$

Proportion with natural crust = 1.0

$$EF_{NO_storage_slurry} = 0.0001 \text{ NO-N (kg TAN)}^{-1}$$

$$EF_{N2_storage_slurry} = 0.0030 \text{ N}_2\text{-N (kg TAN)}^{-1}$$

$$EF_{NH3_storage_solid} = 0.3200 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$EF_{N2O_storage_solid} = 0.0200 \text{ N}_2\text{O-N (kg TAN)}^{-1}$$

$$EF_{NO_storage_solid} = 0.0100 \text{ NO-N (kg TAN)}^{-1}$$

$$EF_{N2_storage_solid} = 0.3000 \text{ N}_2\text{-N (kg TAN)}^{-1}$$

For slurry:

$$E_{storage_slurry_NH3} = mm_{storage_slurry_TAN} \cdot EF_{storage_slurry_NH3} = 566,982.9420 \text{ kg NH}_3\text{-N}$$

$$E_{storage_slurry_N2O} = mm_{storage_slurry_TAN} \cdot EF_{storage_slurry_N2O} = 32,964.1245 \text{ kg N}_2\text{O-N}$$

$$E_{storage_slurry_NO} = mm_{storage_slurry_TAN} \cdot EF_{storage_slurry_NO} = 329.6412 \text{ kg NO-N}$$

$$E_{storage_slurry_N2} = mm_{storage_slurry_TAN} \cdot EF_{storage_slurry_N2} = 9,889.2374 \text{ kg N}_2\text{-N}$$

For solid manure emissions:

$$E_{storage_solid_NH3} = m_{storage_solid_TAN} \cdot EF_{storage_solid_NH3} = 882,939.9305 \text{ kg NH}_3\text{-N}$$

$$E_{storage_solid_N2O} = mm_{storage_solid_TAN} \cdot EF_{storage_solid_N2O} = 55,183.7457 \text{ kg N}_2\text{O-N}$$

$$E_{storage_solid_NO} = mm_{storage_solid_TAN} \cdot EF_{storage_solid_NO} = 27,591.8728 \text{ kg NO-N}$$

$$E_{storage_solid_N2} = mm_{storage_slurry_TAN} \cdot EF_{storage_solid_N2} = 827,756.1849 \text{ kg N}_2\text{-N}$$

Intermediate step - 5B2 - Calculate the digestate created by the anaerobic digestion of manure, that is returned from chapter 5B2.

$$EF_{NH3 \text{ Pre-storage}} = 0.0009 \text{ kg NH}_3\text{-N per kg N in feedstock}$$

$$N_{H3-N \text{ Storage of digestate}} = 0.0266 \text{ kg NH}_3\text{-N per kg N in feedstock}$$

$$f_{\min_biogas} = 0.32 \text{ kg N kg}^{-1}$$

$$AR_{feedstock} = m_{storage_slurry_N} + m_{biogas_slurry_N} = 1,083,613.31 \text{ kg N}$$

$$E_{NH3} = AR_{feedstock} \cdot \sum_{stages} EF_{NH3-N_i} \cdot \frac{17}{14} = 36,184.94 \text{ kg NH}_3$$

$$TAN_{sub} = m_{biogas_slurry_TAN} + m_{biogas_solid_TAN} = 577,251.95 \text{ kg N}$$

$$N_{sub} = m_{biogas_slurry_N} + m_{biogas_solid_N} = 1,083,613.31 \text{ kg N}$$

$$m_{dig_TAN} = TAN_{sub} + f_{\min_biogas} \cdot (N_{tot} + TAN_{sub}) - \left(E_{NH3} \cdot \frac{14}{17} \right) = 709,488.22 \text{ kg N (TAN in digestate after storage)}$$

$$m_{dig_N} = N_{tot_dig} - \left(E_{NH3} \cdot \frac{14}{17} \right) = 1,053,813.94 \text{ kg N (total-N in in digestate that is returned to application to soil)}$$

Step 11

For slurry and digestate:

$$m_{applic_slurry_TAN} = m_{appl_direct_slurry_TAN} + mm_{storage_slurry_TAN} + mm_{dig_TAN} - E_{storage_slurry} = 3,395,734.73 \text{ kg N}$$

$$m_{applic_slurry_N} = m_{appl_direct_slurry_N} + mm_{storage_slurry_N} + mm_{dig_N} - E_{storage_slurry} = 6,132,617.88 \text{ kg N}$$

For solid:

$$m_{applic_solid_TAN} = m_{appl_direct_solid_TAN} + mm_{storage_solid_TAN} - E_{storage_solid_TAN} = 965,715.55 \text{ kg N}$$

$$m_{applic_solid_N} = m_{appl_direct_solid_N} + mm_{storage_solid_N} - E_{storage_solid_N} = 5,918,798.45 \text{ kg N}$$

Step 12

$$EF_{NH3_applic_slurry} = 0.55 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$EF_{NH3_applic_solid} = 0.48 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

For slurry:

$$E_{applic_slurry} = m_{applic_slurry_TAN} \cdot EF_{applic_slurry} = 1,867,654.10 \text{ kg NH}_3\text{-N}$$

For solid:

$$E_{applic_solid} = m_{applic_solid_TAN} \cdot EF_{applic_solid} = 459,680.60 \text{ kg NH}_3\text{-N}$$

Step 13

For slurry:

$$m_{returned_slurry_TAN} = m_{applic_slurry_TAN} - E_{applic_slurry} = 1,528,080.63 \text{ kg N}$$

$$m_{returned_slurry_N} = m_{applic_slurry_N} - E_{applic_slurry} = 4,264,963.78 \text{ kg N}$$

For solid:

$$m_{returned_solid_TAN} = m_{applic_solid_TAN} - E_{applic_solid} = 506,034.95 \text{ kg N}$$

$$m_{returned_solid_N} = m_{applic_solid_N} - E_{applic_solid} = 5,459,117.85 \text{ kg N}$$

Step 14

$$EF_{NH_3_grazing} = 0.14 \text{ NH}_3\text{-N (kg TAN)}^{-1}$$

$$E_{graz} = m_{graz_TAN} \cdot EF_{grazing} = 81,975.69 \text{ kg NH}_3\text{-N}$$

Step 15

Results are prepared for the reporting. Respective results are converted using conversion factors.

Table 1 Manure Management Systems distribution (MMS), 1990 – 2019

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<i>Dairy cows</i>																														
<i>Pasture/Range/Paddock</i>	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.06
<i>Solid storage</i>	0.83	0.83	0.82	0.82	0.81	0.81	0.8	0.79	0.78	0.77	0.76	0.72	0.72	0.71	0.7	0.7	0.69	0.67	0.64	0.62	0.6	0.58	0.56	0.54	0.53	0.48	0.46	0.44	0.44	0.42

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
<i>Liquid/ Slurry</i>	0.054	0.06	0.07	0.07	0.08	0.08	0.09	0.1	0.11	0.12	0.13	0.18	0.19	0.19	0.2	0.21	0.22	0.24	0.27	0.29	0.27	0.28	0.25	0.24	0.27	0.33	0.35	0.36	0.31	0.36	
<i>Anaerobic digester</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.04	0.05	0.11	0.14	0.13	0.13	0.13	0.14	0.19	0.16	
Sheep																															
<i>Pasture/Range/ Paddock</i>	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.24	0.26	0.29	0.32	0.35
<i>Solid storage</i>	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.77	0.74	0.71	0.68	0.65	
<i>Liquid/ Slurry</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<i>Anaerobic digester</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Goats																															
<i>Pasture/Range/ Paddock</i>	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10
<i>Solid storage</i>	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.90	0.90
<i>Liquid/ Slurry</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<i>Anaerobic digester</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Horses																															
<i>Pasture/Range/ Paddock</i>	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.14	0.18	0.21	0.25	0.30	
<i>Solid storage</i>	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.86	0.82	0.79	0.75	0.70	
<i>Liquid/ Slurry</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<i>Anaerobic digester</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sows and boars																															
<i>Pasture/Range/ Paddock</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
<i>Solid storage</i>	0.72	0.71	0.69	0.68	0.66	0.64	0.62	0.6	0.57	0.55	0.53	0.48	0.44	0.4	0.37	0.33	0.3	0.28	0.25	0.23	0.21	0.18	0.16	0.14	0.12	0.10	0.09	0.08	0.05	0.05	
<i>Liquid/ Slurry</i>	0.28	0.29	0.31	0.32	0.34	0.36	0.38	0.41	0.43	0.45	0.47	0.52	0.56	0.6	0.63	0.67	0.7	0.72	0.75	0.77	0.71	0.71	0.61	0.56	0.52	0.60	0.60	0.56	0.56	0.50	

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.08	0.11	0.24	0.3	0.36	0.31	0.32	0.36	0.39	0.45
Piglets																														
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	0.72	0.71	0.7	0.68	0.67	0.65	0.63	0.6	0.58	0.56	0.53	0.49	0.45	0.41	0.37	0.34	0.31	0.28	0.26	0.23	0.21	0.19	0.16	0.14	0.12	0.10	0.09	0.08	0.05	0.05
Liquid/ Slurry	0.28	0.29	0.3	0.32	0.33	0.35	0.38	0.4	0.42	0.45	0.47	0.51	0.55	0.59	0.63	0.67	0.69	0.72	0.74	0.77	0.71	0.71	0.60	0.56	0.52	0.59	0.60	0.56	0.56	0.50
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.08	0.11	0.23	0.3	0.36	0.31	0.32	0.36	0.39	0.45
Fattening and young breeding pigs																														
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	0.71	0.7	0.68	0.67	0.65	0.63	0.61	0.58	0.56	0.54	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.07	0.05	0.05
Liquid/ Slurry	0.29	0.3	0.32	0.33	0.35	0.37	0.39	0.42	0.44	0.46	0.49	0.53	0.57	0.61	0.65	0.68	0.71	0.73	0.76	0.78	0.72	0.72	0.61	0.56	0.52	0.60	0.60	0.57	0.56	0.50
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.09	0.11	0.24	0.31	0.36	0.31	0.32	0.36	0.39	0.45
Laying hens																														
Pasture/Range/Paddock	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
Solid storage	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.87	0.84	0.71	0.63	0.46	0.61	0.55	0.27	0.16	0.20
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.10	0.13	0.26	0.35	0.51	0.36	0.42	0.70	0.80	0.77
Broilers																														
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1.0	1.0	1.0	1.0
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Turkeys																														
Pasture/Range/Paddock	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.17	0.20	0.22	0.25	0.26
Solid storage	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.83	0.81	0.78	0.75	0.74
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ducks																														
Pasture/Range/Paddock	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.19	0.21	0.24	0.26	0.29
Solid storage	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.81	0.79	0.76	0.74	0.71
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Geese																														
Pasture/Range/Paddock	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.18	0.19	0.22	0.24	0.27
Solid storage	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.83	0.81	0.78	0.76	0.73
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Rabbits																														
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fur animals																														
Pasture/Range/	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Paddock																														
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Deer																														
Pasture/Range/ Paddock	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Solid storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Dairy cattle calves under 1 year																														
Pasture/Range/ Paddock	0.11 7	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	
Solid storage	0.88 3	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.91	0.91	0.88	0.88	0.84	0.81	0.82	0.83	0.83	0.82	0.78	0.81
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.03	0.04	0.08	0.11	0.10	0.10	0.10	0.11	0.15	0.13
Beef cattle calves under 1 year																														
Pasture/Range/ Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Dairy cow young cattle, aged 1-2 years																														
Pasture/Range/ Paddock	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.07	

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Solid storage	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.91	0.91	0.88	0.88	0.84	0.81	0.82	0.83	0.83	0.82	0.78	0.81	
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.03	0.04	0.08	0.11	0.09	0.10	0.10	0.11	0.15	0.13	
Beef young cattle, aged 1-2 years																															
Pasture/Range/ Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bulls over 2 year																															
Pasture/Range/ Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Heifers over 2 years																															
Pasture/Range/ Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other cows over 2 year																															
Pasture/Range/ Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<i>Anaerobic digester</i>	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 2 Average gross energy (GE) intake (MJ day⁻¹) and cattle weight (kg head⁻¹ year⁻¹) 1990-2019

Year	Dairy cows		Growing cattle		Other mature cattle	
	Weight	GE	Weight	GE	Weight	GE
1990	550	241.6	272	80.4	581	152.9
1991	550	236.1	271	79.7	581	152.9
1992	550	225.2	268	77.6	581	152.9
1993	550	224.6	267	77.0	581	152.9
1994	550	230.9	269	77.9	582	153.0
1995	550	236.3	272	78.6	580	152.9
1996	550	242.3	270	77.9	581	152.9
1997	550	253.9	268	77.5	573	153.9
1998	550	258.0	271	77.7	555	150.1
1999	550	257.7	269	76.8	552	149.7
2000	555	264.2	262	76.0	542	147.6
2001	555	268.9	254	74.8	566	152.9
2002	555	265.9	264	76.1	557	154.4
2003	555	285.0	270	77.2	559	155.9
2004	555	276.3	261	75.6	563	158.7
2005	555	281.1	261	76.1	563	167.3
2006	560	286.2	268	76.4	564	168.8
2007	560	291.5	271	77.1	557	174.8
2008	560	296.9	269	76.5	561	165.2
2009	560	299.4	271	77.1	567	170.5
2010	560	295.8	272	77.5	570	173.8
2011	565	297.4	272	77.2	569	176.2
2012	565	301.7	274	77.9	572	179.4
2013	565	307.8	278	79.1	575	180.1

Year	Dairy cows		Growing cattle		Other mature cattle	
	Weight	GE	Weight	GE	Weight	GE
2014	565	311.8	274	78.7	575	182.4
2015	565	310.7	278	79.6	576	185.4
2016	570	323.3	276	79.5	576	187.8
2017	570	332.1	276	79.4	576	188.2
2018	570	334.7	273	79.0	574	189.7
2019	570	342.8	272	78.7	576	192.0

Table 3 Average milk yield and fat content, 1990 - 2019

Year	Average milk yield, kg year ⁻¹	Fat content, %
1990	3437	3.50
1991	3205	3.58
1992	2793	3.67
1993	2741	3.75
1994	2923	3.84
1995	3074	3.92
1996	3237	4.01
1997	3585	4.09
1998	3733	4.06
1999	3754	4.00
2000	3898	4.08
2001	4055	4.08
2002	3958	4.08
2003	4261	4.11
2004	4251	4.17
2005	4364	4.25
2006	4492	4.26
2007	4636	4.31
2008	4822	4.29
2009	4892	4.31

Year	Average milk yield, kg year⁻¹	Fat content, %
2010	4998	4.29
2011	5064	4.22
2012	5250	4.16
2013	5508	4.08
2014	5812	3.86
2015	5905	3.99
2016	6182	4.15
2017	6525	4.10
2018	6614	4.10
2019	6891	4.10

Annex IV: Summary Information on Condensable in PM

Table 1 Inclusion/exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors

NFR	Source/sector name	PM emissions: the condensable component is		EF references and comments
		included	excluded	
1A1a	Public electricity and heat production		PM _{2.5} , PM ₁₀	EMEP/EEA 2016 – 1.A.1 Energy Industries - Table 3-3, Table 3-4, Table 3-5, Table 3-6, Table 3-7
1A1c	Manufacture of solid fuels and other energy industries		PM _{2.5} , PM ₁₀	EMEP/EEA 2016 – 1.A.1 Energy Industries - Table 3-3, Table 3-4, Table 3-5, Table 3-6, Table 3-7
1A2a	Iron and steel	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)
1A2b	Non-ferrous metals	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)
1A2c	Chemicals	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)
1A2d	Pulp, Paper and Print	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)
1A2e	Food processing, beverages and tobacco	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)
1A2f	Non-metallic minerals	Information provided in reference column		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM); EMEP/EEA 2016 - 5.C.1.b Industrial waste incineration including hazardous waste and sewage sludge – Table 3-1 (for Industrial and Municipal waste incineration 1999-2009)
1A2gvii	Off-road vehicles and other machinery	PM _{2.5} , PM ₁₀		EMEP/EEA 2016 - 1.A.4 Non road mobile machinery – Table 3-1
1A2gviii	Other	No information		EMEP/EEA 2016 – 1.A.2 Manufacturing industries and construction – Table 3-2, Table 3-3, Table 3-4, Table 3-5 (PM _{2.5} , PM ₁₀ emissions from biomass combustion represents filterable PM)

NFR	Source/sector name	PM emissions: the condensable component is		EF references and comments
		included	excluded	
1A3ai(i)	<i>International aviation LTO (civil)</i>	No information		<i>EMEP/EEA 2016 – 1.A.3.a Aviation - Table 3.4</i>
1A3aii(i)	<i>Domestic aviation LTO (civil)</i>	No information		<i>EMEP/EEA 2016 – 1.A.3.a Aviation - Table 3.4</i>
1A3bi	<i>Passenger cars</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3bii	<i>Light duty vehicles</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3biii	<i>Heavy duty vehicles and buses</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3biv	<i>Mopeds & motorcycles</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3bvi	<i>Automobile tyre and brake wear</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3bvii	<i>Automobile road abrasion</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 – COPERT 5.2 model</i>
1A3c	<i>Railways</i>	No information		<i>EMEP/EEA 2016 – 1.A.3.c Railways - Table 3.1</i>
1A3dii	<i>National navigation (shipping)</i>	No information		<i>EMEP/EEA 2016 - 1.A.3.d.i(i), 1.A.3.d.i(ii), 1.A.3.d.ii, 1.A.4.c.iii, 1.A.5.b International maritime navigation, international inland navigation, national navigation (shipping), national fishing, military (shipping), and recreational boats - Table 3.1, Table 3.2</i>
1A4ai	<i>Commercial/institutional - Stationary</i>	No information		<i>EMEP/EEA 2016 - 1.A.4 Small combustion - Table 3-7, Table 3-8, Table 3-9, Table 3-10 (PM_{2.5}, PM₁₀ emissions from biomass combustion represents filterable PM)</i>
1A4aii	<i>Commercial/institutional - Off-road vehicles and other machinery</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 - 1.A.4 Non road mobile machinery – Table 3-1</i>
1A4bi	<i>Residential - Stationary</i>	Information provided in reference column		<i>EMEP/EEA 2016 - 1.A.4 Small combustion – Table 3-15 (emission factors represent filterable PM emissions), Table 3-16 (no information), Table 3-18 (emission factors represent filterable PM emissions), Table 3-39 (emission factors includes condensable component), Table 3-40 (emission factors includes condensable component), Table 3-41 (emission factors includes condensable component), Table 3-42 (emission factors includes condensable component), Table 3-43 (emission factors includes condensable component), Table 3-44 (emission factors includes condensable component)</i>
1A4bii	<i>Residential - Off-road vehicles and other machinery</i>	<i>PM_{2.5}, PM₁₀</i>		<i>EMEP/EEA 2016 - 1.A.4 Non road mobile machinery – Table 3-1</i>
1A4ci	<i>Agriculture/Forestry/Fishing - Stationary</i>	No information		<i>EMEP/EEA 2016 - 1.A.4 Small combustion - Table 3-7, Table 3-8, Table 3-9, Table 3-10 (PM_{2.5}, PM₁₀ emissions from biomass combustion represents filterable PM)</i>

NFR	Source/sector name	PM emissions: the condensable component is		EF references and comments
		included	excluded	
1A4cii	Agriculture/Forestry/Fishing - Off-road vehicles and other machinery	PM _{2.5} , PM ₁₀		EMEP/EEA 2016 - 1.A.4 Non road mobile machinery – Table 3-1
1A4ciii	Agriculture/Forestry/Fishing	No information		EMEP/EEA 2016 - 1.A.3.d Navigation (shipping) - Table 3-1, Table 3-2
1A5b	Other, Mobile	No information		EMEP/EEA 2016 - 1.A.3.d Navigation (shipping) - Table 3-2
1B1a	Coal mining and handling	No information		EMEP/EEA 2016 - 1.B.1.a Fugitive emissions from solid fuels - Coal mining and handling – Table 3-6
2A1	Cement production		PM _{2.5} , PM ₁₀	The filter method is used in the enterprise, thus obtaining filterable PM
2A2	Lime production	No information		EMEP/EEA 2016 - 2.A.2 Lime production – Table 3-2 (1990-2004), Table 3-3 (2005-2015)
2A3	Glass production		PM _{2.5} , PM ₁₀	ISO 9096:2003/Cor 1:2006 Stationary source emissions - Manual determination of mass concentration of particulate matter
2A5a	Quarrying mining minerals	No information		EMEP/EEA 2016 - 2.A.5.a Quarrying and mining of minerals other than coal – Table 3-1
2A5b	Construction demolition	No information		EMEP/EEA 2016 - 2.A.5.b Construction and demolition - Table 3-1, Table 3-2, Table 3-3, Table 3-4
2A5c	Storage handling transport		PM _{2.5} , PM ₁₀	The filter method is used in the enterprise, thus obtaining filterable PM
2C1	Iron and steel		PM _{2.5} , PM ₁₀	EMEP/EEA 2016 – 2.C.1 Iron and steel production – Table 3-13, Table 3-15
2D3b	Road paving with asphalt		PM _{2.5} , PM ₁₀	EMEP/EEA 2016 – 2.D.3.b Road paving with asphalt – Table 3-1
2D3c	Asphalt roofing	No information		EMEP/EEA 2016 - 2.D.3.c Asphalt roofing – Table 3-1
2G	Other product use	No information		EMEP/EEA 2016 - 2.G Other solvent and product use – Table 3-13, Table 3-14
3B1a	Dairy cattle	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B1b	Non-dairy cattle	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B2	Sheep	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B3	Swine	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4d	Goats	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4e	Horses	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4gi	Laying hens	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4gii	Broilers	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4giii	Turkeys	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4giv	Other poultry	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5
3B4h	Other animals	No information		EMEP/EEA 2016 – 3B Manure Management – Table 3-5

NFR	Source/sector name	PM emissions: the condensable component is		EF references and comments
		included	excluded	
3Dc	<i>Farm-level agricultural operations including storage, handling and transport of agricultural products</i>	No information		<i>EMEP/EEA 2016 – 3D Crop production and agricultural soils – Table 3-1, Table 3-5, Table 3-7</i>
3I	<i>Agriculture other</i>	No information		<i>EMEP/EEA 2016 – 11.B Forest fires - Table 3-8</i>
5A	<i>Biological treatment of waste - Solid waste disposal on land</i>	No information		<i>EMEP/EEA 2016 – 5.A Biological treatment of waste - Table 3-1</i>
5C1bii	<i>Hazardous waste incineration</i>	No information		<i>EMEP/EEA 2016 - 5.C.1.b.i, 5.C.1.b.ii, 5.C.1.b.iv Industrial waste incineration including hazardous waste and sewage sludge - Table 3- 1</i>
5C1bv	<i>Cremation</i>	No information		<i>EMEP/EEA 2016 - 5.C.1.b.v Cremation - Table 3-1</i>
5E	<i>Other waste (please specify in IIR)</i>	No information		<i>EMEP/EEA 2016 – 5.E Other waste - Table 3-2, Table 3-4, Table 3-6</i>
6A	<i>Other</i>	No information		<i>EMEP/EEA 2016 – 11.B Forest fires - Table 3-1</i>
11B	<i>Forest fires</i>	No information		<i>EMEP/EEA 2016 – 11.B Forest fires - Table 3-5</i>

Annex V: List of NFR codes

NFR Code	Longname
1A1a	Public electricity and heat production
1A1b	Petroleum refining
1A1c	Manufacture of solid fuels and other energy industries
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)
1A3ai(i)	International aviation LTO (civil)
1A3aii(i)	Domestic aviation LTO (civil)
1A3bi	Road transport: Passenger cars
1A3bii	Road transport: Light duty vehicles
1A3biii	Road transport: Heavy duty vehicles and buses
1A3biv	Road transport: Mopeds & motorcycles
1A3bv	Road transport: Gasoline evaporation
1A3bvi	Road transport: Automobile tyre and brake wear
1A3bvii	Road transport: Automobile road abrasion
1A3c	Railways
1A3di(ii)	International inland waterways
1A3dii	National navigation (shipping)
1A3ei	Pipeline transport
1A3eii	Other (please specify in the IIR)
1A4ai	Commercial/institutional: Stationary
1A4aii	Commercial/institutional: Mobile
1A4bi	Residential: Stationary
1A4bii	Residential: Household and gardening (mobile)
1A4ci	Agriculture/Forestry/Fishing: Stationary
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery
1A4ciii	Agriculture/Forestry/Fishing: National fishing
1A5a	Other stationary (including military)
1A5b	Other, Mobile (including military, land based and recreational boats)
1B1a	Fugitive emission from solid fuels: Coal mining and handling
1B1b	Fugitive emission from solid fuels: Solid fuel transformation
1B1c	Other fugitive emissions from solid fuels
1B2ai	Fugitive emissions oil: Exploration, production, transport
1B2aiv	Fugitive emissions oil: Refining / storage
1B2av	Distribution of oil products
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)
1B2c	Venting and flaring (oil, gas, combined oil and gas)
1B2d	Other fugitive emissions from energy production
2A1	Cement production
2A2	Lime production
2A3	Glass production
2A5a	Quarrying and mining of minerals other than coal

NFR Code	Longname
2A5b	Construction and demolition
2A5c	Storage, handling and transport of mineral products
2A6	Other mineral products (please specify in the IIR)
2B1	Ammonia production
2B2	Nitric acid production
2B3	Adipic acid production
2B5	Carbide production
2B6	Titanium dioxide production
2B7	Soda ash production
2B10a	Chemical industry: Other (please specify in the IIR)
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)
2C1	Iron and steel production
2C2	Ferroalloys production
2C3	Aluminium production
2C4	Magnesium production
2C5	Lead production
2C6	Zinc production
2C7a	Copper production
2C7b	Nickel production
2C7c	Other metal production (please specify in the IIR)
2C7d	Storage, handling and transport of metal products (please specify in the IIR)
2D3a	Domestic solvent use including fungicides
2D3b	Road paving with asphalt
2D3c	Asphalt roofing
2D3d	Coating applications
2D3e	Degreasing
2D3f	Dry cleaning
2D3g	Chemical products
2D3h	Printing
2D3i	Other solvent use (please specify in the IIR)
2G	Other product use (please specify in the IIR)
2H1	Pulp and paper industry
2H2	Food and beverages industry
2H3	Other industrial processes (please specify in the IIR)
2I	Wood processing
2J	Production of POPs
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)
2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)
3B1a	Manure management - Dairy cattle
3B1b	Manure management - Non-dairy cattle
3B2	Manure management - Sheep
3B3	Manure management - Swine
3B4a	Manure management - Buffalo
3B4d	Manure management - Goats
3B4e	Manure management - Horses
3B4f	Manure management - Mules and asses
3B4gi	Manure management - Laying hens
3B4gii	Manure management - Broilers
3B4giii	Manure management - Turkeys
3B4giv	Manure management - Other poultry
3B4h	Manure management - Other animals (please specify in IIR)

NFR Code	Longname
3Da1	Inorganic N-fertilizers (includes also urea application)
3Da2a	Animal manure applied to soils
3Da2b	Sewage sludge applied to soils
3Da2c	Other organic fertilisers applied to soils (including compost)
3Da3	Urine and dung deposited by grazing animals
3Da4	Crop residues applied to soils
3Db	Indirect emissions from managed soils
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products
3Dd	Off-farm storage, handling and transport of bulk agricultural products
3De	Cultivated crops
3Df	Use of pesticides
3F	Field burning of agricultural residues
3I	Agriculture other (please specify in the IIR)
5A	Biological treatment of waste - Solid waste disposal on land
5B1	Biological treatment of waste - Composting
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities
5C1a	Municipal waste incineration
5C1bi	Industrial waste incineration
5C1bii	Hazardous waste incineration
5C1biii	Clinical waste incineration
5C1biv	Sewage sludge incineration
5C1bv	Cremation
5C1bvi	Other waste incineration (please specify in the IIR)
5C2	Open burning of waste
5D1	Domestic wastewater handling
5D2	Industrial wastewater handling
5D3	Other wastewater handling
5E	Other waste (please specify in IIR)
6A	Other (included in national total for entire territory) (please specify in IIR)
Memo items (not to be included in national totals)	
1A3ai(ii)	International aviation cruise (civil)
1A3aii(ii)	Domestic aviation cruise (civil)
1A3di(i)	International maritime navigation
1A5c	Multilateral operations
1A3	Transport (fuel used)
6B	Other not included in national total of the entire territory (please specify in the IIR)
11A	Volcanoes
11B	Forest fires
11C	Other natural emissions (please specify in the IIR)