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Environment Agency

Estonian Informative Inventory Report 1990-2022

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Data sheet

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Return to the Table of Contents

TABLE OF CONTENTS

INDEX OF TABLES

Return to the Table of Contents

Return to the Table of Contents

Return to the Table of Contents

Return to the Table of Contents

INDEX OF FIGURES

Return to the Table of Contents

Return to the Table of Contents

ABBREVIATIONS

CAS	Chemical Abstracts Service, pollutants nomenclature
CEIP	Centre on Emission Inventories and Projections
CEPMEIP	Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance
CLRTAP	Convention on Long Range Transboundary Air Pollution
CN	Combined Nomenclature
CollectER	Point and area sources database
COPERT 5	Microsoft Windows software program which is developed as a European tool for the calculation of emissions from the road transport sector
CORINAIR	CORe INventory AIR emissions programme
GNFR	Gridding NFR (aggregated NFR categories)
EB	Energy Balance
EEA	European Environment Agency
EEB	Estonian Environmental Board
EERC	Estonian Environment Research Centre
EF	Emission factor
EMEP	Cooperative programme for the monitoring and evaluation of the long range transmission of air pollutants in Europe (European monitoring and evaluation programme)
EMTAK	Estonian Classification of Economic Activities
E-PRTR	European Pollutant Release and Transfer Register
ESTEA	Estonian Environment Agency
EU	European Union
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies model
GHG	Greenhouse gases
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
KOTKAS	Integrated Environmental Information System (EEB)
LCP	Large combustion plant
LPS	Large point sources, equals to the definition of E-PRTR installations
NECD	Directive (EU) 2016/2284 of the European Parliament and of 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, OJ L 344, 17 December 2016

Return to the Table of Contents

NFR	Nomenclature for Reporting
OSIS	Web-interfaced air emissions data system for point sources at the Estonian Environment Agency (ESTEA)
PP	Power Plant
RAINS	Regional Air Pollution Information and Simulation model
QA/QC	Quality Assurance / Quality Control
SNAP	Selected Nomenclature for Air Pollution
TVP	True Vapour Pressure
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention for Climate Change

Pollutants

As	Arsenic
B(a)p	Benzo(a)pyrene
B(b)f	Benzo(b)fluoranthene
BC	Black carbon
B(k)f	Benzo(k)fluoranthene
Cd	Cadmium
CFC	Chlorofluorocarbon
Cr	Chromium
Cu	Copper
CO	Carbon monoxide
HCB	Hexachlorobenzene
HCl	Hydrochloric acid
HFCs	Hydrofluorocarbons
Hg	Mercury
HMs	Heavy metals
I(1,2,3-cd)p	Indeno(1,2,3-cd)pyrene
NH_3	Ammonia
Ni	Nickel
NMVOC	Non-methane volatile organic compounds, any organic compound, excluding methane, having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. For the purpose of the UNECE CLRTAP Reporting Guidelines, the fraction of creosote which exceeds this value of vapour pressure at 293.15 K is considered as a NMVOC.
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides, nitric oxide and nitrogen dioxide, expressed as nitrogen dioxide

Return to the Table of Contents

PAH-4	Polyaromatic hydrocarbons expressed as the sum of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3,-cd)pyrene
Pb	Lead
PCDD/PCDF	Dioxins and furans: 1, 2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; 1,2,3,4,7,8-HxCDF; 1,2,3,6,7,8-HxCDF
PCB	Polychlorinated biphenyls
PCP	Pentachlorophenol
PFCs	Perfluorocarbons
$PM_{2.5}$	Particulate matter, the mass of particulate matter that is measured after passing through a size-selective inlet with a 50 per cent efficiency cut-off at 2.5 μm aerodynamic diameter
PM_{10}	Particulate matter, the mass of particulate matter that is measured after passing through a size-selective inlet with a 50 per cent efficiency cut-off at 10 μm aerodynamic diameter
POPs	Persistent organic pollutants, (lindane, dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyl (PCBs), pentabromodiphenyl ether (PeBDE), perfluorooctane sulfonate (PFOS), hexachlorobutadeine (HCBD), octabromodiphenyl ether (OctaBDE), polychlorinated naphthalenes (PCNs), pentachlorobenzene (PeCB) and short-chained chlorinated paraffins (SCCP)
Se	Selenium
SCCP	Short-chained chlorinated paraffins
SO_2	Sulphur dioxide
SO_x	Sulphur oxides, all sulphur compounds expressed as sulphur dioxide
TSP	Total suspended particulates. The mass of particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions
Zn	Zinc

Units

g	Gramme
g I-Teq	Gramme International Toxic Equivalent
Gg	Gigagramme, 10^9 gramme
GJ	Gigajoule, 10^9 joule
GWh	Gigawatt hour
kg	Kilogramme, 10^3 gramme
kPa	Kilopascal, 10^3 Pa
kt	Kilotonne, 10^3 tonne
Mg	Megagramme, 10^6 gramme

Return to the Table of Contents

mg	Milligramme, 10^{-3} gramme
µg	Mikrogramme, 10^{-6} gramme
MJ	Megajoule, 10^{6} joule
ng	Nanogramme, 10^{-9} gramme
t	Tonne
TJ	Terajoule, 10^{12} joule
PJ	Petajoule, 10^{15} joule

Notation keys

IE	Included elsewhere – Emissions for this source are estimated and included in the inventory but not presented separately for this source (the source where included is indicated).
NA	Not applicable – The source exists but relevant emissions are considered never to occur. Instead of NA, the actual emissions are presented for source categories where both the sources and their emissions are well-known due to availability of bottom-up data (i.e. mainly in the energy and industrial processes sectors).
NE	Not estimated – Emissions occur, but have not been estimated or reported.
NO	Not occurring – A source or process does not exist within the country.
C	Confidential information – Emissions are aggregated and included elsewhere in the inventory because reporting at a disaggregated level could lead to the disclosure of confidential information.
NR	Not relevant - According to paragraph 9 in the Emission Reporting Guidelines, emission inventory reporting should cover all years from 1980 onwards if data are available. However, NR (not relevant) is introduced to ease the reporting where emissions are not strictly required by the different protocols.

Like Snow (photo by Margus Muts)

EXECUTIVE SUMMARY

Estonia, as a party to the Convention on Long-range Transboundary Air Pollution (CLRTAP) is required to report annual emission data, projections of main pollutants, activity data and to provide an Informative Inventory Report. The emissions data of all pollutants for the period 1990-2022 was submitted on 13th February 2023.

The current report contains an explanation of pollutant trends and key categories, information about sectoral methodologies, recalculations and planned inventory improvements.

The latest recalculations in the emission inventory were made for the time period from 1990 to 2021. The reasons for the recalculations are specified in the The status of recalculations in the 2024 submission Table 0.1.

Table 0.1 The status of recalculations in the 2024 submission

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1a	Public electricity and heat production	Correction of activity data for some years	NO_x,	1992-2007; 2009-2012; 2014-2021
			NMVOC	1992-1996; 1998-2002; 2007; 2010-2011; 2015-2021
			NH_3	1992-2021
			SO_x	2019-2021
			TSP, $PM_{2.5}$, PM_{10}	2017-2021
			BC	2000-2021
			CO	2010-2021
			PCDD/F, PAHs	1990-2021
			PCB	2021
			HCB	2017
1A1c	Manufacture of solid fuels and other energy industries	Correction of emission factors	NMVOC, CO,	1990-2021
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Correction of activity data for some years	NO_x	2000-2002; 2005-2007; 2009-2017; 2021
			NMVOC	2001; 2005; 2007; 2010; 2012-2013; 2016-2017
			NH_3	2000-2002; 2011-2014
			SO_x	2000; 2005-2006; 2011-2014
			CO	2000; 2002; 2005-2006; 2010-2014; 2016-2017; 2021
			PCDD/F	2000-2007; 2009-2021
			PAHs	2005-2006; 2019
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Correction of activity data for some years	NO_x	2001-2004; 2005-2016; 2020
			NMVOC	2002; 2007-2015; 2017; 2020
			NH_3	2007; 2016
			SO_x	2001-2003; 2007-2015
			CO	2001-2003; 2007-2017; 2020
			TSP, $PM_{2.5}$, PM_{10}, BC	2001; 2003; 2007; 2009-2014; 2017
			PCDD/F	2001-2021
			PAHs	2007; 2009-2014; 2017
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Correction of activity data for some years	NO_x,	1990-2021
			NMVOC	1992-1997; 2000; 2002-2006; 2008-2014; 2018-2021

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
			NH_3	1999-2018
			SO_x	2001-2006; 2009-2011; 2016-2014; 2017-2021
			CO	1992-1995; 2000-2021
			TSP	2002-2005; 2009; 2013; 2019
			$PM_{2.5}$, PM_{10}	2002-2005; 2007-2009; 2013-2014; 2021
			PCDD/F	1990-2021
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Correction of activity data for some years	NO_x,	1992-2017; 2020-2021
			NMVOC	1992-1993; 1995; 1999-2001; 2003; 2006-2008; 2012-2014; 2016; 2020-2021
			NH_3,	1996-2021
			SO_x	2001; 2005; 2007-2009; 2013-2017; 2020-2021
			CO	1992-2021
			TSP, $PM_{2.5}$, PM_{10}, BC	2021
			PCDD/F	1992-2021
			PAHs	1995-2021
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Correction of activity data for some years	NO_x,	1990-2020
			NMVOC	1992-2005; 2008; 2010-2011; 2013-2017; 2020-2021
			NH_3	1992-2021
			SO_x	2005; 2010-2012; 2014-2017; 2020-2021
			CO	1992-1993; 1995-2006; 2009-2017; 2020-2021
			TSP	1993; 1995-2005; 2010-2011; 2016-2017; 2021
			PM2.5, PM10, BC	2000-2005; 2010-2011; 2016-2017
			PCDD/F, PAHs	1992-2021
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Correction of activity data for some years	NO_x	1992-2000; 2002; 2004; 2006; 2009-2011; 2013-2017; 2021
			NMVOC	1992-1993, 1996-1997, 2000, 2002, 2004, 2010, 2014-2015, 2017
			NH_3	1992; 1996-2021
			$PM_{2.5}$	2016-2017
			POPs	1992-2021
1A2giii	Stationary combustion in manufacturing industries and construction: Other	Correction of activity data for some years	NO_x	1990; 1992-2017; 2021
			NMVOC	1992-1994, 1996, 1998-2001, 2012-2013, 2016-2017, 2021
			NH_3	1990- 2021
			SO_x	2009-2013; 2016, 2021
			CO	1998; 2001; 2012-2013; 2016; 2021

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
			PCDD/F, PAHs	1990-2021
1A3bi	Road transport: Passenger cars	Correction of activity data and emission factors	NO$_x$, NMVOC, NH$_3$, TSP, CO, PCDD/F, PAHs, HM	1990-2021
			PM2,5, PM10, BC	2000-2021
1A3bii	Road transport: Light duty vehicles	Correction of activity data and emission factors	NO$_x$, NMVOC, TSP, CO, PCDD/F, PAHs, HM	1990-2021
			PM$_{2.5}$, PM$_{10}$, BC	2000-2021
1A3biii	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NOx, NMVOC, TSP, CO, PCDD/F, PAHs	1990-2021
			PM$_{2.5}$, PM$_{10}$, BC	2000-2021
1A3biv	Road transport: Road transport: Mopeds & motorcycles	Correction of activity data and emission factors	NMVOC, TSP, CO, HMs, PCDD/F, PAHs, HM	1990-2021
			PM$_{2.5}$, PM$_{10}$, BC	2000-2021
1A4ai	Commercial/institutional: Stationary	Correction activity data for some years	NO$_x$	1990-1991; 1993-2021
			NH3	1990-2021
			NMVOC	1993,1995,1997-2021
			SOx	1997-2021
			CO	1995-2021
			TSP	1997-2016; 2019-2021
			PM$_{2.5}$, PM$_{10}$, BC	2000-2016; 2019-2021
			HCB	1990-1991; 1995; 1997; 1999
			PCB	1990-1991,1993-2000,2002-2003,2005,2007
			PCDD/F, PAHs	1990-2021
1A4ci	Agriculture/Forestry/Fishing: Stationary	Correction of activity data for some years	NO$_x$	1990-2009; 2011-2021
			NH3	1990-2021
			NMVOC	1990-1992,1993-2005,2007,2009,2011-2013,2016-2021
			SOx	1990-1991; 1993-2000; 2002-2004; 2007-2009; 2011-2012; 2014; 2016-2017; 2019-2021
			CO	1990-2000; 2002-2007; 2011-2017; 2019-2021
			POPs	1990-2021
			PM$_{2.5}$, PM$_{10}$, BC, TSP	2000; 2002-2003; 2005; 2007
1A4bi	Residential: Stationary	Correction of emission factors and activity data	All pollutants	1990-2021
1B1c	Other fugitive emissions from solid fuels	Correction of emission factor	NO$_x$, NMVOC, NH$_3$, SO$_x$, CO, TSP, PM$_{2.5}$, PM$_{10}$	1990-2021
1B2av	Distribution of oil products	Correction of activity data	NMVOC	1994-1995; 1997; 1999-2001; 2003; 2008; 2010; 2013; 2015-2021
1B2b	Fugitive emissions from natural gas	Correction of activity data	NMVOC	2018-2021
2A5b	Construction and demolition	Correction of emission factors and activity data	PM2.5, PM10, TSP	1990-2021
2H1	Pulp and paper production	Correction and part of emissions data reallocation to another NFR	NMVOC, CO	2013-2021
		Correction of emissions data	NMVOC	2014
2H2	Food and drink production	Correction of emissions data	NMVOC	2014

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
		Correction and part of emissions data reallocation to another NFR	NMVOC, CO	2013-2021
2I	Wood processing	Correction of emissions data	PM2.5, PM10, TSP	2019-2021
		Correction and part of emissions data reallocation to another NFR	PM2.5, PM10, TSP, CO, NMVOC	2013-2021
2D3a	Domestic solvent use including fungicides	Corrections of activity data.	NMVOC	2004-2021
2D3d	Coating applications	Corrections of activity data. Correction of point sources database data and correction of emission data from the point sources database	NMVOC	2018-2021
2D3g	Chemical products	Correction of point sources database data and correction of emission data from the point sources database.	NMVOC	2021
2D3h	Printing	Corrections of activity data	NMVOC	2021
2D3i	Other product us	Correction of emissions calculations	NMVOC	2021
3B4e	Manure management - Horses	Corrected information about animal numbers	NMVOC, NOx, NH_3 $PM_{2.5}$, PM_{10}, TSP	2020-2021
3B4gi	Manure management –Laying hens	Updated information about technologies and the corresponding emissions reduction measures	NH_3	2016-2021
3B4gii	Manure management – Broilers	Updated information about technologies and the corresponding emissions reduction measures	NH_3	2021
3B4giv	Manure management - Other poultry	Updated information about technologies and the corresponding emissions reduction measures	NH_3	2019-2021
3Da1	Inorganic N-fertilizers (includes also urea application)	Renewed emission factor from GB2023	NH_3	1990-2021
3Da2a	Animal manure applied to soils	Updated information about technologies and the corresponding emissions reduction measures	NO_x, NH_3	2019-2021
3Da2c	Other organic fertilisers applied to soils (including compost)	Correction of activity data	NH_3	2014-2021
3Da3	Urine and dung deposited by grazing animals	Updated information about technologies and the corresponding emissions reduction measures	NO_x, NH_3	2020-2021
3De	Cultivated crops	Correction of calculation	NMVOC	1990-2020
5A	Solid waste disposal on land	A change in methodology	$PM_{2.5}$, $PM_{10,}$ P	2000-2021
			TSP, NMVOC	1990-2021
		Emissions data reallocation to another NFR	NH_3	2007-2021
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	Calculation of emissions from a new source	NH_3	2011-2021
5C1bii	Clinical waste incineration	Correction activity data	Pb, Cd, Hg, As, Ni, PCDD/PCDF, PAH Total, HCB	2020
5C1biii	Clinical waste incineration	Correction of emission factor	NOx, $SO_{x,}$ TSP, CO, Cu,	1990-2007
			PM2.5, PM10, BC	2000-2007
			Pb, Cd, Hg, As, Ni, PAH Total	1990-2021
		Correction of activity data	PCDD/PCDF, HCB, PCB	2021
5C1bv	Cremation	Emissions data reallocation to another NFR	NH_3	2009-2021
5C2	Open burning	Correction of emission factor	$PM_{2.5}$, PM_{10}	2000-2021
5D1	Domestic wastewater handling	Calculation of emissions from a new source	NH_3	1990-2021
5E	Other waste	Correction of point sources database data and correction of activity data	$NO_{x,}$ CO, Ni, Zn, b(a)p, b(b)f, b(k)f, indeno, PAHs Total	2012, 2013
			$PM_{2.5}$, PM_{10}, pB, Hg	2012-2021
			TSP	2011-2021
			Cd	2013-2021

Return to the Table of Contents

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
			As, Cr, Cu, PCDD/PCDF	2015-2021
11B	Forest fires	Correction of activity data	$PM_{2.5}$, PM_{10}, TSP	1990-2021
11C	Other natural emissions	Correction of activity data	NMVOC	2012-2021

Detailed sector by sector explanations concerning the recalculations are presented in Chapter 8.

The differences in total emissions between the 2023 and 2024 submissions are presented in the Table 0.2.

Table 0.2 Difference between the 2023 and 2024 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
1990	0.14	0.60	0.28	8.18	NR	NR	-1.45	NR	-0.97	0.00	0.03	0.41
1991	0.15	0.45	0.33	7.65	NR	NR	-1.37	NR	-1.30	0.00	0.03	0.45
1992	0.14	0.83	0.24	8.57	NR	NR	-1.70	NR	-1.42	0.00	0.02	0.31
1993	0.12	1.30	0.21	6.82	NR	NR	-0.71	NR	-0.01	0.00	0.02	0.28
1994	0.04	1.46	0.11	6.72	NR	NR	-1.16	NR	-1.75	0.00	0.01	0.17
1995	-0.04	2.01	0.19	6.70	NR	NR	-0.86	NR	-3.85	0.00	0.02	0.26
1996	-0.03	2.16	0.23	6.77	NR	NR	-0.97	NR	-3.70	0.00	0.04	0.33
1997	-0.03	2.16	0.13	7.24	NR	NR	-1.49	NR	-2.66	0.00	0.03	0.26
1998	-0.01	1.80	0.06	8.08	NR	NR	-2.99	NR	-2.54	0.00	0.02	0.20
1999	0.00	1.84	0.07	7.95	NR	NR	-1.48	NR	-2.33	0.00	0.03	0.24
2000	0.04	2.21	0.03	8.09	-5.83	-2.93	-1.61	-24.71	-1.86	0.00	0.02	0.23
2001	0.05	2.06	-0.02	6.89	-5.74	-4.05	-3.29	-22.67	-1.51	0.00	0.01	0.20
2002	0.11	2.16	0.02	5.98	-3.33	-2.08	-0.93	-20.28	-2.00	0.00	0.01	0.21
2003	0.15	2.60	-0.03	6.90	-4.20	-6.43	-8.13	-20.66	-2.09	0.00	0.01	0.24
2004	0.18	5.85	0.00	7.27	-4.69	-8.30	-10.88	-19.30	-1.07	0.00	0.01	0.34
2005	0.21	7.66	0.01	6.71	-3.05	-7.23	-10.87	-17.16	0.21	0.00	0.01	0.47
2006	0.24	10.11	-0.03	5.94	-2.52	-7.67	-12.08	-16.99	1.80	0.01	0.02	0.27
2007	0.24	7.71	-0.08	7.67	-3.41	-7.66	-13.55	-17.71	-2.49	0.00	0.01	0.24
2008	0.30	9.39	-0.09	7.76	-5.25	-14.92	-22.06	-18.68	-0.67	0.00	0.01	1.03
2009	0.32	8.63	-0.16	6.86	-3.86	-7.23	-10.06	-18.89	0.24	0.00	0.00	3.13
2010	0.34	10.17	-0.09	6.14	-1.17	-2.98	-4.41	-17.23	2.01	0.00	0.00	1.94
2011	0.40	9.44	-0.07	5.75	0.39	-2.61	-5.70	-13.58	4.89	0.00	0.01	1.62
2012	0.51	9.05	-0.16	5.23	-0.73	-12.86	-22.93	-14.69	0.00	0.00	0.00	2.33
2013	0.56	21.20	-0.16	5.64	1.94	-5.85	-12.76	-12.85	1.47	-0.01	-0.01	0.44
2014	0.57	14.89	-0.16	5.67	2.55	-6.08	-13.35	-12.42	0.50	-4.96	-1.84	-1.90
2015	0.58	13.08	-0.24	5.62	4.56	-5.40	-11.42	-12.22	-2.13	-11.54	-3.77	-5.67
2016	0.56	11.34	-0.34	6.38	4.35	-5.52	-11.47	-11.66	-4.41	-12.15	-4.11	-6.27
2017	0.60	12.61	-0.30	6.28	5.49	-7.50	-15.58	-10.96	2.60	-12.74	-4.31	-6.26
2018	0.62	12.33	-0.39	6.87	5.36	-10.44	-19.82	-10.38	1.61	-14.01	-4.77	-6.84
2019	0.48	9.00	-0.67	7.74	1.45	-13.49	-23.25	-9.82	0.20	-16.89	-6.29	-8.72
2020	0.19	3.69	-1.17	7.66	-4.06	-17.56	-26.73	-8.65	-0.97	-20.40	-6.83	-4.52
2021	1.02	2.35	-1.03	8.86	-3.06	-16.38	-24.93	-8.59	-0.52	-21.54	-6.66	-5.89

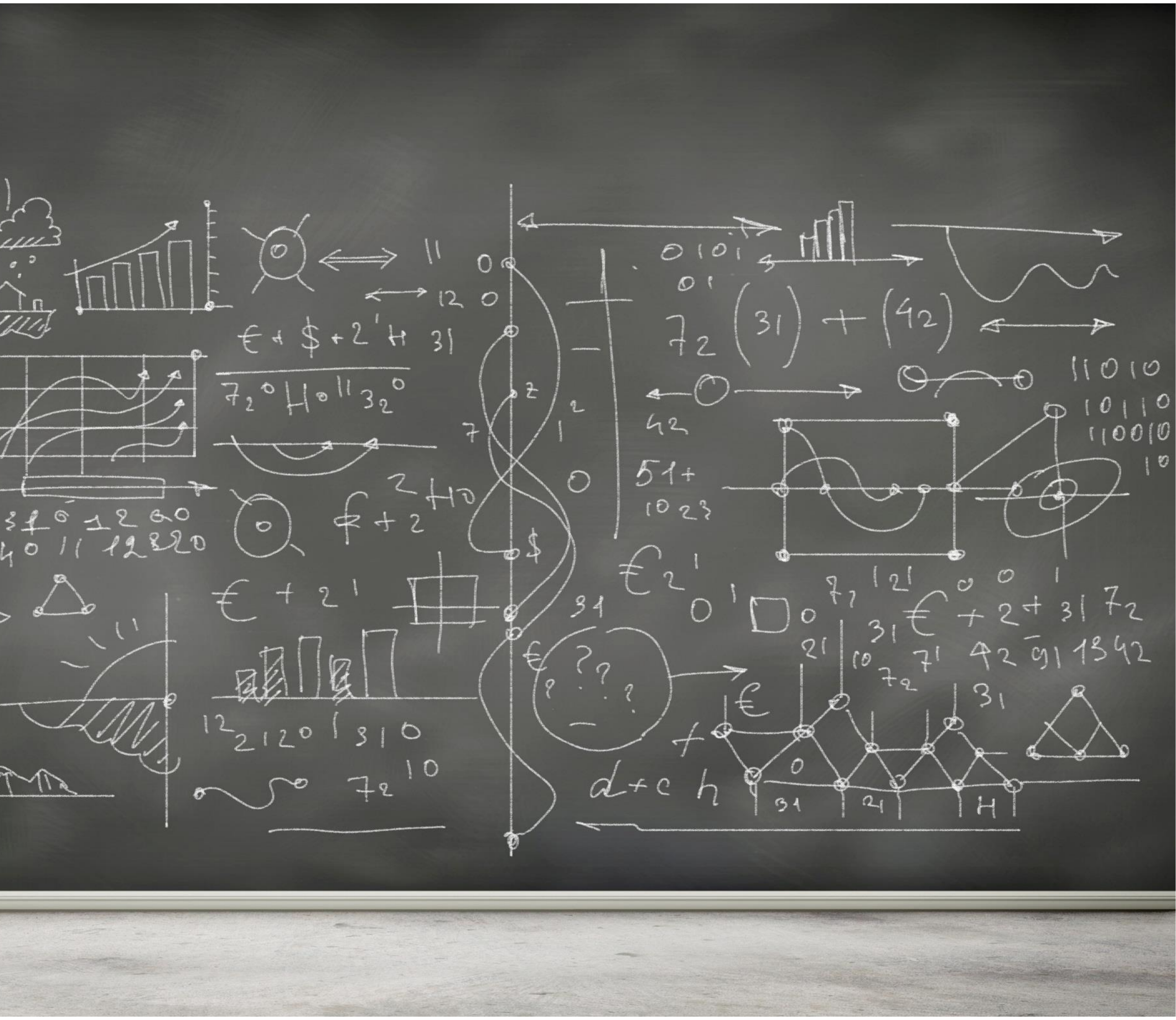
Table 0.2 continues

Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
1990	0.00	0.00	-0.01	0.00	0.03	0.00	5.99	15.68	18.62	8.63
1991	0.00	0.00	-0.01	0.00	0.03	0.00	6.21	15.88	18.91	8.83
1992	0.00	0.00	-0.01	0.00	0.02	0.01	0.87	12.67	15.69	7.51
1993	0.00	0.00	-0.01	0.00	0.02	0.00	-2.18	11.18	14.08	6.87
1994	0.00	0.00	-0.01	0.00	0.01	0.00	-8.96	7.57	9.41	5.30
1995	0.00	0.00	-0.01	0.00	0.02	0.00	-15.59	7.38	9.31	5.34
1996	0.00	0.00	0.00	0.00	0.02	0.00	-14.47	8.19	10.32	5.89
1997	0.00	0.00	-0.01	0.00	0.01	0.00	-18.21	7.44	8.94	5.69
1998	0.00	0.00	-0.01	0.00	0.01	0.00	-13.57	7.22	8.25	5.69
1999	0.00	0.00	0.00	0.00	0.01	0.00	-12.19	8.03	9.22	6.19

Return to the Table of Contents

Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
2000	0.00	0.00	0.00	0.00	0.01	0.00	-12.90	8.11	9.00	6.41
2001	0.00	0.00	0.00	0.00	0.01	0.00	-12.95	8.15	8.42	6.61
2002	0.00	0.00	-0.01	0.00	0.01	0.00	-10.27	9.08	9.41	7.20
2003	0.00	0.00	-0.01	0.00	0.01	0.00	-12.57	9.46	9.23	7.74
2004	0.00	0.00	-0.01	0.00	0.01	0.00	-11.32	10.49	10.16	8.36
2005	0.00	0.00	-0.01	0.00	0.01	0.00	-9.19	11.22	10.65	8.94
2006	0.00	0.00	0.00	0.00	0.01	0.00	-10.39	11.70	10.82	9.39
2007	0.00	0.00	0.00	0.00	0.01	0.00	-14.50	12.33	10.99	10.11
2008	0.00	0.00	0.00	0.00	0.01	0.00	-11.16	13.10	11.78	10.70
2009	0.00	0.00	0.00	-0.01	0.01	0.00	-12.76	13.87	11.97	11.36
2010	0.00	0.00	0.00	0.00	0.00	0.00	-12.34	14.80	12.85	12.02
2011	0.00	0.00	0.00	0.00	0.00	0.00	-8.14	16.31	14.39	13.09
2012	0.00	0.00	0.00	0.00	0.00	0.00	-10.68	18.29	16.01	14.59
2013	0.00	0.00	0.00	0.00	0.00	0.00	-11.29	19.37	16.44	15.53
2014	-0.56	-0.01	0.00	-0.01	0.00	-0.01	-10.25	20.24	17.06	16.26
2015	-1.33	-0.01	0.02	-0.03	0.00	-0.02	16.20	20.95	17.04	16.84
2016	-1.33	-0.01	0.01	-0.04	0.00	-0.02	10.99	21.34	16.34	17.27
2017	-1.43	-0.02	0.01	-0.04	0.00	-0.02	4.61	22.11	16.78	17.89
2018	-1.74	-0.03	0.01	-0.04	0.00	-0.02	5.76	23.12	17.25	18.77
2019	-3.88	-0.21	-0.01	-2.28	0.00	-0.04	5.46	24.19	17.93	19.57
2020	-4.70	-0.23	-0.01	-2.10	0.00	-0.04	5.40	24.83	18.16	20.19
2021	-6.22	-0.14	-0.15	-1.68	-0.11	2.90	9.93	26.99	22.22	20.84

In comparison to last year’s submission, recalculations were made for all pollutants. The detailed descriptions for recalculations are presented in the following chapters.



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1. INTRODUCTION

1.1. National Inventory Background

Estonia ratified the Convention on Long-range Transboundary Air Pollution in 2000 and became a party to the Convention and the following protocols:

- The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent;
- The 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes;
- The 1991 Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes;
- The 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP);
- The 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs);
- The 1998 Aarhus Protocol on Heavy Metals.

According to the Guidelines for Estimating and Reporting Emission Data, each party must report the annual national emission data of pollutants in the NFR source category and shall submit an informative inventory report on the latest version of the templates to the Convention Secretariat.

Estonia's Informative Inventory Report is due by March 2020. The report contains information on Estonian emission inventory from 1990 to 2020. The inventory detail the anthropogenic emissions of the main pollutants (SO_x, NO_x, NMVOC, NH_3 and CO), particulate matter (TSP, PM_{10}, $PM_{2.5}$), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn) and persistent organic pollutants (dioxins, HCB, PAHs, PCB). Projected emissions for sulphur dioxide, nitrogen oxides, ammonia, $PM_{2.5}$ and NMVOCs are reported for the years 2020, 2025 and 2030.

Methods used to quantify emissions as well as data analysis and other additional information to understand the emission trends as required in the Guidelines are included in the national Informative Inventory Reports (IIR) submitted annually.

1.2. Institutional Arrangements for Inventory Preparation

The Atmospheric Air Protection Act regulates data collection and reporting. Methods for the calculation of emissions are laid down in several regulations of the Minister of the Environment. The Air Pollution Database consists of data on point sources (about 1,800 reports for the year 2021) and diffuse sources. Structure and emission calculations from small point sources and area sources are mainly based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023.

The Estonian Environment Agency (ESTEA) is responsible for collecting, analysing, storing, reporting and publishing environment-related information and data. The ESTEA is a state authority administered by the Ministry of Climate. The ESTEA's field of activity is the fulfilment of the national environmental monitoring programme, the preparation of national and international reports in the field of environment, evaluating environmental status, ensuring vital services, including weather forecasts, and the maintenance and renewal of monitoring stations and equipment.

The Data Management Department of the ESTEA is responsible for the preparation of the air pollution inventory in Estonia.

The ESTEA performs the final data quality control and assurance procedure before its submission. In preparation for the inventory and in compiling basic data, ESTEA cooperates with the Ministry of Climate,

Return to the Table of Contents

the Ministry of Economic Affairs and Communications, the Ministry of Rural Affairs, Statistics Estonia, Estonian Rescue Service, Estonian Defence Forces, Estonian Road Administration, Estonian Tax and Customs Board, EVR Cargo Ltd, Tallinn Airport Ltd and the Estonian Environmental Research Centre (EERC).

The important aim of the inventory is to test the effectiveness of governmental environmental policies and provide national and international bodies with official emission data within the country. The emission data is updated every year and the results are reported annually.

1.3. The Process of Inventory Preparation

The processes of inventory preparation vary for different sources of pollution.

The Estonian national air pollution inventory preparation can be described as an annual cycle, primarily because there is an annual reporting obligation. In order to improve the quality of the inventory and the use of resources more efficiently, analysis of inventory preparation has to be a part of inventory preparation. The main activities of inventory preparation are given in Figure 1.1. The inventory structure in question is presented in Figure 1.3.

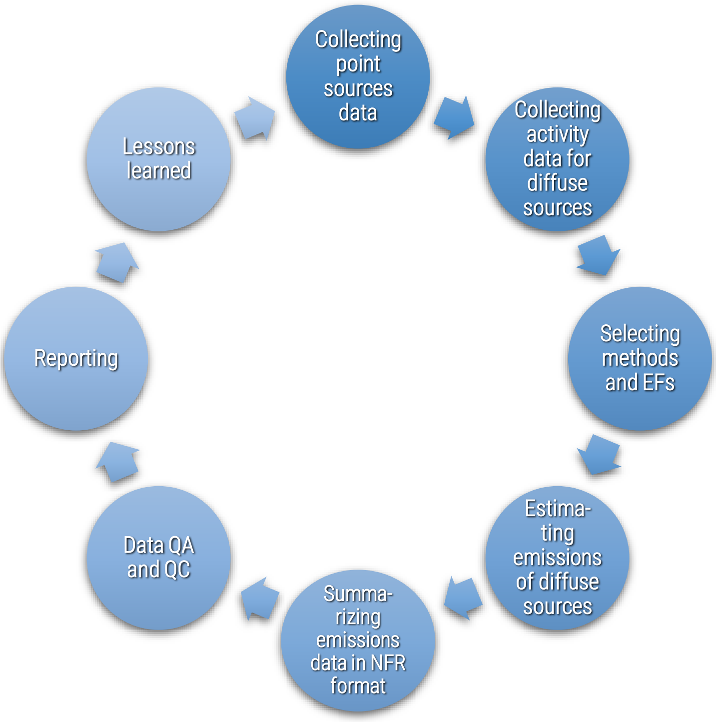


Figure 1.1 The main activities of inventory preparation

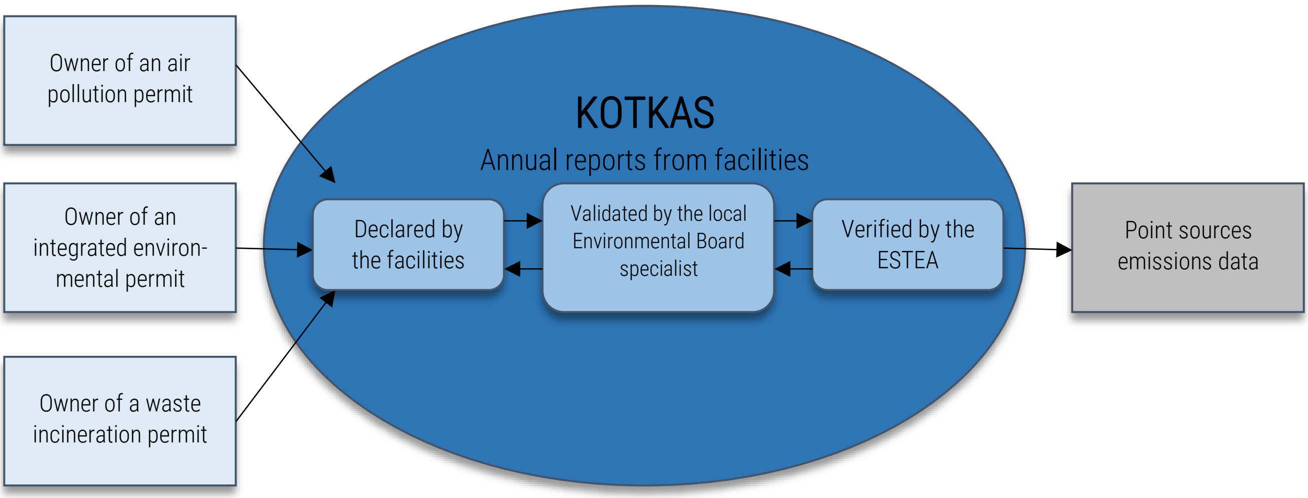
The national database contains data for both point and diffuse sources of emissions. The emission inventory for the period of 1990–1999 is based on data pertaining to the large point sources and diffuse sources. From 2000 to 2004, CollectER software was used to accumulate data (both point and diffuse sources). In order to accumulate data on point sources, the Estonian Environment Information Centre created a web-interfaced air emissions data system for the point sources (OSIS) in 2004, where operators of point sources directly complete their annual air pollution reports. In 2000, the national database contained data from about 600 facilities; however, by 2018 the number had increased to 1,950. The OSIS was used until 2019 when the annual reporting function was replaced by the Integrated Environmental Information System (KOTKAS) managed by the Estonian Environmental Board (EEB).

The Integrated Environmental Information System contains data reported by the operators that have a pollution permit issued by the EEB. Each facility submits data on the emissions of pollutants together with the data regarding burnt fuel, used solvents, amount of distributed liquid fuels, etc. Operators are obliged to specify any data related to accidental releases where such information is available (deliberate, accidental, routine and non-routine). Data is presented on each source of pollution and on the facility as a whole. Emission data is available in SNAP (Source Nomenclature for Air Pollutants) and E-PRTR codes. The operator of point sources can directly add their calculated or measured annual emissions into the KOTKAS by hand or use calculation modules, which use legally regulated national emissions estimation methodologies. The operator can also calculate emissions through the use of other available methods, though this should be approved by the Environmental Board (regulated by the Atmospheric Air Protection Act). The operator shall indicate the method of emission calculation.

Emissions for some air pollutants (POPs, in some cases PM_{10} and $PM_{2.5}$) not included in the reporting requirements under the environmental permits are additionally calculated by the Data Management Department and used in the preparation of the national inventory.

After entering the report, the local Environmental Board specialist confirms receipt of the report; at this point, the final verification at the ESTEA is carried out and the data is then ready for use in various reports (see Figure 1.2).

Figure 1.2 Validation of Estonian point sources data



The pollutant emissions from all diffuse sources have been calculated by the ESTEA. The main diffuse sources are combustion in the residential sector, mobile sources, agriculture, parts of solvent use and industrial activities and fugitive emissions from fuel consumption.

The non-direct GHG emissions (SO_2, NO_x, CO, NMVOC), also N_2O, CH_4 and road transport emissions and NMVOC emissions from the solvent use sector calculated by the ESTEA are used in reporting to the UNFCCC Secretariat and the EU CO_2 Monitoring Mechanism.

Return to the Table of Contents

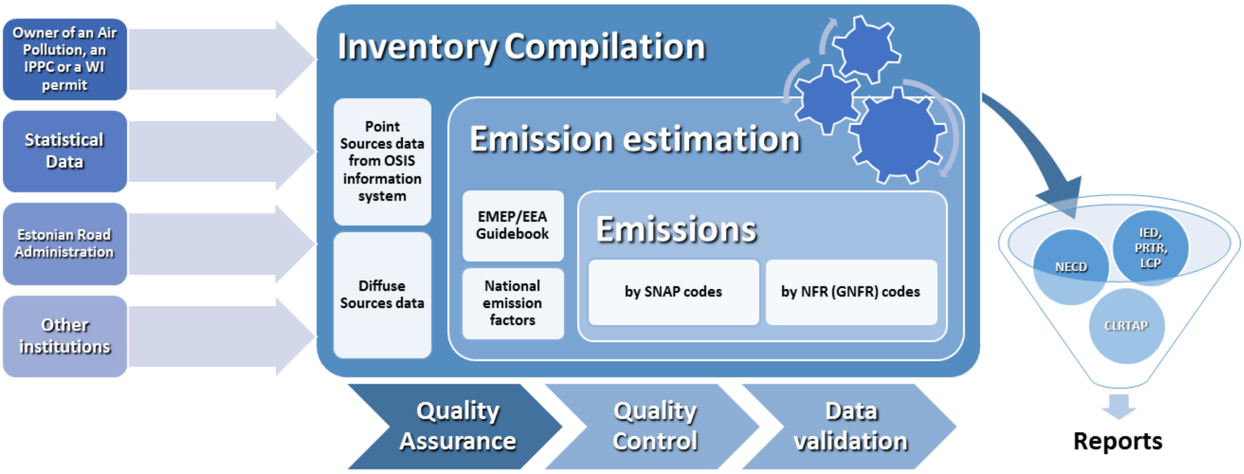


Figure 1.3 Air pollution inventory structure

1.4. Methods and Data Sources

The data reported by the operators and the national specific emission factors or EMEP/EEA Air Pollutant Emission Inventory Guidebook methodology for the emissions calculation from the diffuse sources are used in the preparation of emission inventories.

At present, the ESTEA uses the CollectER tool for the calculation of emissions of diffuse sources from energy sector. The Statistical Office energy balance (EB) and fuel consumption by point sources (PS) are used in this calculation.

Diffuse sources Fuel = EB fuel – PS fuel

With regard to the calculation of emissions from road transport, the COPERT 5 program (ver. 5.7.2) and emission factors are used. Total emissions are calculated on the basis of the combination of firm technical data (e.g. emission factors) and activity data (e.g. number of vehicles, annual mileage per vehicle, average trip, speed, fuel consumption, monthly temperatures). ESTEA has obtained vehicle data (passenger cars, light and duty vehicles, buses, motorcycles) and annual mileage per vehicle from the Estonian Road Administration. Meteorological data are provided by the ESTEA's Meteorological Observation Department and data pertaining to fuel consumption by Statistics Estonia.

The detailed methods for emission calculations are described in each sector of the IIR.

1.5. Key Categories

This chapter presents the results of Estonian key sources analyses.

Key sources analysis is based on methods described in the EMEP/EEA Guidebook 2023.

Key categories are the categories of emissions that have a significant influence on the total inventory in terms of the absolute level of emissions (certain year). The key categories are those that together represent 80% of the inventory level or trend.

The results of all pollutants (including main pollutants), which are reported under CLRTAP, are presented in the Table 1.1.

The energy (1A1a), stationary combustion (1A4bi) and road transport (1A3bi, 1A3biii) sectors are the main sources of NO_x. NO_x emissions from the energy sector primarily originate from oil-shale power plants. Additionally, the energy and stationary combustion sectors are key sources for dioxins.

Domestic solvent use (2D3a) is a main source of NMVOC (26.5%). Other key sources of NMVOC emissions include decorative coating applications (2D3d), combustion in residential plants (1A4bi), manure management (dairy cattle, non-dairy cattle, and swine), and distribution of oil products (1B2av).

SO_2 emissions from the energy sector, particularly from two oil shale power plants in east Estonia (Eesti and Balti power plants), account for 85.1% of total SO emissions in 2022, according to level assessment.

Agriculture is the key source for ammonia, especially livestock manure management (dairy cattle, swine and non-dairy cattle), manure application to the soils (3Da2a) and the use of mineral fertilises (3D1a), which are the main sources of pollution regarding ammonia.

The construction and demolition (2A5b) is a key source for particles. Additionally, combustion in residential plants (1A4bi) is a key source for TSP, PM_{10}, $PM_{2.5}$, BC, HCB, PAHs and heavy metals.

According to level assessment, 51.5% of CO emissions come from residential combustion plants (1A4bi). Furthermore, the oil-shale industry (1A1c) and public electricity and heat production (1A1a) are significant sources of CO emissions.

Table 1.1 Results of key sources analysis

Pollutant	Key categories (Sorted from high to low from left to right)								Total (%)
SO_x	1A1a								85.1
	85.1%								
NO_x	1A1a	1A4bi	1A3bi	1A3biii	3Da1	1A3bii			80.4
	29.0%	19.4%	11.1%	8.9%	7.2%	4.8%			
NH_3	3B1a	3Da1	3Da2a	3B1b	3B3				83.3
	29.1%	23.4%	17.0%	7.7%	6.0%				
NMVOC	2D3d	2D3a	1A4bi	3B1a	1A1c	2D3i	3B1b	1A1a	81.8
	26.5%	13.7%	12.7%	9.3%	6.2%	5.5%	4.5%	3.3%	
CO	1A4bi	1A1c							88.0
	51.5%	36.4%							
TSP	2A5b	1A4bi	1A3bvii	1A1a	3Dc	1B1c			80.7
	30.7%	14.4%	13.3%	9.1%	7.3%	5.9%			
PM_{10}	1A4bi	2A5b	3Dc	1A3bvii	1A1a	1B1c			80.1
	23.8%	19.3%	12.9%	11.8%	9.7%	5.5%			
$PM_{2.5}$	1A4bi	1A3bvii	1A1a	1B1c	2A5b	1A3bvi	1A1c		82.7
	41.7%	11.7%	11.1%	9.8%	2.9%	2.8%	2.7%		
Pb	1A4bi	1A3bvi	1A1a						87.8

Return to the Table of Contents

Pollutant	Key categories (Sorted from high to low from left to right)			Total (%)
	38.8%	25.1%	23.8%	
Hg	1A1a	1A4bi	5Cbv	86.1
	56.6%	20.9%	8.7%	
Cd	1A4bi	1A1a		85.9
	56.8%	29.1%		
DIOX	1A1a	5E	1A4bi	85.8
	51.8%	25.7%	8.3%	
PAH	1A4bi			82.5
	82.5%			
HCB	1A4bi	1A1a	5C2	88.2
	37.5%	37.3%	13.4%	

1.6. QA/QC and Verification Methods

A quality management system has been developed to support the inventory of air pollutant emissions.

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

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process.

Estonia's QA/QC plan consists of six parts:

- **Stakeholder engagement (stakeholders = e.g. suppliers of data, reviewers, recipients, other inventory compiling institutes):** The Estonian inventory was reviewed under the stage 3 review in 2016 summer by the EMEP emission centre CEIP acting as the review secretariat. The results are available at CEIP home page (http://www.ceip.at/review-process/centralised-review-stage-3/).
  In 2017-2023 the Estonian inventory has been a subject for the comprehensive technical review of national emission inventories pursuant to the Directive on the Reduction of National Emissions of Certain Atmospehric Pollutants (Directive (EU) 2016/2284). The recommendations from TERT and improvements made in the inventory are included in the Annex II of the IIR.
- **Data collection:** Data collection includes both point sources emissions and diffuse sources activity. Prior to using activity data, common statistical quality checking related to the assessment of trends is carried out.
  ESTEA uses only point sources data, which are checked and validated by local environmental departments.
- **Data manipulation:** Common statistical quality checking is carried out.
- **Inventory compilation:** Before submitting data to CEIP/EEA NFR, formats have to be checked with RepDab.
- **Reporting**
- **Archiving**

1.7. General Uncertainty Evaluation

Uncertainty analysis has been carried out for the 2024 submission under the terms and conditions of the LRTAP Convention as part of the Estonian IIR 2024.

Any uncertainty was calculated regarding those pollutants and sectors that are reflected in the inventory of Estonian ambient air. These pollutants include sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH_3), particulate matter ($PM_{2.5}$, PM_{10}, TSP), carbon monoxide (CO), heavy metals (Pb, Cd, Hg), persistent organic pollutants (dioxins (PCDD/F), polycyclic aromatic hydrocarbons (PAHs), HCB, PCBs. Activities are defined according to NFR source categories.

1.7.1. Overview of the Method

The process of evaluating the uncertainties was based on the Tier 1 methodology as described by the guidance document in the EMEP/EEA Guidebook 2023. Tier 1 methodology calculations are based on the emissions for the base year and what is known as the reference year, and on activity rate uncertainties and emissions factors for every NFR sector. Firstly, the uncertainty level was calculated on a pollutant-by-pollutant basis for every subcategory, and then the uncertainty levels for all subcategories were added together, thereby producing the overall uncertainty level for the inventory data. Uncertainty levels were also evaluated for aggregated sectors such as stationary combustion, aviation, road transport, other forms of transportation, industrial processes, solvent use, and agriculture and waste management; the results are presented under each IIR chapter. The base year for all pollutants was 1990, except for the PM_{10} and $PM_{2.5}$ figures, in which case the appointed base year was 2000. The reference year is 2022.

The uncertainty values for emissions factors were for the most part based on the figures that are included in the EMEP/EEA guidance document. If the default figures for uncertainty values of specific pollutant emissions were not set out in the guidance document, then expert evaluations were also used. The recommended range of error that is listed in the EMEP/EEA Guidebook 2023 for source data and emissions factors is given in Table 1.3. The margins of error for source data and emissions factors in this document are shown respectively by sectors in Table 1.2 and Table 1.4.

Table 1.2 Activity data uncertainty and sources

NFR sector	Uncertainty, %	Data source
1A1	2	National energy statistics; operators data
1A2	2	National energy statistics; operators data
1A3	2	National energy statistics;
1A4 (liquid fuels)	3	National energy statistics
1A4 (solid fuels)	2	National energy statistics
1A4 (natural gas)	2	National energy statistics
1A4 (biomass)	5	National energy statistics
1A4 (waste)	50	Expert judgement; waste management information system
1B1	2	National statistics; operators data
1B2	2	National statistics; operators data
2A1	2	National statistics; operators data
2A2	2	National statistics; operators data
2A5	2-5	National statistics; operators data
2B1	2	Operators data
2B10a	2	Operators data
2C1	2	Operators data
2C3	2	Operators data
2C5	2	Operators data
2C6	2	Operators data
2C7	2	Operators data

Return to the Table of Contents

NFR sector	Uncertainty, %	Data source
2D3	2-10	National statistics; operators data
2G	5	National statistics
2H1	2	National statistics; operators data
2H2	2	National statistics; operators data
2I	2	Operators data
2K	2	Operators data
2L	2	Operators data
3B1	2	National statistics
3B2	2	National statistics
3B3	2	National statistics
3B4	2	National statistics
3D	2	National statistics
5A	2	Operators data
5B1	2	Operators data
5B2	2	Operators data
5C1	2	Operators data
5C2	10	Expert judgement; waste management information system
5D1	2	National statistics; operators data
5D2	2	National statistics; operators data
5D3	2	National statistics; operators data
5E	2	National statistics; operators data

Table 1.3 The EMEP/EEA Guidebook emission factors uncertainty range

Rating	Definition	Typical error range
A	An estimate based on a large number of measurements made at a large number of facilities that fully represent the sector	10 – 30 %
B	An estimate based on a large number of measurements made at a large number of facilities that represent a large part of the sector	20 – 60 %
C	An estimate based on a large number of measurements made at a small number of representative facilities, or an engineering judgement based on a number of relevant facts	50 – 200 %
D	An estimate based on a single of measurements, or an engineering calculation derived from a number of relevant facts	100 – 300 %
E	An estimate based on an engineering calculation derived from assumption only	Order of magnitude

Table 1.4 NFR source categories with applicable quality data rating

NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxins	PAHs	HCB	PCBs
1.A.1.a	B	C	A	C	B	B	B	B	D	D	D	D	D
1.A.1.c	B	C	A		B	B	B	B	D	D	D	D	D
1.A.2.a					B	B	B		D				
1.A.2.gvii	C	C	C	C	C	C	C	C	D		C		
1.A.2.gviii	B	C	A	C	B	B	B	B	D	D	C	C	C
1A3ai(i)	B	B	B		B	B	B	B					
1A3aii(i)	B	B	B		B	B	B	B					
1.A.3.bi	B	B	B	B	B	B	B	B	B	D	C	C	C
1.A.3.bii	B	B	B	B	B	B	B	B	B	D	C	C	C
1.A.3.biii	B	B	B	B	B	B	B	B	B	D	C	C	C
1.A.3.biv	B	B	B	B	B	B	B	B	B	D	C	C	C
1.A.3.bv		B											
1.A.3.bvi					B	B	B		B				
1.A.3.bvii					B	B	B						
1.A.3.c	D	D	C	C	B	B	B	D	B	D	D	D	D
1.A.4.ai	C	C	B		B	B	B	B	D	D	D	D	D
1.A.4.aii	C	C	B	C	C	C	C	C	D		D	D	D
1.A.4.bi (liquid fuels)	D	D	C	C	B	B	B	B	D	D	D	D	D
1.A.4.bi (solid fuels)	D	D	C	C	B	B	B	B	D	D	D	D	D
1.A.4.bi (gaseous fuels)	D	D	C	C	B	B	B	B	D	D	D	D	D
1.A.4.bi (biomass)	D	D	C	C	B	B	B	B	D	B	D	D	D
1.A.4.bii	C	C	B	C	C	C	C	C	C		D	D	D

Return to the Table of Contents

NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxins	PAHs	HCB	PCBs
1.A.4.ci	C	C	B	C	C	C	C	C	C	D	D	D	D
1.A.4.cii	C	C	B	C	C	C	C	C	C		D		D
1.B.1.a	C				D	D	D	D					
1.B1..c		C											
1.B.2.av		C											
1.B.2.b		C											
2A1					C	C	C						
2A2					C	C	C						
2A3					C	C	C						
2A5a					C	C	C						
2.A.5.b					D	D	D						
2.A.6	B	B	B		D	D	D						
2.B.1	C												
2.B.10.a		C		B	B	B	B	C					
2C1		B			B	B	B						
2C3		B			B	B	B						
2C5					B	B	B						
2C6					B	B	B						
2C7a					B	B	B						
2.C.7.c	C			E	B	B	B						
2.D.3.a		B							B (Hg)				
2.D.3.b		D			D	D	D						
2.D.3.d		C											
2.D.3.e		B											
2.D.3.f		B											
2.D.3.g		B		D									
2.D.3.h		C											
2.D.3.i		C				B							
2.G	C	C	C	C	C	C	C	C	C	D	D		
2.H.1	C	C			D	D	D	C					
2.H.2		C			D	D	D						
2.L				E									
3.B.1.a	D	D		D	D	D	D						
3.B.1.b	D	D		D	D	D	D						
3.B.2	D	D		D	D	D	D						
3.B.3	D	D		D	D	D	D						
3.B.4.e	D	D		D	D	D	D						
3.B.4.gi	D	D		D	D	D	D						
3.B.4.gii	D	D		D	D	D	D						
3.B.4.giv	D	D		D	D	D	D						
3.B.4.h	D	D		D	D	D	D						
3.D.a.1	D	D		D	D	D	D						
5A		C		C	C	C	C						
5.B.1		C		C									
5.B.2	C	C	C	C			C	C					
5.C.1.bi	C	C		C	C	C	C	C		D			
5.C.1.biii										D			
5.C.1.bv	C	C	C	C	C	C	C	C	C	C	C	C	C
5.C.2	C	C	C		D	D	D	C	D	D	D	D	D
5.D.1		C											
5.D.2	C	C	C	C									
5.E		D			D	D	D		D				

Return to the Table of Contents

1.7.2. Results of Uncertainty Evaluation

Table 1.5 shows the results of the uncertainty evaluation, which include the estimated emissions by pollutants for both 1990 and 2022, the uncertainties for trends in 1990-2022, and the full uncertainty figures for 2022's national emissions.

Table 1.5 Uncertainty evaluation

Pollutant	Total emission, 1990	Total emission, 2022	Unit	Trend in 1990-2022, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	74.72	23.43	kt	-68.65	16.87	5.00
NMVOC	64.44	26.45	kt	-58.95	19.94	7.97
SO_x	279.02	14.66	kt	-94.74	8.75	0.14
NH_3	22.42	10.17	kt	-54.62	42.46	11.14
$PM_{2.5}$	10.18	4.91	kt	-51.78	27.02	15.65
PM_{10}	26.60	9.01	kt	-66.11	27.37	10.61
TSP	265.73	15.97	kt	-93.99	36.70	2.36
BC	1.57	1.17	kt	-25.15	44.28	40.30
CO	243.88	106.35	kt	-56.39	27.30	16.65
Pb	201.71	4.17	t	-97.93	45.89	1.04
Cd	4.46	0.46	t	-89.73	65.24	7.83
Hg	1.21	0.20	t	-83.78	37.34	4.15
PCDD/F	11.04	4.14	g I-TEQ	-62.53	123.92	48.72
B(a)p	2.81	1.07	t	-61.96	172.16	22.67
B(b)f	3.57	1.01	t	-71.62	154.27	17.60
B(k)f	1.69	0.67	t	-60.58	174.65	23.54
I(1,2,3-cd)p	1.78	1.00	t	-44.05	189.46	36.55
HCB	0.54	0.50	kg	-8.73	108.04	107.24
PCB	4.88	0.57	kg	-88.40	128.36	5.98

According to the results it can be concluded that most pollutant emissions originated mainly from electricity and heating production and the non-industrial combustion sector. Furthermore, a significant proportion originated from the road transport sector. The main source of ammonia emissions is the agricultural sector.

The uncertainty level was at its highest for the POPs and heavy metals. The main reason is a high emissions factors uncertainty level for energy-related activities. Ammonia also showed something of a higher uncertainty level than did the others, with uncertainty levels at about 100%. Uncertainty levels regarding the pollutant trend were at their highest for HCB and PAHs.

1.8. General Assessment of Completeness

Next two tables present, which sources of pollution in emission inventory are not estimated (see Table 1.6) or are included elsewhere (see Table 1.7).

Table 1.6 Sources not estimated (NE)

NFR19 code	Substance(s)	Reason for not estimated
1A1c	Se	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A2gvii	Hg, As, PCDD/F, B(k)f, I(1,2,3-cd)p	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3ai(i)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3aii(i)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023

Return to the Table of Contents

NFR19 code	Substance(s)	Reason for not estimated
1A3ai(ii)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3aii(ii)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3bv	POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3bvi	PCDD/F, HCB, PCB	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3c	Pb, Hg, As, PCDD/F	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3dii	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A4aii	Hg, As, PCDD/F, B(k)f, I(1,2,3-cd)p	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A4bii	Hg, As, PCDD/F, B(k)f, I(1,2,3-cd)p	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A4cii	Hg, As, PCDD/F, B(k)f, I(1,2,3-cd)p	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A4ciii	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1A3di(i)	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1B1c	BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1B2c	NH_3,	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
1B2av	SO_2	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2B10a	SO_2	No data
2C1	NH_3,, Se, PAHs, HCB	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2D3a	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2023
2D3e	$PM_{2.5}$	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2D3f	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2023
2D3g	NO_x, SO_2, $PM_{2.5}$, PM_{10}, BC, HMs (exc. Cr, Zn), PCDD/F, PAHs, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2D3h	$PM_{2.5}$, BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2D3i	NO_x, SO_2, $PM_{2.5}$, PM_{10}, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
2G	HCB, PCBs	Emission have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
3Df	HCB	Emissions have not been estimated due to lack of activity data for the previous years
5A	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
5B1	NO_x, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
5B2	NH_3, BC	NH_3 emissions have not been estimated due to lack of activity data. BC emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
5C1bi	Cr, Cu, Se, Zn, PCDD/F, PAHs	Cr, Cu, Se, Zn, PAHs Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023. PCDD/F emissions have not been estimated due to lack of activity data
5C1bii	NH_3, Se, Zn, PAHs (exc. PAHs Total)	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2023
5C1biii	Se, Zn, PAHs (exc. PAHs Total)	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2023
5C1bv	BC	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2023
5C2	NH_3, HMs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023 and in document "Review of emission factors for incident fires were used for calculation (Science report: SC060037/SR3, UK Environment Agency)"
5D1	$PM_{2.5}$, PM_{10}, TSP, BC, HMs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023

NFR19 code	Substance(s)	Reason for not estimated
5D2	$PM_{2.5}$, PM_{10}, TSP, BC, HMs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023
5E	NO_x, BC, CO, Ni, Se, Zn, PAHs (exc. PCDD/F), HCB, PCB	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2023

Table 1.7 Sources included elsewhere (IE)

NFR19 code	Substance(s)	Included under NFR code
1A5a	All	1A4ai
1A5b	All	1A4aii
2A1	All substances, excluding particulates	1A2f
2A2	All substances, excluding particulates	1A2f
2A3	All substances, excluding particulates	1A2f
3B4giii	NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TSP	3B4giv
3Da2a	NMVOC	3B
3Da3	NMVOC	3B
5C1a	All (2013-2019)	1A1a
5C1biii	NO_x, NMVOC, SO_x, PMs, BC, CO, Cu (2008-2022)	5C1bii
5D2	NMVOC (1994-2007)	5D1

ource: http://coachespanel.com.au/

2. POLLUTANT EMISSION TRENDS

[Return to the Table of Contents]

Estonia has been reporting data regarding the total and sectoral national emissions under the LRTAP Convention since 2000.

Estimates are available as follows:

- NO_x, SO_2, NH_3, NMVOC, CO, TSP: 1990–2022;
- PM_{10}, $PM_{2.5}$ and BC: 2000–2022
- All Heavy Metals: 1990–2022;
- POPs: 1990–2022.

2.1. Main pollutants emission trends (SO_2, NO_x, NMVOC, NH_3, CO)

This chapter describes the changes in emissions of major substances from 1990 to 2022. Emissions of all substances decreased significantly over the entire period (see Table 2.1, Figures 2.1-2.3). Information for each substance separately, as well as key sources and the reasons for the decrease are described below.

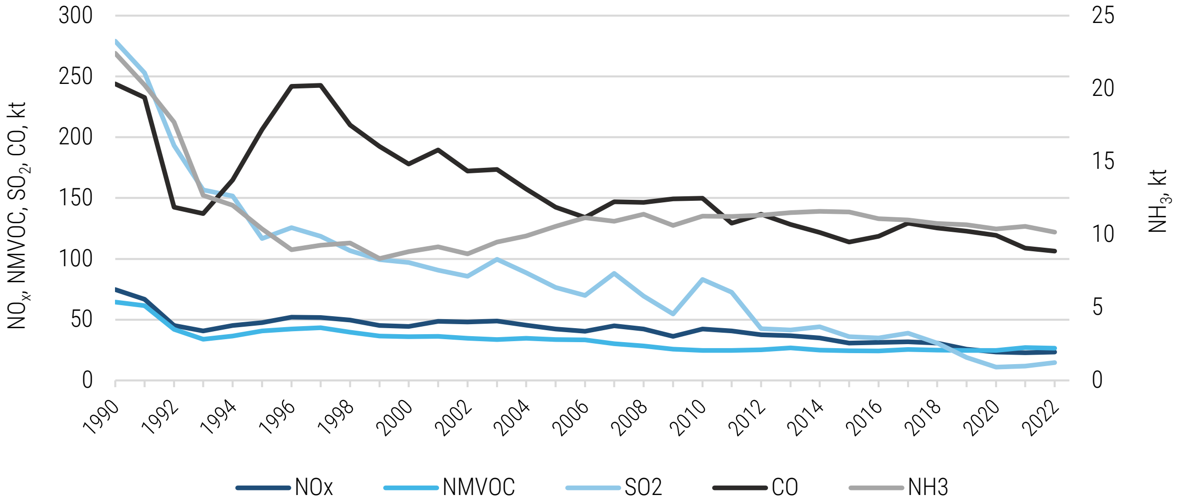


Figure 2.1 Main pollutants emissions trends in the period 1990-2022, kt

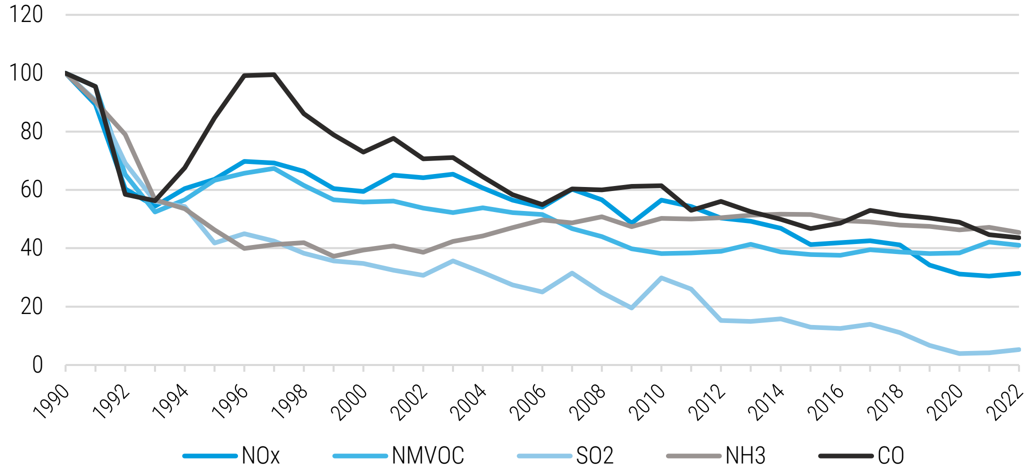


Figure 2.2 Indexed of main pollutants emissions (1990=100) in the period 1990-2022

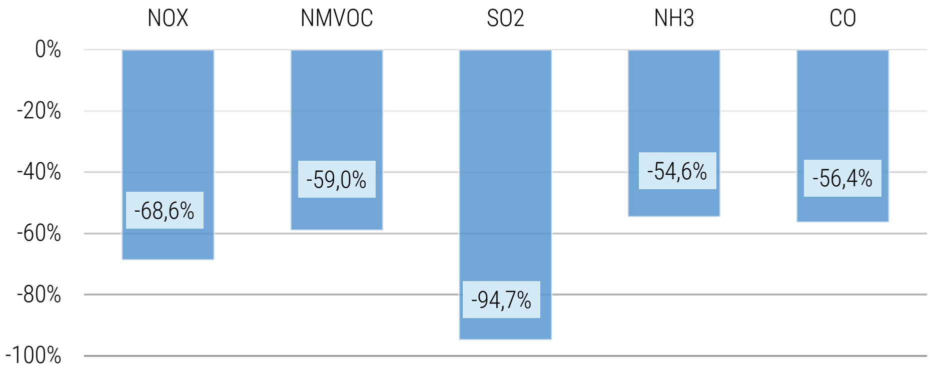


Figure 2.3 Reduction of main pollutants emissions in the period 1990-2022

Table 2.1 Main pollutant emissions in the period of 1990–2022 (kt)

Year	NO$_x$	NMVOC	SO$_2$	NH$_3$	CO
1990	74.716	64.444	279.020	22.420	243.877
1991	66.743	61.509	252.998	20.233	232.746
1992	45.103	42.093	193.170	17.707	142.526
1993	40.686	33.796	156.547	12.686	137.343
1994	45.209	36.510	151.595	11.998	164.940
1995	47.517	40.824	116.759	10.372	206.498
1996	52.113	42.319	125.567	8.962	241.892
1997	51.739	43.418	118.489	9.261	242.539
1998	49.596	39.644	106.720	9.409	209.997
1999	45.154	36.462	99.456	8.352	192.386
2000	44.450	35.962	97.065	8.831	177.880
2001	48.649	36.197	90.613	9.158	189.422
2002	47.971	34.646	85.660	8.672	172.308
2003	48.867	33.687	99.596	9.484	173.442
2004	45.364	34.705	88.515	9.906	157.386
2005	42.230	33.674	76.551	10.547	142.444
2006	40.454	33.223	69.851	11.156	133.987
2007	44.989	30.095	87.907	10.911	147.035
2008	42.330	28.387	69.310	11.382	146.491
2009	36.357	25.673	54.608	10.634	149.245
2010	42.201	24.642	83.142	11.270	149.846
2011	40.604	24.775	72.498	11.228	129.246
2012	37.668	25.086	42.581	11.319	136.768
2013	36.814	26.688	41.590	11.503	128.181
2014	35.001	24.961	44.013	11.579	121.716
2015	30.810	24.382	36.085	11.555	113.874
2016	31.322	24.236	35.037	11.088	118.544
2017	31.830	25.462	38.850	10.987	129.340
2018	30.713	24.963	30.814	10.754	125.275
2019	25.619	24.625	18.801	10.659	122.710
2020	23.283	24.771	10.950	10.388	119.250
2021	22.761	27.131	11.745	10.568	108.824
2022	23.426	26.452	14.663	10.173	106.350
Change 1990-2022, %	-68.6	-59.0	-94.7	-54.6	-56.4
Change 2005-2022, %	-44.5	-21.4	-80.8	-3.5	-25.3
Change 2021-2022, %	2.9	-2.5	24.8	-3.7	-2.3

2.1.1. Sulphur Dioxide

During the period of 1990–2022, the emissions of sulphur dioxide had decreased by 94.7%, which was largely influenced by a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 277 PJ in 1990 to 123 PJ in 2022) (see Figure 2.3 and 2.4, Tables 2.1 and 2.2). The latter, in turn, was the result of a restructuring of the economy. Likewise, the export possibilities regarding electricity have also decreased noticeably.

The use of local fuels (including wood, oil shale oil) and natural gas has been constantly increasing since 1993, while the relevance of heavy fuel oil in the production of thermal energy has reduced.

The use of fuel with lower sulphur content was also the reason for a decrease in SO_2 emissions (with regard to fuel for road transport and heating). Other reasons for the decrease in emissions are given below.

Table 2.2 SO_2 emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	5 Waste	Total
1990	235.31	29.39	9.21	3.21	1.86	0.04	0.000	0.004	279.02
1995	99.35	10.64	3.36	2.59	0.79	0.02	0.000	0.006	116.76
2000	89.01	2.66	2.41	2.55	0.36	0.02	0.042	0.007	97.07
2005	71.93	2.79	1.29	0.06	0.31	0.02	0.132	0.005	76.55
2010	81.22	1.12	0.62	0.01	0.11	0.03	0.032	0.012	83.14
2015	35.09	0.39	0.51	0.01	0.02	0.03	0.003	0.025	36.08
2016	34.18	0.33	0.42	0.01	0.02	0.03	0.002	0.045	35.04
2017	38.24	0.19	0.34	0.01	0.03	0.03	0.002	0.004	38.85
2018	30.13	0.20	0.33	0.01	0.03	0.03	0.002	0.072	30.81
2019	17.70	0.63	0.33	0.01	0.02	0.03	0.002	0.076	18.80
2020	10.17	0.44	0.27	0.01	0.02	0.02	0.001	0.014	10.95
2021	11.14	0.29	0.26	0.01	0.02	0.02	0.002	0.014	11.74
2022	14.01	0.29	0.30	0.01	0.02	0.02	0.002	0.011	14.66
Share in total 1990 emission, %	84.3	10.5	3.3	1.2	0.7		0.0	0.0	
Share in total 2022 emission, %	95.5	2.0	2.1	0.1	0.1	0.1	0.0	0.1	
Change 1990-2022, %	-94.0	-99.0	-96.7	-99.8	-98.9	-49.8	502.9	184.5	-94.7
Change 2021-2022, %	25.8	-0.5	17.6	19.4	9.9	16.5	17.4	-20.6	24.8

Return to the Table of Contents

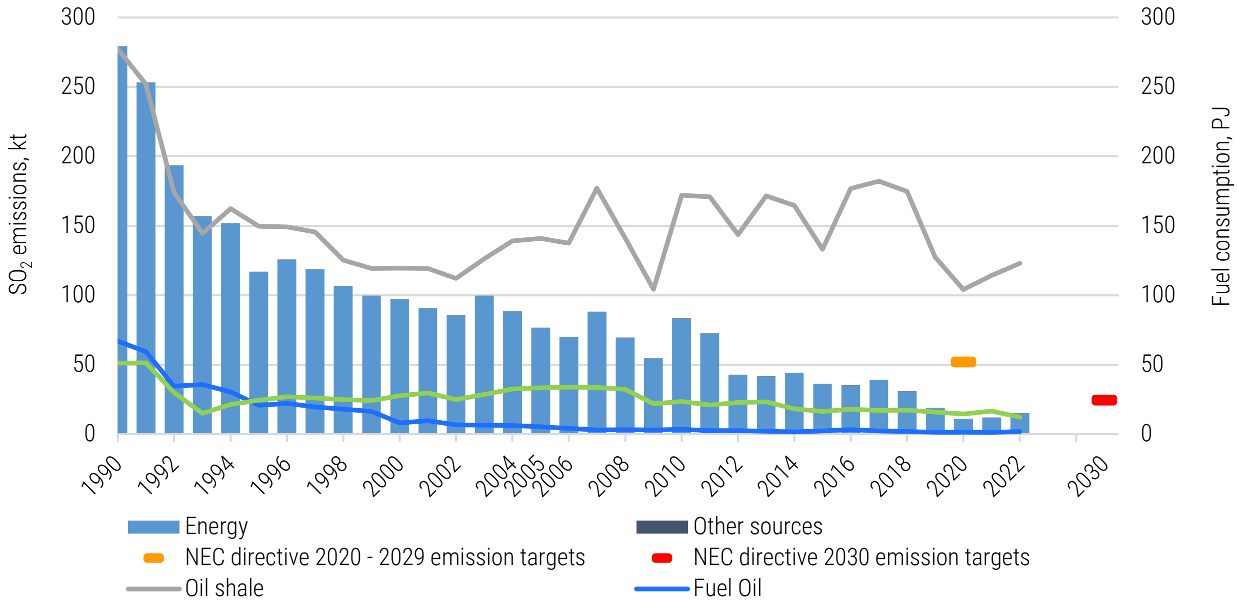


Figure 2.4 SO_2 emissions in the period of 1990–2022 and NEC directive 2016/2284 targets

The main reason for the drop in emissions since 2004 is the launch of two new boilers at the Narva Power Plants (PP). The boilers, which are based on circulating fluidized bed (CFB) technology, have significantly reduced SO_2 emissions. Emissions have also been considerably reduced by shutting down the old blocks.

A number of additional measures to reduce SO_2 emissions have been implemented over the past decade.

Unique sulphur scrubbers designed in the course of five years of research and development were installed in the Narva PP on four energy production units of the Eesti PP in 2012. The semi-dry NID (Novel Integrated Desulphurisation) technology, which uses the fly ash in the gas itself, does not require any additional compounds to bind the SO_2. With regard to the energy units which have not been equipped with the clearing equipment, alternative methods are used for reducing SO_2 emissions, such as water injection to furnaces of PC (old pulverised combustion boilers). Water injection lowers the flame temperature and thus improves conditions for sulphur capture with limestone included in oil shale. All these solutions mean that these filter-equipped units will meet the tighter limits on sulphur emissions in flue gases. Measures have also been taken to reduce nitrogen emissions. These scrubbers also reduce the solids content of the flue gases.

According to the Resolution of the Riigikogu General Principles of Climate Policy until 2050 Estonia will be a competitive economy with low carbon dioxide emissions. Various measures are provided in the national programs to prevent climate change and reduce emissions into the atmosphere, the energy development program, one of which is the steady decline in the share of oil shale energy, as the main source of greenhouse gases and other substances polluting the atmosphere. In addition to the early measures taken, in spring 2020, 3 power units at the Enefit Power AS oil shale Estonian Power Plant were closed and one unit at the Baltic power plant was not operating from 2020.

In 2022, SO_2 emissions had increased by about 24.8% when compared to 2021's figures.

2021 was the year of economic recovery after the COVID-19 pandemic, which caused an increase in energy consumption. However, the war against Ukraine launched by Russia in February 2022 caused an energy crisis in Europe, which used to be highly dependent on cheap natural gas imports from Russia. The crisis was aggravated by Russia's cessation of electricity exports to Finland and the Baltic countries. This has led to an increase in electricity production from oil shale (about 47% more than in 2021), which in turn has led to an increase in SO2 emissions. Another reason is the failure of power plants in nearby countries. The export of electricity has increased in the same period by 31%. The cold winter also caused an increase in heat production by 4.7%.

The share of energy sector, including mobile sources, in total SO_2 emission is 99.9%; the combustion in energy industry (NFRs 1A1a-c) is responsible for about 95.5% of total emissions in 2022 (see Table 2.2 and Figure 2.5). The share of SO_2 emissions from the three large oil shale plants – Narva PP (Eesti, Balti and Auvere PPs) – accounts for approximately 42.1% of total SO_2 emissions. The large contribution (29.8% in total emission) is made by Kiviõli Keemiatööstuse AS, in the boilers of which generator gas is burned (secondary fuel in the production of shale oil).

The share of manufacturing industries and non-industial combustion sector in 2022 were approximately the same and amounted to 2%.

In 1990 the main polluters of SO_2 were combustion in energy industries (84.3%) and combustion in manufacturing industries (10.5%). In 2022, the dominant source was the same – energy industries, but share of industrial combustion has decreased to 2%, which is mostly due to the cessation of cement production, as well as a significant decrease in the use of solid and liquid fuels (see Table 2.2 and Figure 2.5). The share of mobile sourcesis very small, only 0.2%.

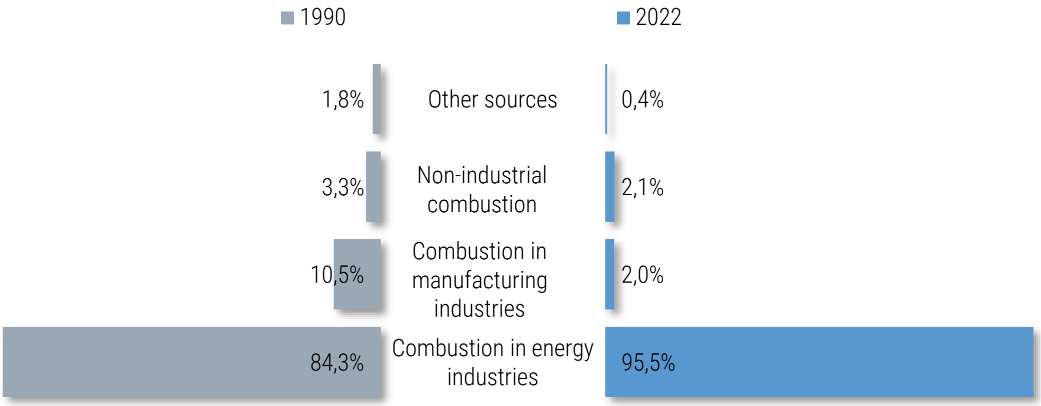


Figure 2.5 SO_2 emissions by sources of pollution in 1990 and 2022

According to the new NEC directive 2016/2284, the Member States should comply with the emission reduction commitments set out in this directive. Estonia fulfilled the requirements of the directive and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of sulphur dioxide emissions by 32% relative to 2005 baseline emissions by 2020, already in 2012. SO_2 emissions decreased by 80.8% in 2022 compared to 2005 (see Table 2.3).

Table 2.3 SO_2 emission and NEC directive 2016/2284 emission targets

National total for compliance calculations and checks (NECD)		Change 2005-2022, %	2020-2029 emission targets		2030 emission targets	
2005	2022		%	Emission, kt	%	Emission, kt
76.551	14.663	-80.8	32	52.055	68	24.496

Return to the Table of Contents

2.1.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 68.6% compared to 1990 (see Figure 2.6, Tables 2.1 and 2.4). The reduction is mainly due to the decrease in energy production and changes in fuel consumption in the transport sector during the period of 1990–1993 (the consumption of petrol by road transport dropped 54% at this time and diesel by 37%). The increasing share of catalyst cars in more recent years was also a contributing factor to the reduction of NO_x emissions. Also, one of Eesti Energia's major achievements over the past years is the desulphurisation and denitrification systems that were added to the older energy production units of the Narva Power Plants that use pulverised combustion technology, owing to which the sulphur and nitrogen emissions have decreased by three and almost two times, respectively.

The energy industry sector and road transport are the main sources of nitrogen oxide emissions – 30.7% and 24.9% respectively, the share of non-industrial combustion – 20.9% and agriculture was 11% in 2022 (see Table 2.4 and Figure 2.7).

Table 2.4 NO_x emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	24.74	6.05	5.29	25.53	8.03	0.11	0.20	4.75	0.02	74.72
1995	13.13	2.66	10.14	15.73	3.98	0.06	0.07	1.72	0.03	47.52
2000	12.30	2.58	8.38	14.24	5.02	0.07	0.20	1.63	0.04	44.45
2005	12.18	1.91	6.18	13.28	6.76	0.09	0.18	1.62	0.02	42.23
2010	15.36	1.59	7.31	9.72	6.03	0.12	0.04	2.01	0.03	42.20
2015	9.50	1.20	5.38	8.30	3.82	0.15	0.05	2.38	0.02	30.81
2016	10.94	0.90	5.54	7.91	3.43	0.14	0.05	2.38	0.03	31.32
2017	11.56	1.24	5.45	7.52	3.40	0.17	0.06	2.42	0.03	31.83
2018	10.88	1.31	5.35	7.21	3.23	0.17	0.06	2.48	0.02	30.71
2019	7.21	0.97	5.04	6.91	2.70	0.12	0.07	2.57	0.03	25.62
2020	6.02	0.49	5.07	6.42	2.53	0.07	0.07	2.58	0.04	23.28
2021	6.14	0.38	4.83	6.31	2.16	0.07	0.07	2.78	0.02	22.76
2022	7.19	0.36	4.89	5.83	2.39	0.10	0.07	2.58	0.02	23.43
Share in total 1990 emission, %	33.1	8.1	7.1	34.2	10.7	0.1	0.3	6.4	0.03	
Share in total 2022 emission, %	30.7	1.5	20.9	24.9	10.2	0.4	0.3	11.0	0.1	
Change 1990-2022, %	**-70.9**	**-94.0**	**-7.6**	**-77.2**	**-70.3**	**-7.5**	**-62.6**	**-45.7**	**-16.2**	**-68.6**
Change 2021-2022, %	**17.0**	**-3.8**	**1.1**	**-7.6**	**10.5**	**41.4**	**13.0**	**-7.3**	**-15.0**	**2.9**

In 2022, NO_x emissions increased by 2.9% compared to 2021 levels, mainly as a result of increased capacity of shale power plants, as well as increased emissions from other mobile sources.

At the same period the NO_x emission from road transport decreased by 7.6%, mainly by the stricter emission standards for new vehicles categories. This means that new technologies have been introduced gradually and the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage).

Emissions from the agriculture sector have decreased by 7.3% due to the decrease in fertilizer use. Although the use of emission reduction technologies also increased at the same time, the impact of the increase in fertilizer use was greater.

Return to the Table of Contents

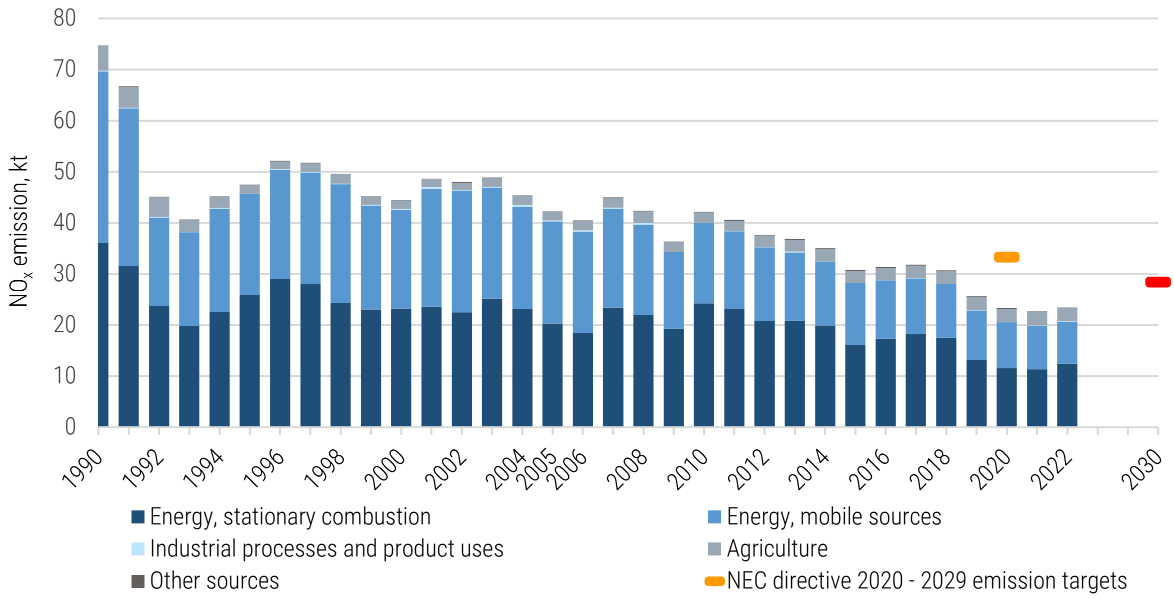


Figure 2.6 NO_x emissions in the period of 1990–2022 and NEC directive 2016/2284 targets

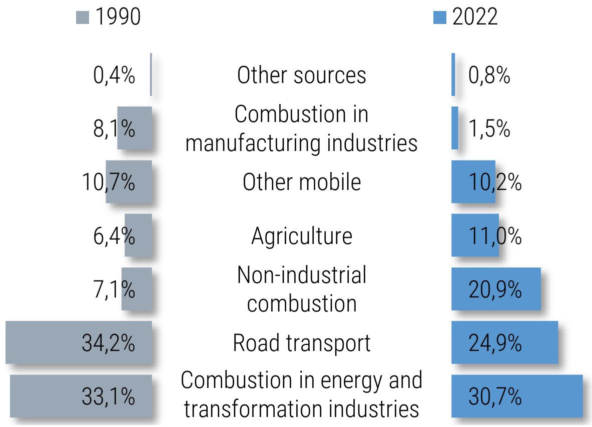


Figure 2.7 NO_x emissions by sources of pollution in the period of 1990 and 2022

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of nitrogen oxides emissions by 18% relative to 2005 baseline emissions by 2020, already in 2015. NO_x emissions decreased by 48.7% in 2022 compared to 2005 (see Table 2.5). It should be noted that the data for 2005 and 2022 in the Tables 2.1, 2.4 and Figure 2.6 include emissions from agriculture (National total for compliance calculations and checks (CLRTAP), in the Table 2.7 data in accordance with the National total for compliance calculations and checks (NECD).

Table 2.5 NO_x emission and NEC directive 2016/2284 emission targets

National total for compliance calculations and checks (NECD)		Change 2005-2022, %	2020-2029 emission targets		2030 emission targets	
2005	2022		%	Emission, kt	%	Emission, kt
40.607	20.846	-48.7	18	33.297	30	28.425

Return to the Table of Contents

2.1.3. Non-Methane Volatile Organic Compounds

The total emissions of non-methane volatile organic compounds decreased by 59% between 1990 and 2022 (see Tables 2.1 and 2.6, Figure 2.8).

Table 2.6 NMVOC emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	1.58	0.28	6.31	17.41	2.54	2.47	23.74	9.96	0.15	64.44
1995	1.08	0.35	8.74	10.92	0.68	1.63	12.30	4.90	0.22	40.82
2000	1.08	0.28	6.77	8.88	1.09	4.33	9.61	3.68	0.26	35.96
2005	1.91	0.44	4.88	5.31	1.08	4.20	11.53	4.16	0.17	33.67
2010	2.43	0.31	5.61	3.07	0.80	1.40	6.77	4.09	0.17	24.64
2015	2.57	0.26	3.88	1.63	0.66	1.14	9.44	4.70	0.11	24.38
2016	2.71	0.07	3.94	1.57	0.71	1.17	9.46	4.49	0.13	24.24
2017	2.86	0.06	3.87	1.36	0.70	1.08	10.54	4.87	0.13	25.46
2018	3.11	0.18	3.79	1.27	0.54	1.04	10.16	4.76	0.12	24.96
2019	2.79	0.26	3.55	1.22	0.53	0.79	10.88	4.48	0.12	24.63
2020	2.97	0.10	3.58	0.98	0.44	0.85	11.10	4.63	0.13	24.77
2021	2.59	0.06	3.40	0.86	0.35	0.78	14.15	4.82	0.12	27.13
2022	2.51	0.06	3.46	0.72	0.38	0.72	13.70	4.78	0.11	26.45
Share in total 1990 emission, %	2.5	0.4	9.8	27.0	3.9	3.8	36.8	15.5	0.2	
Share in total 2022 emission, %	9.5	0.2	13.1	2.7	1.4	2.7	51.8	18.1	0.4	
Change 1990-2022, %	**58.9**	**-77.5**	**-45.1**	**-95.9**	**-85.1**	**-71.0**	**-42.3**	**-52.0**	**-25.3**	**-59.0**
Change 2021-2022, %	**-3.0**	**12.6**	**1.9**	**-16.1**	**6.8**	**-7.7**	**-3.2**	**-0.7**	**-8.1**	**-2.5**

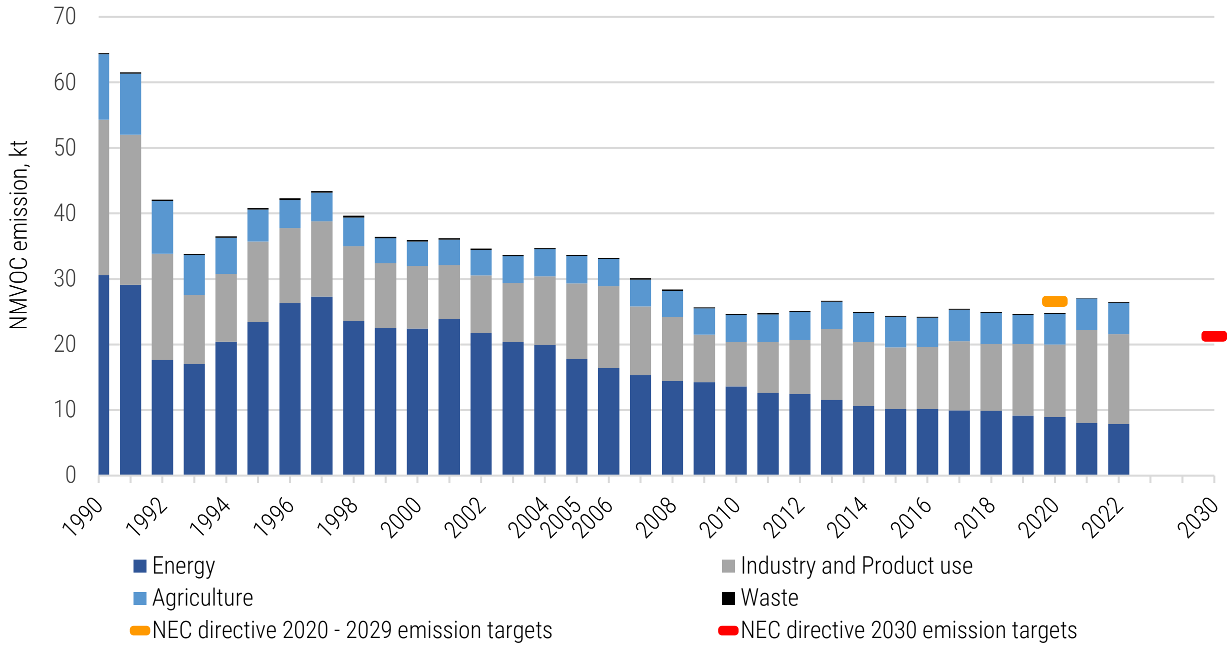


Figure 2.8 NMVOC emissions in the period of 1990–2022 and NEC directive 2016/2284 targets

The decline in emissions since 1990 has primarily been due to reductions that have been achieved in the road transport sector due to the introduction of catalytic converters on vehicles to reduce exhaust emissions, and carbon canisters on petrol-driven cars for evaporative emission control. These reductions have been driven by tighter vehicle emission standards, combined with limits on the maximum volatility of petrol. Also, reductions in NMVOC emissions have been enhanced by switching from petrol to diesel cars.

Secondly, during the period of 1990–2022, the production of chemical products fell. Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. These are the results of the increasing tendency towards wood and wood waste combustion (the NMVOC emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion).

In 1990, the main polluters of NMVOC were industrial processes and product uses (36.8%) and mobile sources (31%, of which road transport – 27%). In 2022, the dominant source was the same – industrial processes and product uses sector (51.8%, from which solvent and other product use sector is 48%); agriculture (18.1%); contribution of stationary combustion has increased from 12.7% to 22.8% and share of mobile sources has decreased from 31% to 4.2% (see Table 2.6 and Figure 2.9).

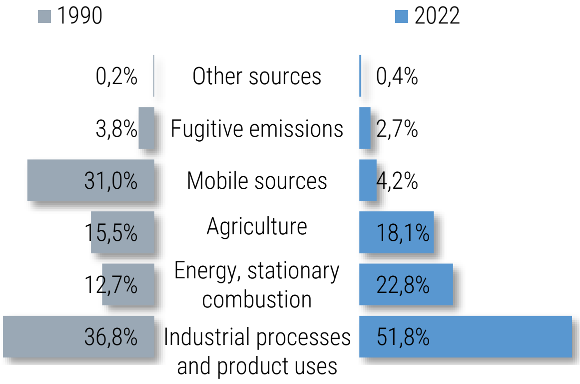


Figure 2.9 NMVOC emission by sources of pollution in 1990 and 2022

Total emissions of NMVOC in 2022 decreased by 2.5% compared to 2021 (see Table 2.6).

The main reason for the reduction in emissions is the decrease in consumption of domestic (9.5%) and other solvents use (21.6%, mainly cleaning products and adhesive). Emissions from printing also fell (25.5%) as a result of the decrease in the amount of chemicals used.

The decrease in shale oil production at the Enefit 140 unit at the Eesti Energia plant was the reason for a slight decrease in NMVOC emissions in the energy industries sector (3%). Another reason was a decrease in the consumption of biomass and peat.

A small increase of NMVOC emissions from non-industrial combustion sector by about 2% when compared to 2021's figures, was mainly due to a increase of solid biomass combustion in domestic sector.

During the same period, NMVOC emissions from road transport decreased by 16.1%, mainly due to decrease in annual mileage and increase newer cars.

A increase (6.8%) in NMVOC emissions from other mobile sources took place due to a increase in fuel consumption during that period in household/gardening and agriculture sectors.

In 2022, the consumption of biomass as well as liquid fuels by industrial boilers increased, which was the reason for the increase in NMVOC emissions in this sector (12.6%). The termination of clinker production has also had a significant impact in the last years (starting from 2020 clicker for cement production is imported from Sweden).

Emissions from the agriculture sector remained almost at 2021 levels.

The decrease in NMVOC emissions from terminals and gasoline distribution have contributed to a reduction in emissions (about 7.7%) in the Fugitive emissions sector.

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of non-methane volatile organic compounds emissions by 10% relative to 2005 baseline emissions by 2020, already in 2009. NMVOC emissions decreased by 26.6% in 2022 compared to 2005 (see Figure 2.8 and Table 2.7). It should be noted that the data for 2005 and 2022 in the Tables 2.1, 2.6 and Figure 2.8 include emissions from agriculture (National total for compliance calculations and checks (CLRTAP), in the Table 2.7 data in accordance with the National total for compliance calculations and checks (NECD).

Table 2.7 NMVOC emission and NEC directive 2016/2284 emission targets

National total for compliance calculations and checks (NECD)		Change 2005-2022, %	2020-2029 emission targets		2030 emission targets	
2005	2022		%	Emission, kt	%	Emission, kt
29.513	21.667	-26.6	10	26.562	28	21.249

2.1.4. Ammonia

Total NH_3 emissions decreased by 54.7% between the years 1990 to 2022 due to a reduction in the number of animals and the use of fertilisers (see Table 2.8 and Figure 2.10). Livestock manure management and use of mineral fertiliser are the main sources of pollution regarding ammonia (93.2% in 2022).

Stationary fuel combustion activity is responsible for 2.9% of total emissions. Between 1990 and 2022, shale oil production at the Enefit 140 plant, which is the main source of ammonia emissions, increased by almost four times, leading to a significant increase in emissions in this sector. Increasing biomass combustion also played a role in increasing ammonia emissions from this sector by almost 181%.

Transport emissions of NH_3 have increased approximately five times during the period between 1990-2022. In detail, the majority of NH_3 emissions is emitted from road transport. Ammonia is not created in significant quantities during typical combustion in a gasoline powered vehicle, but is an undesirable by-product of NO reduction on the catalyst surface which leads to ammonia in motor vehicle exhaust. Consequently, NH_3 emissions are low for older gasoline-powered vehicles and have since increased following the widespread use of three-way catalytic converters.

Waste sector (domestic waste water handling) account for 2% emissions, mobile sources makes up 1%. All other sectors (industry and product use, fugitive emissions from fuels) account for approximately 1% of total ammonia emissions (see Table 2.8 and Figure 2.11).

In 2022, NH_3 emissions decreased by about 3.7% when compared to 2021's figures, emissions from the agriculture sector have decreased due to the decrease in fertilizer use and the decrease in the number of swines by 10% and 14%, respectively. The number of swine has decreased due to simultaneous decrease in the market price of pork and the increase in the price of animal feed.

Table 2.8 NH_3 emissions by sector (kt), change in emissions and share in total emission

Year	Energy, stationary combustion	Mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	0.11	0.02	0.03	0.68	21.21	0.370	22.42
1995	0.18	0.03	0.02	0.30	9.54	0.310	10.37
2000	0.17	0.10	0.01	0.14	8.13	0.277	8.83
2005	0.20	0.20	0.01	0.22	9.66	0.249	10.55
2010	0.31	0.21	0.02	0.08	10.43	0.232	11.27
2015	0.28	0.15	0.01	0.08	10.82	0.219	11.55
2016	0.29	0.15	0.01	0.08	10.33	0.233	11.09
2017	0.27	0.15	0.01	0.09	10.24	0.223	10.99
2018	0.30	0.14	0.01	0.11	9.98	0.224	10.75
2019	0.31	0.14	0.01	0.10	9.89	0.211	10.66
2020	0.31	0.11	0.01	0.09	9.66	0.206	10.39
2021	0.28	0.10	0.01	0.11	9.87	0.207	10.57
2022	0.30	0.09	0.01	0.08	9.49	0.208	10.17
Share in total 1990 emission, %	0.5	0.1		3.1	94.6	1.6	
Share in total 2022 emission, %	2.9	0.9	0.1	0.8	93.2	2.0	
Change 1990-2022, %	**181.2**	**440.0**	**-70.8**	**-88.4**	**-55.3**	**-43.6**	**-54.6**
Change 2021-2022, %	**7.3**	**-2.5**	**-6.1**	**-27.4**	**-3.9**	**0.9**	**-3.7**

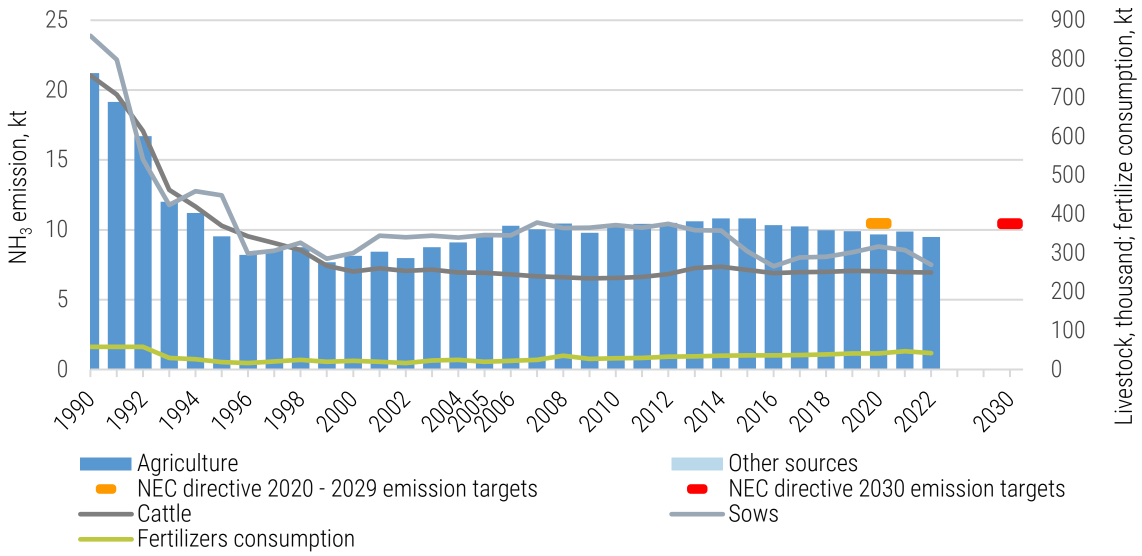


Figure 2.10 NH_3 emissions in the period of 1990–2022 and NEC directive 2016/2284 targets

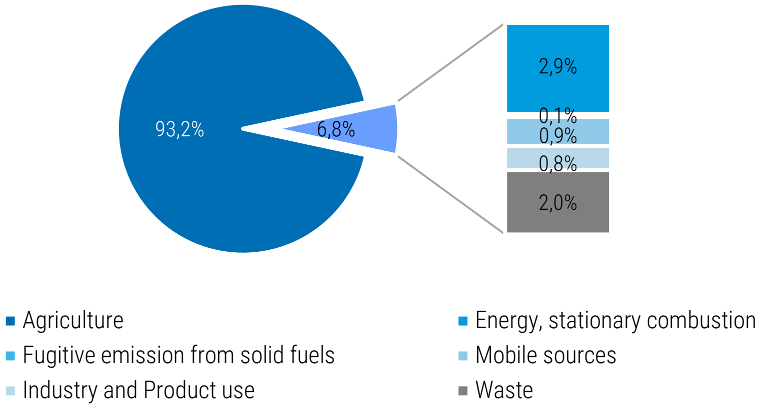


Figure 2.11 NH_3 emissions by sources of pollution in 2022

Return to the Table of Contents

According to the new NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, Estonia is obliged to reduce ammonia emissions by 2020 by 1% as compared with 2005.

In 2022, ammonia emissions decreased by 3.5% at the 2005 level. Technological innovations in the agricultural sector as well as environmental protection measures (eg duration and timing of manure application) have made an impact on agricultural emissions in recent years (see Table 2.9).

Table 2.9 NH_3 emission and NEC directive 2016/2284 emission targets

National total for compliance calculations and checks (NECD)		Change 2005-2022, %	2020-2029 emission targets		2030 emission targets	
2005	2022		%	Emission, kt	%	Emission, kt
10.547	10.173	-3.5	1	10.442	1	10.442

2.1.5. Carbon Monoxide

In the period of 1990–2022, the emissions of carbon monoxide decreased by 56.4%. That was, among other things, caused by the reduction in the use of vehicle fuels (especially from 1990 to 1992), and in recent years, by a decrease in the number of cars driving on petrol. The sharp increase in emissions from 1994 to 1996 is caused by a growth in the burning of wood in the household sector (see Table 2.10 and Figure 2.12).

Table 2.10 CO emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	5 Waste	Total
1990	18.57	3.57	72.65	117.70	30.01	0.49	0.57	0.32	243.88
1995	15.28	3.12	120.91	62.80	3.52	0.28	0.15	0.44	206.50
2000	15.60	1.96	95.65	57.31	5.94	0.29	0.64	0.48	177.88
2005	23.06	2.15	69.67	40.41	6.06	0.39	0.51	0.20	142.44
2010	34.51	1.78	83.90	23.95	4.52	0.51	0.53	0.14	149.85
2015	34.34	0.76	59.27	12.76	5.49	0.65	0.51	0.08	118.54
2016	34.61	0.37	60.93	12.72	8.74	0.61	0.49	0.08	129.34
2017	47.01	0.65	60.19	11.31	8.81	0.73	0.56	0.08	129.34
2018	46.90	1.48	59.28	10.49	5.67	0.73	0.65	0.08	125.27
2019	47.96	1.15	55.78	10.03	6.47	0.51	0.73	0.08	122.71
2020	50.52	0.51	56.32	7.55	3.24	0.31	0.72	0.08	119.25
2021	44.62	0.12	53.84	6.68	2.44	0.31	0.74	0.08	108.82
2022	42.15	0.12	55.10	5.45	2.26	0.44	0.76	0.07	106.35
Share in total 1990 emission, %	7.6	1.5	29.8	48.3	12.3	0.2	0.2	0.1	
Share in total 2022 emission, %	39.6	0.1	51.8	5.1	2.1	0.4	0.7	0.1	
Change 1990-2022, %	**127.0**	**-96.6**	**-24.2**	**-95.4**	**-92.5**	**-11.7**	**33.4**	**-77.0**	**-56.4**
Change 2021-2022, %	**-5.5**	**-1.3**	**2.4**	**-18.5**	**-7.4**	**39.1**	**3.0**	**-2.4**	**-2.3**

CO emissions from transport have declined over the past two decades. The introduction of catalytic converters and progressively stricter Euro emission standards are the main factors behind these reductions. However, the reductions have been accompanied by a shift from petrol to diesel-powered cars and the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage). These serve as additional reasons for CO emissions declining by 18.5% in the road transport sector in 2022 when compared to the previous year.

Carbon monoxide emissions in the other mobile sector have decreased by about 92.5% between 1990 and 2022 due to a significant decrease in petrol consumption.

Return to the Table of Contents

In 1990, the main polluters of carbon monoxide were road transport (48.3%), while in 2022, the dominant source was non-industrial combustion (50.6%) (see Figure 2.13). Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. These are the results of the increasing tendency towards wood and wood waste combustion (the CO emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion). The share of the energy industries sector increased at the same period from 7.6% to 38.7%, mainly due to an increase in shale oil production in Enefit Energiatootmine AS (Eesti Energia Oil Industry plant). This was the main reason for the 127% increase of CO emissions from the energy industries sector in the period 1990–2022.

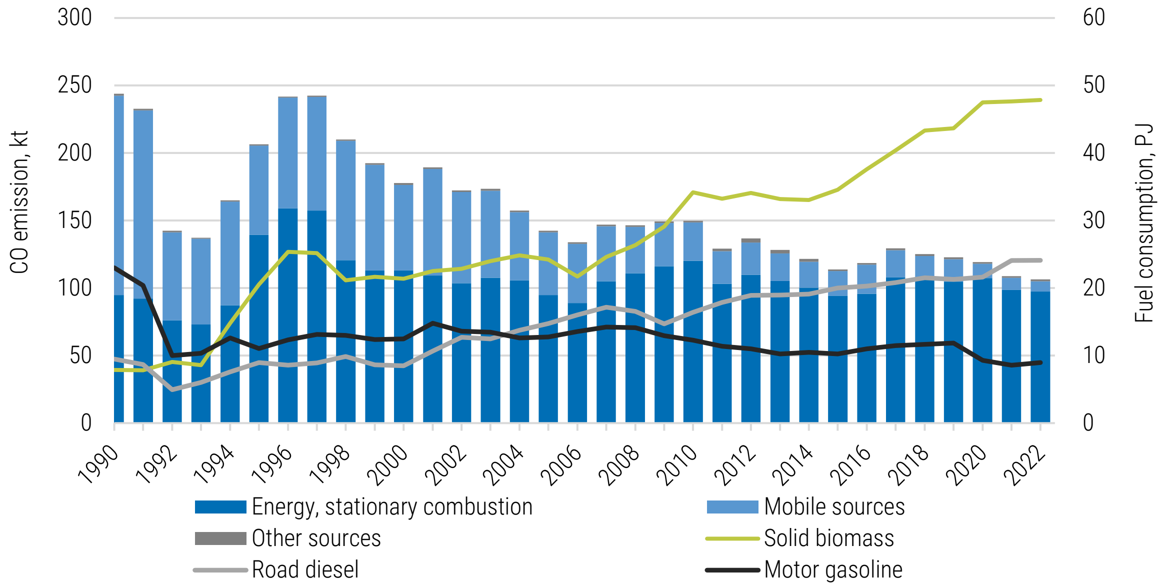


Figure 2.12 CO emissions in the period of 1990–2022

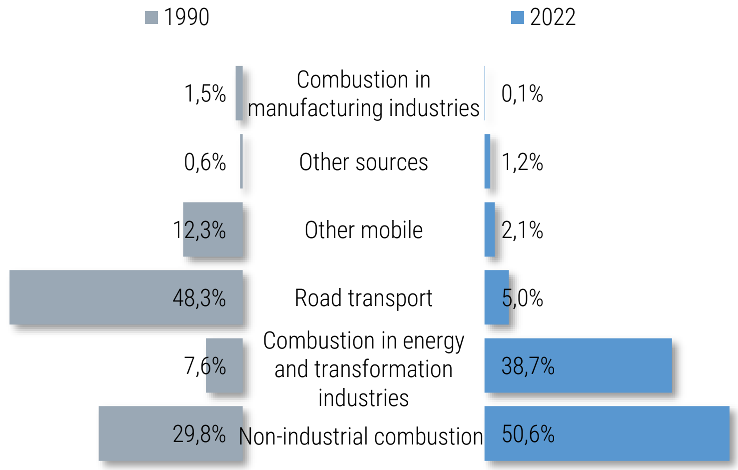


Figure 2.13 CO emissions by sources of pollution in 1990 and 2022

In 2022, carbon monoxide emissions decreased by 2.1% in comparison to 2021. During this period an decrease was observed in emissions in all combustion-related sectors. For example, carbon monoxide emissions have decreased in energy industries by 5.5% due to a decrease in the production of shale oil at the Solid Heat Carrier Plant facilities.

In 2022, CO emissions from other mobile sources decreased by 7.4% compared to 2021. In general, emissions factors for CO have a great deal of difference when a comparison is made between diesel and petrol fuels and therefore total CO emissions are mostly influenced by the amount of petrol consumed. A decrease in CO emissions has occurred also due to the gradual penetration of new engine technologies that are used by non-road working machinery which have significantly smaller emission factors compared to older machinery.

A small increase of CO emissions from non-industrial combustion sector by about 2.4% when compared to 2021's figures, was mainly due to a increase of solid biomass combustion in domestic sector.

The increase in emissions in the Fugitive emission sector by 39% is due to the increase in blasting in open oil shale mining.

In 2022, the biggest polluters of CO were combustion in the non-industrial sector (about 50.6%, from which a large part is wood combustion in the domestic sector), combustion in the energy and transformation industries (38.7%, mainly from shale oil production industry) and road transport – 5% (see Figure 2.13).

2.2. Particulates (TSP, $PM_{2.5}$, PM_{10}, BC)

This chapter describes the changes in emissions of TSP from 1990 to 2022 and $PM_{2.5}$, PM_{10} and BC from 2000 to 2022. Emissions of all substances decreased significantly over the entire period (see Table 2.11, Figures 2.14 - 2.16). The information for each substance separately, as well as key sources and the reasons for the decrease, are described below.

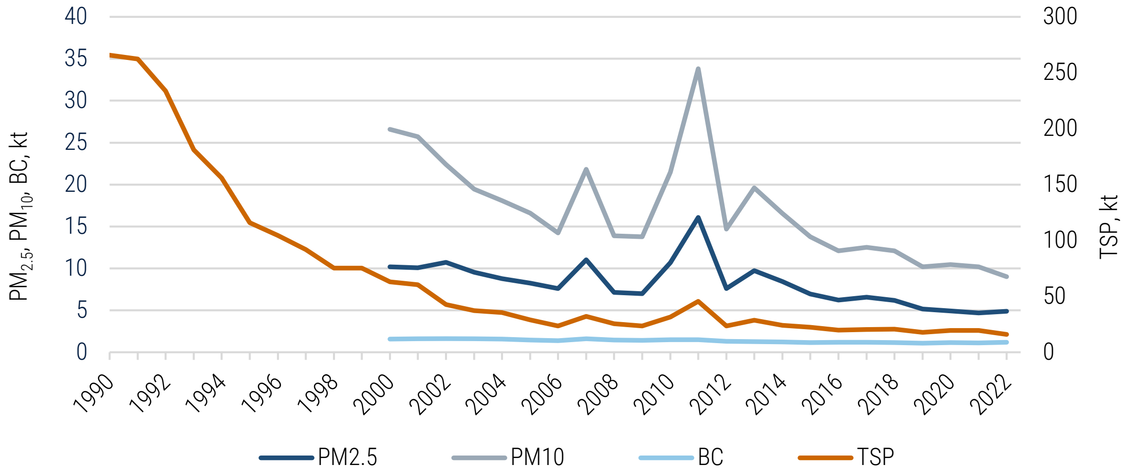


Figure 2.14 Particulates emissions trends in the period 1990-2022, kt

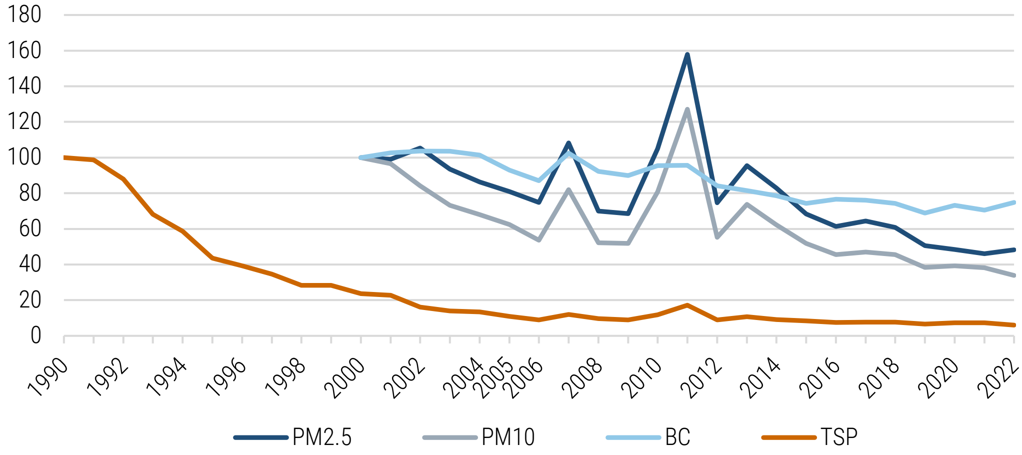


Figure 2.15 Indexed of particulates emissions (1990=100) in the period 1990-2022

Table 2.11 Particulates emissions in the period 1990–2022 (kt)

Year	$PM_{2.5}$	PM_{10}	BC	TSP
1990	NR	NR	NR	265.73
1991	NR	NR	NR	262.36
1992	NR	NR	NR	233.77
1993	NR	NR	NR	181.18
1994	NR	NR	NR	155.78
1995	NR	NR	NR	115.97
1996	NR	NR	NR	104.33
1997	NR	NR	NR	91.89
1998	NR	NR	NR	75.32
1999	NR	NR	NR	75.22
2000	10.18	26.60	1.57	63.00
2001	10.08	25.69	1.61	60.49
2002	10.73	22.41	1.63	42.77
2003	9.53	19.46	1.62	37.26
2004	8.80	18.07	1.59	35.52
2005	8.24	16.61	1.46	28.86
2006	7.61	14.25	1.37	23.63
2007	11.01	21.81	1.61	32.04
2008	7.13	13.90	1.45	25.47
2009	6.98	13.77	1.41	23.62
2010	10.68	21.48	1.50	31.41
2011	16.08	33.81	1.50	45.50
2012	7.59	14.70	1.32	23.59
2013	9.72	19.61	1.28	28.58
2014	8.45	16.56	1.23	24.07
2015	6.96	13.78	1.17	22.44
2016	6.24	12.11	1.20	19.77
2017	6.57	12.52	1.19	20.32
2018	6.19	12.12	1.17	20.62
2019	5.15	10.19	1.08	17.77
2020	4.93	10.44	1.15	19.51
2021	4.69	10.18	1.11	19.46
2022	4.91	9.01	1.17	15.97
Change 2000-2022 (TSP 1990-2022), %	-51.8	-66.1	-25.1	-94.0
Change 2005-2022, %	-40.4	-45.7	-19.5	-44.7
Change 2021-2022, %	4.6	-11.4	6.2	-17.9

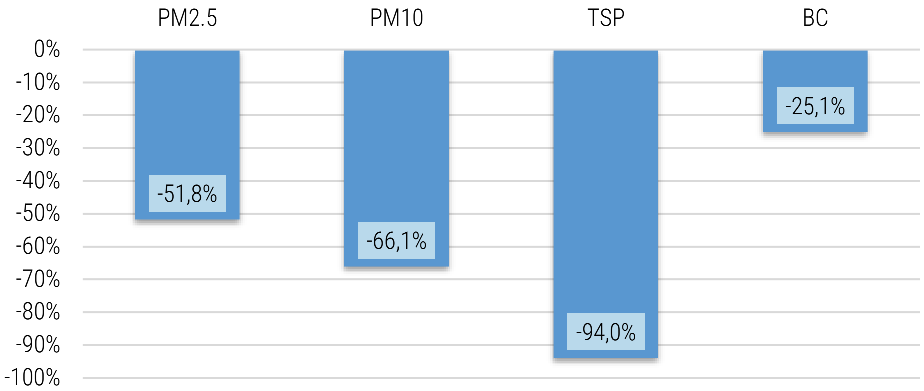


Figure 2.16 Reduction of TSP emissions in the period 1990-2022, $PM_{2.5}$, PM_{10} and BC in the period 2000-2022

2.2.1 Total suspended particulate matter (TSP)

In 1990–2022, TSP emissions dropped significantly – by 94% (see Table 2.12 and Figures 2.16, 2.17). This is due to the increase in the efficiency of combustion devices and cleaning installations (especially in oil shale power plants and the cement factory – from 1990 to 1998) as well as the decrease in electricity production. Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. The growth of TSP and fine particulates emission in 2010 resulted from the growth in electricity production at the same period. The significant growth of particulates emission in 2011 was due to the increase in electricity production by 34% in Balti PP (Enefit Power AS) and it is a result of bad operation of electric precipitators on two power units of this power plant.

Table 2.12 TSP emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	162.15	83.13	4.59	2.35	0.65	0.82	8.41	3.58	0.07	265.73
1995	72.71	32.13	4.14	1.72	0.22	0.49	2.22	2.26	0.09	115.97
2000	49.84	0.94	3.31	1.69	0.24	0.57	4.04	2.08	0.30	63.00
2005	11.69	0.78	2.52	2.38	0.30	0.81	8.28	1.89	0.21	28.86
2010	14.78	0.43	2.66	2.31	0.23	1.12	7.83	1.93	0.13	31.41
2015	5.30	0.26	2.08	2.49	0.15	1.45	8.27	2.23	0.20	19.77
2016	3.95	0.07	2.15	2.61	0.13	1.41	7.09	2.19	0.17	20.32
2017	4.35	0.06	2.17	2.69	0.13	1.67	6.94	2.16	0.14	20.32
2018	3.58	0.07	2.14	2.81	0.12	1.66	7.89	2.20	0.15	20.62
2019	2.32	0.08	2.00	2.85	0.10	1.14	6.92	2.24	0.14	17.77
2020	1.79	0.08	2.20	2.73	0.09	0.64	9.58	2.25	0.13	19.51
2021	1.35	0.04	2.21	2.75	0.07	0.66	9.97	2.27	0.13	19.46
2022	1.78	0.04	2.37	2.62	0.08	0.97	6.18	1.79	0.13	15.97
Share in total 1990 emission, %	61.0	31.3	1.7	0.9	0.2	0.3	3.2	1.3	0.0	
Share in total 2022 emission, %	11.2	0.3	14.8	16.4	0.5	6.1	38.7	11.2	0.8	
Change 1990-2022, %	**-98.9**	**-99.9**	**-48.3**	**11.6**	**-87.2**	**19.1**	**-26.5**	**-49.9**	**98.5**	**-94.0**
Change 2021-2022, %	**32.3**	**16.2**	**7.2**	**-4.8**	**12.4**	**46.6**	**-38.0**	**-21.2**	**-1.7**	**-17.9**

The main sources of particulates in 2022 are the IPPU sector (mainly Construction and demolition), which accounts for 38.7% of the total TSP emission, road transport (16.4%), non-industrial combustion (14.8%) and energy industries (11.2%). The emissions of TSP by sectors of pollution are shown in Table 2.12 and Figure 2.17 -2.18.

In 2022, particulate emissions fell by approximately 18%, mainly due to lower emissions from the construction sector, particularly as a result of a 68% reduction in road construction and reconstruction compared to 2021, as well as a reduction in building construction and renovation.

Slight reductions in emissions were also observed in the road transport, agriculture and waste sectors. The decrease in the number of swines by 14% was the reason for the small decrease of particulates emission in agriculture.

The particle emissions from road transport have decreased due to decreased annual mileage of vehicles. The increase of emissions from other mobile sources took place due to a increase in diesel consumption during that period.

In the stationary combustion and fuel fugitive sectors, emissions increased by 16.7% and 19.1%, respectively. The main reason was the increase in the share of oil shale combustion and its mining, as well as a slight increase in the use of biomass by boilers with a capacity of less than 50 MW.

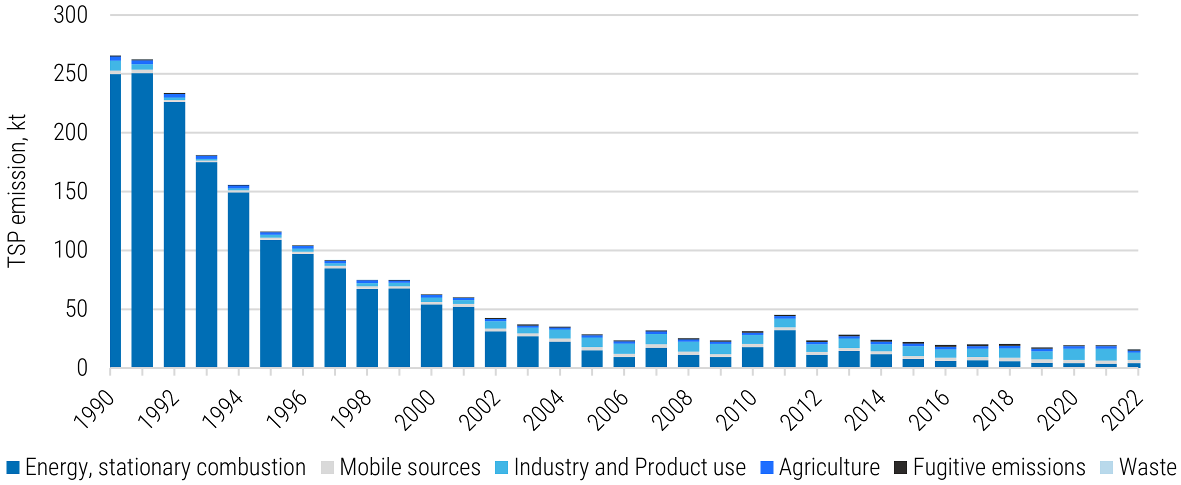


Figure 2.17 TSP emissions in the period of 1990–2022

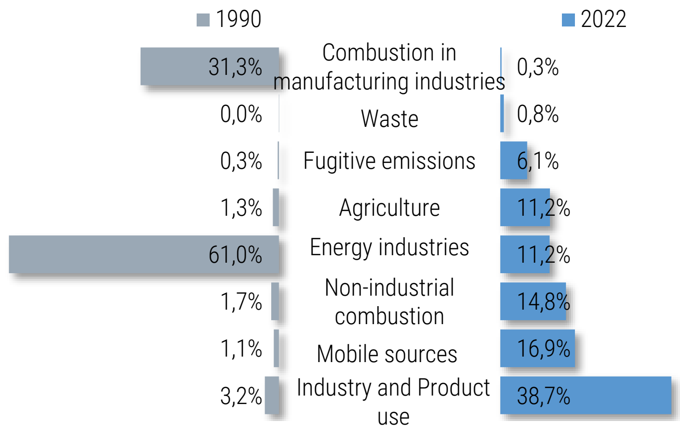


Figure 2.18 TSP emissions by sources of pollution in 1990 and 2022

In 1990, the main polluters of TSP were the energy industry (61%) and combustion in manufacturing industries (31.3%). In 2022, the share of combustion in energy industries dropped to 11.2% and the dominant source was industrial processes and product uses (the construction sector having the main impact) (38.7%). If the share of energy and transformation sector and combustion in manufacturing industries have decreased by 49.8% and 30% respectively, the share of mobile sources, non-industrial combustion and agriculture has increased by 15.8%, 13.1% and 9.9% respectively compared to 1990 (see Figure 2.18). The main reasons for such changes are the following: an increase in the share of wood combustion in the domestic sector (high emission factor of particulates), modernisation of cleaning equipment at the cement plant and oil shale power plants, and a decrease in electricity production.

2.2.2 Particulate matter (PM_{10})

In 2000–2022, PM_{10} emissions dropped significantly – by 66.1% (see Table 2.13 and Figure 2.19). This is due to the increase in the efficiency of combustion devices and cleaning installations (especially in oil shale power plants). Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. It should be noted that emissions from the non-industrial combustion sector decreased between 2000 and 2022 by 27.8%, despite an increase in the biomass burned in the residential sector. The reason for this is the growth of the last year's share of new high-efficiency technologies. The decrease in particulates emissions from agriculture sector by 14.9% was mainly due to an increase in the area covered by crops.

The growth of PM_{10} emission in 2010 resulted from the growth in electricity production at the same period. The significant growth of particulates emission in 2011 (Table 2.11) was due to the increase in electricity production by 34% in Balti PP (Enefit Power AS) and it is a result of bad operation of electric precipitators on two power units of this power plant.

Table 2.13 PM_{10} emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy ndustries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	3B-D Agriculture	Fugitive emissions	Waste	Total
2000	18.02	0.51	3.07	1.10	0.21	1.45	1.65	0.298	0.29	26.60
2005	6.99	0.55	2.34	1.53	0.27	2.87	1.44	0.425	0.21	16.61
2010	12.30	0.32	2.49	1.40	0.20	2.58	1.47	0.59	0.13	21.48
2015	4.72	0.20	1.95	1.46	0.13	2.61	1.75	0.76	0.19	13.78
2016	3.48	0.04	2.01	1.51	0.12	2.25	1.77	0.74	0.17	12.11
2017	3.81	0.04	2.04	1.55	0.12	2.24	1.72	0.88	0.14	12.52
2018	3.05	0.04	2.01	1.61	0.11	2.49	1.79	0.87	0.15	12.12
2019	1.79	0.06	1.87	1.62	0.09	2.19	1.83	0.60	0.13	10.19
2020	1.39	0.07	2.06	1.55	0.08	2.98	1.84	0.34	0.12	10.44
2021	1.03	0.03	2.07	1.55	0.07	3.10	1.85	0.35	0.12	10.18
2022	1.16	0.04	2.21	1.48	0.07	2.00	1.41	0.51	0.12	9.01
Share in total 2000 emission, %	67.8	1.9	11.5	4.1	0.8	5.5	6.2	1.1	1.1	
Share in total 2022 emission, %	12.9	0.4	24.5	16.4	0.8	22.2	15.6	5.7	1.4	
Change 2000-2022, %	**-93.5**	**-92.7**	**-27.8**	**34.6**	**-64.0**	**38.0**	**-14.9**	**72.0**	**-57.9**	**-66.1**
Change 2021-2022, %	**12.9**	**15.6**	**7.1**	**-4.7**	**13.9**	**-35.4**	**-24.1**	**46.3**	**-0.3**	**-11.4**

In 2022, total PM_{10} emissions decreased by 11.4% in comparison to 2021, mainly due to lower emissions from the construction sector, particularly as a result of a 68% reduction in road construction and reconstruction compared to 2021, as well as a reduction in building construction and renovation. The other reason the decrease in the number of swines by 14%. Increased oil shale mining in 2022 compared to the previous year was responsible for the increase in particulate emissions in the sector. The reason for the change in emissions from combustion activities is described in the TSP chapter.

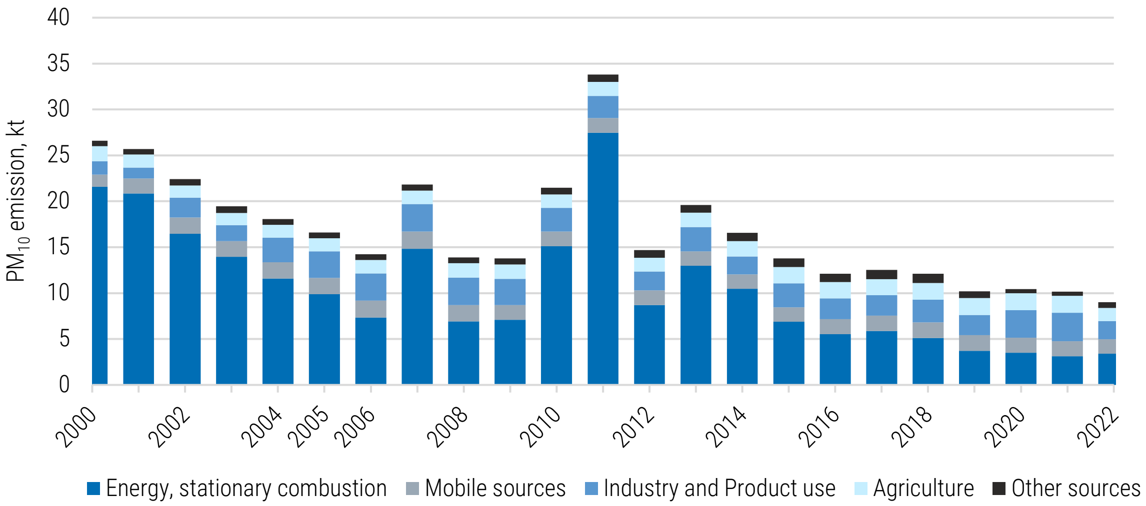


Figure 2.19 PM$_{10}$ emissions in the period of 2000–2022

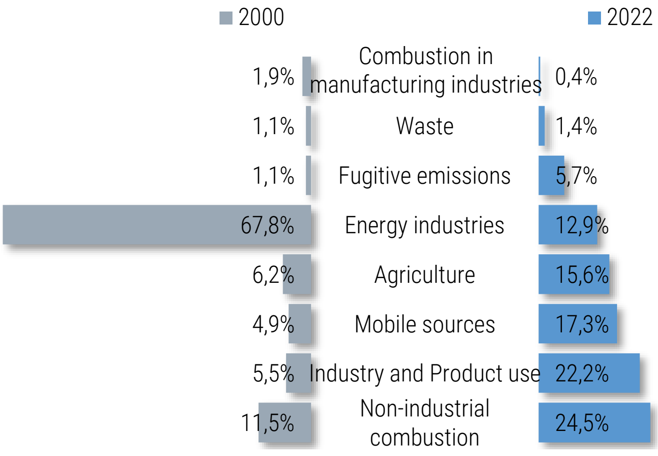


Figure 2.20 PM$_{10}$ emissions by sources of pollution in 2000 and 2022

In 2000, the main polluters of PM$_{10}$ were the energy industry (67.8%) and non-industrial combustion (11.5%). In 2022, the dominant sources are non-industrial combustion (24.5%) and the industry sector – more precisely, construction and demolition (22.2%); combustion in energy industries dropped to 12.9%; the share of mobile sources increased from 5% to 17.3%; the contribution of agriculture sector in total PM$_{10}$ emissions also increased (see Figure 2.20). The main reasons for such changes are the following: an increase in the share of solid biomass combustion in the domestic (high emission factor of fine particulates) and solid fuels in industrial combustion sectors , modernisation of cleaning equipment at oil shale power plants, and a decrease in electricity production. The contribution of other sources in total PM$_{10}$ emission is shown in the Table 2.13 and Figure 2.20.

2.2.3 Particulate matter (PM$_{2.5}$)

In 2000–2022, PM$_{2.5}$ emissions decreased by 51.8% (see Table 2.14 and Figure 2.21). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants. Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. It should be noted that emissions from non-industrial combustion sector decreased between 2000 and 2022 by

28.3%, despite the increase in biomass burned in the residential sector. The reason for this is the growing in the last year's share of new high-efficiency technologies.

The reasons of increase in $PM_{2.5}$ emissions in 2010 and 2011 the same as well as for TSP and PM_{10}.

Table 2.14 $PM_{2.5}$ emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	3B-D Agriculture	Fugitive emissions	Other sources	Total
2000	4.70	0.39	2.93	0.78	0.20	0.41	0.19	0.30	0.28	10.18
2005	2.74	0.45	2.23	1.06	0.26	0.72	0.17	0.42	0.19	8.24
2010	5.62	0.26	2.37	0.90	0.19	0.50	0.17	0.59	0.08	10.68
2015	2.36	0.16	1.86	0.90	0.13	0.42	0.21	0.76	0.16	6.96
2016	1.80	0.04	1.92	0.92	0.12	0.38	0.19	0.74	0.14	6.24
2017	1.95	0.03	1.94	0.93	0.11	0.44	0.19	0.88	0.10	6.57
2018	1.59	0.03	1.91	0.96	0.11	0.41	0.19	0.87	0.11	6.19
2019	1.00	0.05	1.78	0.96	0.09	0.36	0.20	0.60	0.11	5.15
2020	0.82	0.06	1.96	0.92	0.08	0.45	0.20	0.34	0.10	4.93
2021	0.62	0.03	1.96	0.91	0.06	0.46	0.20	0.35	0.10	4.69
2022	0.68	0.03	2.10	0.86	0.07	0.36	0.20	0.51	0.09	4.91
Share in total 2000 emission, %	46.1	3.8	28.8	7.6	2.0	4.1	1.9	2.9	2.8	
Share in total 2022 emission, %	13.9	0.6	42.8	17.5	1.5	7.3	4.0	10.4	1.9	
Change 2000-2022, %	**-85.5**	**-92.7**	**-28.3**	**10.8**	**-64.0**	**-12.7**	**3.5**	**72.0**	**-66.5**	**-51.8**
Change 2021-2022, %	**10.1**	**13.5**	**7.1**	**-5.4**	**14.3**	**-22.0**	**-0.8**	**46.3**	**-6.0**	**4.6**

In 2022, total $PM_{2.5}$ emissions increased by about 4.6% in comparison to 2021.The main reason was the increase in the share of oil shale combustion and its mining, as well as a slight increase in the use of biomass by boilers with a capacity of less than 50 MW. The reason for the change in emissions from other sources is described in the TSP and PM_{10} chapters.

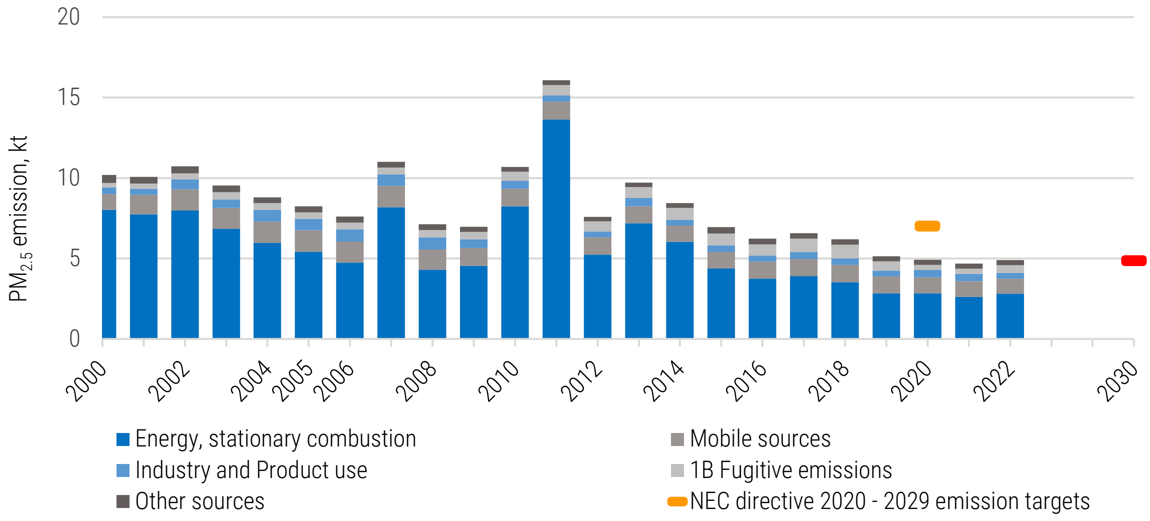


Figure 2.21 $PM_{2.5}$ emissions in the period of 2000–2022 and NEC Directive 2016/2284 $PM_{2.5}$ targets

In 2000, the main polluters of $PM_{2.5}$ were the energy industry (46.1%) and non-industrial combustion (28.8%). In 2022, the dominant sources is non-industrial combustion sector, which share have increased to 42.8% (mainly solid biomass combustion in residential sector), while the share of energy industries decreased to 13.9% (see Figure 2.22). The main reasons for such changes are the following: an increase in the share of wood combustion in the domestic and industrial combustion sectors (high emission factor of fine particulates), modernisation of cleaning equipment at oil shale power plants, and a decrease in electricity production. The contribution of other sources in total $PM_{2.5}$ emission is shown on the Table 2.14 and Figure 2.22.

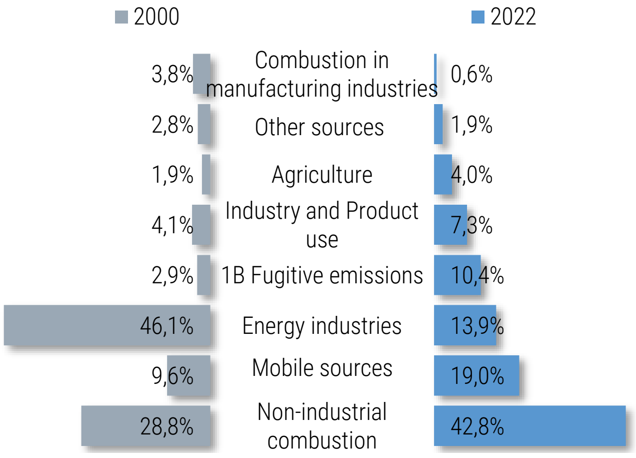


Figure 2.22 $PM_{2.5}$ emissions by sources of pollution in 2000 and 2022

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of fine particulate matter emissions by 15% relative to 2005 baseline emissions by 2020, in 2015. $PM_{2.5}$ emissions decreased by 40.4% in 2022 compared to 2005 (see Table 2.15).

Table 2.15 NH_3 emission and NEC directive 2016/2284 emission targets

National total for compliance calculations and checks (NECD)		Change 2005-2022, %	2020-2029 emission targets		2030 emission targets	
2005	2022		%	Emission, kt	%	Emission, kt
8.236	4.910	-40.4	15	7.001	41	4.859

2.2.4 Black carbon (BC)

In the period between 2000-2022, emissions of BC decreased by 25.1% (see Table 2.16 and Figure 2.21). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants, as well as the decrease of emissions in transport sector.

Return to the Table of Contents

Table 2.16 BC emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	Other sources	Total
2000	0.148	0.054	0.991	0.237	0.109	0.029	0.0000	1.568
2005	0.119	0.065	0.744	0.343	0.149	0.038	0.0000	1.458
2010	0.171	0.036	0.898	0.260	0.115	0.019	0.0002	1.499
2015	0.089	0.024	0.729	0.222	0.077	0.024	0.0001	1.166
2016	0.098	0.006	0.791	0.214	0.071	0.024	0.0001	1.202
2017	0.097	0.005	0.801	0.201	0.065	0.023	0.0000	1.192
2018	0.092	0.005	0.792	0.193	0.063	0.021	0.0000	1.166
2019	0.074	0.012	0.734	0.188	0.052	0.021	0.0000	1.080
2020	0.075	0.007	0.820	0.179	0.047	0.019	0.0000	1.147
2021	0.054	0.005	0.829	0.163	0.035	0.019	0.0000	1.105
2022	0.058	0.005	0.902	0.150	0.041	0.018	0.0000	1.174
Share in total 2000 emission, %	9.5	3.4	63.2	15.1	7.0	1.8	0.000	
Share in total 2022 emission, %	5.0	0.5	76.8	12.8	3.5	1.5	0.0	
Change 2000-2022, %	**-60.8**	**-90.1**	**-9.1**	**-36.7**	**-62.0**	**-38.9**	**155.3**	**-25.1**
Change 2021-2022, %	**7.0**	**15.7**	**8.7**	**-8.3**	**18.3**	**-5.6**	**-42.7**	**6.2**

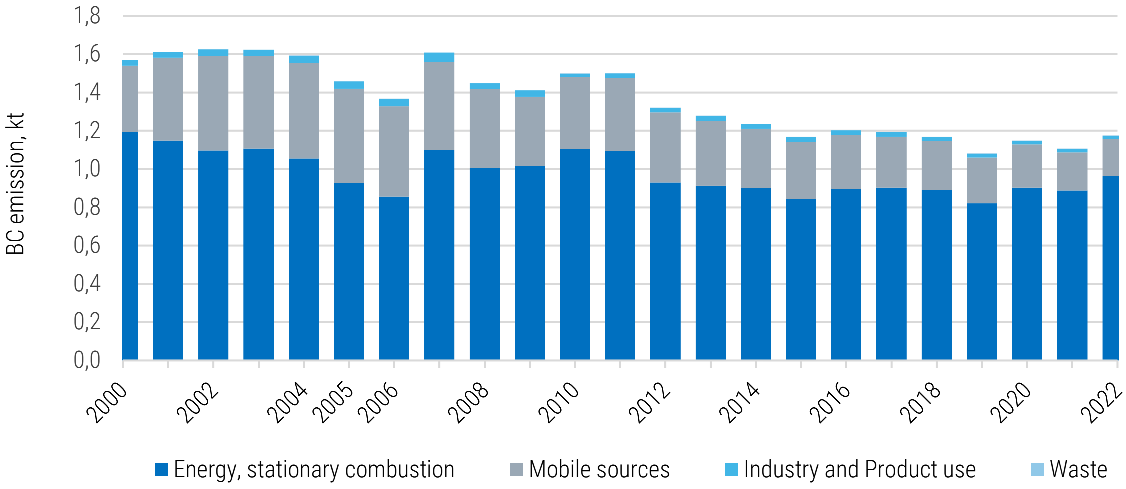


Figure 2.23 BC emissions in the period of 2000–2022

In 2022, BC emissions increased by 6.2% in comparison to 2021 due mainly to a increase of solid biomass consumption in the non-industrial combustion sector. The reason for the change in emissions from other sources is described in the TSP and PM_{10} chapters.
Emission of black carbon for all activities was calculated in this submission for 2000–2022.

The key sources of BC emissions in 2022 were non-industrial combustion (76.8%, mainly wood combustion), mobile sources (16.3%) and combustion in the energy and transformation industries (5%) (see Figure 2.24). Other sources are mainly industrial processes.

The distribution of BC emissions by sources of pollution is also visible in Table 2.16. It is interesting to note that if the share of non-industrial combustion (generally wood combustion in domestic sector) in TSP emissions makes up 14.8% of the total emissions, then share in emissions of BC is significantly higher and makes up 76.8%.

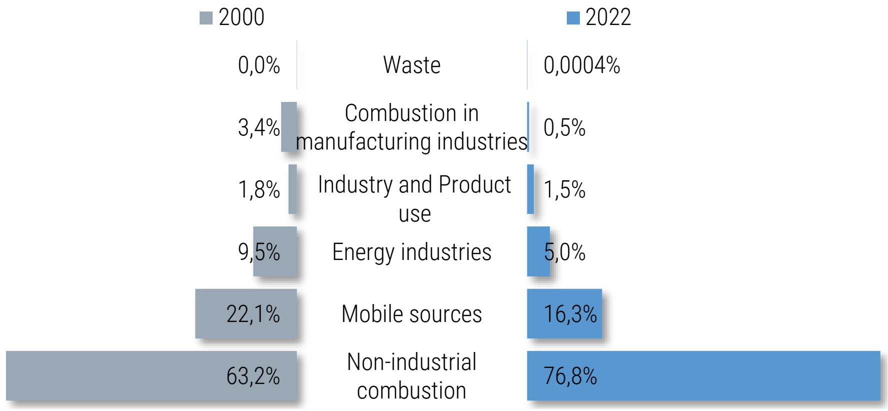


Figure 2.24 BC emissions by sources of pollution in 1990 and 2022

2.3. Heavy Metals

This chapter describes the changes in emissions of heavy metals from 1990 to 2022. Emissions of all substances decreased significantly over the entire period (see Table 2.17 and Figures 2.25 - 2.27). Heavy metals are mainly released by combustion in energy and transformation industries and from mobile sources. The stationary combustion is a key heavy metals polluter in Estonia.

The information for each substance separately, as well as key sources and the reasons for the decrease, are described below.

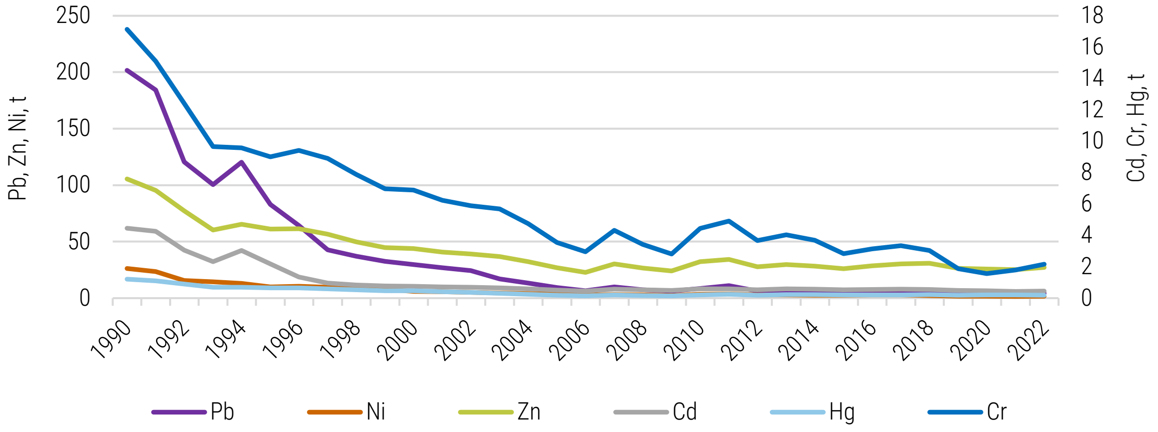


Figure 2.25 Heavy metals emissions in the period 1990 - 2022 (t)

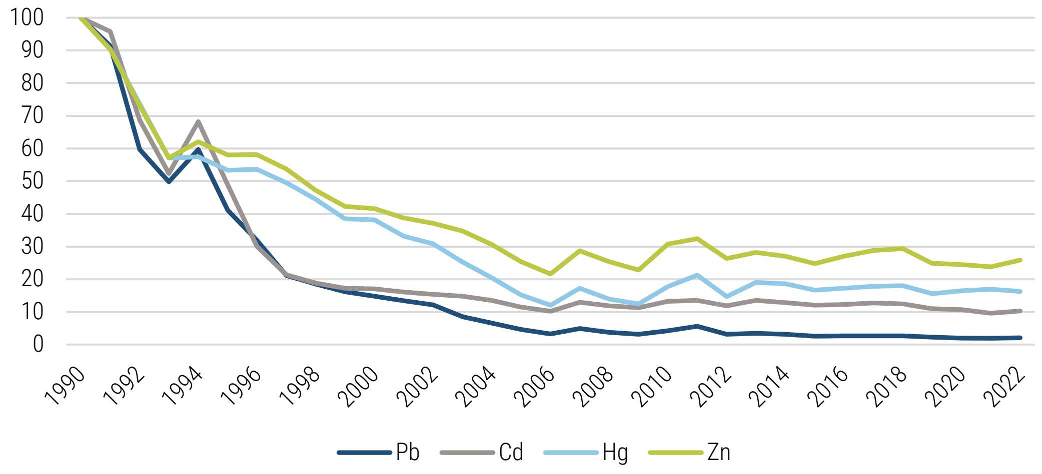


Figure 2.26 Indexed of heavy metals emissions (1990=100) in the period 1990-2022

Table 2.17 Heavy metals emissions in the period 1990–2022 (t)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	201.71	4.46	1.21	19.80	17.14	15.49	26.26	9.21	105.53
1991	184.39	4.27	1.09	17.42	15.10	14.12	23.40	8.16	95.32
1992	120.50	3.06	0.89	14.17	12.42	8.80	15.73	6.94	77.17
1993	100.42	2.33	0.69	11.05	9.67	8.07	14.45	5.36	60.36
1994	120.39	3.04	0.69	10.69	9.58	9.50	13.12	5.26	65.52
1995	82.94	2.18	0.64	9.74	9.01	8.42	10.00	4.91	61.28
1996	64.30	1.34	0.65	10.11	9.42	8.19	10.54	5.10	61.33
1997	42.66	0.95	0.60	9.31	8.91	8.34	9.72	4.78	56.72
1998	37.25	0.84	0.54	8.25	7.89	8.07	8.98	4.26	49.83
1999	32.57	0.77	0.47	6.92	6.96	7.59	7.89	3.63	44.67
2000	29.87	0.76	0.46	6.71	6.88	7.69	6.09	3.63	43.92
2001	27.02	0.72	0.40	5.61	6.25	9.06	5.63	3.16	40.91
2002	24.48	0.69	0.37	4.98	5.89	9.27	5.24	2.90	39.20
2003	17.12	0.66	0.31	3.84	5.68	9.41	4.63	2.54	36.71
2004	13.20	0.60	0.25	2.75	4.74	9.55	4.02	1.97	32.38
2005	9.38	0.51	0.18	1.73	3.55	9.57	3.36	1.43	26.80
2006	6.57	0.45	0.15	1.00	2.95	10.03	2.63	1.17	22.79
2007	9.91	0.58	0.21	1.95	4.32	11.17	3.29	1.78	30.30
2008	7.47	0.53	0.17	1.20	3.42	10.60	2.86	1.29	26.77
2009	6.26	0.50	0.15	0.91	2.81	9.45	2.40	1.00	24.08
2010	8.53	0.59	0.21	2.02	4.45	10.54	3.34	1.79	32.42
2011	11.20	0.60	0.26	2.78	4.91	10.80	3.64	2.10	34.14
2012	6.34	0.53	0.18	1.31	3.66	10.76	2.92	1.41	27.84
2013	6.92	0.60	0.23	1.38	4.03	10.96	2.92	1.49	29.77
2014	6.33	0.57	0.23	1.20	3.69	11.04	2.65	1.37	28.46
2015	5.08	0.54	0.20	0.93	2.84	10.73	2.56	1.05	26.10
2016	5.28	0.55	0.21	1.05	3.14	11.34	2.77	1.18	28.50
2017	5.43	0.57	0.22	1.08	3.34	11.84	2.74	1.30	30.37
2018	5.29	0.56	0.22	0.96	3.04	12.11	2.43	1.21	30.94
2019	4.61	0.49	0.19	0.62	1.88	11.27	1.82	0.74	26.25
2020	3.93	0.47	0.20	0.51	1.56	10.46	1.68	0.56	25.83
2021	3.89	0.43	0.20	0.54	1.79	11.22	1.56	0.59	25.15
2022	4.17	0.46	0.20	0.64	2.16	11.94	1.75	0.71	27.27
Change 1990-2022, %	-97.9	-89.7	-83.8	-96.8	-87.4	-22.9	-93.4	-92.3	-74.2
Change 2021-2022, %	7.4	7.2	-4.2	19.1	20.6	6.4	12.1	21.2	8.4

Return to the Table of Contents

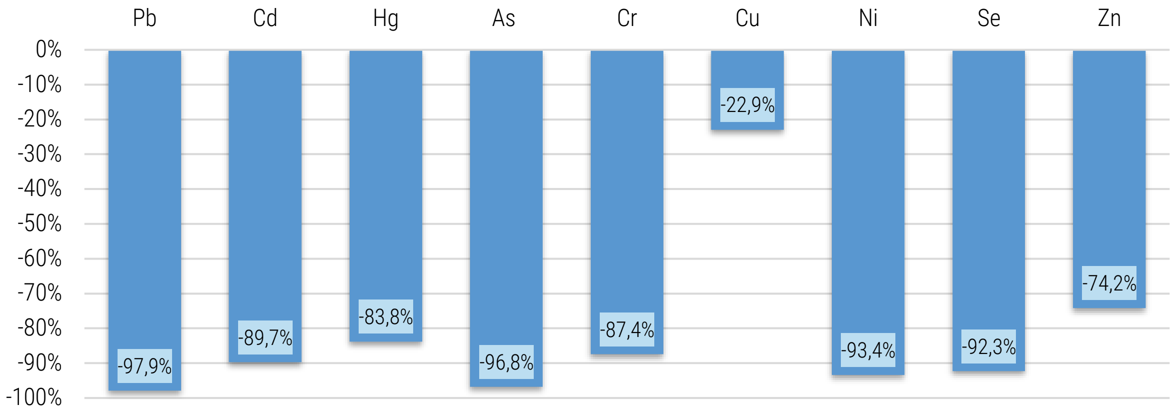


Figure 2.27 Reduction of heavy metals emissions in the period 1990-2022

2.3.1 Priority heavy metals (Pb, Cd and Hg)

2.3.1.1 Lead (Pb)

In the period between 1990-2022, the emissions of lead decreased by 97.9% due to the modernisation of cleaning equipment at both the oil shale Narva PP and Kunda Nordic Cement and due to the decrease in energy production (see Table 2.18 and Figure 2.28). A further reason is the discontinued use of leaded petrol in Estonia since 2000 (see Figure 2.29), what was the reason for the decrease in lead emissions from road transport by 98.6%.

Table 2.18 Pb emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	57.83	62.29	2.88	73.86	4.83	0.01	0.000	201.71
1995	29.90	25.32	3.11	24.13	0.46	0.02	0.001	82.94
2000	20.56	0.63	3.21	5.30	0.08	0.09	0.001	29.87
2005	3.61	0.20	2.61	2.66	0.03	0.27	0.002	9.38
2010	4.58	0.12	2.73	0.84	0.02	0.23	0.001	8.53
2015	1.74	0.08	2.05	0.88	0.03	0.30	0.003	5.08
2016	1.91	0.05	2.01	0.92	0.05	0.34	0.003	5.28
2017	2.11	0.03	1.94	0.95	0.05	0.35	0.004	5.43
2018	1.92	0.05	1.88	0.99	0.03	0.42	0.002	5.29
2019	1.25	0.15	1.79	1.00	0.04	0.39	0.002	4.61
2020	1.03	0.07	1.75	0.95	0.03	0.09	0.003	3.93
2021	0.84	0.02	1.69	1.00	0.02	0.31	0.003	3.89
2022	1.02	0.02	1.67	1.05	0.02	0.39	0.003	4.17
Share in total 1990 emission, %	28.7	30.9	1.4	36.6	2.4	0.0	0.000	
Share in total 2022 emission, %	24.4	0.6	40.0	25.1	0.5	9.3	0.1	
Change 1990-2022, %	**-98.2**	**-100.0**	**-42.1**	**-98.6**	**-99.6**	**2 582.5**	**598.2**	**-97.9**
Change 2021-2022, %	**20.7**	**17.2**	**-1.1**	**4.7**	**-1.8**	**25.9**	**2.9**	**7.4**

The emissions of lead by sources of pollution in 1990 and 2022 are shown in Table 2.18 and Figure 2.30.

The distribution of emissions by sector has considerably changed over the last 33 years. While in 1990 the main sources of lead pollution were almost equally road transport (39%), industrial combustion (31%, mainly cement manufacturing) and energy industries (28.7%), in 2022 the key source of pollution by lead was the non-industrial combustion (40%, from which residential sector of 98%, mainly waste incineration), the second largest source of lead emission – mobile sources (25.6%) and then energy industry (24.4%, mainly oil shale power plants) (see Figure 2.30). The main reason for the significant decline in the share of industrial combustion sector (from 31% to 0.6%) is the termination of clinker production.The main sources of Pb emission in IPPU sector is fireworks use. The waste sector contribute in total lead emission only 0.1%.

A increase in emissions in 2022 compared to 2021 (7.4%) is due to an increase in fuel consumption at oilshale power plants and, accordingly, an increase in electricity production. The increase in emissions was also fueled by an almost 30% increase in the use of fireworks.

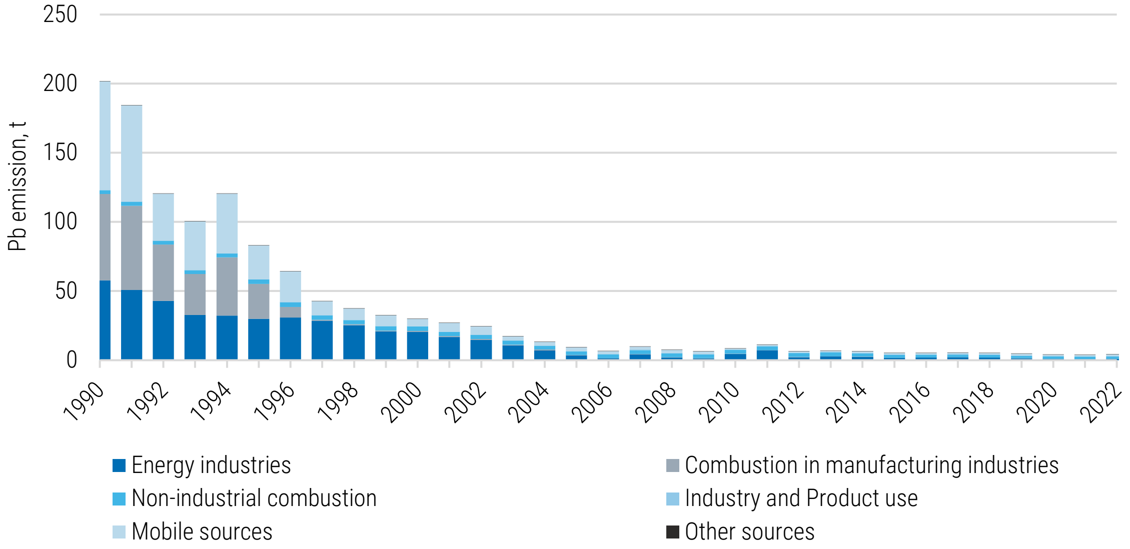


Figure 2.28 Pb emissions in the period of 1990–2022

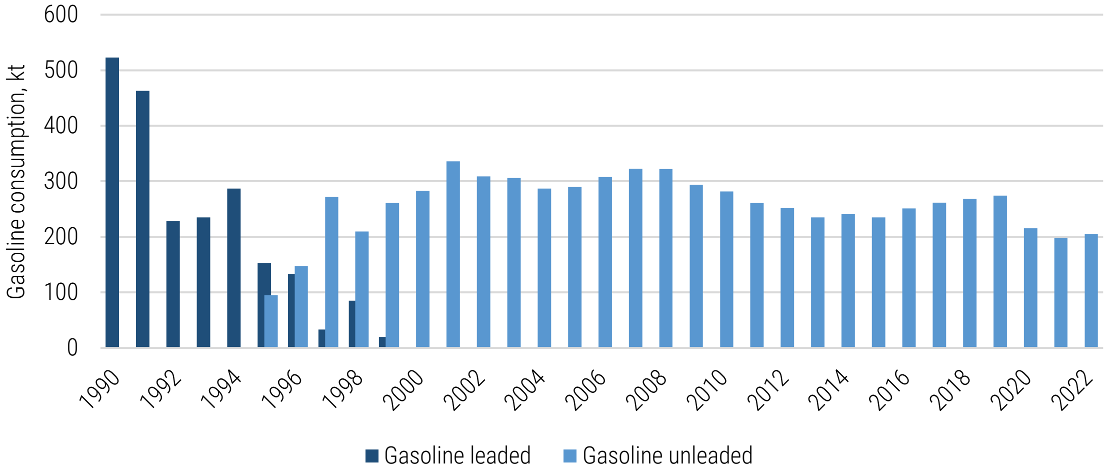


Figure 2.29 Gasoline consumption in 1990–2022

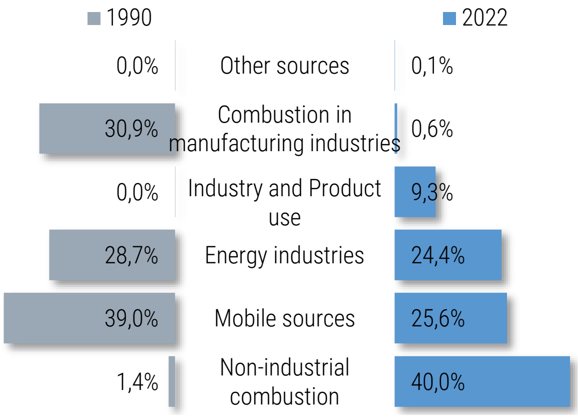


Figure 2.30 Pb emission by sources of pollution in the period of 1990 and 2022

2.3.1.2 Cadmium (Cd)

In the period between 1990-2022, the emissions of cadmium decreased by 89.7% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy and clinker production (see Table 2.19 and Figure 2.31).

Table 2.19 Cd emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	0.99	3.24	0.19	0.004	0.002	0.033	0.000	4.46
1995	0.53	1.34	0.29	0.002	0.001	0.016	0.000	2.18
2000	0.39	0.06	0.29	0.003	0.001	0.014	0.001	0.76
2005	0.17	0.05	0.27	0.003	0.001	0.019	0.001	0.51
2010	0.20	0.04	0.33	0.004	0.001	0.012	0.001	0.59
2015	0.20	0.04	0.28	0.004	0.001	0.017	0.001	0.54
2016	0.21	0.02	0.29	0.004	0.001	0.017	0.001	0.55
2017	0.23	0.02	0.29	0.004	0.001	0.017	0.001	0.57
2018	0.23	0.01	0.29	0.004	0.001	0.017	0.001	0.56
2019	0.18	0.01	0.28	0.004	0.001	0.017	0.001	0.49
2020	0.16	0.01	0.29	0.004	0.001	0.015	0.001	0.47
2021	0.12	0.01	0.28	0.004	0.001	0.015	0.001	0.43
2022	0.13	0.01	0.29	0.005	0.001	0.015	0.001	0.46
Share in total 1990 emission, %	22.2	72.7	4.2	0.1	0.0	0.7	0.00	
Share in total 2022 emission, %	29.4	3.0	62.8	1.0	0.2	3.3	0.2	
Change 1990-2022, %	**-86.4**	**-99.6**	**51.9**	**19.9**	**-55.5**	**-54.2**	**2 325.3**	**-89.7**
Change 2021-2022, %	**11.4**	**47.8**	**4.5**	**5.3**	**14.6**	**-0.8**	**-0.3**	**7.2**

The emissions of cadmium by sources of pollution in 1990 and 2022 are shown in Table 2.19 and Figure 2.32.

The distribution of emissions by sector has changed during this period. While in 1990 the main sources of cadmium pollution were combustion in manufacturing industries (72.7%, mainly cement production industry) and energy industries (22.2%), in 2022, the main sources of pollution by Cd were non-industrial combustion (62.8%, from which residential combasion is 90%) and energy industry (29.4%, mainly oil shale power plants). The contribution of other sources (industrial combustion, IPPU, waste and mobile sources) in 2021 is 6.6%.

The main reason for the increase in cadmium emissions in 2022 compared to 2021 is the increase in fuel consumption at oilshale power plants and, accordingly, an increase in electricity production.

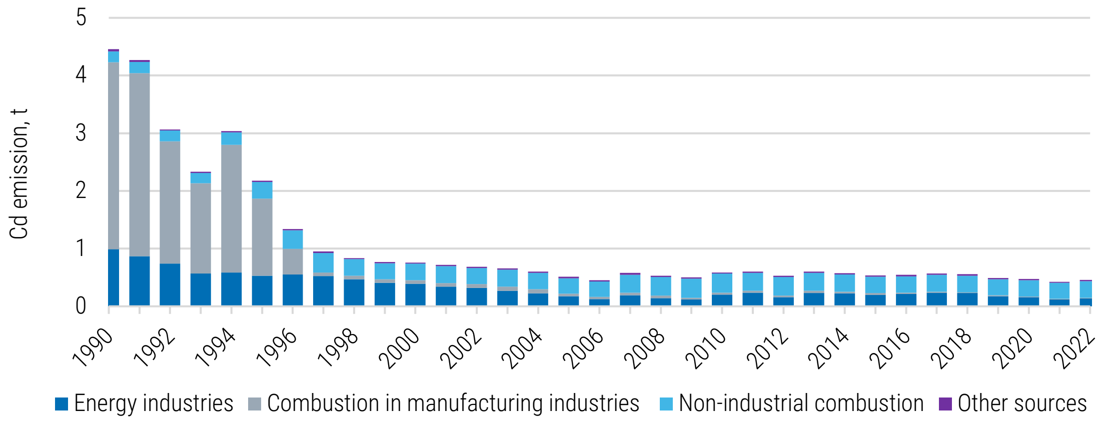


Figure 2.31 Cd emissions in the period of 1990–2022

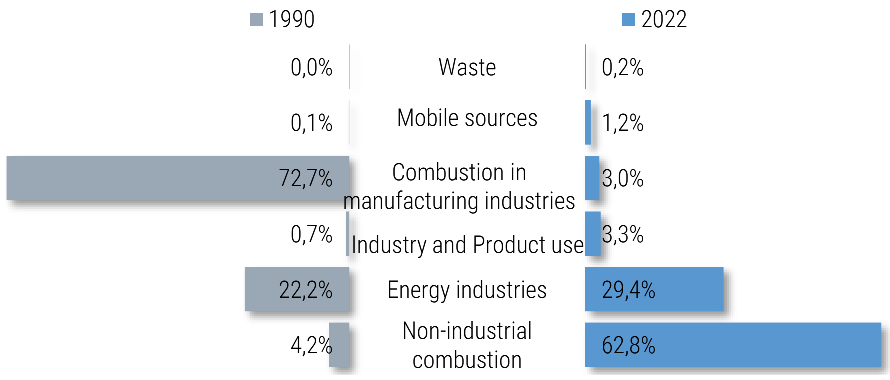


Figure 2.32 Cd emission by sources of pollution in the period of 1990 and 2022

2.3.1.3 Mercury (Hg)

In the period between 1990-2022, the emissions of mercury decreased by 83.8% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy and clinker production (see Table 2.20 and Figure 2.33).

Table 2.20 Hg emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.021	0.092	0.089	0.005	0.001	0.000	0.001	1.209
1995	0.510	0.043	0.086	0.003	0.001	0.000	0.002	0.645
2000	0.356	0.009	0.087	0.003	0.000	0.000	0.006	0.462
2005	0.090	0.008	0.071	0.004	0.000	0.000	0.009	0.183
2010	0.119	0.005	0.072	0.004	0.000	0.000	0.014	0.214
2015	0.122	0.003	0.053	0.005	0.000	0.000	0.018	0.201
2016	0.132	0.001	0.052	0.005	0.000	0.000	0.018	0.208
2017	0.139	0.002	0.050	0.005	0.000	0.000	0.020	0.216
2018	0.131	0.012	0.048	0.005	0.000	0.000	0.021	0.217
2019	0.105	0.011	0.046	0.005	0.000	0.000	0.021	0.188

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
2020	0.112	0.002	0.045	0.005	0.000	0.000	0.035	0.199
2021	0.120	0.001	0.043	0.005	0.000	0.000	0.036	0.205
2022	0.116	0.001	0.042	0.005	0.000	0.000	0.032	0.196
Share in total 1990 emission, %	84.4	7.6	7.4	0.4	0.1	0.0	0.1	
Share in total 2022 emission, %	59.1	0.4	21.7	2.4	0.1	0.0	16.3	
Change 1990-2022, %	**-88.6**	**-99.1**	**-52.5**	**-12.2**	**-87.2**	**-88.4**	**4 858.2**	**-83.8**
Change 2021-2022, %	**-3.1**	**-8.2**	**-1.6**	**1.3**	**-3.6**	**12.1**	**-11.4**	**-4.2**

The emissions of mercury by sources of pollution in 1990 and 2022 are shown in Table 2.20 and Figure 2.33, 2.34.

The distribution of emissions by sector has changed during this period. While in 1990 the energy industries was the main source of mercury pollution (84.4%, mainly oil shale power plants), in 2022 its share decreased to 59.1% and the non-industrial sector became the other key source (21.7%, mainly residential combustion). The share of waste sector is 16% (mainly cremation). The contribution of other sources (combustion in manufacturing industries, IPPU and mobile sources) in 2022 is about 3%.

The main reason for the slight decrease in mercury emissions in 2022 compared to 2021 (4.2%) is the decrease in emissions from waste incineration plant.

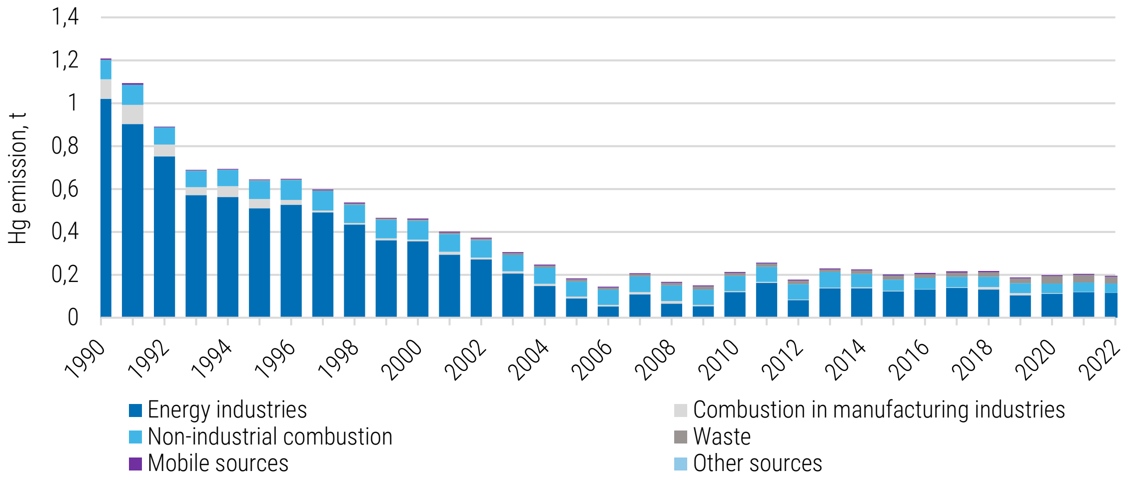


Figure 2.33 Hg emissions in the period of 1990–2022

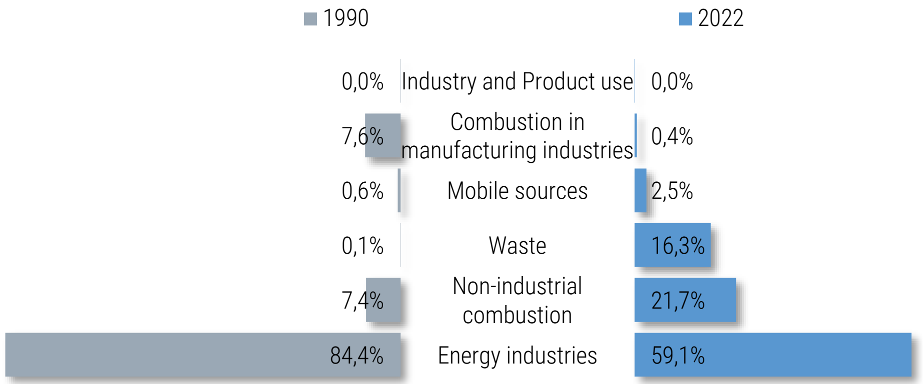


Figure 2.34 Hg emission by sources of pollution in the period of 1990 and 2022

2.3.2 Other heavy metals (As, Cr, Cu, Ni and Zn)

In the period between 1990-2022, the emissions of As, Cr, Cu, Ni, Se and Zn decreased by 96.8%, 87.4%, 22.9%, 93.4%, 92.3% and 74.2% respectively due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy and clinker production (see Table 2.12 and Figure 2.35).

The emissions of all other heavy metals by sources of pollution in 1990 and 2022 are shown in Figure 2.35.

The main source for all heavy metals is the energy industries and only for copper the main source of pollution is road transport (automobile tyre and brake wear).

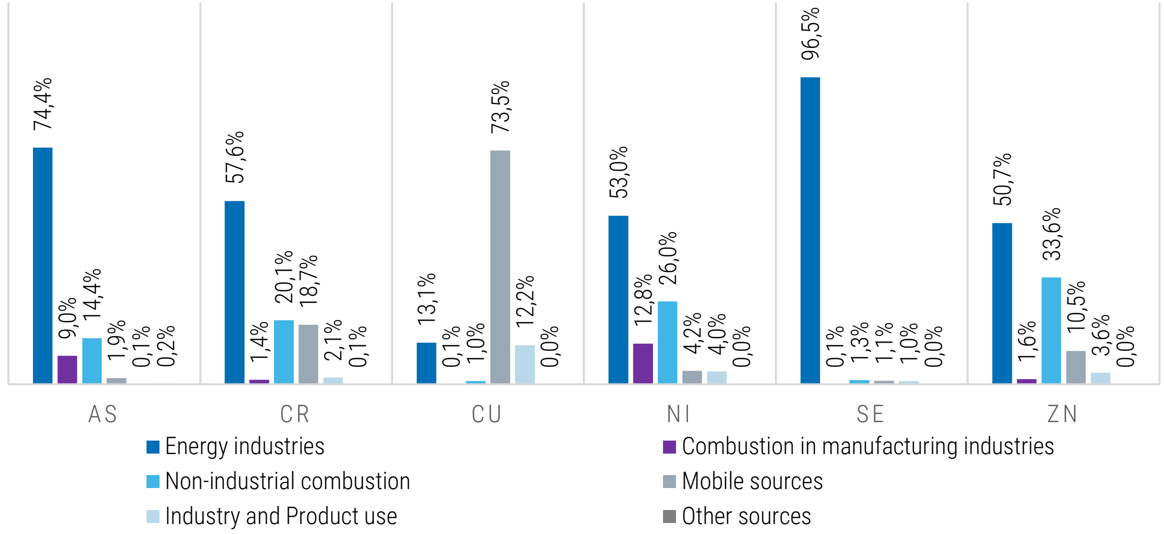


Figure 2.35 Other heavy metals emission by sources of pollution in 2022

Some increase in emissions of all metals was observed in 2022 in all sectors (see Table 2.17).

2.4. Persistent Organic Pollutants (POPs)

This chapter describes the changes in emissions of persistent organic pollutants from 1990 to 2022.

In this period, dioxin, PAHs total, HCB and PCB emissions decreased by approximately 63%, 62%, 9% and 88% respectively (see Table 2.21, figures 2.36 - 2.38).

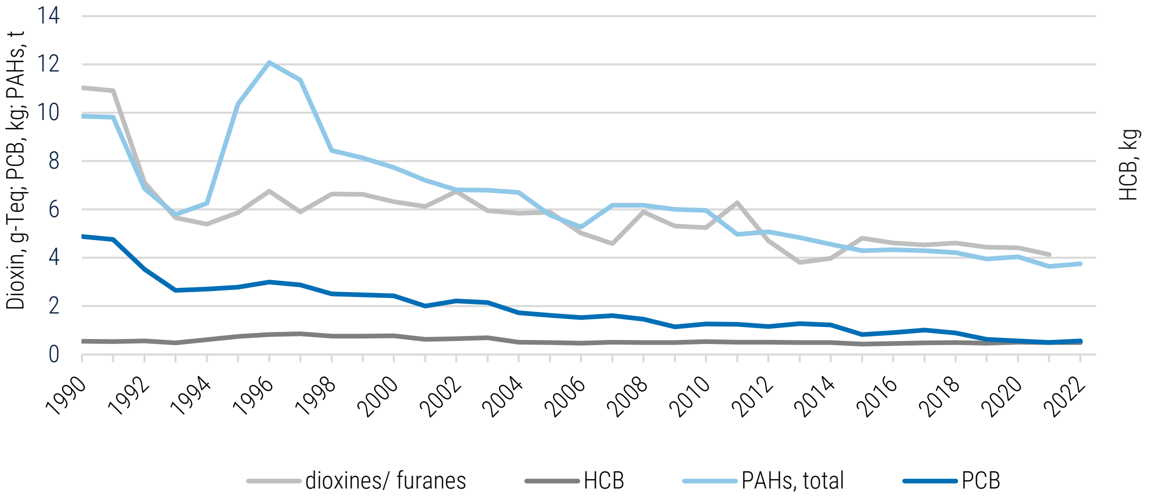


Figure 2.36 Persistent organic pollutants emissions in the period 1990–2022

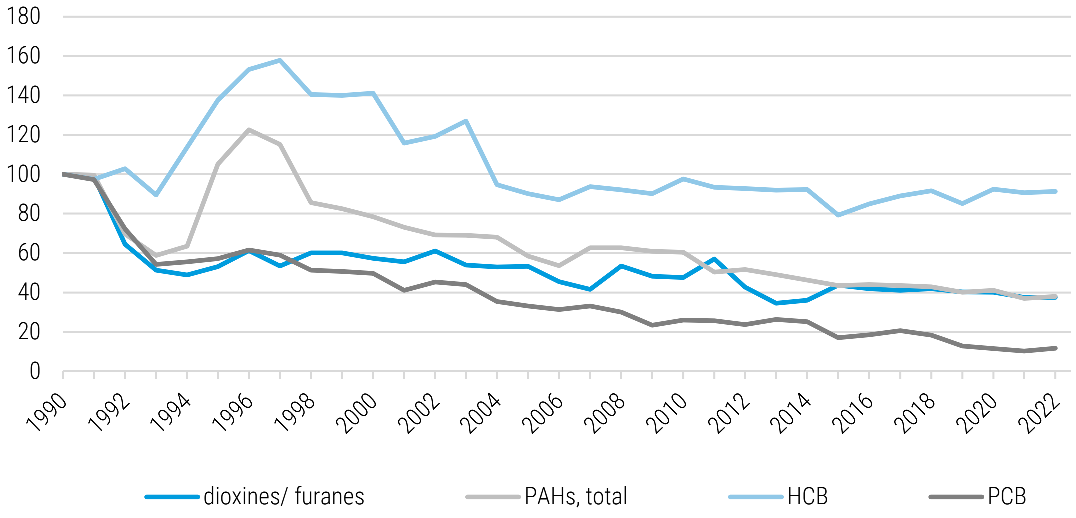


Figure 2.37 Indexed of persistent organic pollutants emissions (1990=100) in the period 1990-2022

Persistent organic pollutants are mainly released by combustion in energy production, from mobile sources and also from waste incineration.

The information for each substance separately, as well as key sources and the reasons for the change in emissions are described below.

The emissions of POPs are shown in Table 2.21 and Figures 2.36.

Table 2.21 POPs emission in the period of 1990–2022

Year	dioxines/ furanes	benzo(a) pyrene	benzo(b) fluoranthene	benzo(k) fluoranthene	Indeno(1,2,3-cd) pyrene	PAHs, total	HCB	PCB
	g I-Teq	t					kg	
1990	11.04	2.81	3.57	1.69	1.78	9.86	0.54	4.88
1991	10.92	2.80	3.56	1.68	1.77	9.82	0.53	4.75
1992	7.11	1.95	2.32	1.20	1.41	6.87	0.56	3.53
1993	5.66	1.63	1.86	1.02	1.28	5.79	0.49	2.65
1994	5.39	1.74	1.84	1.12	1.55	6.26	0.62	2.71
1995	5.87	2.88	2.89	1.87	2.73	10.37	0.75	2.79
1996	6.76	3.36	3.42	2.17	3.14	12.08	0.83	3.00
1997	5.90	3.15	3.09	2.06	3.06	11.36	0.86	2.88
1998	6.63	2.34	2.27	1.53	2.29	8.44	0.76	2.51
1999	6.63	2.26	2.23	1.47	2.18	8.14	0.76	2.47
2000	6.32	2.15	2.08	1.40	2.10	7.74	0.77	2.43
2001	6.13	2.00	1.93	1.31	1.96	7.20	0.63	2.01
2002	6.74	1.90	1.87	1.23	1.81	6.82	0.65	2.21
2003	5.95	1.89	1.82	1.23	1.85	6.80	0.69	2.15
2004	5.85	1.88	1.85	1.21	1.77	6.71	0.51	1.73
2005	5.89	1.62	1.62	1.04	1.49	5.77	0.49	1.62
2006	5.03	1.48	1.45	0.95	1.39	5.28	0.47	1.53
2007	4.58	1.73	1.63	1.12	1.70	6.18	0.51	1.61
2008	5.90	1.73	1.65	1.12	1.69	6.18	0.50	1.47
2009	5.32	1.68	1.56	1.09	1.68	6.01	0.49	1.14
2010	5.25	1.67	1.56	1.08	1.65	5.96	0.53	1.26
2011	6.29	1.40	1.32	0.90	1.35	4.97	0.51	1.26
2012	4.71	1.43	1.33	0.92	1.40	5.08	0.50	1.16
2013	3.81	1.37	1.31	0.87	1.29	4.84	0.50	1.28
2014	3.98	1.29	1.22	0.82	1.22	4.56	0.50	1.23
2015	4.81	1.22	1.16	0.77	1.15	4.29	0.43	0.83
2016	4.62	1.23	1.16	0.78	1.17	4.34	0.46	0.90
2017	4.53	1.22	1.16	0.77	1.15	4.29	0.48	1.01
2018	4.62	1.20	1.15	0.75	1.12	4.22	0.50	0.90
2019	4.44	1.12	1.08	0.70	1.04	3.95	0.46	0.63
2020	4.42	1.15	1.12	0.72	1.06	4.04	0.50	0.56
2021	4.14	1.04	0.98	0.65	0.97	3.64	0.49	0.50
2022	4.14	1.07	1.01	0.67	1.00	3.75	0.50	0.57
Change 1990-2022, %	-62.5	-62.0	-71.6	-60.6	-44.1	-62.0	-8.7	-88.4
Change 1995-2022, %	-29.5	-62.8	-64.9	-64.4	-63.4	-63.8	-33.6	-79.7
Change 2021-2022, %	-0.2	3.0	3.1	2.8	2.5	2.9	0.8	13.3

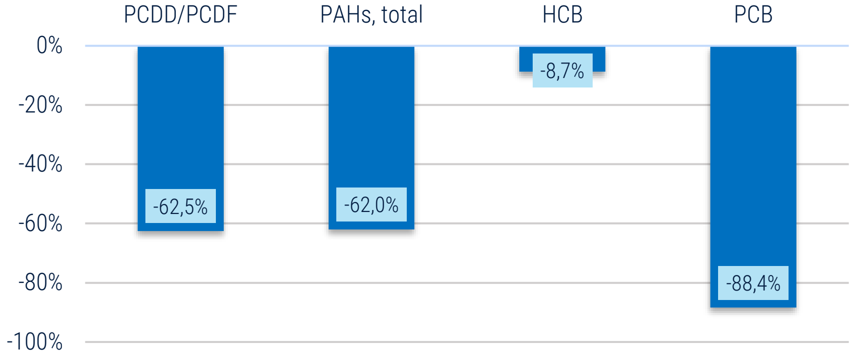


Figure 2.38 Reduction of persistent organic pollutants emissions in the period 1990-2022

2.4.1 Dioxins/Furans (PCDD/PCDF)

In the period between 1990 and 2022, the emissions of dioxin decreased by 62.5% due to decreased production of energy and mineral products and also decreasing of amount of incinerated waste. One of the reasons for the significant decrease in emissions from 1990 to 1994 was the decrease of coal and peat consumption in the residential sector (the dioxin emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion). Growth in wood consumption in the same sector is the reason for an increase in emissions since 1995. The increase in dioxin emissions from 2008 to 2011 is also due to an increased share of burning solid biomass in the energy industries sector (see Table 2.21 and Figure 2.39).

Table 2.22 PCDD/PCDF emissions by sector (g I-TEQ), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	2.14	1.17	6.34	0.28	0.026	0.01	1.06	11.04
1995	1.22	0.80	2.43	0.17	0.009	0.01	1.24	5.87
2000	1.01	0.42	1.50	0.20	0.002	0.03	3.17	6.32
2005	1.08	0.67	1.22	0.27	0.002	0.04	2.60	5.89
2010	2.39	0.48	0.80	0.31	0.001	0.06	1.22	5.25
2015	1.55	0.46	0.57	0.31	0.001	0.03	1.89	4.81
2016	2.05	0.06	0.52	0.29	0.001	0.03	1.66	4.62
2017	2.17	0.23	0.49	0.28	0.001	0.03	1.34	4.53
2018	2.22	0.20	0.47	0.27	0.001	0.03	1.44	4.62
2019	2.18	0.21	0.46	0.26	0.001	0.03	1.31	4.44
2020	2.35	0.09	0.48	0.25	0.001	0.03	1.21	4.42
2021	2.16	0.08	0.45	0.22	0.001	0.03	1.20	4.14
2022	2.16	0.10	0.45	0.20	0.001	0.03	1.19	4.14
Share in total 1990 emission, %	19.4	10.6	57.4	2.5	0.2	0.1	9.6	
Share in total 2022 emission, %	52.2	2.3	11.0	4.9	0.0	0.7	28.8	
Change 1990-2022, %	**0.8**	**-91.8**	**-92.8**	**-27.2**	**-96.9**	**98.3**	**12.2**	**-62.5**
Change 2021-2022, %	**-0.2**	**20.1**	**0.7**	**-6.0**	**-3.4**	**-5.2**	**-0.7**	**-0.2**

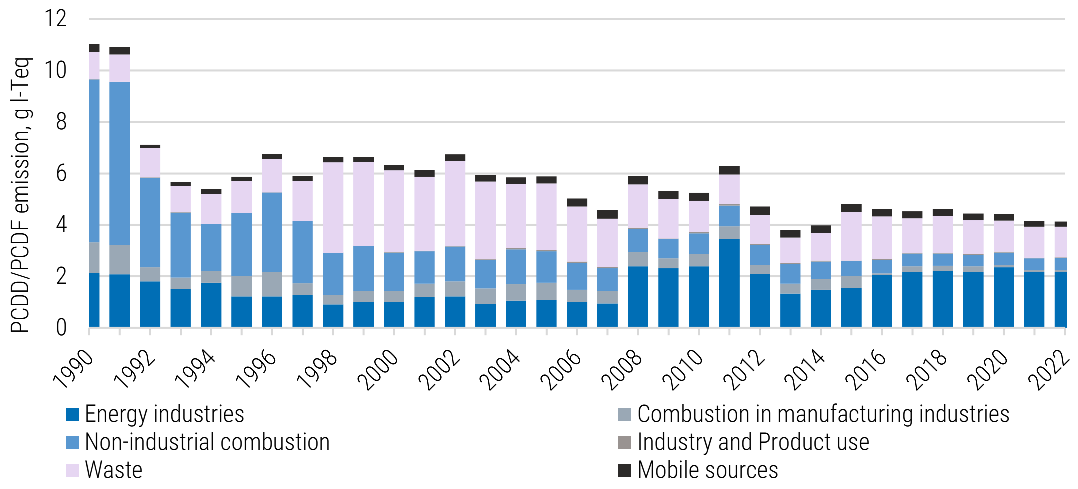


Figure 2.39 PCDD/PCDF emissions in the period of 1990–2022

Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. These are the results of the increasing tendency towards wood and wood waste combustion (the dioxin emission factor for biomass is much higher for the domestic stoves).

The main sources of dioxins emission in 2022 are combustion in energy industries (52.2%, includes also waste combustion as fuel), the waste sector (28.8%, mainly unintentional car and building fires), non-industrial combustion sector (11%),and other sources (8%, includes industrial combustion, IPPU sector and mobile sources) (see Figure 2.40).

The total dioxin emission in 2022 compared to 2021 decreased very slightly (0.2%), mainly due to lower emissions in the road transport and waste sectors (decrease in the number of car and house fires).

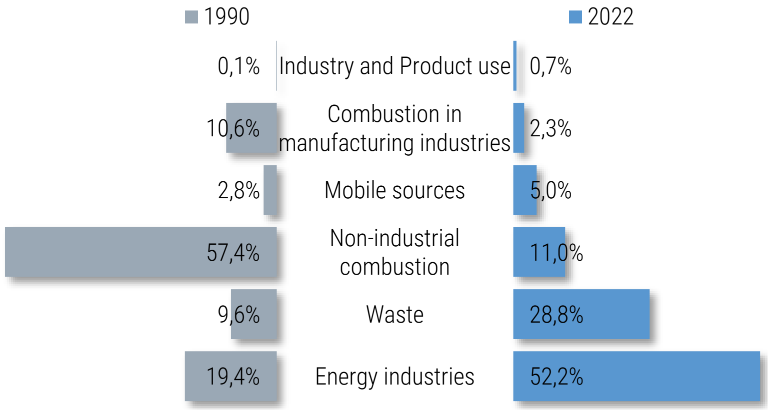


Figure 2.40 PCDD/PCDF emission by sources of pollution in the period of 1990 and 2022

2.4.2 Polycyclic Aromatic Hydrocarbons (PAHs)

For the purposes of emission inventories, the following four indicator compounds shall be used:

- benzo(a)pyrene,
- benzo(b)fluoranthene,
- benzo(k)fluoranthene,
- indeno(1,2,3-cd)pyrene.

Emissions for each substance in the period 1990–2022 are shown in the table 2.21.

In this chapter carried out a sum of four substances (PAHs) analysis.

In the period between 1990-2022, the emissions of PAHs decreased by 62% due to the decrease in electricity and heat production in all energy industries sectors. One of the reasons of the significant decrease in emission from 1992 to 1994 the decrease of coal and peat consumption by residential sector (the PAHs emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion), see Table 2.21. Growth in wood consumption by the same sector the reason of increase in emissions since 1995. It should be noted that emissions from non-industrial combustion sector decreased between 2000 and 2022, despite the increase in biomass burned in the residential sector. The reason for this is the growing in the last year's share of new high-efficiency technologies (see Figure 2.41).

Table 2.23 PAHs emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	0.75	0.35	8.65	0.04	0.034	0.001	0.031	9.86
1995	0.24	0.32	9.72	0.03	0.013	0.001	0.042	10.37
2000	0.21	0.20	7.25	0.03	0.010	0.000	0.046	7.74
2005	0.27	0.30	5.13	0.04	0.013	0.001	0.019	5.77
2010	0.21	0.23	5.45	0.04	0.013	0.000	0.012	5.96
2015	0.29	0.19	3.75	0.05	0.012	0.000	0.006	4.29
2016	0.46	0.06	3.75	0.05	0.012	0.000	0.007	4.34
2017	0.54	0.04	3.64	0.05	0.011	0.000	0.007	4.29
2018	0.57	0.04	3.54	0.05	0.011	0.000	0.007	4.22
2019	0.53	0.04	3.30	0.05	0.010	0.000	0.007	3.95
2020	0.58	0.09	3.30	0.05	0.010	0.000	0.007	4.04
2021	0.43	0.04	3.10	0.06	0.007	0.000	0.007	3.64
2022	0.46	0.05	3.17	0.06	0.008	0.000	0.007	3.75
Share in total 1990 emission, %	7.6	3.6	87.7	0.4	0.3	0.0	0.3	
Share in total 2022 emission, %	12.2	1.3	84.5	1.6	0.2	0.0	0.2	
Change 1990-2022, %	**-39.1**	**-86.3**	**-63.4**	**35.0**	**-75.4**	**-66.5**	**-78.1**	**-62.0**
Change 2021-2022, %	**4.9**	**23.5**	**2.3**	**3.6**	**20.3**	**-7.5**	**-1.3**	**2.9**

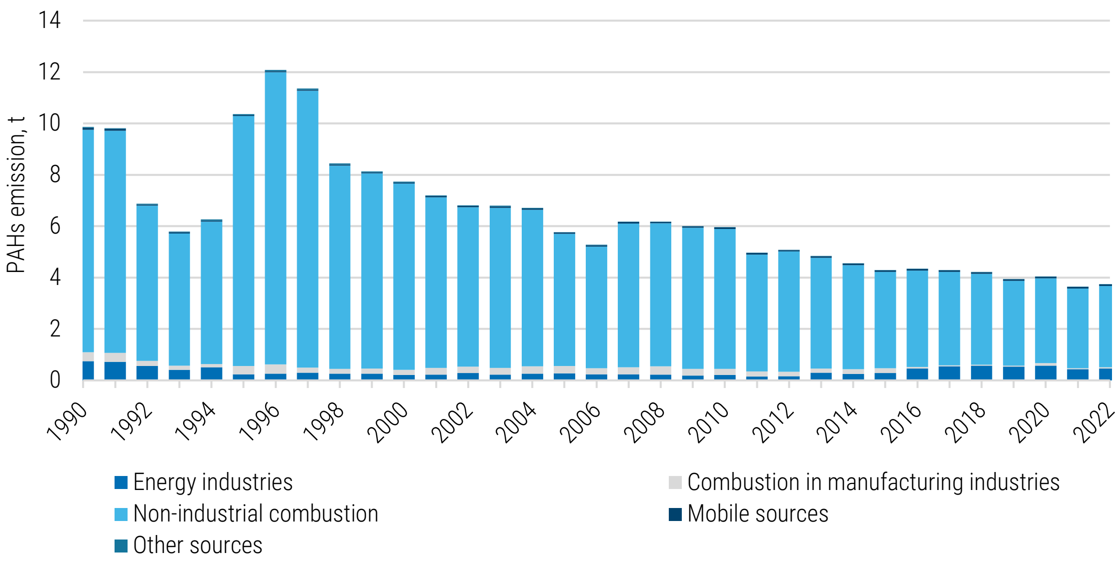


Figure 2.41 PAHs emissions in the period of 1990–2022

Non-industrial combustion is a key source of the total PAHs emissions in 2022 (84.5%), mainly from solid biomass combustion in the residential sector. The contribution of residential sector in total emission is 75.3%. The share of energy industries sector and mobile sources are 12.2% and 1.8% respectively. The contribution of other sources (industrial combustion, waste and industry) is insignificant, only 1.5% (see Table 2.23 and Figure 2.42).

PAHs emissions in 2022 increased by about 3% compared to 2021, mainly due to an increase in the amount of wood burned in all energy sectors.

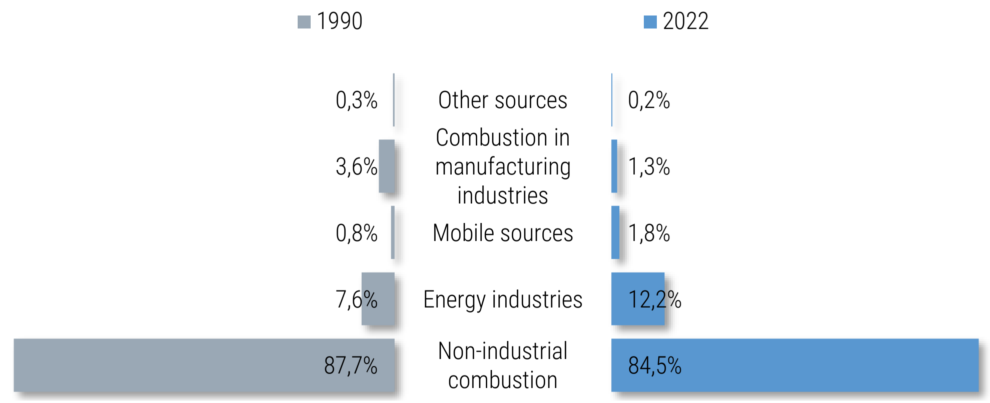


Figure 2.42 PAHs emission by sources of pollution in the period of 1990 and 2022

2.4.3 Hexachlorobenzene (HCB)

During the period of 1990–2022, the emissions of HCB has decreased by about 8.7% being largely influenced by a reduction in the amount of open burned waste. However, during the same period, emissions from the energy industires and non-industrial combustion sectors increased by 46.4% and 87.5%, respectively, as a result of an increase in the amount of biomass burned.

The stationary combustion is responsible for the a slight increase in HCB emissions in 2022 compared to 2021 by 0.8% due to an increase in the amount of biomass burned. During the same period, emissions from the waste sector fell by 7.7% as a result of decrease in amount of open burned waste.

Table 2.24 HCB emissions by sector (kg), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	0.127	0.007	0.101	0.0002	0.002	IE	0.307	0.544
1995	0.077	0.020	0.230	0.0001	0.001	IE	0.419	0.748
2000	0.079	0.021	0.208	0.0002	0.001	IE	0.459	0.768
2005	0.095	0.031	0.173	0.0003	0.001	IE	0.190	0.490
2010	0.144	0.025	0.228	0.0003	0.001	0.002	0.131	0.531
2015	0.137	0.023	0.184	0.0003	0.001	0.002	0.084	0.431
2016	0.177	0.004	0.191	0.0003	0.001	0.003	0.086	0.461
2017	0.192	0.005	0.192	0.0003	0.001	0.002	0.092	0.484
2018	0.204	0.006	0.192	0.0003	0.001	0.002	0.094	0.498
2019	0.176	0.005	0.184	0.0003	0.000	0.001	0.096	0.463
2020	0.174	0.004	0.189	0.0002	0.001	0.001	0.133	0.502
2021	0.180	0.003	0.182	0.0002	0.001	0.002	0.124	0.492
2022	0.185	0.004	0.190	0.0002	0.001	0.002	0.115	0.496
Share in total 1990 emission, %	23.3	1.3	18.6	0.0	0.3		56.5	
Share in total 2022 emission, %	37.6	0.8	38.5	0.0	0.1	0.4	23.3	
Change 1990-2022, %	**46.4**	**-43.3**	**87.5**	**0.5**	**-66.3**		**-62.7**	**-8.7**
Change 2021-2022, %	**2.8**	**27.3**	**4.0**	**-6.1**	**-3.4**	**13.2**	**-7.7**	**0.8**

The key sources of HCB emission in 2022 are non-industrial combustion, the energy industries and waste sectors (38.2%, 37.3% and 23.1% respectively). The other sources (combustion in manufacturing industries, mobile sources and industry) contribute only 1.3% in total emission. The share of mobile sorces are 0.1%. Emission from industry (the secondary aluminium production) were only 0.4% of total HCB emission (see Table 2.24 and Figures 2.43 - 2.44).

Return to the Table of Contents

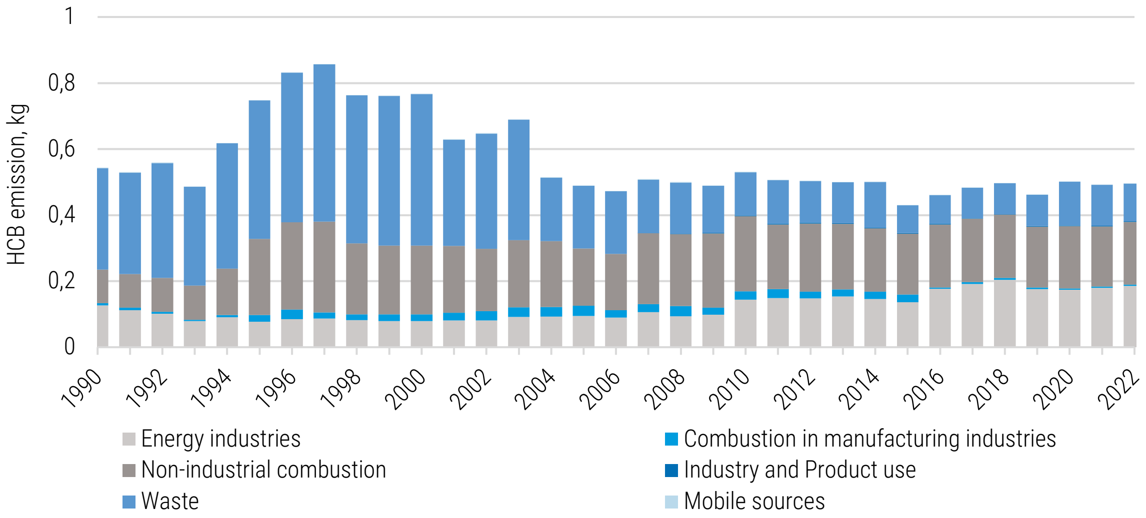


Figure 2.43 HCB emissions in the period of 1990–2022

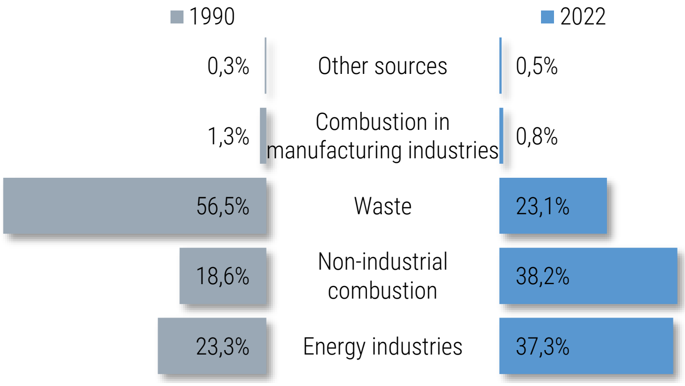


Figure 2.44 HCB emission by sources of pollution in the period of 1990 and 2022

2.4.4 Polychlorinated biphenyls (PCB)

During the period of 1990–2022, the emissions of PCB had decreased by about 88.4% due to the decrease in energy production as well as a reduction in the amount of open burned waste. Emission reduction between 1990 and 1994 was observed as a result of decrease coal and peat consumption in energy sector (see Tables 2.21, 2.25 and Figure 2.45).

Table 2.25 PCB emissions by sector (kg), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	2.27	0.44	1.19	0.0001	0.02091	0.00006	0.96	4.88
1995	0.77	0.29	0.41	0.0000	0.00690	0.00001	1.32	2.79
2000	0.60	0.14	0.26	0.0000	0.0014	0.00003	1.44	2.43
2005	0.66	0.15	0.22	0.0001	0.0005	0.00004	0.59	1.62
2010	0.72	0.09	0.08	0.0001	0.0004	0.00005	0.37	1.26
2015	0.54	0.04	0.04	0.0001	0.0003	0.00003	0.21	0.83
2016	0.59	0.05	0.05	0.0001	0.0002	0.00003	0.21	0.90
2017	0.72	0.05	0.02	0.0001	0.0003	0.00003	0.21	1.01
2018	0.60	0.05	0.02	0.0001	0.0003	0.00003	0.22	0.90
2019	0.32	0.05	0.02	0.0001	0.0002	0.00003	0.23	0.63

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
2020	0.29	0.03	0.02	0.0001	0.0003	0.00003	0.23	0.56
2021	0.26	0.00	0.01	0.0000	0.0002	0.00003	0.23	0.50
2022	0.33	0.00	0.02	0.0000	0.0002	0.00003	0.22	0.57
Share in total 1990 emission, %	46.4	9.0	24.4	0.0	0.4		19.7	
Share in total 2022 emission, %	57.8	0.00	2.9	0.01	0.04	0.00	39.3	
Change 1990-2022, %	-85.6	-100.0	-98.6	-37.9	-98.9	-53.4	-76.9	-88.4
Change 2021-2022, %	27.6	-99.4	14.0	-6.4	-3.6	-5.1	-2.1	13.3

The key sources of PCB emission in 2022 are energy industries sectors (57.8%, mainly oil shale and peat burning) and waste sector – (39.3%, mainly open burning of waste). The share of non-industrial combustion is 2.9%, combustion in manufacturing industries is 0.001%. Emission from industry (the secondary lead and zinc production) were only 0.005% of total PCB emission. The mobile sources contribute 0.05% in total PCB emission (see Table 2.25 and Figure 2.46).

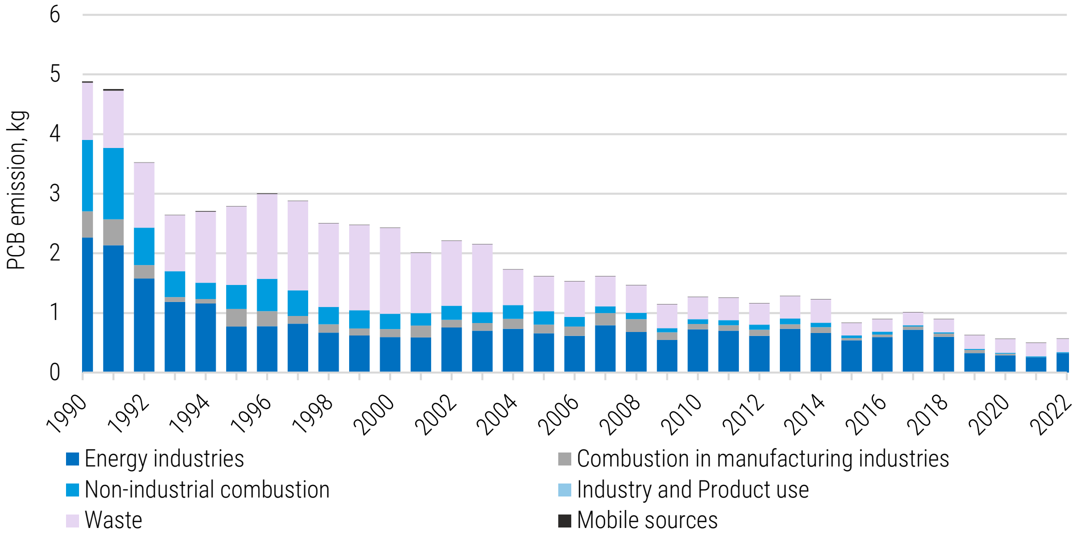


Figure 2.45 PCB emissions in the period of 1990–2022

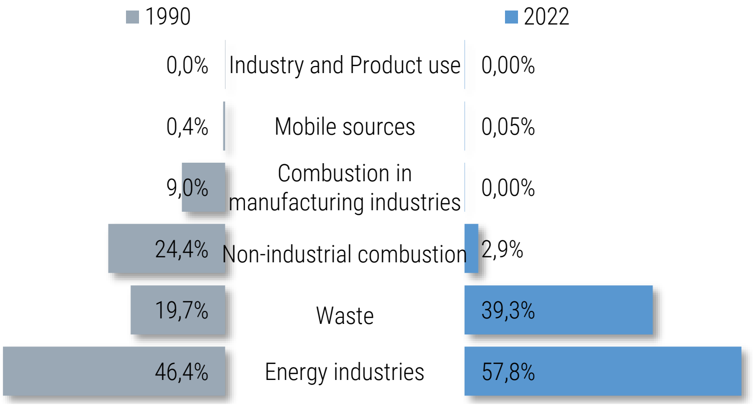


Figure 2.46 PCB emission by sources of pollution in the period of 1990 and 2022

Photo: Piret Pärnpuu

3. ENERGY SECTOR (NFR 1)

Return to the Table of Contents

3.1. Overview of the Sector

The energy sector includes stationary fuel combustion (NFR 1A1, NFR 1A2, NFR 1A4), mobile sources (NFR 1A3), and fugitive fuel emissions (NFR 1B).

The energy sector is a key source of all pollutants emissions, excluding ammonia.

Estonia is relatively rich in natural resources, both mineral and biological. It is a unique country whose energy production depends primarily on the use of oil shale. In 2022, the share of domestic fuels – oil shale, wood and peat – accounted for approximately 86.2% (from which oil shale is about 61%) of the primary energy supply. Coal, natural gas and liquid fuels were imported to Estonia in 2022. Imports of natural gas (90% from Latvia) in 2022 approximately doubled compared to 2021, half of which were exported to Finland. Gas consumption at the same time decreased by 26%. Consumption of motor gasoline increased slightly compared to the previous year, by approximately 3.8%, while diesel fuel remained almost at the 2021 level. Imports of coal decreased by about 43% compared to 2021 and by about 94% compared to 2019 predominantly due to the cessation of clinker production at the cement plant. Imported fuels (natural gas, fuel oils, coal, and motor fuels) made up 3.1% (see Figure 3.1).

Due to energy security concerns, proportion of natural gas has remained small in Estonian energy mix. Recent developments in Estonian biogas sector have increased the share of locally sourced biogas used for electricity and heat production.

According to Statistics Estonia, electricity production in 2022 increased by almost 24% compared to 2021 and electricity import has decreased 2%. At the same time, the amount of electricity generated from oil shale has increased 47,4%.

In Estonia, renewable energy is generated from hydro-, wind and solar energy as well as from biomass. Since electricity generation has accelerated in hydroelectric power plants and wind parks, the proportion of renewable energy has increased. The generation of hydro energy has been stable over the past years and in 2022 was at the level of 2021 - 23 GWh). The share of wind energy in gross electricity production in 2022 is 7.4% and has decreased by 9% compared with 2021; solar is 6.7% (has increased by about 69% compared with 2021) and hydro energy only 0.3% (Statistics Estonia). In 2005, electricity generated from renewable energy sources was only 1.1%, but in 2022, it accounted for 32% (see Figure 3.2). The growth was due to the enlargement of the existing wind and solar parks and the commissioning of new combined heat and power plants working on biomass fuel.

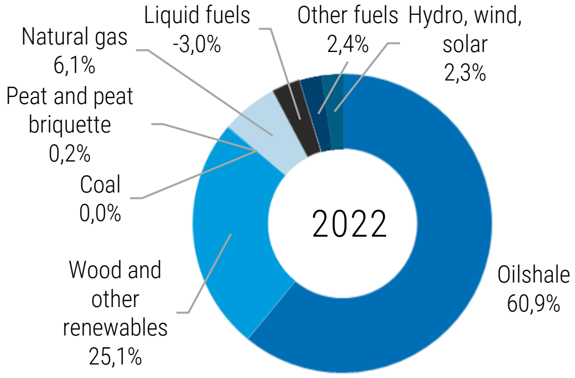


Figure 3.1 Structure of primary energy supply in Estonia in 2022

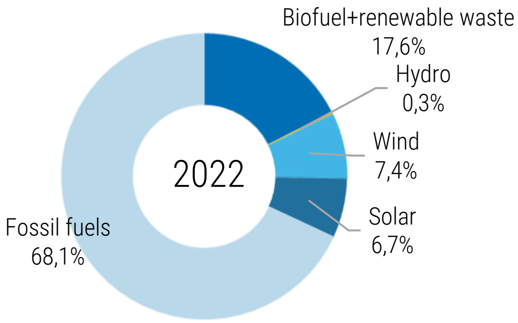


Figure 3.2 Gross electricity production by sources in 2022 *(Source: Statistics Estonia)*

The energy sector is the main source of SO_2, NO_x, CO, particulates, HMs and POPs in Estonia. In 2022, the energy sector contributed 99.9% of total SO_2 emissions, 88.6% of total NO_x emissions, 86.2% of $PM_{2.5}$ emissions, 29.7% of total NMVOC emissions, 99.2% of total CO emissions, and 90.6% of Pb emissions (see Figure 3.4 - 3.6 and Table 3.1).

Table 3.1 Pollutant emissions from the energy sector in the period of 1990–2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	69.74	30.60	279.02	0.16	NR	NR	253.67	NR	242.99
1995	45.69	23.40	116.75	0.22	NR	NR	111.40	NR	205.91
2000	42.57	22.41	97.02	0.28	9.29	23.20	56.58	1.54	176.76
2005	40.41	17.82	76.41	0.42	7.15	12.10	18.47	1.42	141.74
2010	40.12	13.62	83.10	0.53	9.89	17.29	21.52	1.48	149.17
2015	28.35	10.13	36.06	0.44	6.14	9.23	11.74	1.14	113.28
2016	28.87	10.16	34.99	0.45	5.51	7.92	10.32	1.18	117.98
2017	29.32	9.92	38.84	0.43	5.80	8.42	11.08	1.17	128.70
2018	28.16	9.92	30.74	0.45	5.44	7.69	10.38	1.15	124.55
2019	22.95	9.15	18.72	0.46	4.46	6.03	8.47	1.06	121.90
2020	20.60	8.91	10.94	0.43	4.16	5.49	7.54	1.13	118.45
2021	19.89	8.04	11.73	0.38	3.91	5.10	7.08	1.09	108.01
2022	20.75	7.86	14.65	0.40	4.23	5.48	7.87	1.16	105.52
Change 1990-2022 %	**-70.2**	**-74.3**	**-94.7**	**156.5**	**-54.4**	**-76.4**	**-97.2**	**-24.9**	**-56.6**
Change 2021-2022, %	**4.3**	**-2.3**	**24.9**	**4.5**	**8.2**	**7.5**	**11.1**	**6.4**	**-2.3**

Table 3.1 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	201.69	4.42	1.21	19.80	17.11	14.54	26.21	9.20	104.96
1995	82.91	2.16	0.64	9.74	9.00	7.81	9.97	4.91	60.92
2000	29.78	0.74	0.46	6.70	6.84	6.99	6.04	3.63	43.51
2005	9.11	0.49	0.17	1.72	3.44	8.52	3.28	1.43	26.09
2010	8.30	0.57	0.20	2.02	4.29	9.46	3.28	1.78	31.77
2015	4.78	0.52	0.18	0.93	2.74	9.50	2.48	1.04	25.20
2016	4.93	0.53	0.19	1.04	3.06	10.04	2.69	1.17	27.56
2017	5.07	0.55	0.20	1.08	3.27	10.49	2.65	1.29	29.42
2018	4.87	0.54	0.20	0.96	2.97	10.66	2.34	1.20	29.95
2019	4.22	0.47	0.17	0.61	1.81	9.83	1.74	0.73	25.27
2020	3.83	0.46	0.16	0.51	1.50	9.23	1.61	0.56	24.98
2021	3.58	0.41	0.17	0.54	1.73	9.84	1.48	0.58	24.21
2022	3.78	0.44	0.16	0.64	2.11	10.47	1.68	0.70	26.28
Change 1990-2022, %	**-98.1**	**-90.0**	**-86.4**	**-96.8**	**-87.7**	**-27.9**	**-93.6**	**-92.4**	**-75.0**
Change 2021-2022, %	**5.8**	**7.5**	**-2.6**	**19.2**	**22.1**	**6.5**	**13.0**	**21.5**	**8.6**

Table 3.1 continues

Year	PCDD/F	PAHs (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	9.96	9.83	0.24	3.92
1995	4.63	10.32	0.33	1.48
2000	3.13	7.69	0.31	0.99
2005	3.25	5.75	0.30	1.03
2010	3.98	5.95	0.40	0.89
2015	2.89	4.29	0.34	0.62
2016	2.93	4.33	0.37	0.69
2017	3.16	4.29	0.39	0.79
2018	3.15	4.21	0.40	0.67
2019	3.10	3.94	0.37	0.40
2020	3.18	4.04	0.37	0.33
2021	2.91	3.64	0.37	0.27
2022	2.91	3.74	0.38	0.34
Change 1990-2022, %	**-70.7**	**-61.9**	**60.5**	**-91.2**
Change 2021-2022, %	**0.1**	**2.9**	**3.6**	**26.2**

During the period of 1990–2022, the emissions of sulphur dioxide from the energy sector decreased by 94.7% and the emissions of nitrogen oxides by about 70.2% resulting from a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 277 PJ in 1990 to 123.1 PJ in 2022) (see Figure 3.3 and Figure 3.4 and Table 3.1). The other reason for the drop in emissions in last years was installation of the semi-dry NID (Novel Integrated Desulphurisation) technology in the Eesti Energia Narva Elektrijaamad AS (Eesti PP), which uses the fly ash in the gas itself and does not require any additional compounds to bind the SO_2. With regard to the energy units, which are not equipped with the clearing equipment, alternative methods of reduction of SO_2 emissions are used, such as water injection to furnaces of PC (old pulverised combustion boilers). Water injection lowers the flame temperature and therefore improves conditions for sulphur captured with limestone included in oil shale.

In terms of the efficiency of electricity generation, the renovation of two units in the Narva PP of Eesti Energia AS was essential. These resulted in introducing a new technology – the combustion of oil shale in a low-temperature circulating fluidised bed (CFB). Renovation of the 8th unit in the Eesti PP was completed in November 2003. Since the beginning of 2004, the new and more efficient unit has been in constant commercial use. In 2005, the specific fuel consumption for electricity generation in Narva Elektrijaamad AS decreased as a result of shutting down the older boilers: in May 2005, Narva Elektrijaamad AS terminated the use of the old low-efficiency and high-polluting equipment of the first three stages in the Balti PP. On 1 June 2005, the renovated unit No 11 in the Balti PP was launched. The two boilers of the new unit fire oil shale in a circulating fluidised bed. The new units save more than 20% in fuel. The pollution level is several times lower than that stipulated in EU environmental regulations.

In order to meet the targets of different EU legislations, a five-year research and testing project was completed in the beginning of 2012 by installing unique desulphurisation systems on four generating units of the Eesti PP.

According to the Resolution of the Riigikogu General Principles of Climate Policy until 2050 Estonia will be a competitive economy with low carbon dioxide emissions. Various measures are provided in the national programs to prevent climate change and reduce emissions into the atmosphere, the energy development program, one of which is the steady decline in the share of oil shale energy, as the main source of greenhouse gases and other substances polluting the atmosphere. In addition to the early measures taken, in spring 2020, 3 power units at the Enefit Power AS oil shale Estonian Power Plant were closed and one unit at the Baltic power plant was not operating in 2020.

Only ammonia and HCB emissions have increased in comparison with the figures from the 1990s due to the growth of wood and wood waste consumption. An increase in ammonia emissions is also associated with an increase in shale oil production (Table 3.1).

In 2022, SO_2 emissions from energy sector had increased by about 24.9% compared to 2021. The main reason for the increase in emissions is due to an increase in electricity production of approximately 24%.

2021 was the year of economic recovery after the COVID-19 pandemic, which caused an increase in energy consumption. However, the war against Ukraine launched by Russia in February 2022 caused an energy crisis in Europe, which used to be highly dependent on cheap natural gas imports from Russia.

The price of electricity produced from natural gas (and also the reduction in its consumption) was higher than the price of electricity produced from oil shale. This has led to an increase in electricity production from oil shale (about 47% more than in 2021), which in turn has led to an increase in SO_2 emissions. Another reason is the failure of power plants in nearby countries. The cold winter also caused an increase in heat production by 4.7%.

"The crisis was further aggravated by Russia's termination of electricity exports to Finland and the Baltic countries. As a result, electricity generation capacities of over 2,000 MW were cut off from the local market – this is more than the capacity of unit 3 of the Finnish Olkiluoto nuclear power plant.

The year 2022 proved that we could rely on our strategy even during the energy crisis: we continued offering customers energy solutions and flexibility services and investing in additional renewable electricity production assets. Even though we are going to discontinue the use of oil shale for electricity production by the end of the decade, last year's energy crisis drove up demand for oil shale power. We again fired up our thermal power plants to full capacity. Compared with 2021, our electricity output grew 20% and our oil shale mining increased by a third. Eesti Energia's output covered 71% of total electricity consumption in Estonia in 2022, making Estonia after a break of several years a net electricity exporter in May, June, July and September" (Hando Sutter, Chairman of the Management Board of Eesti Energia)[2]. In 2022, electricity exports increased by 31% compared to last year.

In 2022, NO_x emissions increased by 4.3% in comparison to 2021's figures. The increase in emissions from oilshale power plants was the main reasons for the increase in nitrogen oxide emissions in energy sektor.

In 2022, particulate emissions (TSP) increased by 11.1% in comparison to 2021, due to a increase of emissions from oilshale power plants and also due to a increase in the amount of biomass burned in the residential sector.

During this period, heavy metal emissions increased or decreased (Hg), which is explained by the different contribution of each energy sector, different emission factors and also the share of fuel burned (see Figure 3.4, Table 3.1).

The increase in emissions of POPs resulted from the small increase in the amount of biomass burned in the energy sector by boilers with a capacity of less than 50 MW as well as a increase in wood consumption in the domestic sector. The increase in the amount of oil shale burned in 2022 was the reason for the increase in PCB emissions.

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[2] Eesti Energia Annual Report 2022

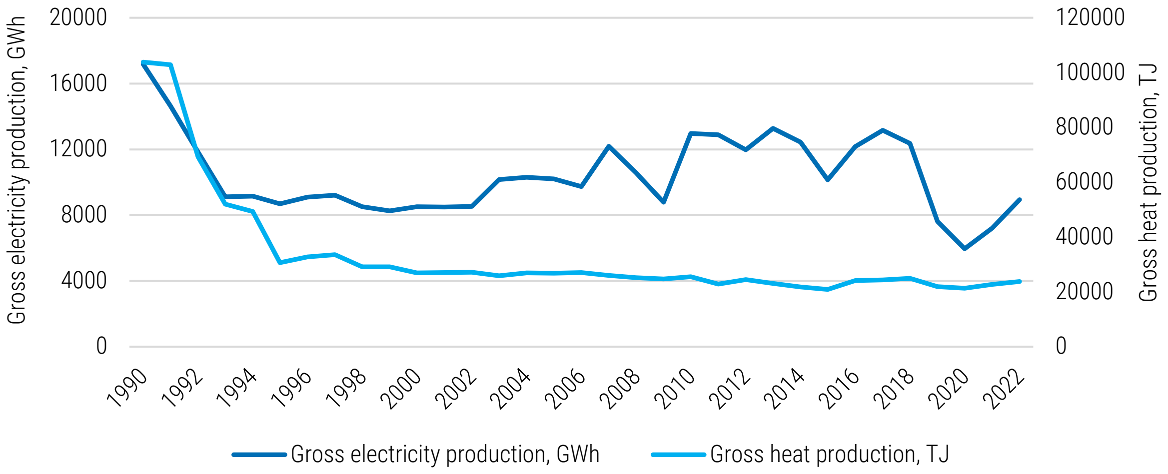

Figure 3.3 Electricity and heat production in the period of 1990–2022

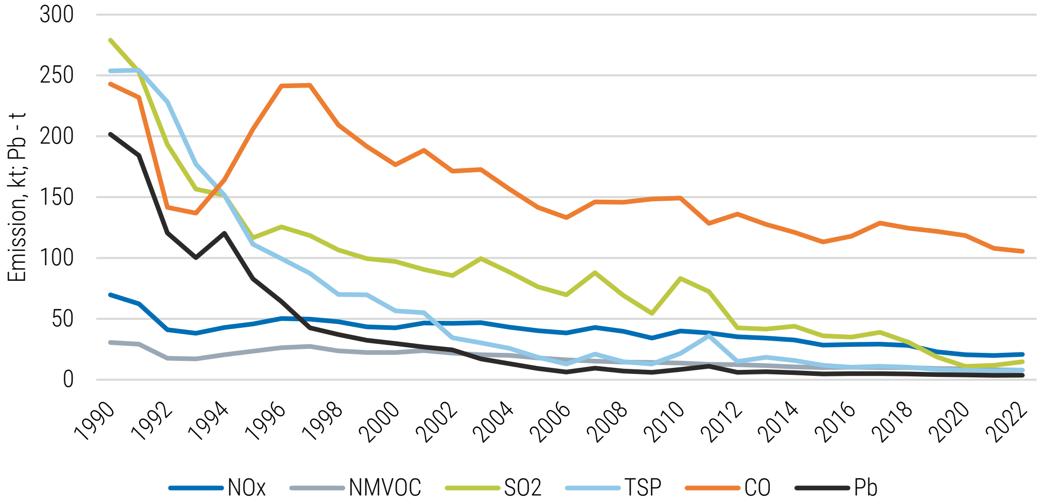

Figure 3.4 Pollutant emissions from the energy industry in the period of 1990–2022

Figure 3.5 Share of NO_x and SO_2 emissions from the energy sector in total emissions in 2022

Figure 3.6 Share of NMVOC and $PM_{2,5}$ emissions from the energy sector in total emissions in 2022

3.2. Stationary Fuel Combustion

3.2.1. Sector Overview

This chapter gives an overview of stationary fuel combustion, which includes energy industries (NFR 1A1), stationary combustion in manufacturing industries (NFR 1A2) and non-industrial combustion plants (NFR 1A4). Energy related activities (excluding transport) are the most significant contributors to SO_2 emissions – 99.5% in 2022. The share of mobile sources of the total emissions is very small – 0.2% (see Figure 3.8-3.9, includes in other sources).

The stationary fuel combustion sector is a key source for all pollutants except ammonia. Pollutant emissions in the 1990-2022 period and the distribution of emissions between stationary combustion and other sectors are presented in the Table 3.3, Figure 3.7-3.9.

3.2.1.1. Source Category Description

Sources category description are presented in the Table 3.2.

Table 3.2 Stationary fuel combustion activities

NFR	Source	Description	Method	Emissions reported
1A1		**Energy Industries**		
	a. Public electricity and heat production	Includes emissions from public power and district heating plants on the basis of point and diffuse sources.	Tier 2 (diffuse sources) Tier 3 (point sources)	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
	c. Manufacture of solid fuels and other energy industries	Includes emissions from solid fuel transformation plants. Only point sources data.	Tier 3	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
1A2		**Stationary combustion in manufacturing industries and construction**		
	a. Iron and steel	Includes emissions from processes with contact (SNAP 030303). Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Ni, Zn, PCDD/F
	b. Non-ferrous metals	Includes emissions from processes with contact (SNAP 030307 - secondary lead production, 030308 - secondary zinc production, 030310 - secondary aluminium production). Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Se, Zn, PCDD/F
	c. Chemicals	Includes emissions from combustion plants of this activity. Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs, PCDD/F
	d. Pulp, Paper and Print	Includes emissions from combustion plants of this activity. Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3,TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs, PCDD/F, HCB, PCBs
	e. Food processing, beverages and tobacco	Includes emissions from combustion plants and other stationary equipment of this activity. Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
	f. Non-metallic minerals	Includes emissions from all boilers in the manufacturing industry, other processes with contact: cement, lime, glass, bricks and other productions. (SNAP 0301, 030311-030320). Point (before 2020) and diffuse sources data.	Tier 2, Tier 3	NO_x, SO_x, NMVOC, NH_3,TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs, PCDD/F, HCB, PCBs
	gviii. Other	Includes emissions from all boilers in the manufacturing industry, other processes with contact: (SNAP 030204-030205; 030326). Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3,TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs, PCDD/F, HCB, PCBs
1A4		**Non-industrial combustion plants**		
	ai Commercial / institutional: Stationary	Includes emissions from boilers or other equipment in the commercial sector. Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
	bi Residential: Stationary plants	Includes emissions from boilers and other equipment in the residential sector. Only diffuse sources data.	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
	ci Agriculture/Forestry/Fishing: Stationary	Includes emissions from boilers and other equipment in the agriculture and forestry sectors. Data of diffuse sources.	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
1A5a	**Other stationary (including military)**			IE, reported under 1A4ai

Return to the Table of Contents

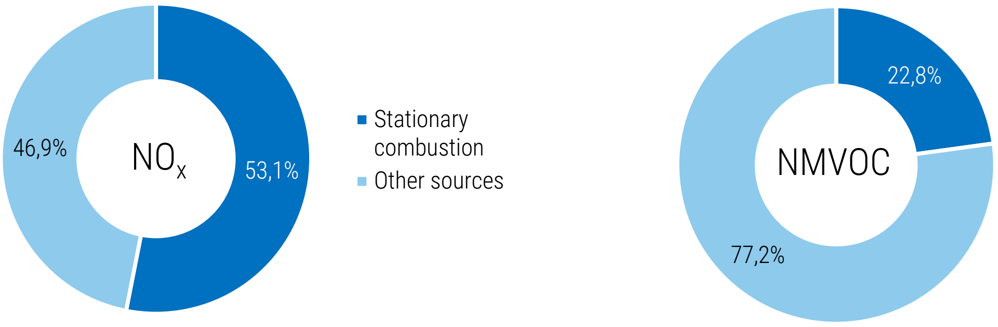

Figure 3.7 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2022

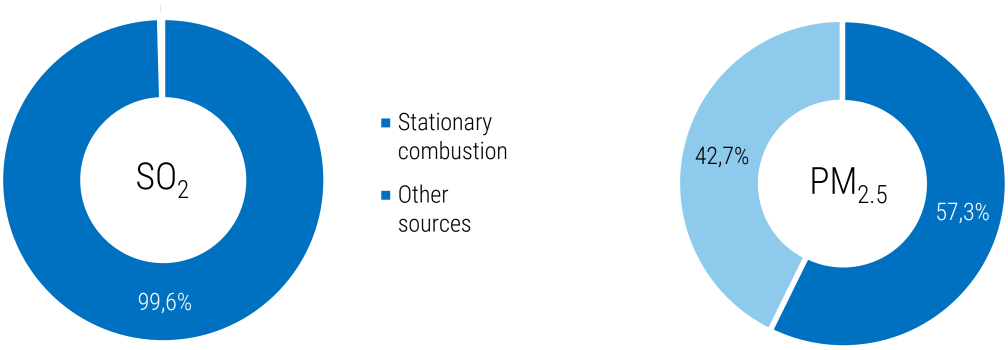

Figure 3.8 SO_2 and $PM_{2.5}$ emissions from stationary fuel combustion and other sources in 2022

Table 3.3 Pollutant emissions from stationary fuel combustion in the period of 1990–2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	36.08	8.17	273.90	0.11	NR	NR	249.86	NR	94.79
1995	25.93	10.17	113.35	0.18	NR	NR	108.97	NR	139.30
2000	23.25	8.13	94.08	0.17	8.02	21.59	54.09	1.19	113.21
2005	20.28	7.22	76.02	0.20	5.42	9.88	14.99	0.93	94.88
2010	24.25	8.34	82.96	0.31	8.25	15.11	17.86	1.10	120.19
2015	16.08	6.70	35.99	0.28	4.38	6.88	7.65	0.84	94.37
2016	17.38	6.72	34.93	0.29	3.75	5.54	6.17	0.89	95.91
2017	18.24	6.79	38.78	0.27	3.91	5.88	6.59	0.90	107.85
2018	17.54	7.07	30.67	0.30	3.53	5.10	5.79	0.89	107.66
2019	13.22	6.61	18.67	0.31	2.83	3.72	4.39	0.82	104.89
2020	11.58	6.64	10.89	0.31	2.84	3.52	4.07	0.90	107.35
2021	11.35	6.05	11.69	0.28	2.61	3.13	3.60	0.89	98.58
2022	12.44	6.04	14.60	0.30	2.81	3.41	4.20	0.97	97.38
Change 1990-2022, %	**-65.5**	**-26.1**	**-94.7**	**181.2**	**-64.9**	**-84.2**	**-98.3**	**-19.1**	**2.7**
Change 2021-2022, %	**9.6**	**-0.1**	**24.9**	**7.3**	**7.9**	**9.1**	**16.7**	**8.6**	**-1.2**

Table 3.3 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	122.99	4.42	1.20	19.79	16.77	7.01	26.12	9.19	102.53
1995	58.33	2.16	0.64	9.73	8.79	3.35	9.93	4.91	59.48
2000	24.39	0.74	0.45	6.70	6.62	2.16	5.99	3.62	41.96
2005	6.42	0.49	0.17	1.71	3.15	2.03	3.21	1.42	23.96
2010	7.44	0.57	0.20	2.01	3.98	2.63	3.21	1.77	29.56
2015	3.87	0.51	0.18	0.92	2.39	2.03	2.41	1.03	22.80

Return to the Table of Contents

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
2016	3.97	0.52	0.19	1.03	2.70	2.28	2.62	1.16	25.07
2017	4.07	0.54	0.19	1.07	2.90	2.47	2.58	1.28	26.83
2018	3.84	0.53	0.19	0.95	2.58	2.28	2.27	1.19	27.25
2019	3.18	0.47	0.16	0.60	1.43	1.43	1.67	0.73	22.57
2020	2.85	0.45	0.16	0.50	1.13	1.19	1.54	0.55	22.40
2021	2.55	0.41	0.16	0.52	1.34	1.47	1.41	0.57	21.54
2022	2.71	0.44	0.16	0.63	1.71	1.70	1.60	0.69	23.42
Change 1990-2021, %	**-97.8**	**-90.1**	**-86.7**	**-96.8**	**-89.8**	**-75.8**	**-93.9**	**-92.4**	**-77.2**
Change 2021-2022, %	**6.2**	**7.6**	**-2.7**	**19.5**	**27.1**	**15.1**	**13.4**	**21.6**	**8.7**

Table 3.3 continues

Year	PAH (4 total)	PCCD/F	HCB	PCB
	t	g I-Teq	kg	
1990	9.75	9.65	0.23	3.90
1995	10.28	4.45	0.33	1.47
2000	7.65	2.93	0.31	0.99
2005	5.70	2.97	0.30	1.03
2010	5.90	3.66	0.40	0.89
2015	4.23	2.58	0.34	0.62
2016	4.27	2.64	0.37	0.68
2017	4.22	2.88	0.39	0.79
2018	4.15	2.88	0.40	0.67
2019	3.88	2.84	0.36	0.40
2020	3.97	2.92	0.37	0.33
2021	3.57	2.69	0.37	0.27
2022	3.67	2.71	0.38	0.34
Change 1990-2022, %	**-62.3**	**-71.9**	**61.3**	**-91.2**
Change 2021-2022, %	**2.8**	**0.6**	**3.6**	**26.3**

The energy industry sector (NFR 1A1a-c) is responsible for the about 95.5% of Estonian total SO_2 emissions, 30.7% of NO_x, 39.6% of CO, 13.9% of $PM_{2.5}$, and 20.7% of Pb in 2022. The main contributors to SO_2 pollution are oil shale and shale gas work gas burning plants (about 83%).

Estonian oil shale is high-ash shale (up to 46%) with low net caloric value (8.4–9.0 MJ/kg) and sulphur content of 1.4% to 1.8%. Two different combustion technologies – the old pulverised combustion of oil shale and the new circulated fluidised bed combustion technology – are currently used in the Estonian power plants. In the combined heat and power block of the Balti PP, around 18% of the fuel used in 2022 is biomass, which is burned together with oil shale. The share of biomass burned at the Auvere oil shale station was 19% of the total amount of fuel consumed. This has significantly increased the proportion of renewable energy both in the Eesti Energia AS portfolio and in overall electricity production in Estonia.

The 3 oil shale power plants of Enefit Power AS contributed about 42% to the total SO_2 emissions in 2022. The Narva PP is investing in scrubbers to reduce sulphurous and nitrous wastes from flue gas in order to make energy production from oil shale cleaner and to ensure that the current production capacity can be maintained after the environmental requirements become stricter in 2012 and 2016.

In 2012, the desulphurisation equipment was finally installed in four blocks of Eesti PP. Eesti Energia AS also completed the building of an additional lime dosing system.

Studies and tests conducted in 2009 and 2010 showed that the nitrogen oxides emissions can also be cut below the limits permitted in the stricter environmental requirements that will enter into force in 2016, and in 2012, the instalment of the equipment (nitrogen oxides scrubbers) to reduce NO_x emissions of the Eesti

Return to the Table of Contents

PP was commenced. The most efficient and newest power plant at Eesti Energia is the Auvere power plant that was launched in 2015. It uses oil shale as its main fuel, and up to 50% of it can be replaced with biomass.

2022 was the tenth year when waste was used as fuel for the production of heat and electricity, which can save about 70 million m^3 of natural gas by generating energy from waste. After sorting household waste, another 300,000 tonnes of mixed municipal waste remains in Estonia, which is now used for producing heat and power in Enefit Green AS, Iru Power Plant. In 2022, 215.8 kt of mixed municipal waste was used to produce heat and electricity. The mixed municipal waste used in Iru plant is mostly local, but the power plant is also providing environment friendly waste management services to Irish and Finnish cooperation partners. Heat generated by Iru power plant is provided to the inhabitants of Maardu and Tallinn at prices that are up to 25% lower than before. Iru waste-to-energy unit impacts every single inhabitant in Estonia since the waste management in Iru is approximately twice cheaper than landfilling. The launching of waste-to-energy unit can be seen as a nation-wide environmental project: the Estonian waste management became environmentally friendlier and the large-scale landfilling in the country has ended.[3]

Combustion in energy industry (NFR 1A1) accounts for 95.9% of SO_2, 57.8% of NO_x, 42.5% of TSP and 43.3% of CO (the main part of carbon monoxide is emitted from shale oil production plant) in stationary combustion. Non-industrial combustion is responsible for about 57.3% of the total NMVOC and 56.6% of CO emissions in stationary combustion, for approximately 2.1% of SO_2 and 56.5% of TSP emissions. Combustion in manufacturing industries accounts for 2.5% of SO_2, for 1.1% of TSP and for the 0.1% of CO emissions in stationary combustion (see Figure 3.9-3.14).

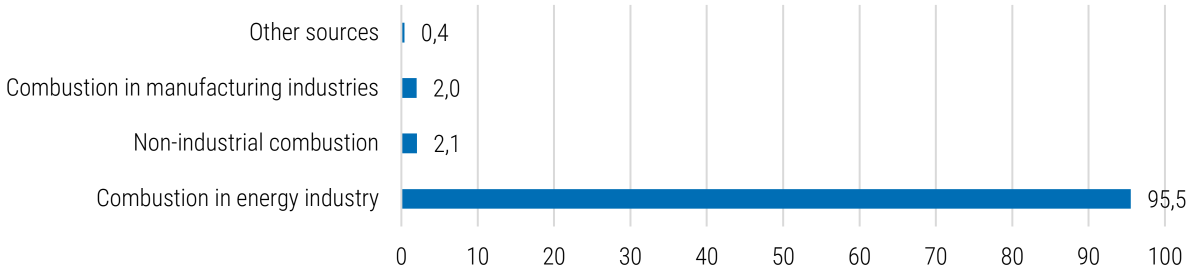

Figure 3.9 SO_2 emissions by sources of pollution in 2022 (%)

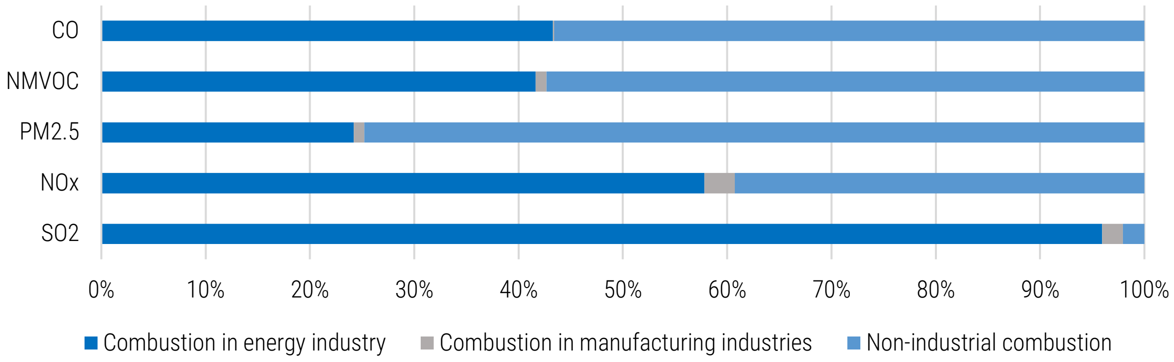

Figure 3.10 Distribution of pollutant emissions by sector in stationary combustion in 2022

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[33] Eesti Energia Keskkonnaaruanne_2014_eng. https://www.energia.ee/-/doc/8457332/keskkond/pdf/keskkonnaaruanne_2014_eng.pdf

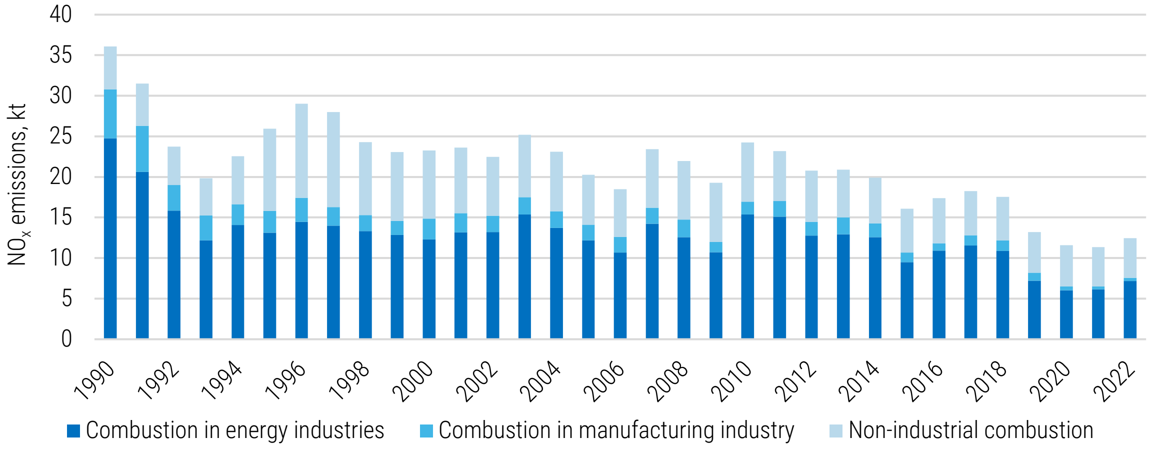

Figure 3.11 Distribution of NO_x emissions by sector in stationary combustion in the period of 1990–2022

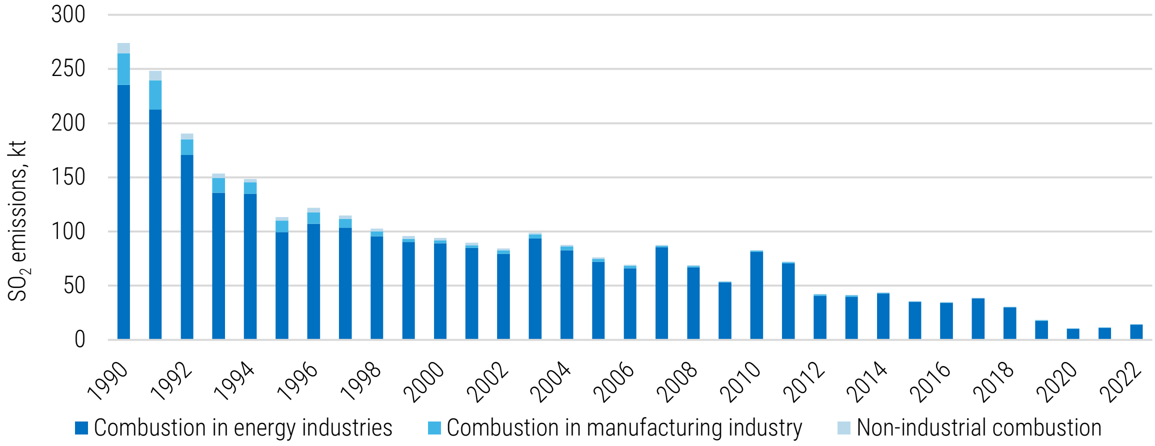

Figure 3.12 Distribution of SO_2 emissions by sector in stationary combustion in the period of 1990–2022

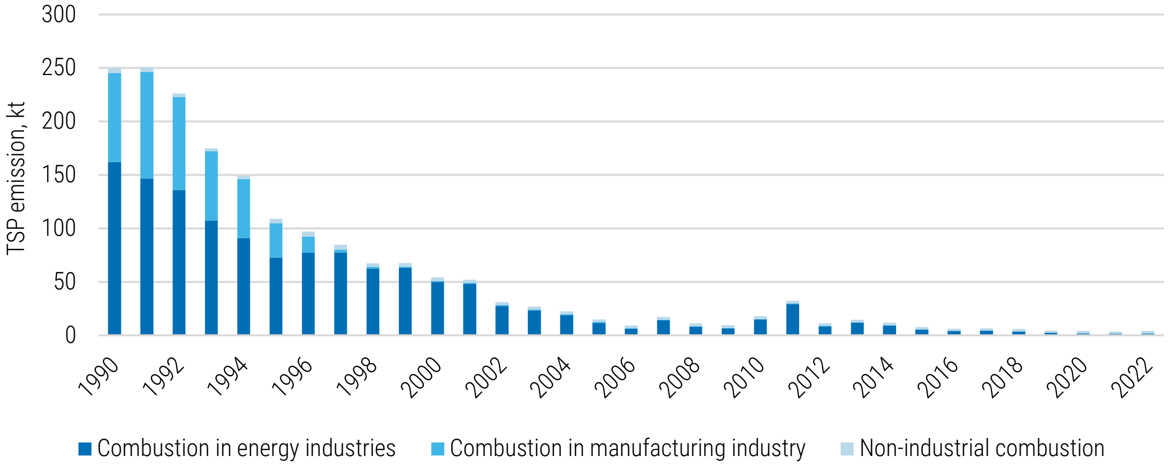

Figure 3.13 Distribution of TSP emissions by sector in stationary combustion in the period of 1990–2022

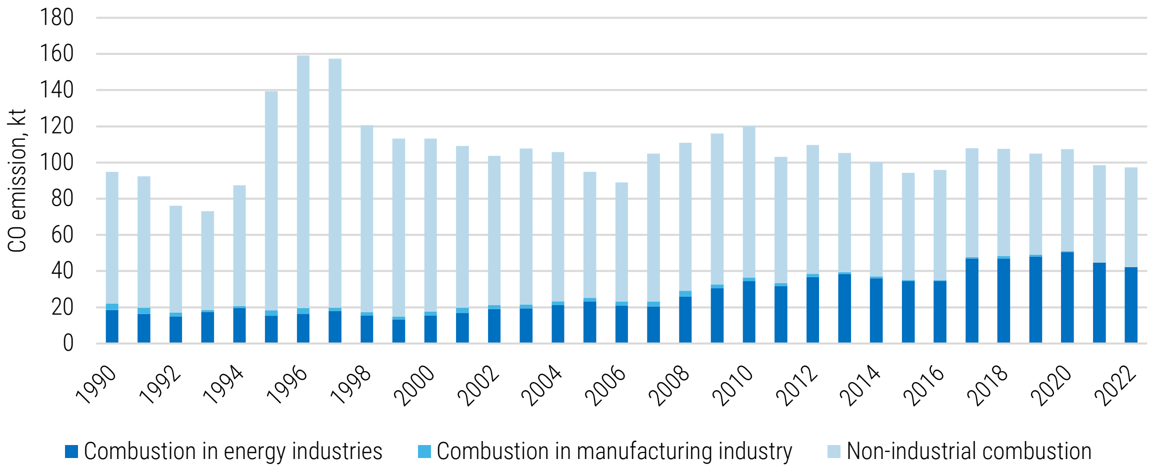

Figure 3.14 Distribution of CO emissions by sector in stationary combustion in the period of 1990–2022

3.2.1.2. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for main pollutants from stationary combustion sector is estimated in the range from 10% to 50%, for heavy metals and PAHs 50–200%, for dioxin 200%; in the activity data, in the range from 2% to 50%. Uncertainty estimates for stationary combustion are given in Table 3.4.

Table 3.4 Uncertainties in stationary combustion sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	12.44	kt	53.09	14.07	4.81
NMVOC	6.04	kt	22.83	7.13	3.81
SO_x	14.60	kt	99.57	8.75	0.14
NH_3	0.30	kt	2.91	1.16	0.50
$PM_{2.5}$	2.81	kt	57.28	24.58	15.16
PM_{10}	3.41	kt	37.86	14.24	8.21
TSP	4.20	kt	26.28	7.65	0.83
BC	0.97	kt	82.21	44.23	40.27
CO	97.38	kt	91.56	27.28	16.19
Pb	2.71	t	64.97	45.03	1.01
Cd	0.44	t	95.25	65.22	7.83
Hg	0.16	t	81.21	36.91	4.05
PCDD	2.71	g I-TEQ	65.49	105.22	42.04
benzo(a) pyrene	1.05	t	98.31	172.15	22.66
benzo(b) fluoranthene	0.99	t	97.63	154.25	17.59
benzo(k) fluoranthene	0.65	t	97.40	174.62	23.52
Indeno	0.98	t	98.50	189.45	36.54
HCB	0.38	kg	76.40	102.34	44.59
PCB	0.34	kg	60.64	115.68	5.13

3.2.2. Energy Industries (NFR 1A1)

3.2.2.1. Source Category Description

The energy industries are a key source of SO_2, NO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, CO, all heavy metals, and POPs emissions.

Energy industries sources category description are presented in the Table 3.5.

Table 3.5 Energy industries reporting activities

NFR	Description	Method	Activity data	Emissions factor
1A1a	Public electricity and heat production	Tier 2/Tier 3	Fuel consumption reported by operators; Energy balance from the Statistics Estonia	National EF; Measurements; Default EMEP/EEA Guidebook 2023
1A1c	Manufacture of solid fuels and other energy industries	Tier 3	Reported by operators	National methodologies; National EF; Measurements; Default EMEP/EEA Guidebook 2023

The energy and transformation industries sector is responsible for about 95.5% of total SO_2 emissions, 30.7% of NO_x, 13.9% of $PM_{2.5}$, 39.6% of CO, and 20.7% of Pb. The largest contributors of all pollutants are oil shale and shale gas work gas burning power plants, while for CO emissions the main source is shale oil production facilities.

Pollutant emissions from this sector and the trend in emissions are presented in the Table 3.6. The distribution of emissions of major pollutants by energy sector in 2022 is shown in Figure 3.15.

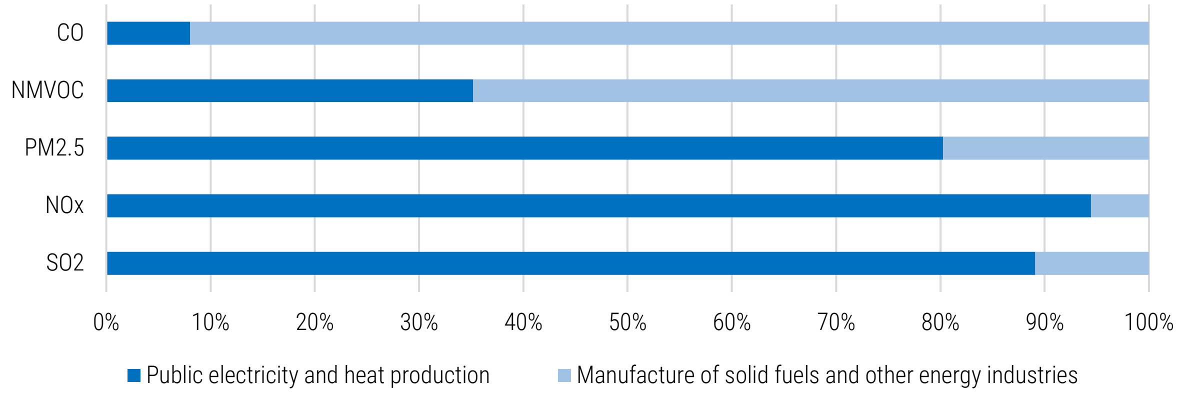

Figure 3.15 Distribution of pollutant emissions by sector in energy industries in 2022

During the 1990-2022 period, emissions of SO_2 decreased by 94% and NO_x emissions by 70.9%, resulting in a decline in energy production and also in the installation of desulphurisation technology by Enefit Power AS (see Chapters 3.1 and 3.2.1.1).

Particulate emissions also dropped significantly during the same period – by about 99%. A decrease in electricity production and the introduction of more effective clearing installations at oil shale power plants was the cause. The significant growth of particulates in 2011 was due to an increase in electricity production, and is a result of the poor operation of electric precipitators on two power units in the oil shale Balti Power Plant.

The increasing of shale oil production on the Enefit 140 installation was the main reason for an increase in emissions of ammonia about three times from 1990 to 2022.

The increase of carbon monoxide emissions by 127% was in the result of increasing shale oil production level (see Figures 3.17, 3.18).

In 2022, emission of SO_2, NO_x and TSP increased by 25.8%, 17% and 32.6% respectively compared to 2021's figures. The main reason for the increase in emissions is due to an increase in electricity production of approximately 24%. The price of electricity produced from natural gas (and also the reduction in its consumption) was higher than the price of electricity produced from oil shale. This has led to an increase in electricity production from oil shale (about 47% more than in 2021), which in turn has led to an increase in SO_2 emissions. Another reason is the failure of power plants in nearby countries. The cold winter also caused an increase in heat production by 4.7%. The same reasons were for increase in heavy metals and POPs emissions. A more detailed description of the reasons for the reduction in emissions can be found in chapter 3.1.

The decrease in emissions of CO compared to 2021's figures resulted from the decrease of shale oil production (Table 3.6, 3.18).

Table 3.6 Pollutant emissions from energy in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	24.74	1.58	235.31	0.07	NR	NR	162.15	NR	18.57
1995	13.13	1.08	99.35	0.07	NR	NR	72.71	NR	15.28
2000	12.30	1.08	89.01	0.09	4.70	18.02	49.84	0.15	15.60
2005	12.18	1.91	71.93	0.14	2.74	6.99	11.69	0.12	23.06
2010	15.36	2.43	81.22	0.22	5.62	12.30	14.78	0.17	34.51
2015	9.50	2.57	35.09	0.21	2.36	4.72	5.30	0.09	34.34
2016	10.94	2.71	34.18	0.22	1.80	3.48	3.95	0.10	34.61
2017	11.56	2.86	38.24	0.21	1.95	3.81	4.35	0.10	47.01
2018	10.88	3.11	30.13	0.23	1.59	3.05	3.58	0.09	46.90
2019	7.21	2.79	17.70	0.25	1.00	1.79	2.32	0.07	47.96
2020	6.02	2.97	10.17	0.24	0.82	1.39	1.79	0.08	50.52
2021	6.14	2.59	11.14	0.21	0.62	1.03	1.35	0.05	44.62
2022	7.19	2.51	14.01	0.23	0.68	1.16	1.78	0.06	42.15
Change 1990-2022, %	**-70.9**	**58.9**	**-94.0**	**254.2**	**-85.5**	**-40.6**	**-98.9**	**-60.8**	**127.0**
Change 2021-2022, %	**17.0**	**-3.0**	**25.8**	**8.6**	**10.1**	**12.9**	**32.3**	**7.0**	**-5.5**

Table 3.6 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	57.83	0.99	1.02	18.27	15.81	4.41	20.14	9.17	82.13
1995	29.90	0.53	0.51	9.17	8.11	2.22	7.81	4.89	43.42
2000	20.56	0.39	0.36	6.39	6.10	1.95	4.99	3.61	32.25
2005	3.61	0.17	0.09	1.44	2.66	1.82	2.27	1.41	13.80
2010	4.58	0.20	0.12	1.81	3.43	2.43	2.47	1.76	17.47
2015	1.74	0.20	0.12	0.71	1.92	1.86	1.51	1.02	12.40
2016	1.91	0.21	0.13	0.85	2.25	2.14	1.83	1.15	16.22
2017	2.11	0.23	0.14	0.90	2.45	2.33	1.86	1.27	17.77
2018	1.92	0.23	0.13	0.81	2.14	2.14	1.64	1.18	18.07
2019	1.25	0.18	0.10	0.44	0.99	1.27	0.97	0.72	13.74
2020	1.03	0.16	0.11	0.34	0.67	1.05	0.89	0.54	13.03
2021	0.84	0.12	0.12	0.39	0.91	1.35	0.86	0.56	12.46
2022	1.02	0.13	0.12	0.48	1.24	1.56	0.92	0.69	13.81
Change 1990-2022, %	**-98.2**	**-86.4**	**-88.6**	**-97.4**	**-92.1**	**-64.7**	**-95.4**	**-92.5**	**-83.2**
Change 2021-2022, %	**20.7**	**11.4**	**-3.1**	**21.6**	**36.9**	**15.8**	**7.7**	**21.9**	**10.9**

Table 3.6 continues

Year	PAH (4 total)	PCCD/F	HCB	PCB
	t	g I-Teq	kg	
1990	0.75	2.14	0.13	2.27
1995	0.24	1.22	0.08	0.77
2000	0.21	1.01	0.08	0.60
2005	0.27	1.08	0.09	0.66
2010	0.21	2.39	0.14	0.72
2015	0.29	1.55	0.14	0.54
2016	0.46	2.05	0.18	0.59
2017	0.54	2.17	0.19	0.72
2018	0.57	2.22	0.20	0.60
2019	0.53	2.18	0.18	0.32
2020	0.58	2.35	0.17	0.29
2021	0.43	2.16	0.18	0.26
2022	0.46	2.16	0.19	0.33
Change 1990-2022, %	-39.11	0.78	46.41	-85.55
Change 2021-2022, %	4.94	-0.19	2.76	27.59

NFR 1A1a Public electricity and heat production include pollutants emission data from large point sources (LPS) reported by operators and from diffuse sources. Emissions from the point sources are calculated on the basis of measurements (for boilers with capacity more than 100 MW continuous measurements), or the combined method (measurements plus calculations), or on the basis of national emission factors. Emissions from other sources are calculated based on energy balance/IEA questionnaire data (balance fuel minus LPS fuel) and national or Guidebook 2023 emission factors.

There are several oil shale power plants in Estonia, including three owned by Enefit AS, which are subject to continuous monitoring. SO_2 emissions from facilities using the new fluidized combustion technology are significantly lower compared to coal-fired power plants.

The Estonian inventory team sent questions for an additional explanation to the operator and Tallinn University of Technology. Below is given the explanation of the University, according to which Estonian Oil Shale (EOS) is a solid fossil fuel that has low heating value and high ash content. Oil shale burned in power plants has the following proximate characteristics: Wir = 9–13%, Ar = 45–57%, CO_2 = 16–19%, and Qir = 7–11 MJ/kg. The molar ratio of Ca/S of 8–10 in oil shale exceeds by over 2–3 times the ratio of Ca/S sufficient to capture SO_2 completely. Oil shale contains a lot of carbonate minerals. Due to decomposition of the carbonate minerals, the CO_2 footprint is bigger than in typical coal firing power plant, but during the calcite decomposition, free lime is formed that binds the Sulphur during combustion process. In 2004, a novel Circulating Fluidized Bed Combustion (CFBC) was introduced for EOS. For EOS CFBC, no sand is needed for bed material since ash is the material that is forming the bed. The circulating ash contains free lime that is one of the key parameters for almost 100% sulphur binding and the second key parameter is low combustion temperature – around 800 °C. Low combustion temperature and low fuel nitrogen content (below 0.1%) mean that NO_x emissions are also below the limit values (below 200 mg/Nm^3) (see Table 3.7).

Table 3.7 Block No 8 of the Eesti PP and old PF Blocks. CFBC unit parameters (Hotta *et al*)

Indices	CFB block	PF block (TP – 101)
Operational capacity, MWel	215/187	180
Self-consumption, %	- /9.13	8.93
Net efficiency factor, %	34 – 36/35	30
Heat rate, kJ/kWh	9230/10256	11,737
CO2 emission, kg/kWh	0.9744	1.2985
SO2 emission, mg/Nm^3	43,952	ca 2000
NOx emission, mg/Nm^3	90 – 120/140 - 160	ca 300

Indices	CFB block	PF block (TP – 101)
Fly ash emission, mg/Nm^3	25 – 30/20	ca 100
Boiler gross efficiency factor, %	93.3 – 94.9	82.28
Fuel consumption as coal equivalent, g/kWh	350	401

Therefore, no deSO$_x$ and deNO$_x$ facilities are needed for EOS CFBC combustion (as can be seen on Figure 3.16). For people dealing with coal firing units, it is difficult to understand, but bear in mind that for coal it is a matter of economics. No power company is willing to put additional/excess lime into the CFBC for Sulphur binding. They insert only the amount of free CaO that is needed to achieve the 200 or 400 mg/Nm^3 for SO$_2$ emissions. For EOS, the free CaO is already present in the fuel. Initially, of course, in the form of limestone, but during combustion process, it decomposes to CO$_2$ and CaO. So, this is the key element for officials to understand. We have more than enough CaO for efficient Sulphur binding.

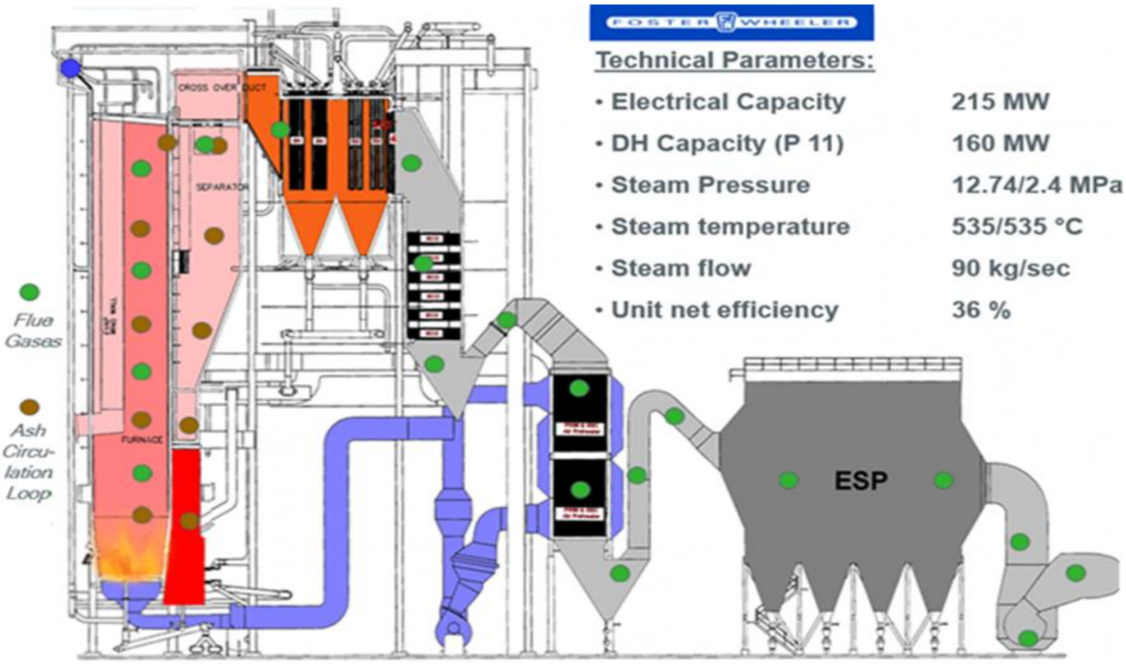

Figure 3.16 Existing EOS CFBC boiler drawing

For CFBC units, CEMS monitoring has been applied. The monitoring values are checked periodically by accredited authorities and the sulphur increase in the ash has also been checked. Therefore, low SO$_2$ emissions are nothing abnormal. It is normal for EOS CFBC units.

Tallinn University of Technology has conducted a lot of laboratory and in situ experiments in the Oil Shale Firing Power Plants. We have an accredited Laboratory that has competence according to CEN/TS 15675:2007 and our flue gas measurements have validated the results given by CEMS monitoring. Also, we have published a lot of research papers regarding EOS firing and emission and ash formation. Some of the results can be seen in Table 3.8 (Konist *et. al*, Plamus *et. al*) that validate the SO$_2$ numbers given so far.

Table 3.8 Concentration of main pollutants in flue gas before ESP (6% O$_2$) (Konist *et. al*)

Fuel used	CO$_2$, %	CO, mg/Nm^3	NO$_x$, mg/Nm^3	SO$_2$, mg/Nm^3
OS + BIO	13.8	20 – 30	140 – 200	0
OS 8.5	14.4	20 – 45	200	15.0
OS 11.1	11.2	20 – 45	200	15.0

NFR 1A1c The manufacture of solid fuels includes pollutant emission data reported by shale oil production facilities (oil shale transformation processes). Emissions are calculated by operators on the basis of measurements, or the combined method (measurements plus calculations) is used.

Under this code, data are also given on boilers in oil shale mining and other fuel transformation industries. Operators used measurement results, national EF or the combined method for emission estimations.

The production of shale oil in Estonia is carried out at three factories: Enefit Õlitööstus (Narva Oil Plant under Eesti Energia AS), KKT Oil OÜ (Kiviõli Chemicals Plant under Alexela Group), and VKG Oil AS (under Viru Chemistry Group Ltd).

Two different technologies are applied in the production of shale oil: the old one – the technology of processing large-particle oil shale in vertical retorts with a gaseous heat carrier. The process itself takes place in a vertical retort with a cross-sectional heat carrier (Kiviter type retort). Oil shale, from which a small-sized fraction has been selected, is fed to the retort from above. Oil shale from the loading box enters a distillation chamber and moves downwards, and hot flows of fuel gases pass through this chamber towards the oil shale movement. Oil and water vapours and gas of low heating value that originate from distillation are emitted from the retort top and are fed to the condensation unit where oil and water condense. Raw oil is refined in oil extraction and distillation units. Phenol water reaches the phenol recovery unit. Retort gas is partly fed back into the process and is burnt to create the heat carrier required, while the remaining gas is sent to the power plant for heat and power production. Semi-coke from oil shale processing is discharged from the retort base and is stored in a semi-coke storage area.

The second technology of processing is fine-grained oil shale with solid heat carrier (SHC). The Solid Heat Carrier Plant (SHCP) is designed for the thermal decomposition (pyrolysis) of fine-grained technological oil shale, with the objective of producing shale oils, gas with high calorific value, and high-pressure steam. The oil shale pyrolysis process is effected in a drum rotating reactor in the absence of air, at a temperature of 450–500 °C, due to the mixture of oil shale with hot ash (as a solid heat carrier). The vapour-gas mixture that appears in the reactor during the pyrolysis process is fed through several process vessels to be refined from ash and mechanical impurities, and then it is subject to a distillation process to produce liquid products and gas with high calorific value. Liquid products are fed to other units for loading as final products, or for further processing. Gas is fed to the heat power plant for heat and power production. Steam is fed to the heat power plant for power production. The by-products of this process include phenol water, flue gases, and ash from thermal processing.

In the Kiviõli Oil Shale Processing (Kiviõli Keemiatööstuse OÜ) and VKG Oil plants, both these technologies are used.

Eesti Energia AS Enefit Õlitööstus operates an industrial plant producing liquid fuels from oil shale. This plant, the only one of its kind in the world, uses the efficient Enefit-140 (in the left on the photo) solid heat carrier system, which was developed and patented by Eesti Energia engineers. Eesti Energia Õlitööstus produces liquid fuels and retort gas, which is used in electricity production in the Narva Power Plants.

The oil Industry produces about one million barrels of liquid fuels per year. Currently, about one fifth of the oil shale mined in Estonia is used in the production of fuel oil and chemicals. In 2009, Eesti Energia started building a new oil plant with Enefit-280 technology, which is cleaner, more reliable, and more efficient. This new generation of technology has been developed jointly by Eesti Energia and the international engineering company Outotec. Having produced its first oil in December 2012, the new Enefit-280 plant will gradually increase it operations to reach the designed parameters. Eesti Energia is planning to expand its oil business and build a hydrogen processing complex by 2016, creating a business capable of producing liquid fuels of higher quality than the current shale oil that will meet all the legal requirements for use as motor fuel.

The production of shale oil has increased in comparison with 1990 by about a factor of three. In 2022 production figures have decreased by 7.2% compared to 2021 (see Figures 3.17-18 and Table 3.18). In recent years, there has been an increase in shale oil production in solid heat carrier units (see Figure 3.18), leading to a significant rise in carbon oxide emissions (approximately 5.5 times higher in 2022 compared to 1990). In 2022, a total of 75% of shale oil was produced with the use of new SHC technologies.

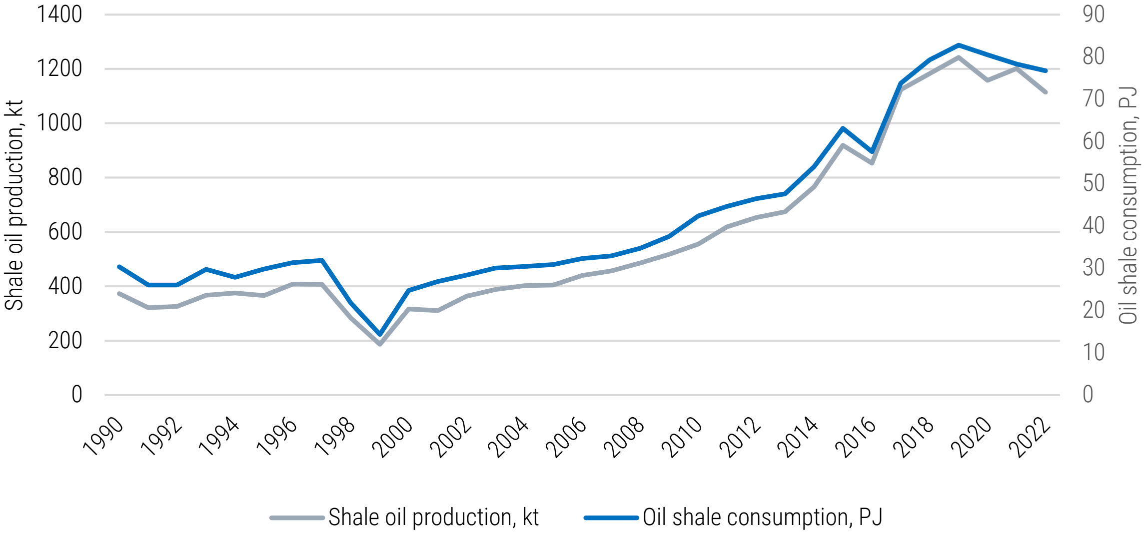

Figure 3.17 Shale oil production and oil shale consumption in the period 1990-2022

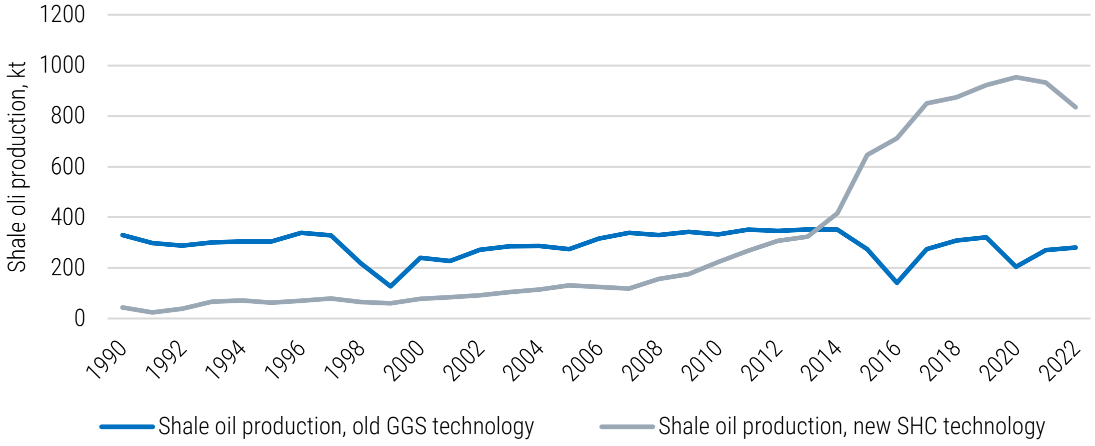

Figure 3.18 Shale oil production by different technologies in the period 1990-2022

3.2.2.2. Methodological Issues

The sector contains data on 19 large point sources, as well as smaller diffuse sources. Large point sources, in accordance with national legislation or the requirements specified in the emission permit, are obliged to carry out continuous or periodic monitoring of emissions.

Therefore, the inventory includes data on substances for which measurements were carried out, based on data from enterprises. For other substances, as heavy metals and POPs, emissions are calculated using national emission factors or Guidebook 2023 EF.

For example, emissions of heavy metals from oil shale power plants are calculated based on measurements carried out by Tallinn University of Technology for different technologies, which made it possible to refine emissions for the entire period from 1990 to 2021 and reduce uncertainty results (see Table 3.14). When making calculations, the time of introduction of new technologies or more modern treatment equipment was taken into account.

Emissions from diffuse sources are calculated on the basis of energy balance data and national or GB 2023 emission factors using the Tier 2 method. As part of the pilot project, an analysis of annual reports provided by enterprises was carried out. The data of combustion plants with a capacity of up to 50 MWh are analysed - types of boilers, availability of abatement techniques for each type of fuel and capacity (from 2004 to 2020). Some corrections were made in 2021. When processing data for the period from 1990 to 2004 data from the Department of Statistics on the capacity of boilers were also used, as well as energy engineers expert judgment. An analysis of the emission factors of old and new national methods was also carried out, and their comparison with international ones.

The energy balance data for the Transformation sector category were used for calculations. First of all, fuel consumed by large sources was excluded from each fuel. Then the remaining part is divided using the data of the analysis into fuel used by boiler houses up to and equal to 1 MW and from 1 to 50 MW (for biomass <=1 MW, >1=<10 MW and >1<50 MW). For boilers with a capacity of less than 1 MW, the Tier 2 emission factors of GB 2023 from the small combustion chapter were used. Then, also using the results of the project, the amount of fuels for installations with and without control (for solid fuels and biomass) were determined. Liquid fuels were split into heavy fuel oil, light fuel oil and shale oil as these fuels all have different sulphur content, which also fluctuated over the entire period, taking into account legislation and fuel quality requirements.

Compared to the previous submission, POPs emissions from gas combustion and ammonia from biomass combustion from small boilers have been recalculated in accordance with changes in the Guidebook 2023, where EF has been changed and is equal to 0.

Emission factors used for calculations are given in the tables 3.9-3.15.

Information on which sectors include the condensable component of PM_{10} and $PM_{2.5}$ can be found in Appendix 1 'Summary Information on Condensable in PM'.

Table 3.9 Pollutants emission factors for boilers using coal

Pollutant	Unit	<=1 MW	>1<50 MW		>=50 MW
			no control	with abatement techniques	
NO_x	g/GJ	160	180	180	
NMVOC	g/GJ	200	20	20	
SO_2*	g/GJ	844	844	844	
$PM_{2.5}$	g/GJ	170	108	26	
PM_{10}	g/GJ	190	117	28	
TSP	g/GJ	200	124	85	
BC	g/GJ	11	7	2	
CO	g/GJ	2 000	1 200	1 200	
Pb	mg/GJ	200	100	18	7.3
Cd	mg/GJ	3	1	0	0.9
Hg	mg/GJ	7	9	9	1.4
As	mg/GJ	5	4	1	7.1
Cr	mg/GJ	15	2	2	4.5
Cu	mg/GJ	30	10	10	7.8
Ni	mg/GJ	20	10	1	4.9
Se	mg/GJ	2	2	2	23
Zn	mg/GJ	300	150	150	19

Pollutant	Unit	<=1 MW	>1<50 MW		>=50 MW
			no control	with abatement techniques	
PCDD/PCDF	ng I-TEQ/GJ	400	100	100	10
benzo(a) pyrene	mg/GJ	100	13	13	0.7
benzo(b) fluoranthene	mg/GJ	130	17	17	37
benzo(k) fluoranthene	mg/GJ	50	9	9	29
Indeno(1,2,3-cd) pyrene	mg/GJ	40	6	6	1.1
HCB	µg/GJ	0.62	0.62	0.6	6.7
PCB	µg/GJ	170	170	170	3.3

**SO_2*: 1990-1995 – 844; 1996-2000 – 614; 2001-2005 – 384; 2006-2022 - 307*

Table 3.10 Pollutants emission factors for boilers using peat and peat products

Pollutant	Unit	<=1 MW		>1<50 MW						>=50 MW
				extended furnace			grate-fired furnace			
		no control	with abatement techniques	no control	electrostatic precipitator	cyclone	no control	electrostatic precipitator	cyclone	
NOx	g/GJ	160	160	156.2	156.2	156.2	156.2	156.2	156.2	
NMVOC	g/GJ	200	200	20	20	20	20	20	20	
SO_2 [1]	g/GJ	909	909	909	36.82	909	909	36.82	909	
NH_3	g/GJ	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	
$PM_{2.5}$	g/GJ	170	34	128	3.9	28	146	3.9	30	
PM_{10}	g/GJ	190	38	135	7.3	29	148	7.3	31	
TSP	g/GJ	200	40	142	30	31	283	30	33	
BC	g/GJ	10.9	2.2	8.2	0.007	1.8	9.3	0.007	1.9	
CO	g/GJ	2 000	2 000	1 200	1 200	1 200	109.5	109.5	109.5	
Pb	mg/GJ	200	200	100	7.5	25	100	7.5	25	7.3
Cd	mg/GJ	3	3	1	0.07	0.4	1	0.07	0.4	0.9
Hg	mg/GJ	7	7	7	7	7	7	7	7	1.4
As	mg/GJ	5	5	4	0.28	1.2	4	0.28	1.2	7.1
Cr	mg/GJ	15	15	20	1.5	5	20	1.5	5	4.5
Cu	mg/GJ	30	30	20	20	20	20	20	20	7.8
Ni	mg/GJ	20	20	10	0.7	2.3	10	0.7	2.3	4.9
Se	mg/GJ	2	2	2	2	2	2	2	2	23
Zn	mg/GJ	300	300	300	300	300	300	300	300	19
PCDD/PCDF	ng I-TEQ/GJ	400	400	100	100	100	100	100	100	10
benzo(a) pyrene	mg/GJ	100	100	13	13	13	13	13	13	0.7
benzo(b) fluoranthene	mg/GJ	130	130	17	17	17	17	17	17	37
benzo(k) fluoranthene	mg/GJ	50	50	9	9	9	9	9	9	29
Indeno (1,2,3-cd) pyrene	mg/GJ	40	40	6	6	6	6	6	6	1.1
HCB	µg/GJ	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	6.7
PCB	µg/GJ	170	170	170	170	170	170	170	170	3.3

1 - SO_2 no control: 1990-1995-909; 1996-2005 - 808;2006-2022 – 606;

1- SO_2 electrostatic precipitator: 36,82

Return to the Table of Contents

Table 3.11 Pollutants emission factors for boilers using biomass

Pollutant	Unit	<=1 MW	>1=<10 MW		>10<50 MW		>=50 MW
			no control	with abatement techniques	no control	with abatement techniques	
NO_x	g/GJ	91	115.7	115.7	105.5	105.5	
NMVOC	g/GJ	156	48.0	48.0	48	48	
SO_2	g/GJ	4.2	4.2	4.2	4.2	4.2	
NH_3	g/GJ	0	0.369	0.369	0.105	0.105	
$PM_{2.5}$	g/GJ	98.5	115	37.9	115	11	
PM_{10}	g/GJ	101	118	54.5	118	13.7	
TSP	g/GJ	105	145	56.7	145	24.6	
BC	g/GJ	28	17.3	4.3	17.3	1.7	
CO	g/GJ	435	144.9	144.9	12.5	12.5	
Pb	mg/GJ	27	27	5	27	5	20.6
Cd	mg/GJ	13	13	3	13	3	1.8
Hg	mg/GJ	0.56	0.56	0.56	0.56	0.56	1.5
As	mg/GJ	0.19	1	0.2	1	0.2	9.5
Cr	mg/GJ	23	23	4.6	23	4.6	9.0
Cu	mg/GJ	6	6	6	6	6	21.1
Ni	mg/GJ	2	20	4	20	4	14
Se	mg/GJ	0.5	0.5	0.5	0.5	0.5	1
Zn	mg/GJ	512	512	512	512	512	181
PCDD/PCDF	ng I-TEQ/GJ	100	100	100	100	100	50.0
benzo(a) pyrene	mg/GJ	10	10	10	10	10	1.12
benzo(b) fluoranthene	mg/GJ	16	16	16	16	16	0.043
benzo(k) fluoranthene	mg/GJ	5	5	5	5	5	0.0155
Indeno (1,2,3-cd) pyrene	mg/GJ	4	4	4	4	4	0.0374
HCB	µg/GJ	5	5	5	5	5	5.0
PCB	µg/GJ	NE	NE	NE	NE	NE	3.5

Table 3.12 Pollutants emission factors for boilers using liquid fuels

Pollutant	Unit	<=1 MW	>1<50 MW	>=50 MW	
				oilshale oil, residual oil	light fuel oil
NO_x	g/GJ	100	159.3		
NMVOC	g/GJ	15	5		
SO_2	g/GJ	404.6[1]/1058[2]/118[3]	404.6[1]/1058[2]/118[3]		
$PM_{2.5}$	g/GJ	0.17	0.17		
PM_{10}	g/GJ	3	2.7		
TSP	g/GJ	3	3.8		
BC	g/GJ	3	7.5		
CO	g/GJ	2	0.07		
Pb	mg/GJ	40	0.56		
Cd	mg/GJ	20	10	4.56	4.07
Hg	mg/GJ	0.3	0.3	1.20	1.36
As	mg/GJ	0.1	0.1	0.34	1.36
Cr	mg/GJ	44.5	44.5	3.98	1.81
Cu	mg/GJ	20	20	2.55	1.36
Ni	mg/GJ	10	6	5.31	2.72
Se	mg/GJ	300	200	255	1.36
Zn	mg/GJ	NE	NE	2.06	6.79
PCDD/PCDF	ng I-TEQ/GJ	10	5	87.8	1.81
benzo(a) pyrene	mg/GJ	10	10	2.5	0.5
benzo(b) fluoranthene	mg/GJ	8	1	NE	NE
benzo(k) fluoranthene	mg/GJ	9	2	0.0045	NE
Indeno (1,2,3-cd) pyrene	mg/GJ	6	1	0.0045	NE

[1] *– oilshale oil*

[2] *– residual oil - SO_2 : 1990-2001 – 1058; 2002-2005 – 504; 2006-2022 – 404,6;*

[3] *– light fuel oil- SO_2 : 1990-2005 – 118; 2006-2010 – 95; 2011-2022 - 66*

Table 3.13 Pollutants emission factors for boilers using gas

Pollutant	Unit	<=1 MW	>1<50 MW	>=50 MW
NO_x	g/GJ	73	31.3	
NMVOC	g/GJ	0.36	2	
SO_2	g/GJ	1.94	1.94	
$PM_{2.5}$	g/GJ	0.262	0.262	
PM_{10}	g/GJ	0.05	0.05	
TSP	g/GJ	0.07	0.07	
BC	g/GJ	0.07	0.07	
CO	g/GJ	0.0003	0.0003	
Pb	mg/GJ	24	0.08	
Cd	mg/GJ	0.0015	0.0015	0.0015
Hg	mg/GJ	0.00025	0.00025	0.00025
As	mg/GJ	0.1	0.1	0.1
Cr	mg/GJ	0.12	0.12	0.12
Cu	mg/GJ	0.00076	0.00076	0.00076
Ni	mg/GJ	0.000076	0.000076	0.000076
Se	mg/GJ	0.00051	0.00051	0.00051
Zn	mg/GJ	0.011	0.011	0.011

Table 3.14 Heavy metals emission factors for oil shale power plants

Pollutant	Pulverised combustion, old electric precipitators	Pulverised combustion, new electric precipitators	Fluidized Bed Combustion
		EF, mg/GJ	
Pb	300	16	3
Cd	5	1	1
Hg	5	0.5	0.2
As	90	8	3
Cr	80	28	5
Cu	20	20	9
Ni	50	12	3
Se	45	10.8	2.7
Zn	410	102	21

Table 3.15 POPs emission factors oil shale Power Plants

Pollutant	unit	EF	Reference
PCCD/F, Enefit, TP-17 pulverised bed combustion	ng I-TEQ/GJ	2.55	Estonian-Danish cooperation project
PCCD/F, Enefit, pulverised bed combustion	ng I-TEQ/GJ	0.55	Estonian-Danish cooperation project
PCCD/F, Enefit, circulating fluidised bed combustion	ng I-TEQ/GJ	0.25	Estonian-Danish cooperation project
PCCD/F, other oil shale PP	ng I-TEQ/GJ	1.00	national EF, on the base of measurements
benzo(a) pyrene	µg/GJ	3.50	national EF, on the base of measurements
benzo(b) fluoranthene	µg/GJ	5.00	national EF, on the base of measurements
benzo(k) fluoranthene	µg/GJ	2.50	national EF, on the base of measurements
Indeno (1,2,3-cd) pyrene	µg/GJ	3.00	national EF, on the base of measurements
PCB	µg/GJ	4.94	national EF, provided by Technical Univercity, on the base of measurements
HCB	µg/GJ	0.60	national EF, on the base of measurements

Pollutant emissions from shale oil production are calculated by operators on the basis of national methodologies, measurements, or the combined method (measurements plus calculations) is used.

The calculated implied emission factors (IEF) for some pollutant for NFR 1A1a are given in the Table 3.16.

Table 3.16 Implied emission factors (IEF) for some pollutant for NFR 1A1a

	SO_2	NO_x	TSP	$PM_{2.5}$	Pb
1990	810.0	85.6	559.8	NR	200.3
1995	718.9	95.8	530.0	NR	219.0
2000	716.2	99.0	401.5	37.0	166.7
2005	532.5	90.9	84.6	19.3	27.1

Return to the Table of Contents

	SO_2	NO_x	TSP	$PM_{2.5}$	Pb
2010	504.5	93.6	86.9	32.9	28.7
2015	275.2	75.6	41.1	18.4	14.0
2016	229.0	74.1	24.7	11.4	13.0
2017	237.6	73.3	26.0	11.8	13.5
2018	193.2	71.6	22.4	10.1	12.9
2019	161.7	72.4	19.9	8.7	12.9
2020	110.7	73.1	19.0	9.0	13.3
2021	107.4	63.6	12.2	5.8	9.3
2022	121.8	66.3	14.1	5.3	9.7

The main impact when it comes to changes in the IEF in this sector is shown in the change of the situation regarding oil shale power plants as they are a key source of emissions. At the beginning of the nineties a change in energy supply involving a decrease in the consumption of residual fuel oil and natural gas also played a role. After 2004 the introduction of new technologies in the oil shale Narva Power Plants began, and a change in the IEF was influenced by the distribution of oil shale burned in new and old boilers as, in the case of electricity production growth, the share of work for old boilers increased. A sharp jump in the TSP and $PM_{2.5}$ IEF in 2011 resulted from poorly-operated clearing equipment in the oil shale Baltic Power Plant (see Figure 3.19). Some increase in IEF in 2022 is associated with an increase in the amount of oil shale burned and, accordingly, with an increase in emissions.

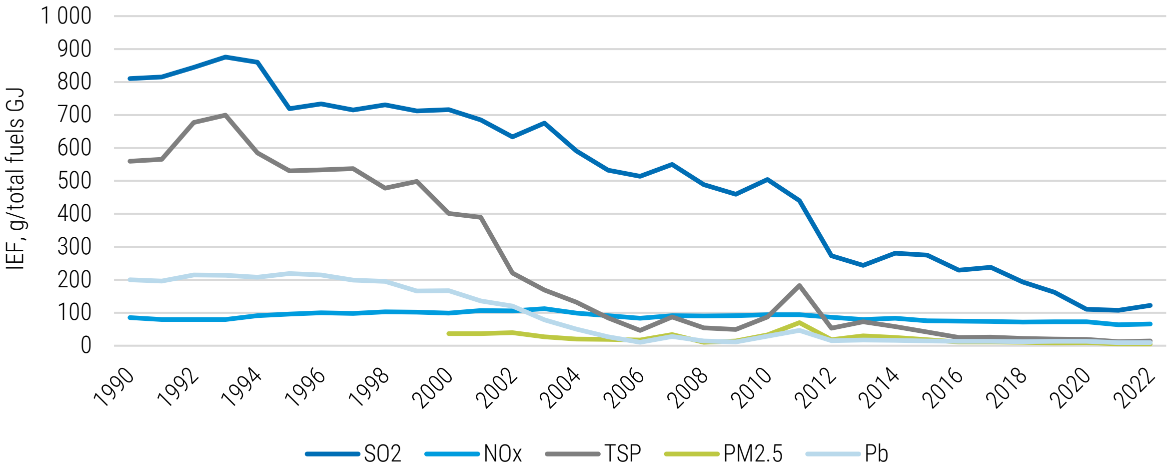

Figure 3.19 Implied emission factors for NFR 1A1a

Activity Data

Fuel consumption data from point sources have been summarised by SNAP codes. Emissions from the diffuse sources were calculated by using data on fuel consumption from Energy Balance (EB), prepared by Statistics Estonia:

Diffuse sources Fuel = EB fuel – PS fuel

The fuel consumption data in energy and transformation industries are presented in the Table 3.17 and Figure 3.20. The consumption of all fuels by this sector with the exception of biomass (mainly wood or wood waste and olso biogas) and other fuels (mainly municipal waste) has decreased across 1990-2022. The biggest decrease has been in terms of liquid fuel, by 98%. The consumption of solid fuels decreased by about 76.7%, mainly due to a decrease in electricity production, but it still remains the main fuel in this sector (involving mainly oil shale) (see Figures 3.20, 3.21). During this period, the consumption of coal decreased significantly (from 4,4 PJ in 1990 to 0, beginning from the 2018), but combustion of biomass has grown approximately by 22 times (from 1.35 PJ in 1992 to 29.2 PJ in 2022).

Table 3.17 Fuel consumption in energy industries in the period of 1990–2022 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	45.26	210.62	NA	32.73	NA
1995	11.99	110.37	2.25	11.90	NA
2000	5.82	97.65	3.65	16.14	NA
2005	4.34	105.24	5.64	17.55	NA
2010	3.26	129.97	11.30	14.88	NA
2015	2.24	95.83	14.97	7.04	2.40
2016	3.06	110.49	20.95	7.36	2.31
2017	2.71	118.89	22.86	7.13	2.22
2018	2.24	109.25	26.48	6.78	2.23
2019	1.39	58.30	27.36	5.83	1.94
2020	1.44	37.82	29.77	4.31	2.40
2021	0.83	49.01	30.16	5.68	2.43
2022	1.71	64.15	29.29	4.87	2.44
Change 1990-2022, %	**-96.2**	**-69.5**		**-85.1**	
Change 2021-2022, %	**104.6**	**30.9**	**-2.9**	**-14.2**	**0.04**

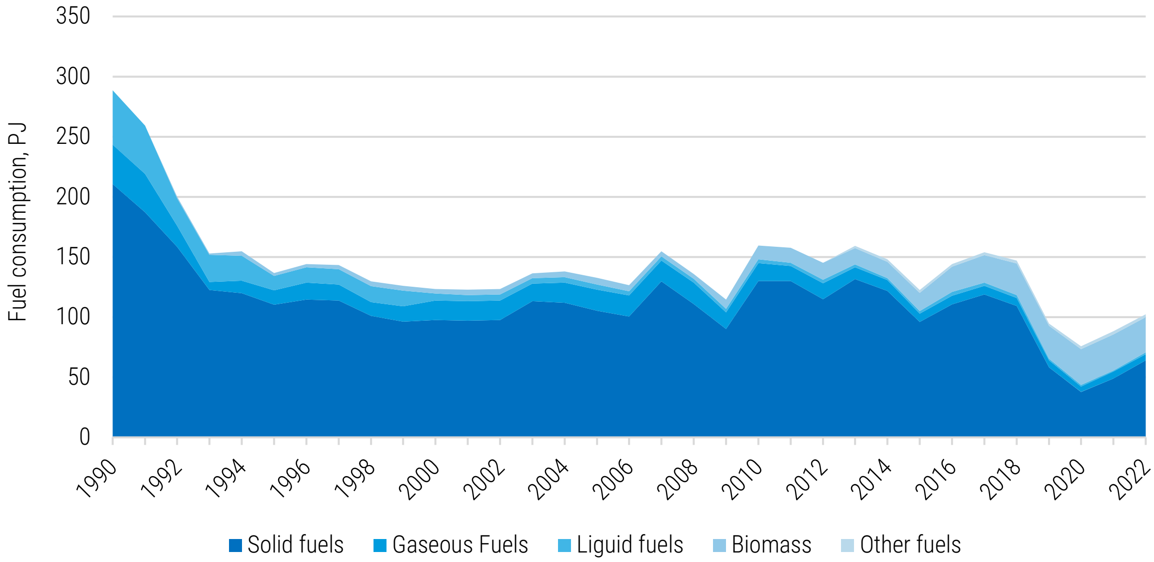

Figure 3.20 Fuel consumption by energy industries sector in the period 1990-2022

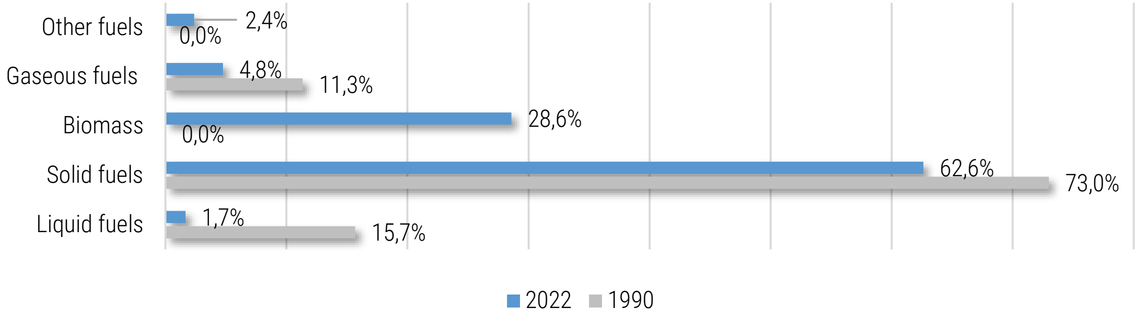

Figure 3.21 Distribution of fuel consumption in energy industries in 1990 and 2022

Return to the Table of Contents

Table 3.18 Shale-oil production in the period of 1990-2022 (kt)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
373.0	321.6	326.0	367.1	375.4	366.4	408.9	407.0	283.6	187.0	317.0
2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
311.6	363.8	389.0	402.2	405.3	441.0	456.5	486.5	518.3	555.4	619.8
2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
653.5	675.1	766.9	918.8	853.5	1,123.8	1,182.2	1,242.5	1,157.6	1,202.1	1,115.0

Table 3.19 Oil-shale consumption for oil-shale production by different technologies, PJ

Year	Solid Heat Carrier (SHC)			Total	Gas generators (GGS)		Total	Total
	Narva	VKG Oil	Kiviõli	SHC	VKG	Kiviõli	GGS	oil-shale
1990	3.24	NO	NO	3.24	21.56	5.55	27.11	30.35
1995	4.31	NO	NO	4.31	20.14	5.35	25.49	29.80
2000	5.86	NO	NO	5.86	13.57	5.30	18.87	24.73
2005	8.87	NO	NO	8.87	17.78	4.21	21.99	30.86
2010	14.74	2.22	0.20	17.16	21.15	4.10	25.25	42.41
2015	23.86	18.61	0.40	42.87	15.36	4.91	20.27	63.14
2016	21.66	23.88	1.50	47.04	5.71	4.85	10.56	57.60
2017	26.74	24.45	1.65	52.84	15.54	5.39	20.93	73.77
2018	27.26	26.64	1.91	55.81	18.16	5.35	23.50	79.31
2019	28.70	28.06	1.82	58.58	19.19	5.01	24.20	82.78
2020	29.36	28.30	1.74	59.40	16.13	4.99	21.12	80.52
2021	28.90	27.09	1.88	57.87	15.62	4.82	20.44	78.31
2022	29.15	24.23	1.99	55.37	15.73	5.60	21.33	76.70

3.2.2.3. Uncertainty

An uncertainty analysis for the stationary combustion sector alone (NFRs 1A1, 1A2, and 1A4) was carried out upon the 2022 inventory (Chapter 3.2.1.2).

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for main pollutants from energy industries sector is estimated in the range from 10% to 50%, for heavy metals and PAHs 50–200%, for dioxin 200%; in the activity data, in the range from 2% to 5%. Uncertainty estimates for stationary combustion are given in the table below.

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	7.19	kt	30.69	2.98	0.30
NMVOC	2.51	kt	9.51	3.09	0.92
SO_x	14.01	kt	95.53	8.75	0.14
NH_3	0.23	kt	2.27	1.12	0.46
$PM_{2.5}$	0.68	kt	13.86	3.44	4.85
PM_{10}	1.16	kt	12.90	3.07	5.75
TSP	1.78	kt	11.16	1.41	0.46
BC	0.06	kt	4.96	1.29	1.05
CO	42.15	kt	39.64	7.33	2.96
Pb	1.02	t	24.37	11.94	0.06
Cd	0.13	t	29.41	14.57	0.37
Hg	0.12	t	59.12	28.56	2.32
PCDD	2.16	g I-TEQ	52.18	103.69	24.31
benzo(a) pyrene	0.13	t	12.19	24.38	3.49
benzo(b) fluoranthene	0.21	t	20.53	41.06	7.10
benzo(k) fluoranthene	0.07	t	9.81	19.63	0.94
Indeno	0.05	t	5.24	10.48	0.64
HCB	0.19	kg	37.34	93.35	32.03
PCB	0.33	kg	57.77	115.55	2.63

Return to the Table of Contents

3.2.2.4. Source-Specific QA/QC and Verification

Several QC procedures are used in the framework of inventory preparation.

Before usage, data are presented by operators, and the data in reports (emissions, fuel used and methods of calculations) are verified. The Point Sources information system consists of calculation modules on the basis of national emission factors, and if the operator uses the calculation module, one can be relatively certain that the received results are correct.

The data on fuel consumption are then summarised by SNAP codes and compared to the statistical energy balance data.

Secondly, the balance data, which is presented both in natural units and in terajoules is analyzed. The analysis covers the most recent year as well as data for the entire period from 1990 to the reporting year. If the data in the energy balance changes, appropriate adjustments are made to the calculation module. Balance sheet data is also compared with the IEA Questionnaire.

Next, fuel emission factors are verified. In the case of new studies to estimate country specific emission factors or changes are made to the new edition of the Guidebook, all necessary corrections are made for the entire time series.

3.2.2.5. Recalculations

In the 2024 submission the following recalculations were carried out:

- NFR 1A1a. Recalculated emissions of POPs and NH_3 for 1990-2021. Compared to the previous submission, POPs emissions from gas combustion and ammonia from biomass combustion from small boilers have been recalculated in accordance with changes in the Guidebook 2023, where EF has been changed and is equal to 0.
- Small changes in emissions in some years due to adjustments to data on natural gas use.
- NFR 1A1c. Recalculated emissions of NMVOC and CO for the period 1990-2021. The reason for that – is a new permit and a change in the methodology for calculating emissions from shale oil production at the Enefit 140 installation.

3.2.2.6. Source-Specific Planned Improvements

Conduct another analysis of data from combustion installations at enterprises with emission permits, specifically focusing on data regarding the distribution by capacity and technology, which will help reduce uncertainty in emissions calculations.

Return to the Table of Contents

3.2.3. Manufacturing Industries and Construction (NFR 1A2)

3.2.3.1. Source Category Description

This sector is not currently a key source for any substance.

Manufacturing industries sources category description are presented in the Table 3.20 and in the text below.

Table 3.20 Manufacturing industries reporting activities

NFR	Description	Method	Activity data	Emissions factor
1A2a	Iron and steel	Tier 2	Statistical Energy Balance	National EF; EMEP/EEA Guidebook 2023
1A2b	Non-ferrous metals	Tier 2	Statistical Energy Balance	National EF; EMEP/EEA Guidebook 2023
1A2c	Chemicals	Tier 2	Statistical Energy Balance	National EF; EMEP/EEA Guidebook 2023
1A2d	Pulp, Paper and Print	Tier 2	Statistical Energy Balance	National EF; EMEP/EEA Guidebook 2023
1A2e	Food processing, beverages and tobacco	Tier 2	Statistical Energy Balance	National EF; EMEP/EEA Guidebook 2023
1A2f	Non-metallic minerals	Tier2, Tier 3	Reported by operators and Statistical Energy Balance	National EF; Measurements; Default EMEP/EEA Guidebook 2023
1A2gviii	Other	Tier 2	Statistical Energy Balance	National EF; Default EMEP/EEA Guidebook 2023

NFR 1A2a: Iron and steel include emissions from processes with contact and combustion plants of this activity. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A2b: Non-ferrous metals include emissions from processes with contact (secondary lead, zinc and aluminium production) and combustion plants of this activity. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A2c: Chemicals include emissions from combustion plants of this activity. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A2d: Pulp, paper and print include emissions from combustion plants of this activity. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A2e: Food processing, beverages, and tobacco include emissions from combustion plants and other stationary equipment of this activity. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A2f: Non-metallic minerals include emissions from combustion in boilers and other processes with contact in the non-metallic minerals industry: cement, lime, glass, bricks, and other productions (SNAP 0301, 030311-030326). Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2, excluding data on emissions from cement production, which themselves are based on enterprise reporting data and are calculated on the basis of measurements or the combined method (measurements plus calculations). For cement production, the PCDD/F, HCB and PAHs emissions are calculated on the basis of measurements. To note, clinker production in Estonia has been discontinued since 2020.

NFR 1A2gviii: Others include emissions from all boilers in the other manufacturing industry (excluding NFRs 1A2a-e, 1A2f), other processes with contact: other productions (SNAP 0301, 030326). Data are from diffuse sources. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

Emissions of all pollutants from the NFR 1A2 sector have decreased across 1990-2022 (see Tables 3.21, 3.24, Figure 3.22). The main reason for the decrease in the main pollutants and HM emissions is the corresponding decrease in the production of cement, which was the main source of pollution in previous years, and also in an increase in the efficiency of combustion and cleaning equipment in the cement production plant. The other reasons are described below.

The increase in emissions all substances (exept NO_x and NH_3) by industrial combustion in 2022 when compared to 2021 is explained by increase in liquid fuel and biomass consumption. (see Table 3.24).

Table 3.21 Pollutants emissions from combustion in manufacturing industries in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	6.05	0.28	29.39	0.007	NR	NR	83.13	NR	3.57
1995	2.66	0.35	10.64	0.022	NR	NR	32.13	NR	3.12
2000	2.58	0.28	2.66	0.003	0.39	0.51	0.94	0.05	1.96
2005	1.91	0.44	2.79	0.004	0.45	0.55	0.78	0.06	2.15
2010	1.59	0.31	1.12	0.003	0.26	0.32	0.43	0.04	1.78
2015	1.20	0.26	0.39	0.002	0.16	0.20	0.26	0.02	0.76
2016	0.90	0.07	0.33	0.002	0.04	0.04	0.07	0.01	0.37
2017	1.24	0.06	0.19	0.001	0.03	0.04	0.06	0.01	0.65
2018	1.31	0.18	0.20	0.002	0.03	0.04	0.07	0.01	1.48
2019	0.97	0.26	0.63	0.001	0.05	0.06	0.08	0.01	1.15
2020	0.49	0.10	0.44	0.001	0.06	0.07	0.08	0.007	0.51
2021	0.38	0.06	0.29	0.001	0.03	0.03	0.04	0.005	0.12
2022	0.36	0.06	0.29	0.00	0.03	0.04	0.04	0.01	0.12
Change 1990-2022, %	**-94.0**	**-77.5**	**-99.0**	**-84.5**	**-92.7**	**-92.7**	**-99.9**	**-90.1**	**-96.6**
Change 2021-2022, %	**-3.8**	**12.6**	**-0.5**	**-21.3**	**13.5**	**15.6**	**16.2**	**15.7**	**-1.3**

Table 3.21 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	62.29	3.24	0.09	1.28	0.62	2.37	4.91	0.004	14.87
1995	25.32	1.34	0.04	0.42	0.27	0.98	1.60	0.004	7.71
2000	0.63	0.06	0.01	0.15	0.13	0.07	0.43	0.003	1.92
2005	0.20	0.05	0.01	0.14	0.14	0.08	0.37	0.004	3.05
2010	0.12	0.04	0.00	0.08	0.09	0.07	0.29	0.003	2.40
2015	0.08	0.04	0.00	0.08	0.07	0.05	0.29	0.002	2.27
2016	0.05	0.02	0.00	0.07	0.04	0.02	0.27	0.000	0.27
2017	0.03	0.02	0.00	0.05	0.03	0.02	0.15	0.000	0.34
2018	0.05	0.01	0.01	0.04	0.02	0.02	0.11	0.000	0.40
2019	0.15	0.01	0.01	0.06	0.03	0.04	0.22	0.000	0.35
2020	0.07	0.01	0.00	0.06	0.03	0.02	0.19	0.001	0.43
2021	0.02	0.01	0.00	0.05	0.03	0.01	0.16	0.000	0.34
2022	0.02	0.01	0.00	0.06	0.03	0.02	0.22	0.000	0.43
Change 1990-2022, %	**-99.96**	**-99.6**	**-99.1**	**-95.5**	**-95.1**	**-99.4**	**-95.5**	**-90.0**	**-97.1**
Change 2021-2022, %	**17.2**	**47.8**	**-8.2**	**20.7**	**20.2**	**24.8**	**41.2**	**15.3**	**26.6**

Table 3.21 continues

Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	1.17	0.35	0.007	0.44
1995	0.80	0.32	0.020	0.29
2000	0.42	0.20	0.021	0.14
2005	0.67	0.30	0.031	0.15
2010	0.48	0.23	0.025	0.09
2015	0.46	0.19	0.023	0.04
2016	0.06	0.06	0.004	0.05
2017	0.23	0.04	0.005	0.05
2018	0.20	0.04	0.006	0.05
2019	0.21	0.04	0.005	0.05

Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
2020	0.09	0.09	0.004	0.03
2021	0.08	0.04	0.003	0.001
2022	0.10	0.05	0.004	0.000
Change 1990-2022, %	**-91.8**	**-86.3**	**-43.3**	**-100.0**
Change 2021-2022, %	**20.1**	**23.5**	**27.3**	**-99.4**

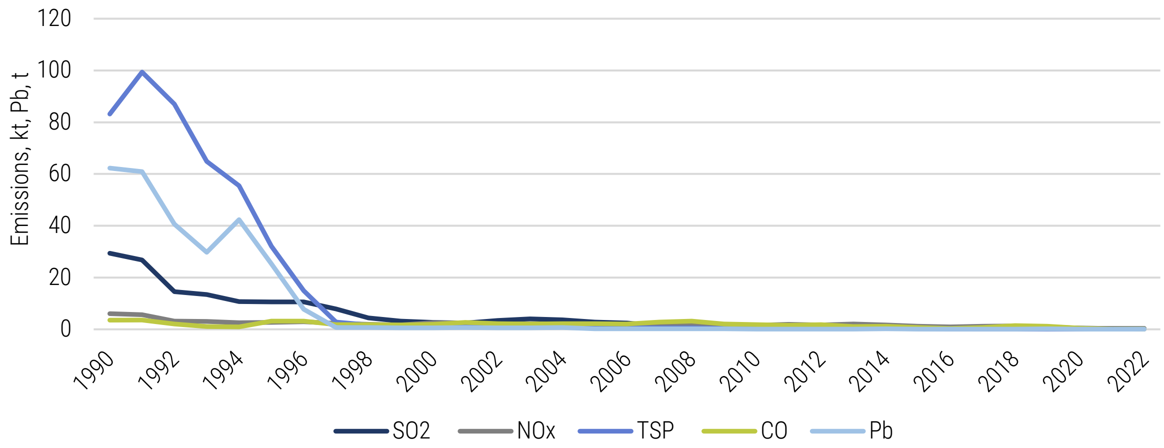

Figure 3.22 Pollutant emissions from the manufacturing industries and construction in the period of 1990–2022

The most significant contribution to pollution with main substances inside the sector is made by NFR 1A2gviii – combustion in other industries (e.g. woodworking and furniture manufacturing), NFR 1A2f – combustion in non-metallic minerals industry (mainly cement, class, brick and asphalt production), , 1A2e – combustion in food industry and NFR 1A2d – pulp and paper industries. The contribution of other activities is very insignificant (see Figures 3.23 – 3.25).

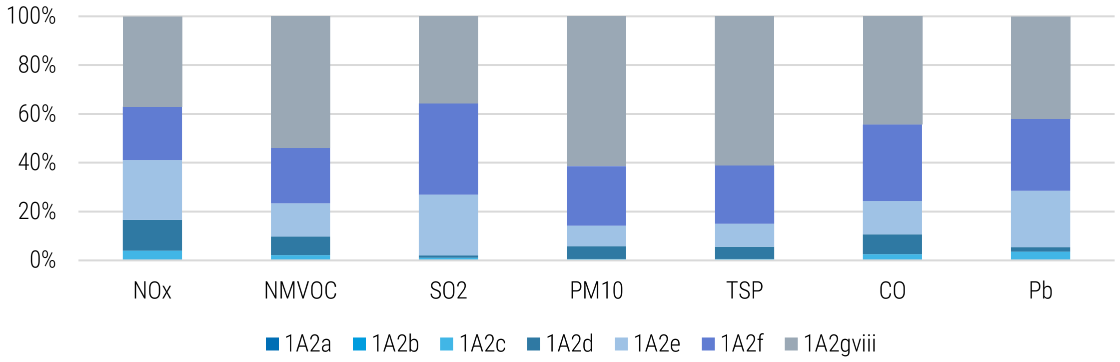

Figure 3.23 Distribution of pollutant emissions by sector in manufacturing industries in 2022

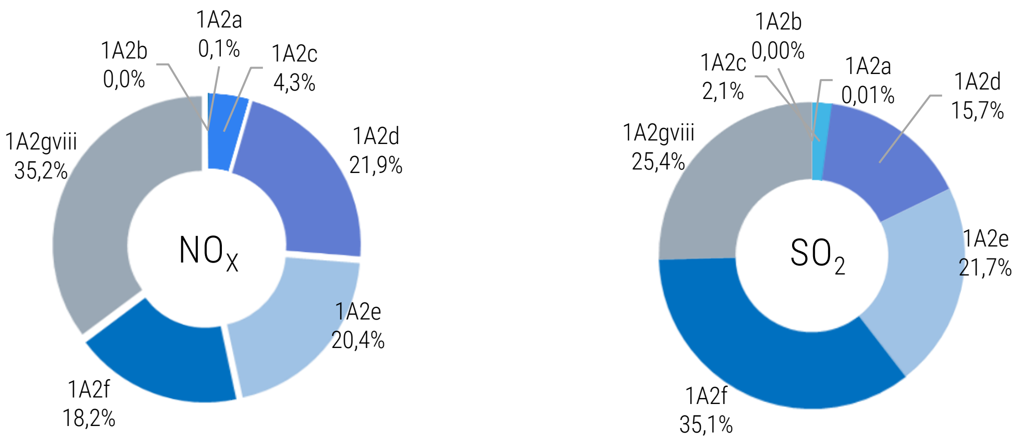

Figure 3.24 NO_x and SO_2 emissions from the combustion in manufacturing industries in 2022

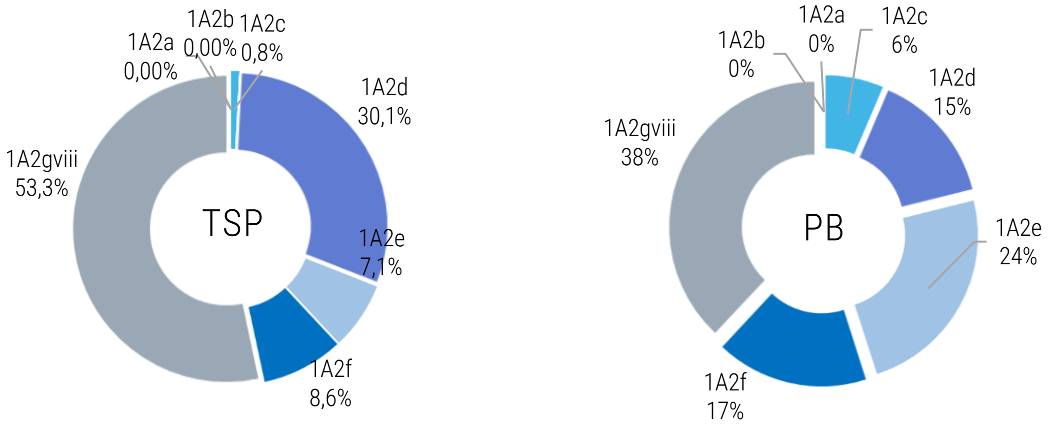

Figure 3.25 TSP and Pb emissions from the combustion in manufacturing industries in 2022

3.2.3.2. Methodological Issues

The energy balance data for the Industry sector category (final energy consumption) were used for calculations. First of all, fuels for each NFR are divided, using the data of the analysis, into fuel used by boiler houses up to and equal to 1 MW and from 1 to 50 MW. For boiler with a capacity of less than 1 MW, the Tier 2 emission factors of GB 2023 from the small combustion chapter were used. Then, also using the results of the project, the amount of fuels for installations with and without control (for solid fuels and biomass) were determined. Liquid fuels were splited into heavy fuel oil, light fuel oil and shale oil because these fuels have different sulphur content, which also changed over the entire period, taking into account legislation and fuel quality requirements.

Emission factors used for calculations are given in the tables 3.9-3.15.

Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2, excluding data on emissions from cement production, which are based on enterprise reporting data and are calculated on the basis of measurements or the combined method (measurements plus calculations). For cement production, the PCDD/F, HCB and PAHs emissions are calculated on the basis of measurements (see Table 3.22). It should be noted that clinker production in Estonia was discontinued since

2020, therefore, the data from this enterprise on combustion processes are no longer included in the energy sector, while emissions of particulates from cement production are accounted for in the IPPU sector.

Table 3.22 Emission factors for cement production

Year	Unit	EF	Reference
PCDD, 1990-1996	µg I-TEQ/t cement	0.6	UNEP "Standardized Toolkit for Identification of Dioxin and Furan Releases"
PCDD, 1997-2007	µg I-TEQ/t cement	0.07	"Dioxin in Candidate Countries" project
PCDD, 2008-2019			emissions data prvided by operator on the base of measurements
HCB	g/t clinker	5.93541E-06	national EF, on the base of measurements
b(a)p	g/t clinker	0.000706	national EF, on the base of measurements
b(b)f	g/t clinker	0.001705	national EF, on the base of measurements
b(k)f	g/t clinker	0.000524	national EF, on the base of measurements
indeno	g/t clinker	0.000291	national EF, on the base of measurements
PCB	µg/t clinker	103	Guidebook 2019, chapter 1A2, table 3-24

Implied emission factors (IEF) for some pollutants for sector 1A2 are presented in the Table 3.23.

The main impact on the IEF decrease in the period of 1990-2000 was exerted by changes on the enterprise for cement production - primarily the introduction of effective clearing equipment and new technologies. In addition, a change of structure in the fuel consumed in this sector in general was also to blame, with a growth in the consumption of natural gas and biomass exerting an impact (see Figure 3.26 and Table 3.24). In 2021, an decrease in the IEF of particulates was caused by a decrease in the consumption of solid fuels and biomass.

Details on fuel consumption by manufacturing industries are presented in the Table 3.24, Figure 3.27-3.28.

Table 3.23 NFR 1A2 pollutants IEF, g/total fuels GJ

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	647.8	133.3	1,832.3	NR
1995	465.2	116.3	1,404.8	NR
2000	166.4	161.2	58.8	24.4
2005	152.7	104.7	42.9	24.5
2010	79.4	112.5	30.3	18.2
2015	32.3	99.2	21.2	12.9
2016	39.2	105.8	8.2	4.2
2017	22.4	142.9	7.3	2.9
2018	22.6	144.6	7.8	3.6
2019	70.5	108.7	8.5	5.4
2020	68.4	75.6	12.7	8.6
2021	49.7	64.0	6.6	4.3
2022	60.5	75.4	9.4	6.0

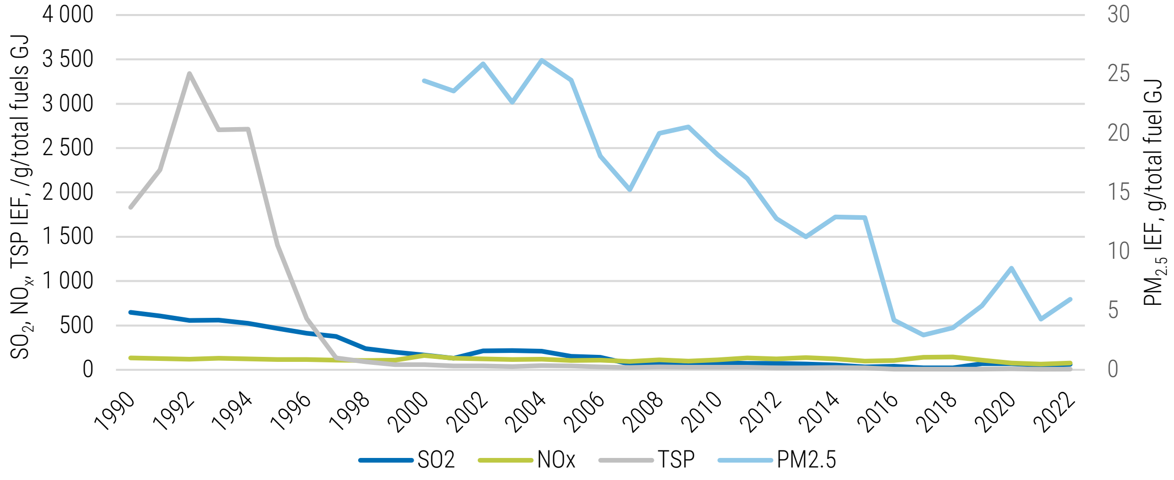

Figure 3.26 Implied emission factors for NFR 1A2

Table 3.24 Fuel consumption by manufacturing industries in the period of 1990-2022

Year	Liquid fuels	Solid fuels	Gaseous fuels	Biomass	Other fuels
1990	28.36	8.74	8.00	0.26	NA
1995	9.04	5.26	5.41	3.16	NA
2000	3.16	3.70	5.10	3.32	0.70
2005	2.82	2.73	6.93	5.46	0.34
2010	1.66	2.93	4.78	4.37	0.35
2015	1.71	1.21	3.95	4.35	0.92
2016	1.63	0.94	4.46	0.47	0.99
2017	1.06	1.59	4.11	0.58	1.33
2018	0.77	1.77	4.57	0.75	1.18
2019	1.39	1.90	4.17	0.50	1.01
2020	1.34	0.26	3.96	0.76	0.11
2021	1.06	0.01	4.13	0.69	NA
2022	1.28	0.00	2.68	0.85	NA
Change 1990-2022, %	-95.5	-100.0	-66.5	222.56	
Change 2021-2022, %	20.6	-100.0	-35.1	23.2	

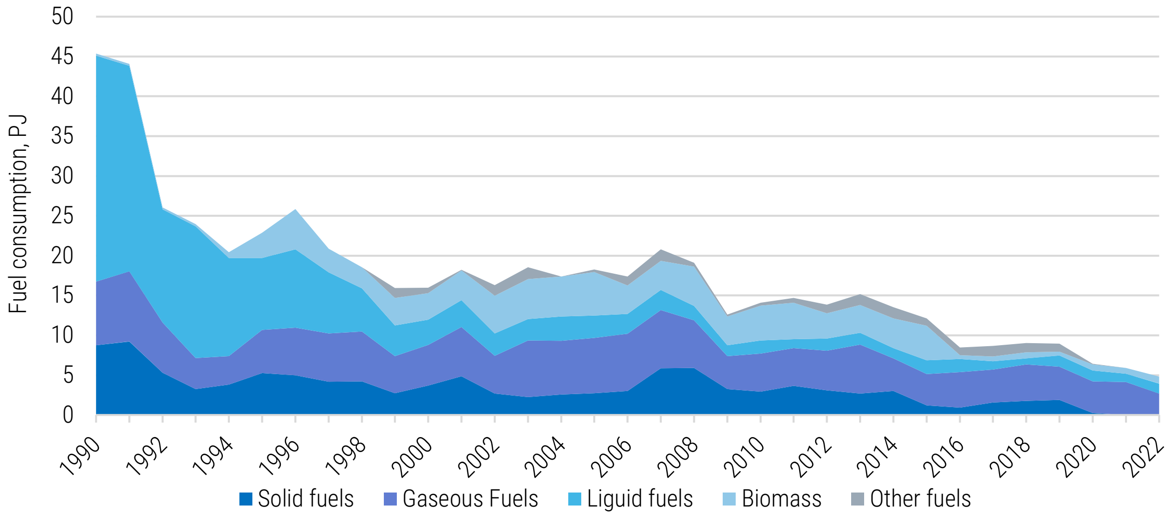

Figure 3.27 Fuel consumption by manufacturing industries in the period of 1990-2022

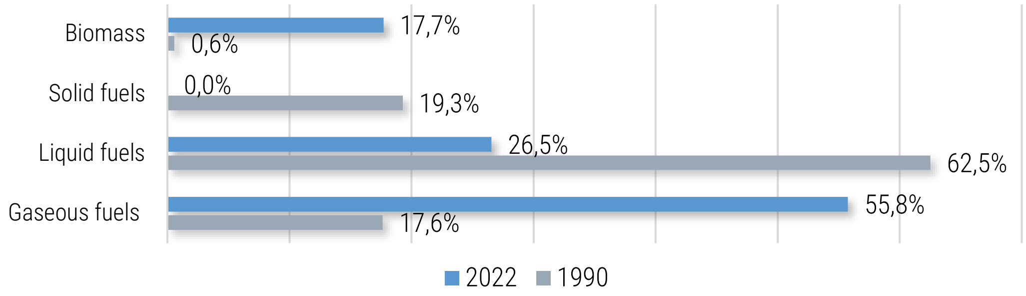

Figure 3.28 Distribution of fuel consumption in manufacturing industries in 1990 and 2022

3.2.3.3. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for main pollutants from energy industries sector is estimated in the range from 7% to 30%, for heavy metals and PAHs 50–200%, for dioxin 200%; for activity data is 2%. Uncertainty estimates for stationary combustion are given in the table below.

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NOx	0.36	kt	1.55	0.08	0.11
NMVOC	0.06	kt	0.24	0.01	0.00
SOx	0.29	kt	1.98	0.10	0.02
NH3	0.00	kt	0.01	0.00	0.00
PM2.5	0.03	kt	0.58	0.11	0.29
PM10	0.04	kt	0.41	0.08	0.10
TSP	0.04	kt	0.28	0.03	0.28
BC	0.01	kt	0.45	0.08	0.42
CO	0.12	kt	0.11	0.01	0.05
Pb	0.02	t	0.59	0.15	0.32
Cd	0.01	t	3.03	0.81	3.67
Hg	0.00	t	0.44	0.12	0.48
PCDD	0.10	g I-TEQ	2.32	2.99	4.79
benzo(a) pyrene	0.01	t	1.30	1.50	1.09
benzo(b) fluoranthene	0.02	t	1.99	2.35	0.77
benzo(k) fluoranthene	0.01	t	1.28	1.42	1.37
Indeno	0.01	t	0.58	0.66	1.61
HCB	0.00	kg	0.84	1.28	0.83
PCB	0.00	kg	0.00	0.00	1.66

3.2.3.4. Source-Specific QA/QC and Verification

Several QC procedures are used in the framework of inventory preparation.

Since all calculations of emissions from this sector are carried out on the basis of energy balance data from Estonian statistics, the balance data, which is presented both in natural units and in terajoules, is analyzed first. The analysis covers the most recent year as well as data for the entire period from 1990 to the reporting year. If the data in the energy balance changes, appropriate adjustments are made to the calculation module. Balance sheet data is also compared with the IEA Questionnaire.

Next, fuel emission factors are verified. In the case of new studies to estimate country specific emission factors or changes are made to the new edition of the Guidebook, all necessary corrections are made for the entire time series.

3.2.3.5. Recalculations

In the 2024 submission the following recalculations were carried out:

- Recalculated emissions of POPs and NH_3 for 1990-2021. Compared to the previous submission, POPs emissions from gas combustion and ammonia from biomass combustion from small boilers have been recalculated in accordance with changes in the Guidebook 2023, where EF has been changed and is equal to 0.
- Small changes in emissions in some years due to adjustments to data on natural gas, biomass, liquid fuel and coal used.

3.2.3.6. Source-Specific Planned Improvements

Not planned for the next submission.

3.2.4. Non-Industrial Combustion (NFR 1A4)

3.2.4.1. Source Category Description

NFR 1A4 sectors include emissions from the small combustion plants used in the Commercial/Institutional, Residential sectors and Agriculture/Forestry/Fisheries (see Table 3.25).

The main source of pollution inside this sector is residential stationary combustion, which is a key source of CO (51.5%), $PM_{2.5}$ (41.7%), PM_{10} (23.8%), TSP (14.4%), NO_x (19.4%), NMVOC (12.7%), some heavy metals and POPs emissions in 2022. The main source of pollution inside this sector is residential stationary, which contributes to over 40% of final energy consumption in Estonia, with the largest share being consumed by building. Biomass consumption in this sector has more than tripled since the 1990s.

During the 1990-2022 period, the emission of some pollutants from this sector have decreased, and some pollutants such as NH_3, Cd, Zn and HCB have increased due to an increase in wood combustion and higher wood emissions factors for these substance (see Table 3.26).

The increase in emissions all substances by non-industrial combustion in 2022 when compared to 2021 is explained by increase in wood consumption and also liguid fuels.

Table 3.25 Non-industrial combustion activities

NFR	Description	Method	Activity data	Emissions factor
1A4ai	Commercial / institutional: Stationary	Tier 2	Energy balance of Statistics Estonia	National EF; Default EMEP/EEA Guidebook 2023
1A4bi	Residential: Stationary plants	Tier 2	Energy balance of Statistics Estonia	National EF; Default EMEP/EEA Guidebook 2023
1A4ci	Agriculture/Forestry/Fishing: Stationary	Tier 2	Energy balance of Statistics Estonia	National EF; Default EMEP/EEA Guidebook 2023

NFR 1A4ai, 1A4ci: Commercial / institutional: Stationary and Agriculture / Forestry / Fishing: Stationary includes pollutant emissions from combustion processes in this sector. Emissions are calculated on the basis energy balance data and emission factors provided in the IIR chapter 3.2.2.2.

NFR 1A4bi: Residential: Stationary plants include pollutant emissions data from diffuse sources.

Emissions are calculated on the basis energy balance data and emission factors provided in the Tables 3.27-30.

Table 3.26 Pollutant emissions from combustion in non-industrial sector in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	5.29	6.31	9.21	0.03	NR	NR	4.59	NR	72.65
1995	10.14	8.74	3.36	0.09	NR	NR	4.14	NR	120.91
2000	8.38	6.77	2.41	0.08	2.93	3.07	3.31	0.99	95.65
2005	6.18	4.88	1.29	0.06	2.23	2.34	2.52	0.74	69.67
2010	7.31	5.61	0.62	0.08	2.37	2.49	2.66	0.90	83.90
2015	5.38	3.88	0.51	0.06	1.86	1.95	2.08	0.73	59.27
2016	5.54	3.94	0.42	0.07	1.92	2.01	2.15	0.79	60.93
2017	5.45	3.87	0.34	0.07	1.94	2.04	2.17	0.80	60.19
2018	5.35	3.79	0.33	0.07	1.91	2.01	2.14	0.79	59.28
2019	5.04	3.55	0.33	0.06	1.78	1.87	2.00	0.73	55.78
2020	5.07	3.58	0.27	0.06	1.96	2.06	2.20	0.82	56.32
2021	4.83	3.40	0.26	0.06	1.96	2.07	2.21	0.83	53.84
2022	4.89	3.46	0.30	0.06	2.10	2.21	2.37	0.90	55.10
Change 1990-2022, %	**-7.6**	**-45.1**	**-96.7**	**93.9**	**-28.3**	**-27.8**	**-48.3**	**-9.1**	**-24.2**
Change 2021-2022, %	**1.1**	**1.9**	**17.6**	**3.7**	**7.1**	**7.1**	**7.2**	**8.7**	**2.4**

Table 3.26 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	2.88	0.19	0.09	0.24	0.33	0.24	1.07	0.018	5.53
1995	3.11	0.29	0.09	0.14	0.42	0.16	0.51	0.012	8.35
2000	3.21	0.29	0.09	0.16	0.40	0.14	0.56	0.010	7.78
2005	2.61	0.27	0.07	0.13	0.35	0.13	0.57	0.009	7.11
2010	2.73	0.33	0.07	0.11	0.46	0.14	0.45	0.010	9.68
2015	2.05	0.28	0.05	0.13	0.40	0.12	0.60	0.008	8.13
2016	2.01	0.29	0.05	0.11	0.42	0.12	0.53	0.009	8.58
2017	1.94	0.29	0.05	0.12	0.42	0.12	0.56	0.009	8.72
2018	1.88	0.29	0.05	0.11	0.42	0.12	0.52	0.009	8.78
2019	1.79	0.28	0.05	0.10	0.41	0.12	0.47	0.009	8.48
2020	1.75	0.29	0.04	0.10	0.42	0.12	0.46	0.009	8.94
2021	1.69	0.28	0.04	0.08	0.41	0.12	0.40	0.009	8.74
2022	1.67	0.29	0.04	0.09	0.43	0.12	0.45	0.009	9.17
Change 1990-2022, %	**-42.1**	**51.9**	**-52.5**	**-60.7**	**30.0**	**-47.3**	**-57.7**	**-48.5**	**66.0**
Change 2021-2022, %	**-1.1**	**4.5**	**-1.6**	**9.4**	**5.7**	**6.1**	**14.8**	**4.8**	**5.0**

Table 3.26 continues

Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	6.34	8.65	0.10	1.19
1995	2.43	9.72	0.23	0.41
2000	1.50	7.25	0.21	0.26
2005	1.22	5.13	0.17	0.22
2010	0.80	5.45	0.23	0.08
2015	0.57	3.75	0.18	0.04
2016	0.52	3.75	0.19	0.05
2017	0.49	3.64	0.19	0.02
2018	0.47	3.54	0.19	0.02
2019	0.46	3.30	0.18	0.02
2020	0.48	3.30	0.19	0.02
2021	0.45	3.10	0.18	0.01
2022	0.45	3.17	0.19	0.02
Change 1990-2022, %	-92.8	-63.4	87.5	-98.6
Change 2021-2022, %	0.7	2.3	4.0	14.0

3.2.4.2. Methodological Issues

Emissions from the diffuse sources were calculated by using data on fuel consumption from the Energy Balance (EB), which was prepared by Statistics Estonia.

Emissions for NFR sectors 1A4ai and 1A4ci have been calculated according to national emissions factors or Guidebook 2023 and fuel consumption, emissions factors are presented in Chapter 3.2.2.2.

Calculation emission from solid, liquid fuels and natural gas were carried out by using of Guidebook 2023 emission factors (Table 3.27), using a more detailed distribution of fuel by type of combustion installation: while in the last report emissions were calculated frombased on the average factor for conventional stoves, fireplaces, saunas and outdoor heaters, then this year the fuel is distributed between old stoves and open fireplaces

Emissions of major substances from the combustion of biomass in the residential sector have been calculated based on new measurement data which were carried out within the framework of the "Greenhouse gases and ambient air pollutants reporting development" project (https://klab.ee/wp-content/uploads/2024/03/Arendus2023_aruanne_final.pdf). It should be noted that the particulate emissions factor also includes the condensable component. Measurements were conducted for various types of combustion installations, allowing for a more precise calculation of pollutant emissions with less uncertainty. Emission factors are shown in Table 3.29

The calculation of POPs emissions for the residential stationary combustion sector was achieved by the use of national factors for wood burning defined within the project "The Geneva Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants Protocol compliance". Within the project, measurements for various types of burning installations (stoves, single household boilers, open fireplaces) were carried out and average values were defined. Measurements were also made for conventional and advanced stoves and boilers. Emission factors are shown in Table 3.29. For the calculation of heavy metals emissions from wood combustion were used as emission factors for the new EMEP/EEA Guidebook 2023 and these are presented in the Table 3.28.

Calculations of emissions of POPs from the burning of waste in stoves were made in addition. Emission factors were also defined within the project *"Tööstuslikest allikatest ja koduahjudest eralduvate välisõhu*

Return to the Table of Contents

saasteainete heitkoguste inventuuri metoodikate täiendamine" (see Table 3.30). Data on the amount of the burned waste were obtained on the basis of the Statistics Estonia questionnaire (see Table 3.34). Emissions are included in sector 1A4bi.

The calculations of heavy metals emissions from the burning of waste in stoves were made on the base of Guidebook 2023 emission factors of, Chapter 5.C.1.a Municipal waste incineration, table 3-2 (see Table 3.30).

The NGO Estonian Chimney Court, believes that in addition to paper and paperboard packaging, diapers, sanitary napkins, various plastic packaging, shoes, clothes, and other residues are burned in domestic stoves. Thanks to growing awareness and new technology, waste burning in households shows a downward trend. People should be motivated not to burn waste as heaters used in such a way will wear faster and maintenance and repair are expensive.

It is estimated that approximately 45% of private households may burn waste (see Table 3.34). Growing awareness and constant notification of the volume of waste being burned is helping to reduce this figure in resent years.

Table 3.27 Main pollutant emission factors for NFR 1A4bi (Tier 2 EMEP/EEA Guidebook 2023)

Pollutant	Unit	Solid fuels (not biomass)			Liquid fuels		Natural gas	
		Conventional stoves, fireplaces, saunas, outdoor heaters (average)	Advanced stoves	Small boilers (<=50 kW_{th})	Stoves	Small boilers (<=50 kW_{th})	Fireplaces, saunas, outdoor heaters	Small boilers (<=50 kW_{th})
NO_x	g/GJ	60	100	150	158	34	69	60
NMVOC	g/GJ	600	600	300	174	1.2	0.17	2
SO_2	g/GJ	500	900	450	900	60	79	0.3
NH_3	g/GJ	5	NA	NA	NA	NA	NA	NA
$PM_{2.5}$	g/GJ	330	450	220	201	2.2	1.5	2.2
PM_{10}	g/GJ	330	450	240	225	2.2	1.5	2.2
TSP	g/GJ	350	500	250	261	2.2	1.5	2.2
BC	g/GJ	32.47	28.8	14.08	12.86	0.29	0.06	0.12
CO	g/GJ	5000	5000	2000	4787	111	3.7	30
Pb	mg/GJ	100	100	100	200	0.01	0.01	0.0015
Cd	mg/GJ	0.50	1	1	3	0.001	0.001	0.00025
Hg	mg/GJ	3	5	5	6	0.12	0.12	0.10
As	mg/GJ	1.5	1.5	1.5	5	0.002	0.002	0.12
Cr	mg/GJ	10	10	10	15	0.20	0.20	0.00076
Cu	mg/GJ	20	20	15	30	0.13	0.13	0.000076
Ni	mg/GJ	10	10	10	20	0.01	0.01	0.00051
Se	mg/GJ	1	2	2	2	0.002	0.002	0.011
Zn	mg/GJ	200	200	200	300	0.42	0.42	0.0015
PCDD/F	ng/GJ	500	1000	500	500	10	1.8	NA
B(a)p	mg/GJ	100	250	150	270	0.08	0.08	NA
B(b)f	mg/GJ	170	400	180	250	0.04	0.04	NA
B(k)f	mg/GJ	100	150	100	100	0.07	0.07	NA
I(1,2,3-cd)p	mg/GJ	80	120	80	90	0.16	0.16	NA
HCB	µg/GJ	0.62	0.62	0.62	0.62	NA	NA	NA
PCBs	µg/GJ	170	170	170	170	NA	NA	NA
NO_x	g/GJ	60	100	150	158	34	69	60

Table 3.28 HMs and PCBs emission factors for wood combustion for NFR 1A4bi (EMEP/EEA Guidebook 2023)

Pollutant	Unit	Biomass			
		Conventional stoves, fireplaces, saunas, outdoor heaters (average)	Small boilers (<=50 kW_{th})	Advanced stoves and boilers	Pellet stoves and boilers
Pb	mg/GJ	27	27	27	27
Cd	mg/GJ	13	13	13	13
Hg	mg/GJ	0.56	0.56	0.56	0.56
As	mg/GJ	0.19	0.19	0.19	0.19
Cr	mg/GJ	23	23	23	23
Cu	mg/GJ	6	6	6	6
Ni	mg/GJ	2	2	2	2
Se	mg/GJ	0.5	0.5	0.5	0.5
Zn	mg/GJ	512	512	512	512
PCBs	µg/GJ	0.06	0.06	0.007	0.01

Table 3.29 Main pollutants and POPs national emission factors for NFR 1A4bi (wood combustion)

Pollutant	Unit	Open fireplaces, sauna	Conventional stoves, Massive stone made wood heater, grate burning technology	Conventional stoves, Massive stone made wood heater, closed burning technology	Advanced stoves, Modulating Croval made wood-heater, build according to EN 15544	Advanced stoves, Massive stone made wood-heater, build according to EN 15544
NO_x	g/GJ	137.334	111.370	103.210	139.06	143.61
NMVOC	g/GJ	49.584	57.570	130.800	58.32	63.38
SO_2	g/GJ	8.989	0.410	0.570	2.02	1.00
NH_3	g/GJ	8.0	3.2	6.6	2.01	4.90
$PM_{2.5}$	g/GJ	241.046	78.090	184.990	24.86	40.02
PM_{10}	g/GJ	250.241	80.990	193.680	26.31	43.42
TSP	g/GJ	275.525	92.210	193.680	28	43.62
BC	g/GJ	114.874	37.215	88.160	11.847	19.072
CO	g/GJ	3035.772	2555.190	2761.620	2024.850	1961.990
PCDD/F	ng/GJ	617.70	13.200	13.200	8.8	8.8
B(a)p	mg/GJ	49.90	24.800	24.800	1.185	1.185
B(b)f	mg/GJ	34.70	18.200	18.200	0.891	0.891
B(k)f	mg/GJ	21.50	12.500	12.500	0.569	0.569
I(1,2,3-cd)p	mg/GJ	27.80	23.800	23.800	0.878	0.878
HCB	µg/GJ	12.738	14.237	14.237	8.341	8.341

Table 3.29 continues

Pollutant	Unit	Cooking stone made stove, grate burning technology; old	Advanced cooking stone made stove, build according to EN 15544	Conventional small boilers (<=35 kW_{th})	Advanced small boilers (<=35 kW_{th})	Wood briquette stoves and boilers	Wood pellet stoves and boilers
NO_x	g/GJ	120.43	139.71	2383.82	74.512	176.21	45.88
NMVOC	g/GJ	227.32	46.85	1851.82	57.883	204.556	2.28
SO_2	g/GJ	0.86	0.79	26.65	11.00	10.89	12.34
NH_3	g/GJ	2.41	5.61	9.86	0.308	2.497	0.93
$PM_{2.5}$	g/GJ	127.64	46.72	295.11	9.224	22.79	684.22
PM_{10}	g/GJ	130.44	50.04	310.64	9.71	23.99	720.23
TSP	g/GJ	133.87	50.04	341.70	10.681	26.65	792.25
BC	g/GJ	60.83	22.27	140.64	4.396	10.86	326.07
CO	g/GJ	1926.23	1670.26	24264.87	758.454	4032.21	269.28
PCDD/F	ng/GJ	11.80	11.80	15.025	0.4696	6.50	1.90
B(a)p	mg/GJ	64.50	64.50	489.008	0.037	2.942	3.381
B(b)f	mg/GJ	48.50	48.50	433.051	0.028	2.212	1.994
B(k)f	mg/GJ	32.50	32.50	358.864	0.018	1.413	1.098
I(1,2,3-cd)p	mg/GJ	50.90	50.90	591.64	0.027	2.181	2.137
HCB	µg/GJ	19.56	19.56	8.333	0.261	5.217	1.288

Table 3.30 National pollutants emission factors (for HMs – Guidebook 2023) for the waste combustion in stoves

Pollutant	Unit	Emission factor
NO_x	g/GJ	224.593
SO_2	g/GJ	19.749
NH_3	g/GJ	3.067
NMVOC	g/GJ	190.561
CO	g/GJ	2,795.054
TSP	g/GJ	1,167.613
PM_{10}	g/GJ	1,061.466
$PM_{2.5}$	g/GJ	1,008.393
BC	g/GJ	77.349
PCDD/PCDF	µg/GJ	0.055
B(a)p	µg/GJ	10,428.571
B(b)f	µg/GJ	10,557.619
B(k)f	µg/GJ	4,566.167
I(1,2,3-cd)p	µg/GJ	5,637.013
HCB	µg/GJ	35.943
Pb	g/Mg waste	104
Cd	g/Mg waste	3.4
Hg	g/Mg waste	2.8
As	g/Mg waste	2.14
Cr	g/Mg waste	0.185
Cu	g/Mg waste	0.093
Ni	g/Mg waste	0.12
Zn	g/Mg waste	0.9

Implied emission factors (IEF) for some pollutants for sector 1A4 are presented in the Table 3.31.

The main impact on the change of IEF in this sector is the exerted change of the situation regarding residual stationary as it is a main source of pollution inside the non-industrial sector. At the beginning of the 1990s this involved a change in energy supply, involving a decrease in the consumption of solid fuel, mainly coal and peat, and the significant growth of wood consumption after 1995 (see Table 3.32, Figure 3.30-3.31). A sharp increase in the IEF of NO_x and a decrease in SO_2 is explained by it. A further decrease of NO_x IEF is explained by a change in the share of conventional and advanced technologies for wood burning in residential sector (the share of new equipment grows every year) (see Figure 3.29).

In 2022, an increase in the IEF of particulates was caused by a increase in the biomass amount.

Table 3.31 NFR 1A4 pollutants IEF, g/total fuels GJ

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	366.0	210.3	182.3	NR
1995	150.3	453.0	185.0	NR
2000	110.7	384.5	151.8	134.7
2005	60.7	290.3	118.1	104.8
2010	24.5	290.3	105.6	94.2
2015	21.5	224.8	87.0	77.6
2016	16.3	217.0	84.1	75.0
2017	13.6	215.2	85.8	76.5
2018	13.2	211.4	84.5	75.4
2019	13.5	205.6	81.5	72.7
2020	10.9	201.6	87.4	77.8
2021	10.3	195.1	89.2	79.3
2022	12.6	204.8	99.3	88.2

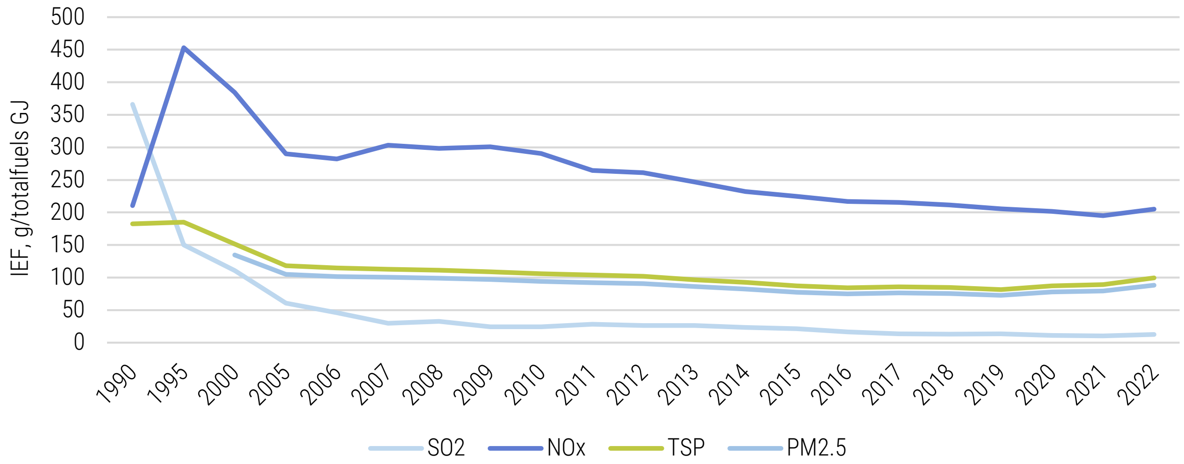

Figure 3.29 Implied emission factors for NFR 1A4

Activity Data

The fuel consumption figures for the non-industrial stationary combustion sector are presented in Table 3.32 and Figure 3.25. The consumption of liquid and solid fuels (mainly coal and peat) has decreased across 1990-2022, by about 78.8% and 98.7% respectively. At the same time, wood burning and natural gas consumption increased by about 135.5% and 47.1%. The distribution of fuel consumption rates in 1990 and 2022 are shown in Figure 3.31.

Table 3.32 Fuel consumption in non-industrial combustion plants in the period of 1990–2022 (PJ)

Year	Liquid fuels	Solid fuels	Gaseous fuels	Biomass	Other fuels
1990	7.44	7.01	2.79	7.60	0.32
1995	2.23	2.38	2.12	15.20	0.439
2000	3.01	1.50	2.32	14.47	0.479
2005	2.26	1.31	4.09	13.26	0.374
2010	1.76	0.46	3.89	18.68	0.390
2015	2.39	0.25	5.25	15.79	0.283
2016	2.16	0.26	5.94	16.92	0.271
2017	2.23	0.13	5.56	17.12	0.260
2018	2.07	0.11	5.67	17.21	0.248
2019	1.93	0.10	5.66	16.57	0.237
2020	1.74	0.09	5.65	17.44	0.226
2021	1.44	0.08	5.98	17.05	0.218
2022	1.58	0.09	4.10	17.88	0.210
Change 1990-2022, %	**-78.8**	**-98.7**	**47.1**	**135.2**	**-34.7**
Change 2021-2022, %	**9.4**	**14.5**	**-31.5**	**4.8**	**-3.7**

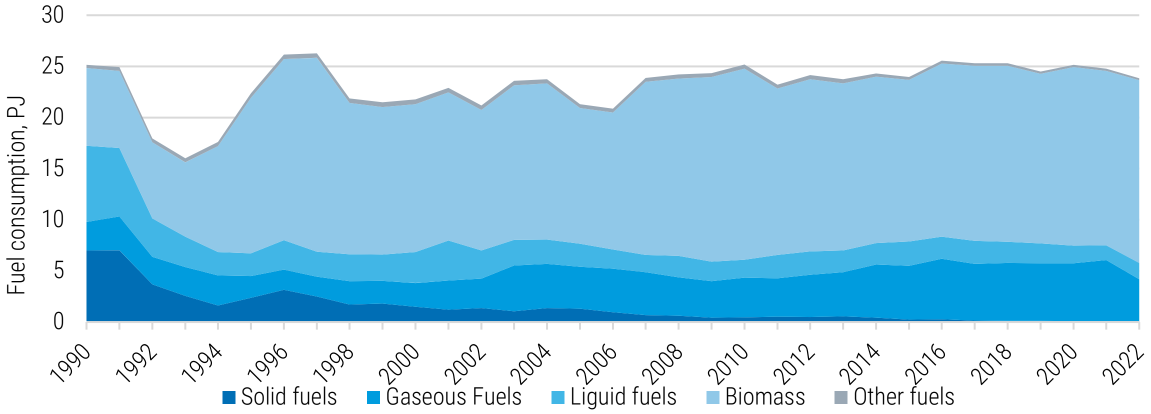

Figure 3.30 Fuel consumption by non-industrial combustion plants in the period of 1990–2022

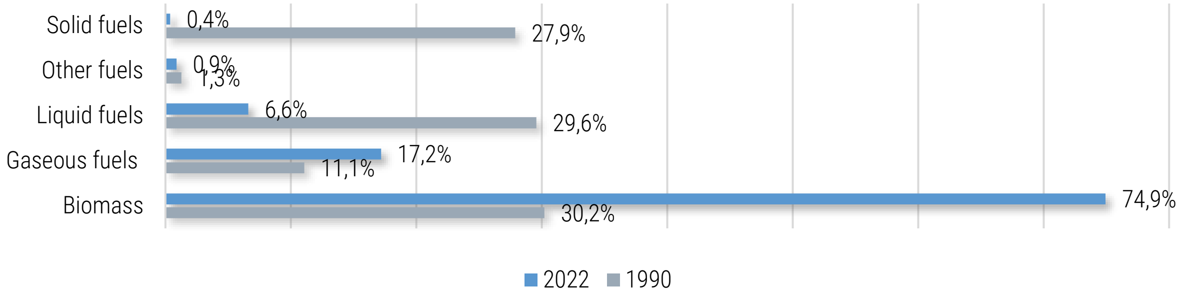

Figure 3.31 Distribution of fuel consumption in non-industrial combustion sector in 1990 and 2022

Fuel consumption figures by residential stationary sector are presented in Table 3.33. Figure 3.32 shows fuel consumption levels for each non-industrial sector in 2022. It should be noted that the domestic sector is the main source of wood burning.

Table 3.33 Fuel consumption in residential combustion plants (NFR 1A4bi) in the period of 1990–2022, PJ

Year	Liquid fuels	Solid fuels	Gaseous fuels	Biomass	Other fuels
1990	3.41	6.70	2.38	5.09	321.34
1995	0.36	2.32	2.00	15.01	438.85
2000	0.87	1.24	1.77	13.89	479.31
2005	0.39	0.98	1.88	12.34	374.40
2010	0.35	0.36	2.30	17.73	389.78
2015	0.40	0.22	2.07	15.13	282.60
2016	0.45	0.08	2.42	16.07	271.23
2017	0.40	0.09	2.32	16.35	259.85
2018	0.36	0.04	2.30	16.50	248.48
2019	0.39	0.05	2.42	15.84	237.10
2020	0.27	0.04	2.35	16.60	225.73
2021	0.20	0.03	2.52	16.24	217.78
2022	0.13	0.00	2.04	17.10	209.82
Change 1990-2022, %	**-96.1**	**-100.0**	**-14.3**	**235.8**	**-34.7**
Change 2021-2022, %	**-32.4**	**-100.0**	**-19.2**	**5.3**	**-3.7**

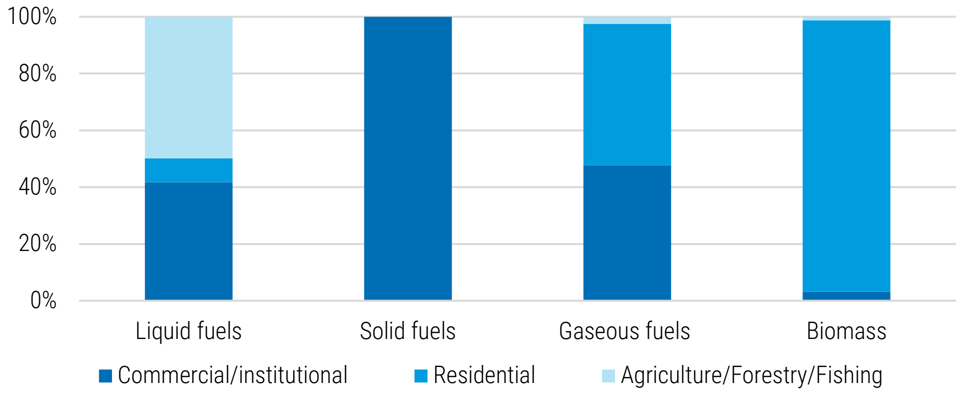

Figure 3.32 Fuel consumption by non-industrial sectors in 2022

Table 3.34 Amount of waste incinerated in domestic stoves (tonnes)

Year	Amount of waste
1990	16,757.789
1995	22,886.049
2000	24,996.018
2005	19,764.689
2010	20,701.470
2015	15,009.040
2016	14,404.920
2017	13,800.790
2018	13,196.670
2019	12,592.540
2020	11,988.420
2021	11,566.100
2022	11,143.780

3.2.4.3. Uncetainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for main pollutants from energy industries sector is estimated in the range from 7% to 50%, for heavy metals and PAHs 50–200%, for dioxin 200%; in the activity data, in the range from 2% to 50%. Uncertainty estimates for stationary combustion are given in the table below.

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NOx	4.89	kt	20.86	13.75	4.80
NMVOC	3.46	kt	13.09	6.42	3.70
SOx	0.30	kt	2.05	0.35	0.03
NH3	0.06	kt	0.62	0.31	0.20
PM2.5	2.10	kt	42.83	24.33	14.37
PM10	2.21	kt	24.55	13.91	5.86
TSP	2.37	kt	14.83	7.52	0.62
BC	0.90	kt	76.80	44.21	40.25
CO	55.10	kt	51.81	26.27	15.92
Pb	1.67	t	40.00	43.42	0.96
Cd	0.29	t	62.81	63.57	6.90
Hg	0.04	t	21.65	23.37	3.29
PCDD	0.45	g I-TEQ	10.99	17.63	33.97
benzo(a) pyrene	0.91	t	84.83	170.41	22.36
benzo(b) fluoranthene	0.76	t	75.12	148.67	16.08
benzo(k) fluoranthene	0.57	t	86.31	173.51	23.46

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
Indeno	0.92	t	92.68	189.16	36.50
HCB	0.19	kg	38.23	41.93	31.02
PCB	0.02	kg	2.87	5.49	4.08

3.2.4.4. Source-Specific QA/QC and Verification

Several QC procedures are used in the framework of inventory preparation.

Since all calculations of emissions from this sector are carried out on the basis of energy balance data from Estonian statistics, the balance data, which is presented both in natural units and in terajoules, is analyzed first. The analysis covers the most recent year as well as data for the entire period from 1990 to the reporting year. If the data in the energy balance changes, appropriate adjustments are made to the calculation module. Balance sheet data is also compared with the IEA Questionnaire.

Next, fuel emission factors are verified. In the case of new studies to estimate country specific emission factors or changes are made to the new edition of the Guidebook, all necessary corrections are made for the entire time series.

3.2.4.5. Recalculations

In the 2024 submission the following recalculations were carried out:

- Recalculated emissions of POPs and NH3 for 1990-2021. Compared to the previous submission, POPs emissions from gas combustion and ammonia from biomass combustion from small boilers have been recalculated in accordance with changes in the Guidebook 2023, where EF has been changed and is equal to 0.
- Small changes in emissions in some years due to adjustments to data on natural gas, biomass, liquid and solid fuels used.
- Emissions of major substances and particulate matter in the residential sector have been recalculated based on the results of new measurements for biomass combustion. It should be noted that the particulates emissions factor for biomass includes condensable part. Additionally, a more detailed distribution of burning facilities by types and technologies has been carried out (Table 3.29).
- Recalculated emissions of all pollutants from coal and peat combustion, using a more detailed distribution of fuel by type of combustion installation: while in the last report emissions were calculated based on the average factor for conventional stoves, fireplaces, saunas and outdoor heaters, then this year the fuel is distributed between old stoves and fireplaces (Table 3.27).

3.2.4.6. Source-Specific Planned Improvements

A more detailed analysis and description of each activity within the non-industrial sector.

3.3. Transport

3.3.1. Overview of the Sector

In this chapter the trends and shares in emissions of the different source categories within the transport sector are described. A detailed description of methodology, activity data, emission factors and emissions is given in each subsector. Table 3.35 gives an overview of all the transport sectors and the methodologies used for calculating emissions from the transport sector.

Table 3.35 Transport sector reporting activities

NFR	Source	Description	Method	Emissions
1A2gvii	Mobile combustion in manufacturing industries and construction	Mobile combustion in manufacturing industries and construction land based mobile machinery (e.g. rollers, asphalt pavers, excavators, cranes, tractors, other industrial machinery)	Tier 2	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO
			Tier 1	SO_x, Pb, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
1A3ai-ii(i)	International and Civil aviation (LTO)	Activities include all use of aircraft (jets, turboprop powered and piston engine aircraft, helicopters) consisting passengers and freight transport	Tier 2	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO
1A3ai-ii(ii)	International and Civil aviation (Cruise)	Activities include all use of aircraft consisting passengers and freight transport	Tier 1	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO
1A3bi-iv	Road transport	Road transport includes use of vehicles with combustion engines: passenger cars, light duty vehicles, heavy duty trucks, buses and motorcycles	Tier 3	NO_x, NMVOC, SO_x, 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, PAHs total, HCB, PCBs
1A3bv	Road transport: Gasoline evaporation	Fuel evaporation from automobiles	Tier 3	NMVOC
1A3bvi	Automobile tyre and brake wear	PM, heavy metal and PAHs emissions from automobile tyre and brake wear	Tier 3	$PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs total
1A3bvii	Road transport: Automobile road abrasion	PM emissions from road abrasion	Tier 1	$PM_{2.5}$, PM_{10}, TSP, BC
1A3c	Railways	Railway transport operated by steam and diesel locomotives	Tier 1/Tier 2	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs total
1A3dii	National navigation (Shipping)	Merchant ships, passenger ships, technical ships, pleasure and tour ships and other inland vessels	Tier 1	NO_x, NMVOC, SO_x, $PM_{2.5}$, 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, PAHs total, HCB, PCBs
1A4aii	Commercial/Institutional: Mobile	Commercial and institutional land based mobile machinery. This source category includes 1A5b Other, Mobile - Military sector	Tier 2	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO
			Tier 1	SO_x, Pb, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
1A4bii	Residential: Household and gardening (mobile)	Household and gardening sector includes various machinery: lawn mowers, wood splitters, lawn and garden tractors etc.	Tier 2	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO

NFR	Source	Description	Method	Emissions
			Tier 1	SO_x, Pb, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Land based mobile off-road vehicles and other machinery used in agriculture/forestry sector (agricultural tractors, harvesters, combines etc.)	Tier 2	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO
			Tier 1	SO_x, Pb, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
1A4ciii	Agriculture/Forestry/Fishing: National fishing	National fishing sector covers emissions from fuels combusted for inland, coastal and deep-sea fishing	Tier 1	NO_x, NMVOC, SO_x, $PM_{2.5}$, 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, PAHs total, HCB, PCBs
1A3di(i)	International maritime navigation	Vessels of all flags that are engaged in international water-borne navigation	Tier 1 (cruise); Tier 3 (hotelling, maneuvering)	NO_x, NMVOC, SO_x, $PM_{2.5}$, 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, PAHs total, HCB, PCBs

The transport sector is a major contributor to national emissions. The transport sector includes road transport which is the largest and most important emission source (see Figure 3.33). The share of mobile sources in total national emissions in 2022 was the following: NO_x – 35.1%, BC – 16.3%, CO – 7.2% and NMVOC – 4.2%. The methodology of emissions calculations in regards to road transport automobile road abrasion, specifically the use of studded tyres, has been improved past years. The share of particle emissions in total national emissions in 2022 was the following: $PM_{2.5}$ – 11.7%, PM_{10} – 11.8%, TSP – 13.3%. Emissions of most compounds have decreased throughout the time series, mainly due to the stricter emission standards for road vehicles. The emissions of nitrogen oxides have decreased compared to 1990 by 75.5%. The emissions of NMVOC and CO from the transport sector have decreased by 94.5% and 94.8% respectively since 1990. The trend of the emissions of these categories is given in Figure 3.34 and Table 3.36.

Recalculations have been made for the following sectors: road transport (1A3bi-vii). Recalculations entail using updated emission factors, which led to a change in total emissions. A detailed overview is given in each transport subsector and in Chapter 8.

In addition, information on which transport sectors include the condensable component of PM_{10} and $PM_{2.5}$ can be found in Appendix 1 'Summary Information on Condensable in PM'.

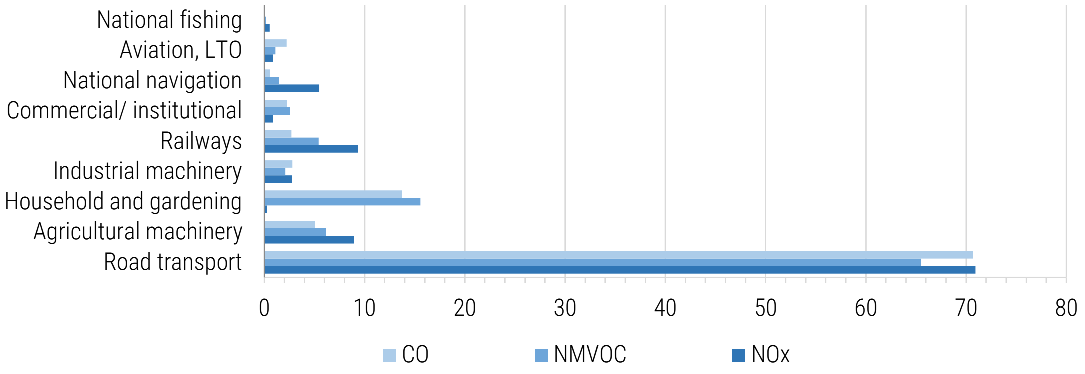

Figure 3.33 NO_x, NMVOC and CO emission shares in the transport sectors in 2022 (%)

Return to the Table of Contents

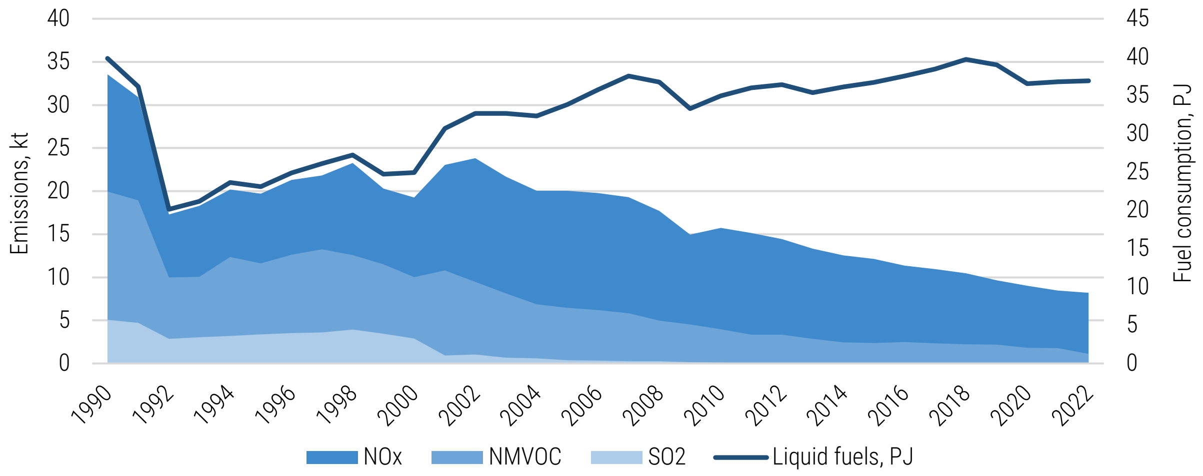

Figure 3.34 NO$_x$, NMVOC and CO emissions from the transport sector in the period of 1990-2022

Table 3.36 Total emissions from the transport sector in the period of 1990-2022

Year	NO$_x$	NMVOC	SO$_2$	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO
	kt								
1990	33.557	19.953	5.068	0.017	NR	NR	2.995	NR	147.703
1995	19.703	11.606	3.382	0.027	NR	NR	1.945	NR	66.320
2000	19.257	9.963	2.912	0.099	0.979	1.308	1.927	0.346	63.258
2005	20.036	6.393	0.370	0.204	1.323	1.794	2.682	0.492	46.472
2010	15.750	3.869	0.112	0.208	1.095	1.595	2.540	0.375	28.473
2015	12.123	2.287	0.032	0.152	1.032	1.593	2.641	0.300	18.258
2016	11.347	2.279	0.031	0.150	1.045	1.635	2.741	0.284	21.453
2017	10.913	2.054	0.036	0.146	1.046	1.663	2.819	0.266	20.123
2018	10.446	1.806	0.036	0.140	1.064	1.714	2.933	0.256	16.157
2019	9.608	1.754	0.031	0.140	1.051	1.710	2.945	0.239	16.498
2020	8.954	1.415	0.031	0.112	1.002	1.635	2.822	0.226	10.786
2021	8.471	1.213	0.026	0.096	0.975	1.620	2.825	0.198	9.121
2022	8.217	1.099	0.029	0.094	0.934	1.556	2.701	0.191	7.704
Change 1990-2022, %	-75.5	-94.5	-99.4	440.0	-4.6	18.9	40.2	-44.7	-94.8
Change 2021-2022, %	-3.0	-9.4	12.3	-2.5	-4.2	-3.9	-4.4	-3.6	-15.5

Table 3.36 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	78.697	0.006	0.007	0.011	0.344	7.522	0.083	0.008	2.433
1995	24.583	0.003	0.004	0.007	0.205	4.452	0.043	0.004	1.434
2000	5.388	0.003	0.004	0.007	0.221	4.826	0.048	0.005	1.554
2005	2.686	0.005	0.005	0.009	0.297	6.496	0.066	0.006	2.132
2010	0.862	0.005	0.005	0.010	0.313	6.831	0.067	0.007	2.209
2015	0.910	0.005	0.005	0.010	0.342	7.472	0.067	0.007	2.406
2016	0.965	0.005	0.005	0.011	0.355	7.756	0.069	0.007	2.498
2017	0.999	0.006	0.005	0.011	0.367	8.020	0.072	0.008	2.584
2018	1.022	0.006	0.005	0.012	0.384	8.381	0.074	0.008	2.698
2019	1.034	0.006	0.005	0.012	0.385	8.404	0.072	0.008	2.699
2020	0.981	0.005	0.005	0.011	0.368	8.035	0.070	0.007	2.581
2021	1.022	0.005	0.005	0.012	0.385	8.363	0.070	0.007	2.674
2022	1.070	0.006	0.005	0.012	0.403	8.777	0.074	0.008	2.865
Change 1990-2022, %	-98.6	-7.6	-28.2	8.9	17.1	16.7	-11.4	1.4	17.7
Change 2021-2022, %	4.6	6.8	1.1	4.6	4.8	4.9	5.4	7.1	7.2

Table 3.36 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					kg	
1990	0.307	0.017	0.031	0.017	0.012	0.078	0.0017	0.0210
1995	0.175	0.008	0.015	0.010	0.007	0.040	0.0008	0.0097
2000	0.200	0.007	0.014	0.009	0.006	0.036	0.0009	0.0014
2005	0.274	0.011	0.019	0.012	0.009	0.050	0.0012	0.0005
2010	0.313	0.012	0.020	0.014	0.009	0.054	0.0012	0.0005
2015	0.307	0.015	0.022	0.014	0.011	0.062	0.0008	0.0003
2016	0.290	0.015	0.022	0.014	0.011	0.063	0.0008	0.0003
2017	0.278	0.015	0.022	0.015	0.011	0.064	0.0009	0.0004
2018	0.268	0.016	0.023	0.015	0.012	0.066	0.0008	0.0003
2019	0.262	0.016	0.022	0.014	0.012	0.064	0.0007	0.0003
2020	0.254	0.016	0.022	0.014	0.012	0.064	0.0008	0.0003
2021	0.218	0.015	0.021	0.015	0.013	0.064	0.0007	0.0003
2022	0.205	0.016	0.023	0.016	0.013	0.067	0.0007	0.0003
Change 1990-2022, %	-33.3	-10.1	-26.9	-6.5	4.3	-13.6	-58.6	-98.7
Change 2021-2022, %	-6.0	6.1	6.8	5.2	1.3	5.4	-4.2	-4.0

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

3.3.2.1. Source Category Description

Estonian inventory contains estimates for both domestic and international aviation. Emission estimates from the aviation sector include all aircraft types: helicopters, jets, turboprop powered and piston engine aircrafts.

Emissions from the aviation sector are split into different aircraft activities, and allocations are made according to the requirements for reporting:

- 1.A.3.a.i (i) International aviation LTO (civil);
- 1.A.3.a.ii (i) Domestic aviation LTO (civil);
- 1.A.3.a.i (ii) International aviation cruise (civil);
- 1.A.3.a.ii (ii) Domestic aviation cruise (civil).

In addition, emissions from the cruise phase are reported as a memo item and are not included in national totals.

The aviation sector has quite a minor share in total emissions. The total contribution of aircraft LTO emissions to the emissions of NO_x, NMVOC and CO in the transport sector in 2022 was 0.9%, 1.1%, and 2.2% respectively (see Figure 3.35). Other pollutants have an even smaller share.

Aviation emissions reflect the level of overall aviation activity. All the changes in the time series are mostly borne from changes in fuel consumption and the number of landing and take-off operations (see Figure 3.37), which is roughly correlated with the trends in the number of air passengers and passenger traffic volume over the same period. Figure 3.36 illustrate the importance of the international aviation sector, which contributes the majority of the emissions from the aviation sector.

The growth of air travel for the past decades has been noticeable. During the period of 1990–2019, the emission of NO_x, NMVOC, and CO from the LTO phase increased by 63.4%, 26.1%, and 60.2% respectively (see Figure 3.35 and Table 3.37). A rapid drop (in emissions) occurred in the year of 2020. The aviation sector was most affected by the COVID-19 pandemic during lockdowns and restrictions, which led to a decrease in pollutant emissions. After the decrease, the aviation sector has started to improve. In 2022, NO_x,

Return to the Table of Contents

NMVOC, SO_2, PM and CO emissions increased by 41.6%, 20.1%, 44.5%, 48.6% and 28.2% respectively compared to 2021. The increase in the amount of fuel consumed, the number of landing and take-off operations, passenger traffic volumes and the number of passengers resulted in a increase in emissions from the LTO-phase.

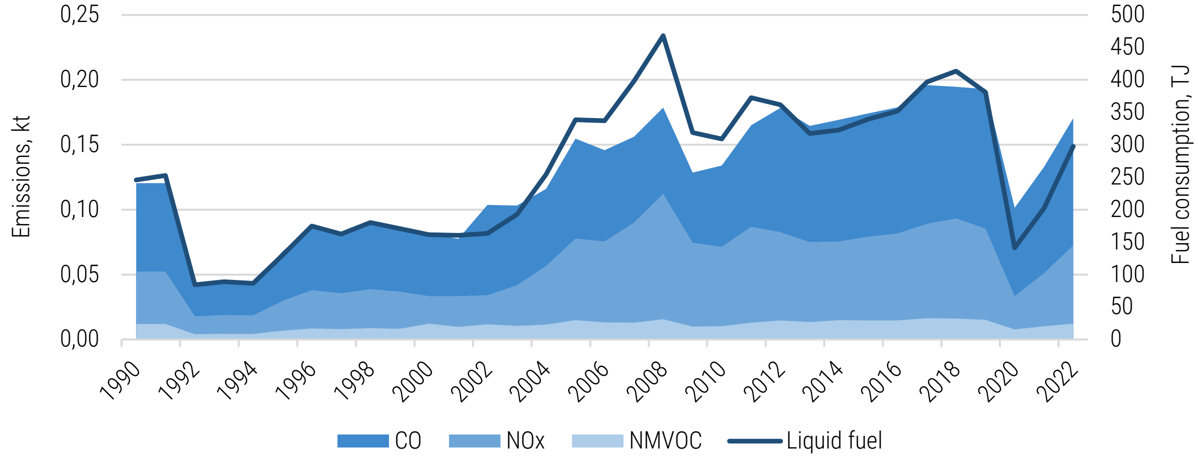

Figure 3.35 NO_x, NMVOC and CO emissions from the LTO cycle in aviation sector in the period of 1990-2022

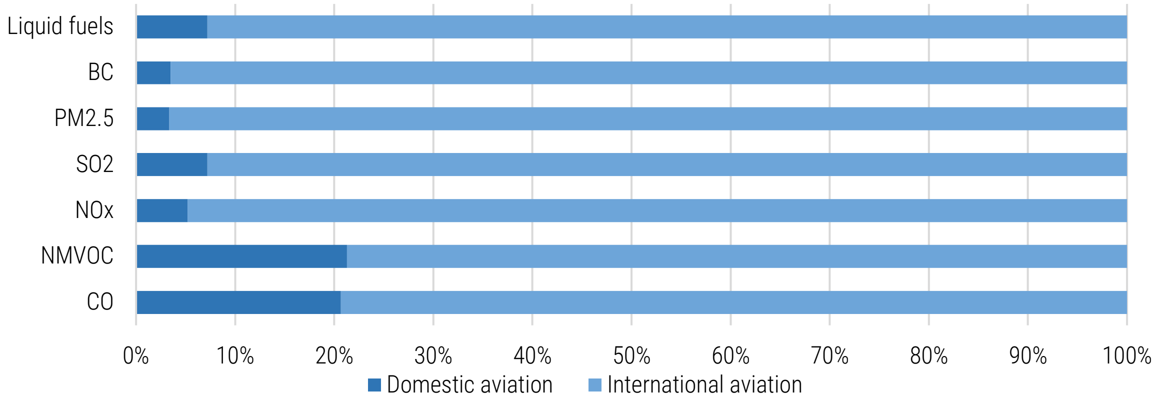

Figure 3.36 The share of pollutant emissions from the LTO cycle in aviation sector in 2022

Table 3.37 Emissions from the LTO cycle in the aviation sector in the period of 1990–2022 (kt)

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.052	0.012	0.006	NR	NR	0.0004	NR	0.120
1995	0.030	0.007	0.003	NR	NR	0.0002	NR	0.068
2000	0.033	0.012	0.004	0.0003	0.0003	0.0003	0.0002	0.082
2005	0.078	0.015	0.008	0.0007	0.0007	0.0007	0.0003	0.155
2010	0.071	0.010	0.007	0.0006	0.0006	0.0006	0.0003	0.134
2015	0.079	0.015	0.007	0.0005	0.0005	0.0005	0.0002	0.174
2016	0.082	0.015	0.008	0.0005	0.0005	0.0005	0.0002	0.179
2017	0.089	0.016	0.009	0.0006	0.0006	0.0006	0.0003	0.196
2018	0.093	0.016	0.009	0.0005	0.0005	0.0005	0.0003	0.195
2019	0.085	0.015	0.008	0.0005	0.0005	0.0005	0.0002	0.193
2020	0.034	0.008	0.003	0.0002	0.0002	0.0002	0.0001	0.101
2021	0.051	0.010	0.004	0.0003	0.0003	0.0003	0.0002	0.133
2022	0.073	0.012	0.006	0.0005	0.0005	0.0005	0.0002	0.170
Change 1990-2022, %	38.7	1.8	17.5	51.9	51.9	21.7	51.7	41.6
Change 2021-2022, %	41.6	20.1	44.5	48.6	48.6	48.6	49.7	28.2

Table 3.38 Emissions from the cruise phase in the aviation sector in the period of 1990–2022 (kt)

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.385	0.015	0.030	NR	NR	0.006	NR	0.035
1995	0.190	0.007	0.015	NR	NR	0.003	NR	0.017
2000	0.224	0.009	0.018	0.004	0.004	0.004	0.002	0.020
2005	0.482	0.018	0.038	0.008	0.008	0.008	0.004	0.043
2010	0.337	0.013	0.026	0.005	0.005	0.005	0.003	0.030
2015	0.537	0.021	0.042	0.008	0.008	0.008	0.004	0.047
2016	0.479	0.018	0.038	0.008	0.008	0.008	0.004	0.042
2017	0.638	0.025	0.050	0.010	0.010	0.010	0.005	0.056
2018	0.757	0.029	0.059	0.012	0.012	0.012	0.002	0.066
2019	0.757	0.029	0.059	0.012	0.012	0.012	0.002	0.066
2020	0.270	0.010	0.021	0.004	0.004	0.004	0.001	0.024
2021	0.496	0.019	0.039	0.008	0.008	0.008	0.001	0.044
2022	0.644	0.025	0.050	0.010	0.010	0.010	0.002	0.057
Change 1990-2022, %	**67.3**	**70.3**	**66.3**	**186.5**	**186.5**	**66.3**	**-10.4**	**62.6**
Change 2021-2022, %	**29.7**	**30.7**	**29.4**	**29.4**	**29.4**	**29.4**	**29.5**	**28.1**

3.3.2.2. Methodological Issues

All flights to and from Estonian airports are divided into domestic and international flights. Detailed aircraft type data is supplied by 7 Estonian airports. Separate emission estimates are made for domestic and international civil aircrafts, which are divided into emissions from the landing and take-off (LTO) phase and the cruise phase. Emission calculations from the LTO cycle are based on the Tier 2 method and cruise emission calculations on Tier 1.

For the LTO phase, fuel consumed and the emissions of pollutants per LTO cycle are based on representative aircraft type group data. The energy use by aircrafts is calculated for both domestic and international LTOs by multiplying the LTO fuel consumption factor for each representative aircraft type (see Table 3.39) by the corresponding number of LTOs. In order to calculate domestic and international LTO emissions, the number of LTOs for each aircraft type is multiplied by the respective emission factor per LTO.

Cruise energy usage is estimated as the difference between the total fuel use from aviation fuel sale statistics and the total calculated LTO fuel use (see Table 3.41). Fuel-based cruise emission factors are taken from the EMEP/EEA Guidebook as a single set for an average aircraft (see Table 3.40). Finally, when given the fuel-related cruise emission factors, total domestic and international energy use and emissions can be calculated. All the calculations are made by using the following equations:

LTO emissions = number of LTOs × emission factor LTO

LTO fuel consumption = number of LTOs × fuel consumption per LTO

Cruise emissions = (total fuel consumption − LTO fuel consumption) × emission factor cruise

Tier 2 methodology requires information on the number of LTOs grouped by representative aircraft types (see Table 3.39). This kind of detailed knowledge is hard to obtain (individual aircraft with their specific engines) and therefore data is aggregated for practical reasons. Assumptions are made if missing data exist in some situations. In spite of the different levels of aviation statistics, it is possible to divide air traffic activity into the number of LTOs per aircraft type by using different statistical sources. Estonian emission calculations are based on the EMEP/EEA methodology and other referred sources in the EMEP/EEA Guidebook (IPCC, FOCA, ICAO engine database etc.).

A complete emission calculation (LTO and cruise emissions for domestic and international flights) was carried out by ESTEA between 1992 and 2022. Extrapolation has been done for 1990 and 1991.

Table 3.39 Emission factors for the LTO cycle (kg/LTO)

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
Turbofans (Jets)						
Airbus A310	23.20	5.00	1.50	0.14	25.80	1,540.5
Airbus A320	10.80	1.70	0.80	0.09	17.60	802.3
Bae 111	4.90	19.30	0.70	0.17	37.70	681.6
Bae 146	4.20	0.90	0.60	0.08	9.70	569.5
B727	12.60	6.50	1.40	0.22	26.40	1,412.8
B737-100	8.00	0.50	0.90	0.10	4.80	919.7
B737-400	8.30	0.60	0.80	0.07	11.80	825.4
B747-100-300	55.90	33.60	3.40	0.47	78.20	3,413.9
B747-400	56.60	1.60	3.40	0.32	19.50	3,402.2
B757	19.70	1.10	1.30	0.13	12.50	1,253.0
B767-300	26.00	0.80	1.60	0.15	6.10	1,617.1
B777	53.60	20.50	2.60	0.20	61.40	2,562.8
Fokker 100	5.80	1.30	0.70	0.14	13.70	744.4
Fokker 28	5.20	29.60	0.70	0.15	32.70	666.1
2XB737-100	16.00	1.00	1.80	0.20	9.60	1,839.4
McDonnell Douglas DC-9	7.30	0.70	0.90	0.16	5.40	876.1
McDonnell Douglas DC-10	41.70	20.50	2.40	0.32	61.60	2,381.2
McDonnell Douglas	12.30	1.40	1.00	0.12	6.50	1,003.1
C525	0.74	3.01	0.34	0	34.07	340.0
EC RJ_100ER	2.27	0.56	0.33	0	6.70	330.0
ERJ-145	2.69	0.50	0.31	0	6.18	310.0
GLF4	5.63	1.23	0.68	0	8.88	680.0
GLF5	5.58	0.28	0.60	0	8.42	600.0
RJ85	4.34	1.21	0.60	0	11.21	600.0
Turboprop						
turboprop, <1000sph/engine	0.30	0.58	0.07	0	2.97	70.0
turboprop, 1000-2000sph/engine	1.51	0	0.20	0	2.24	200.0
turboprop, >2000sph/engine	1.82	0.26	0.20	0	2.33	200.0
Piston engine						
microlight aircraft	0.03	0.04	0.00	0	0.94	1.4
4 seat single engine (<180hp)	0.01	0.06	0.00	0	3.93	3.9
single engine high performance (180-360hp)	0.02	0.16	0.00	0	7.33	7.5
twin engine high performance (2x235hp)	0.05	0.22	0.01	0	19.33	21.6
Helicopters						
A109	0.13	0.89	0.02	0.01	1.31	32.8
A139	0.38	0.68	0.03	0.01	0.97	60.3
ALO3	0.11	0.28	0.01	0.00	0.40	21.4
AS32	0.65	0.49	0.04	0.02	0.68	77.4
AS35	0.18	0.22	0.01	0.01	0.32	27.5
AS55	0.15	0.82	0.02	0.01	1.20	34.8
H269	0.01	0.09	0.00	0.00	6.59	6.6
B412	0.64	0.49	0.04	0.02	0.69	77.0
B06	0.08	0.35	0.01	0.00	0.50	18.2
EC35	0.21	0.71	0.02	0.01	1.03	41.1
EN48	0.08	0.34	0.01	0.00	0.48	18.6
MI8	0.53	0.55	0.04	0.02	0.78	70.0
R22	0.01	0.09	0.00	0.00	6.21	6.2
R44	0.02	0.11	0.00	0.00	8.79	8.8
S76	0.29	0.59	0.02	0.01	0.85	48.2

Return to the Table of Contents

Table 3. 40 Emission factors for the cruise phase (kg/t)

	NO_x	NMVOC	SO_2	$PM_{2.5}$	f-BC	CO
Domestic aviation	10.3	0.1	1.0	0.2	0.15	2.0
International aviation	12.8	0.5	1.0	0.2	0.15	1.1

Table 3.41 Fuel consumption in the aviation sector (TJ)

Year	Domestic LTO	Domestic cruise	International LTO	International cruise	Total
1990	12.413	65.987	233.371	1,256.229	1,568.0
1995	6.102	39.498	123.667	571.733	741.0
2000	6.576	27.424	154.654	730.346	919.0
2005	13.244	52.847	325.441	1,576.563	1,968.1
2010	12.339	26.768	296.382	1,112.111	1,447.6
2015	13.836	44.305	325.494	1,767.179	2,150.8
2016	12.803	34.544	338.793	1,580.193	1,966.3
2017	14.395	35.598	382.477	2,115.109	2,547.6
2018	14.556	42.462	398.742	2,507.628	2,963.4
2019	15.182	39.818	365.924	2,575.076	2,996.0
2020	12.836	37.427	128.321	876.591	1,055.2
2021	22.137	56.345	180.383	1,621.582	1,880.4
2022	21.43	46.38	276.00	2,124.77	2,468.59

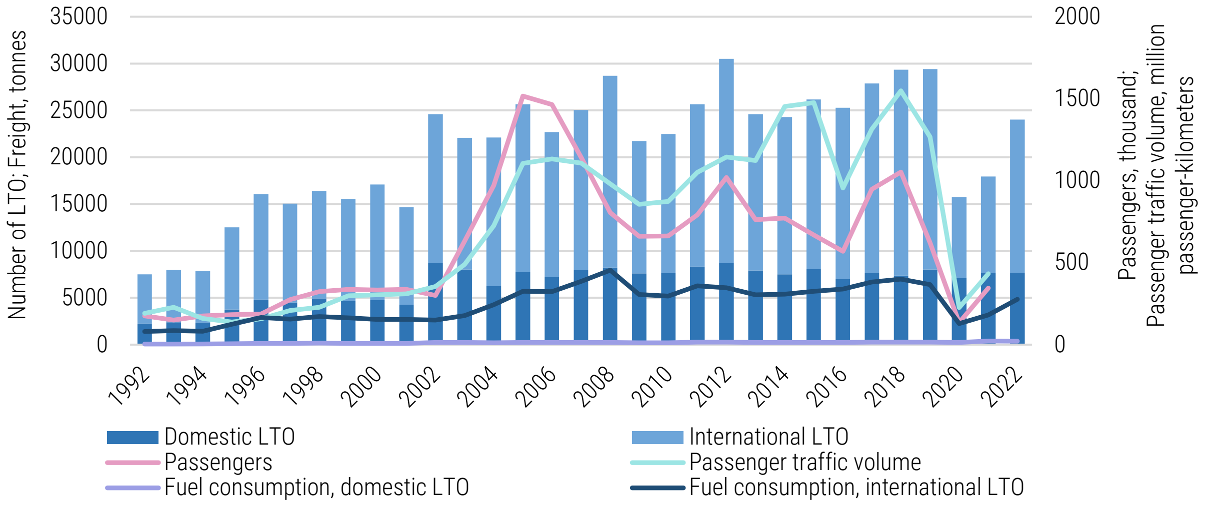

Figure 3.37 The number of LTO cycles, passengers carried and freight transported

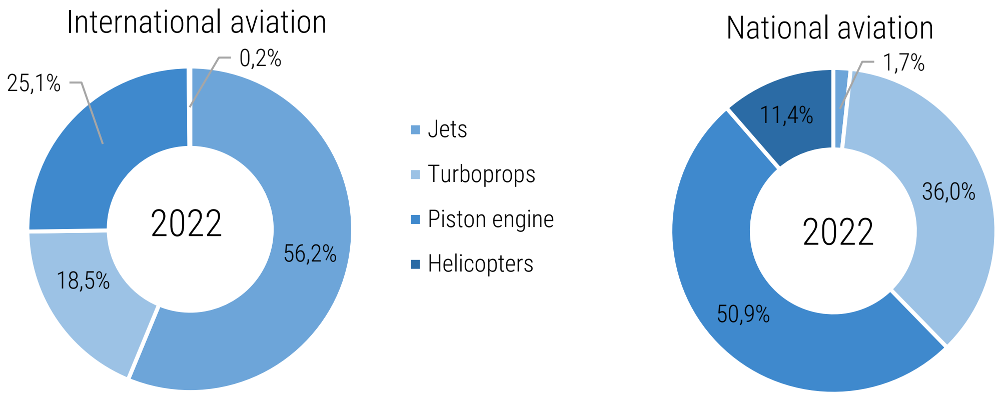

Figure 3.38 The share of different aircraft types in domestic and international civil aviation

Return to the Table of Contents

3.3.2.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for all pollutants from the aviation (LTO) sector is estimated to be 30% and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.42. No uncertainty estimation for cruise phase has been carried out.

Table 3.42 Uncertainties in the aviation (LTO) sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	0.07	kt	0.31	0.09	0.02
NMVOC	0.01	kt	0.05	0.01	0.003
SO_x	0.01	kt	0.04	0.01	0.001
$PM_{2.5}$	0.0005	kt	0.01	0.003	0.001
PM_{10}	0.0005	kt	0.01	0.002	0.0004
TSP	0.0005	kt	0.003	0.001	0.00005
BC	0.0002	kt	0.02	0.01	0.0022
CO	0.17	kt	0.16	0.04	0.01

3.3.2.4. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends was carried out.

3.3.2.5. Source-Specific Planned Improvements

The aviation sector is no key category and contributes to only a marginal share of total emissions. Therefore, there are currently no improvements planned for this sector.

3.3.3. Road Transport (1A3bi-vii)

3.3.3.1. Source Category Description

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

The road transport sector includes emissions from fuel combustion, lubricant oil, road abrasion, tyre and brake wear, and NMVOC emissions from fuel evaporation.

In 2022, road transport contributed to the total national emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide by 24.9%, 2.7%, and 5.1% respectively, and in the transport sector, 70.9%, 65.5%, and 70.7% respectively (see Figure 3.33). Emissions from the main pollutants have decreased significantly throughout the time series with the exception of NH_3. The decrease in emissions (see Figure 3.39) has mainly been caused by the stricter emission standards for road vehicles. Particle emissions have slightly increased or maintained in the same level due to increased annual mileage of vehicles. Figure 3.40 illustrates the importance of different vehicle types in pollutant emissions in the road transport sector.

The lead emissions from road transport have decreased by about 98.6% since 1990 (see Figure 3.39). The reduction of emissions is related to the prohibition on leaded petrol in 2000. The share of road transport in the total Pb emissions was 25.1% in 2022.

Return to the Table of Contents

The reduction of sulphur content in fuels has led to a substantial decrease in SO_2 emissions in the road transport sector (see Figure 3.39). In 2001, the sulphur content was reduced from 5,000 ppm (diesel) and 1,000 ppm (petrol) to 500 ppm and since then, sulphur content in fuel has been gradually reduced even more (see Table 3.44). Currently, all road transport fuels are sulphur free (sulphur content less than 10 ppm). Therefore, SO_2 emissions have decreased by 99.8% between 1990 and 2022.

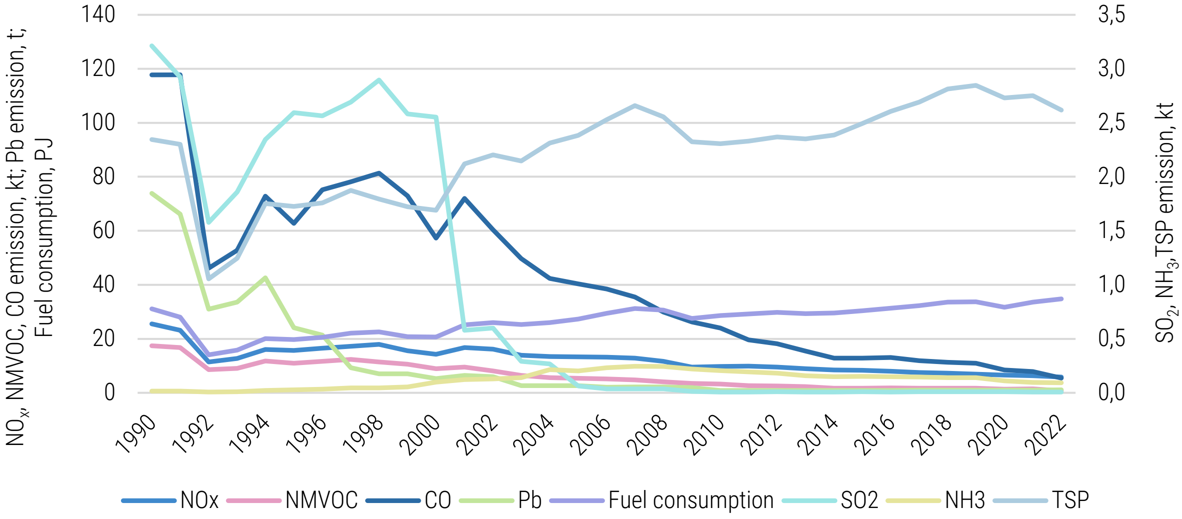

Figure 3.39 Fuel consumption and pollutant emissions from road transport in the period 1990-2022

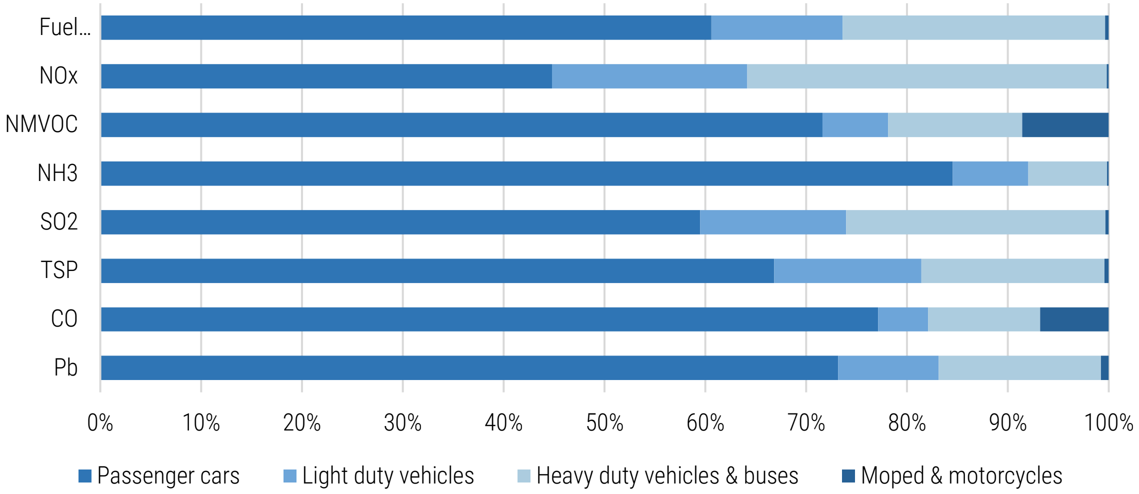

Figure 3.40 The share of pollutant emissions in the road transport sector in 2022

Fuel consumption has changed over the decades in the road transport sector. In the 1990s, petrol consumption dominated but from 2003, we can see the continuous growth in diesel consumption in road transport (see Figure 3.41 and Table 3.49). This trend can be explained by the fact that the popularity of vehicles with petrol engines has declined in recent years, and diesel engines dominate due to their greater fuel efficiency and torque compared to petrol engines.

Emissions from petrol vehicles have been dramatically reduced by the introduction of catalytic converters which have much lower CO, NMVOC, and NO_x emissions in comparison to petrol cars without catalysts. Since 1990, the number of petrol-driven passenger cars and light duty vehicles which are equipped with catalytic converters has increased, resulting in relatively decreasing emissions in road transport as NO_x and NMVOC, by 77.2% and 95.9% respectively between 1990 and 2022. Whilst significantly reducing emissions of carbon monoxide, nitrogen oxides, and non-methane volatile organic compounds, some catalytic converters may also produce other nitrogen-containing pollutants such as ammonia.

Road transport emissions of NH_3 have increased by fifteen times during the period between 1990-2007 as a result of the increased use of three-way catalytic converters for petrol vehicles which produce NH_3 as a by-product. However, NH_3 emissions have fallen since 2008 as the second generation of catalytic converters - which emit lower levels of NH_3 than the first generation of catalytic converters - become more widely used in the vehicle fleet. NH_3 emissions have decreased by 62.2% in 2022 in comparison to 2007's figures. The second reason for the decline in NH_3 emissions in recent years is the fact that the share of diesel vehicles has grown rapidly, which has had only a minor impact upon total road transport NH_3 emissions. Nevertheless, NH_3 emissions emitted by road transport amounted to only 0.9% of the national total NH_3 emissions in 2022.

However, despite these improvements, petrol vehicles which are fitted with catalytic converters still produce more CO and NMVOC than diesel vehicles, although exhaust emissions containing NO_x are much lower than with diesel vehicles. Diesel engines are the main power source in heavy-duty trucks and buses, and their share is rapidly growing in passenger cars as well. Therefore, the reasons for emission reductions include a 59.6% decrease in petrol consumption during the period of 1990–2022 and an increasing amount of new cars that are designed to reduce both energy consumption and pollutant emissions, as a result of new technologies.

In addition, Estonia has taken the obligation to reach a level of 10% in the use of renewable sources of energy in transport sector by 2020. Over the last few years, steps have been taken to use biofuels in road transport. The share of biofuels used for road transport accounted for 0.02% in 2005 and increased approximately to 5% in 2022 (see Table 3.49).

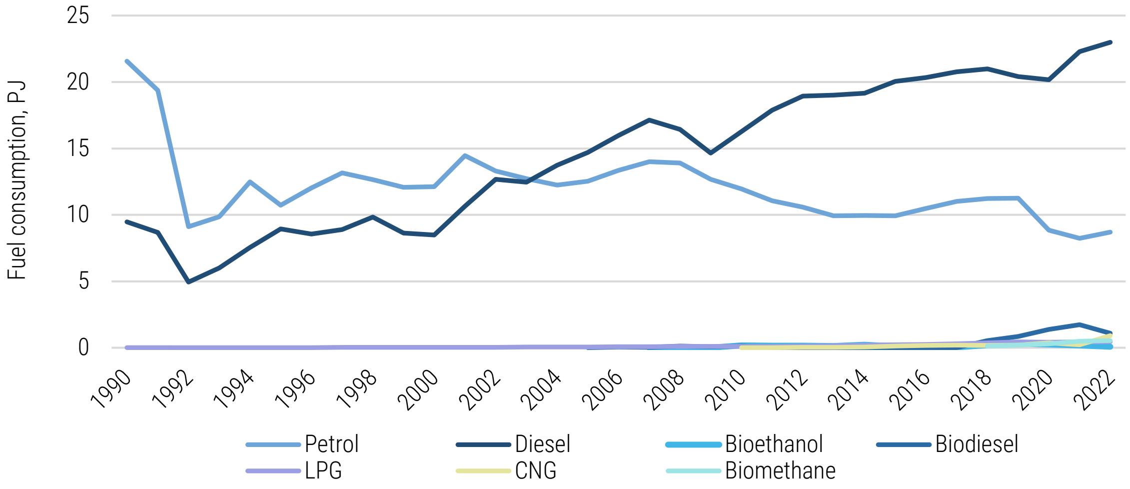

Figure 3.41 Fuel consumption in the road transport sector

TSP exhaust emissions from road transport vehicles have decreased by 72.3% during the 1990-2022 period. PM exhaust emissions are declining in new model vehicles due to tightening regulations, and new engine and after-treatment technologies. However, a substantial part of the total PM emissions originates from non-exhaust sources (road abrasion). Figure 3.42 illustrates the importance of different sources in pollutant emissions in the road transport sector.

As shown in Figure 3.42, only a small volume of heavy metal emissions originate from vehicle exhausts. Instead, a substantial share of heavy metals originate from tyre and brake wear and also from lubricant combustion, since vehicle engines consume a small amount of lubricant oil while they operate. A significant increase in lubricant oil consumption is apparent: the total lubricant oil consumption in this sector increased by 24% between 1990 and 2022 (1.2 thousand tonnes to 1.5 thousand tonnes) which is directly linked with the change in annual mileage driven by the vehicles (an increase of 28.7%) over the same period of time. As shown in Figure 3.42, the share of lubricant combustion in heavy metals emissions are relatively high, except for Pb. The combustion of lubricants contributed around 60.7% of Cd, 7.0% of Cr, 12.4% of Cu, 45.3% of Ni, 50.9% of Se, 20.4% of Zn, and only 0.01% of Pb across the entire total road transport sector in 2022.

Concerning lubricant consumption in 4-stroke engines, all heavy metals emissions are reported in 2G (Other product use) in accordance with EMEP/EEA Guidebook 2023.

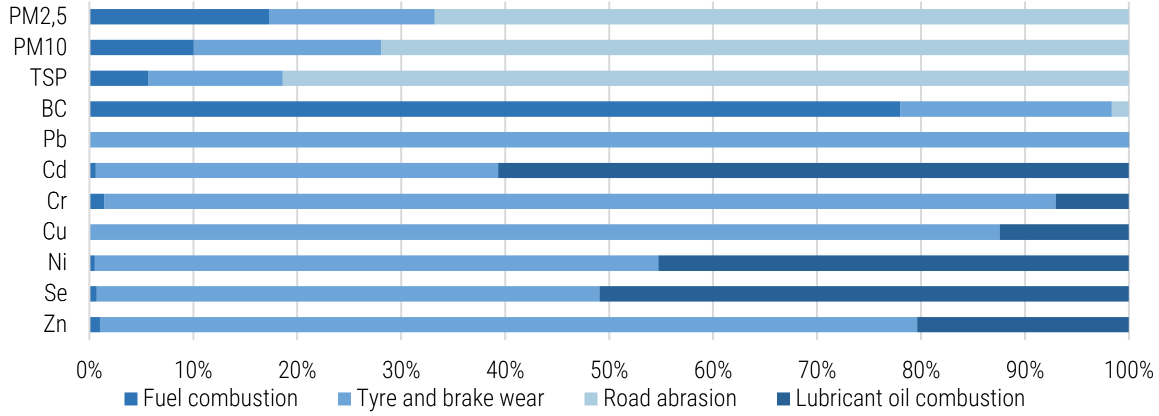

Figure 3.42 The share of different sources in pollutant emissions in 2022

The emission trend in recent years has been impacted by the improved fuel efficiency and minimised emissions of new vehicles. In 2022, statistics showed that the number of vehicles increased by 2.1% compared to 2021. At the same time, overall fuel consumption increased by 3.6%. Main pollutant emissions from road transport decreased compared to 2021: nitrogen oxides emissions by 7.6%, non-methane volatile compounds emissions by 16.2% and carbon monoxide by 18.5%, mainly by the stricter emission standards for new vehicle categories and the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage).

In the Figures 3.39-3.40, a detailed overview of NO_x, NMVOC, NH_3, SO_2, TSP, CO and Pb emission sources in the road transport sector is provided. All the emission trends are presented in Table 3.43.

Passenger cars (1A3bi)

Passenger cars contributed the majority of exhaust emissions within the road transport sector: 44.8% of NO_x, 50.3% of NMVOC, 59.5% of SO_2, 84.5% of NH_3, 66.8% of $PM_{2.5}$, 66.8% of PM_{10}, 66.8% of TSP, 70.0% of BC, 77.1% of CO in 2022.

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 642 thousand between 1990 and 2022. Cars with petrol engines make up a majority of registered passenger cars – 88% in 1990 and 46% in 2022 (see Figure 3.43). This trend reflects that the number of diesel cars has grown fast during the same period (see Figure 3.44). Significant changes have also taken place in annual mileage – annual mileage driven by diesel cars increased approximately ten times (441 to 4,215 million km) and annual mileage per petrol cars decreased by 49% (5,285 to 2,732 million km). Overall fuel consumption in this subsector increased by 11.3% between 1990 and 2022. In detail, fuel consumed by diesel cars increased approximately ten times and petrol fuel amount decreased by 48% during the same period.

During the period of 1990–2022 the pollutant emissions decreased significantly: 80.5% of NO_x, 96.6% of NMVOC, 99.5% of SO_2, and 96.0% of CO, although all the activity data increased in the same time. Therefore, the main pollutant emissions from passenger cars have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicles categories. This means that new technologies have been introduced gradually (Euro 1-6) and the fact that older vehicles are used less compared to new ones (i.e. they have a lower annual mileage). However, medium-sized engines still dominate in diesel and petrol-powered cars, and cars which are powered by alternative fuels, including hybrid cars, make up only a minor share of the car fleet in 2022.

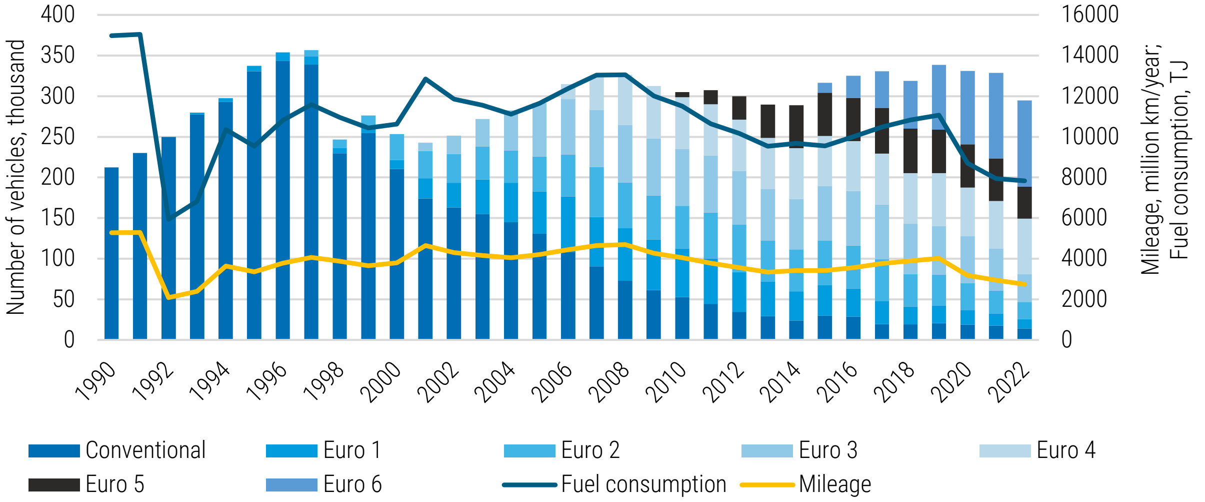

Figure 3.43 Petrol passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

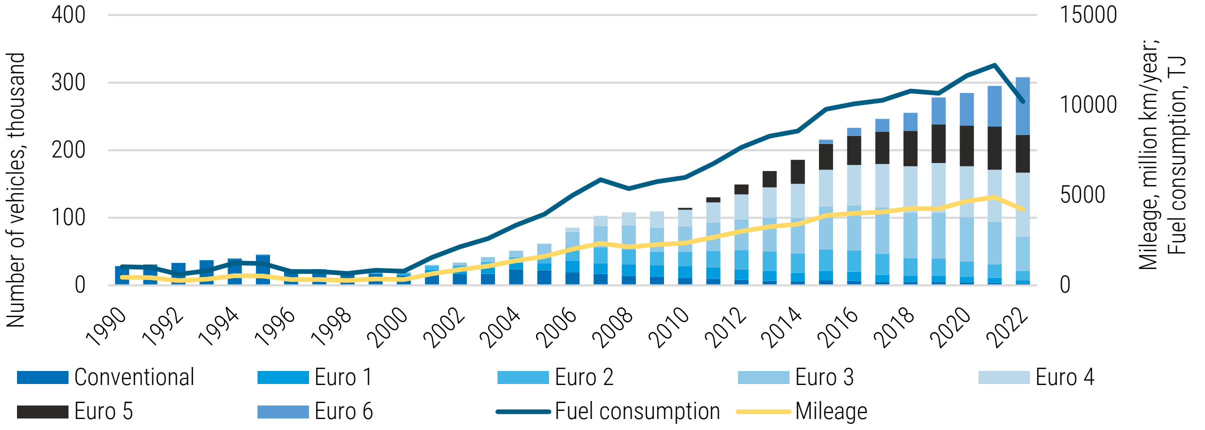

Figure 3.44 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

Light duty vehicles (1A3bii)

Light commercial vehicles exhaust emissions contributed about 19.4% of NO_x, 4.6% of NMVOC, 14.5% of SO_2, 7.5% of NH_3, 14.6% of $PM_{2.5}$, 14.6% of PM_{10}, 14.6% of TSP, 15.2% of BC and 4.9% of CO in the total road transport sector in 2022.

The light commercial vehicle fleet has grown over the last decades from 31 thousand vehicles to 84 thousand between 1990 and 2022. Vehicles with diesel engines dominated during the entire period. The number of diesel light duty vehicles was 18 thousand in 1990 and increased approximately four times to 75 thousand vehicles in 2022 (see Figure 3.46). The petrol light duty vehicle fleet decreased by 29% over the same period from 13 thousand to 9 thousand vehicles (see Figure 3.45). A similar trend can be seen in the annual mileage and fuel consumption – mileage and fuel consumption increased by 71% and 47% respectively in this subsector. As expected, annual mileage driven by petrol vehicles decreased by 75% and the total annual kilometres driven by diesel vehicles increased approximately four times. In addition, petrol fuel consumption decreased by 83% and diesel fuel consumption increased almost four times in this subsector during the same period.

The pollutant emissions decreased significantly: 29.9% of NO_x, 96.0% of NMVOC, 99.6% of SO_2 and 97.1% of CO, although all the activity data increased in the period of 1990–2022. Therefore, main pollutant emissions from light duty vehicles have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicle categories.

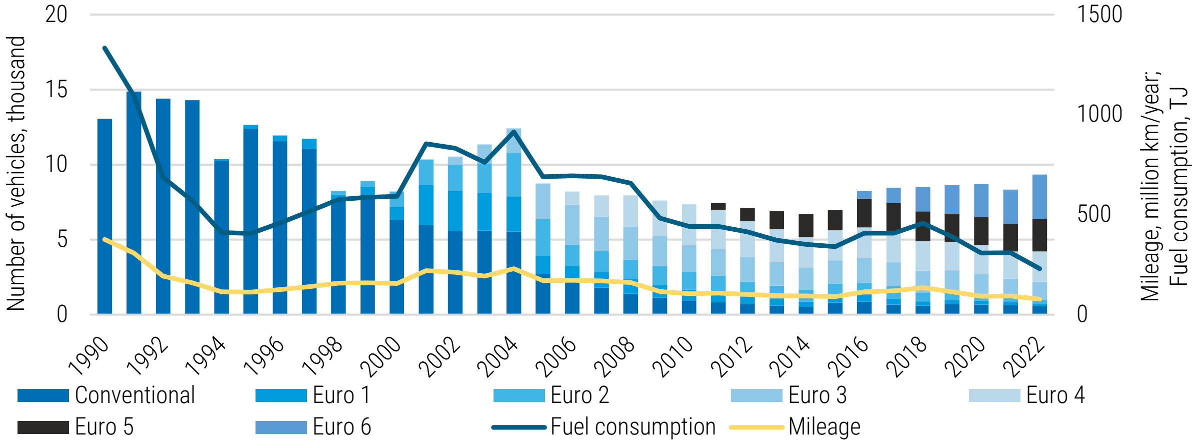

Figure 3.45 Petrol light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

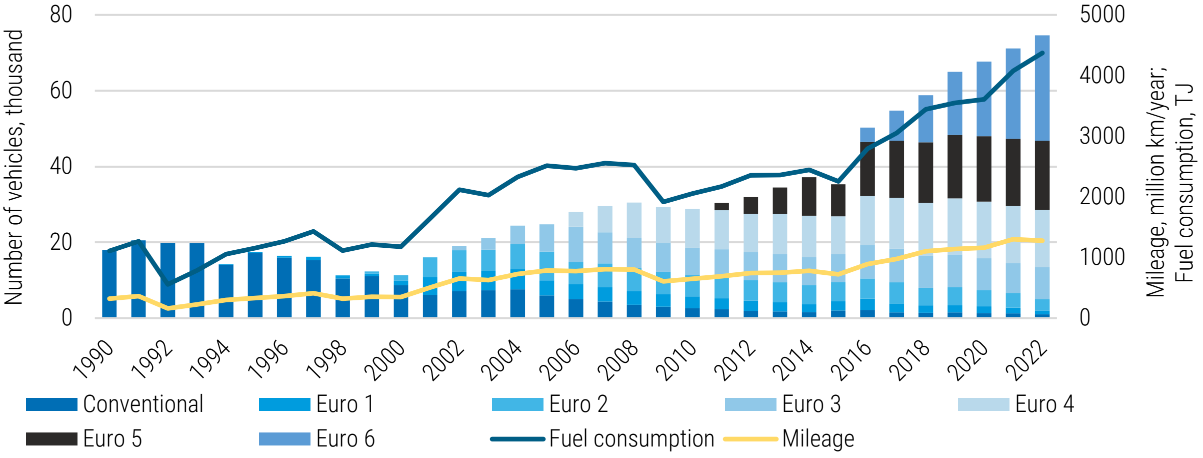

Figure 3.46 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

Heavy duty vehicles and buses (1A3biii)

The exhaust emissions of heavy duty vehicles and buses contributed about 35.7% of NO_x, 9.3% of NMVOC, 25.7% of SO_2, 7.8% of NH_3, 18.2% $PM_{2.5}$, 18.2% of PM_{10}, 18.2% of TSP, 14.7% of BC and 11.1% of CO in the total road transport sector in 2022.

The heavy duty vehicle and bus fleet has declined over the last decades from 45 thousand vehicles to 31 thousand between 1990 and 2022. Heavy duty vehicles with diesel engines make up the majority of registered vehicles – 60% in 1990 and 96% in 2022. The number of petrol vehicles has declined by 94% and the number of diesel vehicles increased by 3%. Total annual mileage and fuel consumption decreased by 43% and 35% respectively during this period. In detail, mileage driven by diesel vehicles increased by 11% and fuel consumed increased approximately 9% (see Figure 3.48). However, the same indicators for petrol powered heavy duty vehicles decreased by 99.2% (see Figure 3.47).

During the period of 1990–2022, the pollutant emissions decreased significantly: 80.2% of NO_x, 97.4% of NMVOC, 99.9% of SO_2 and 85.5% of CO.

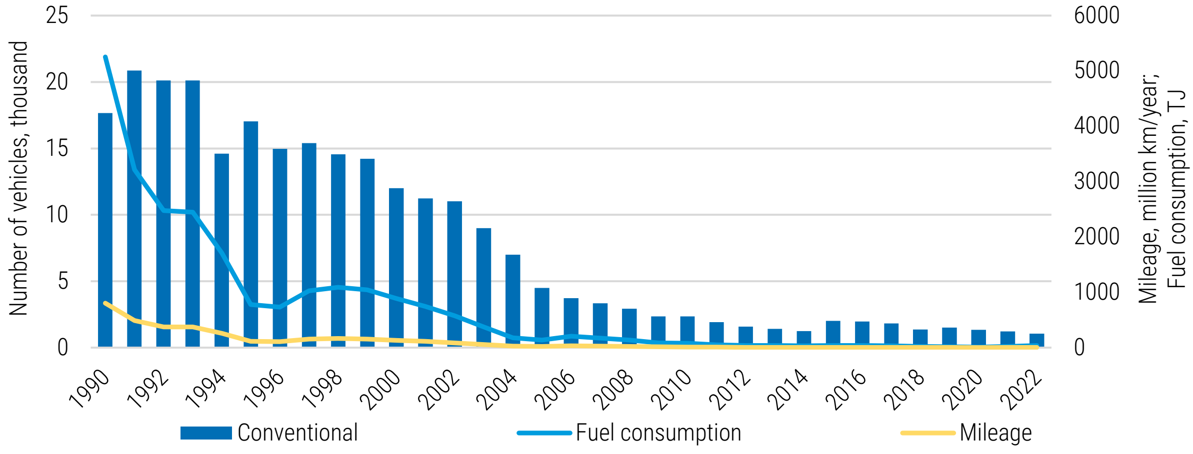

Figure 3.47 Petrol heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

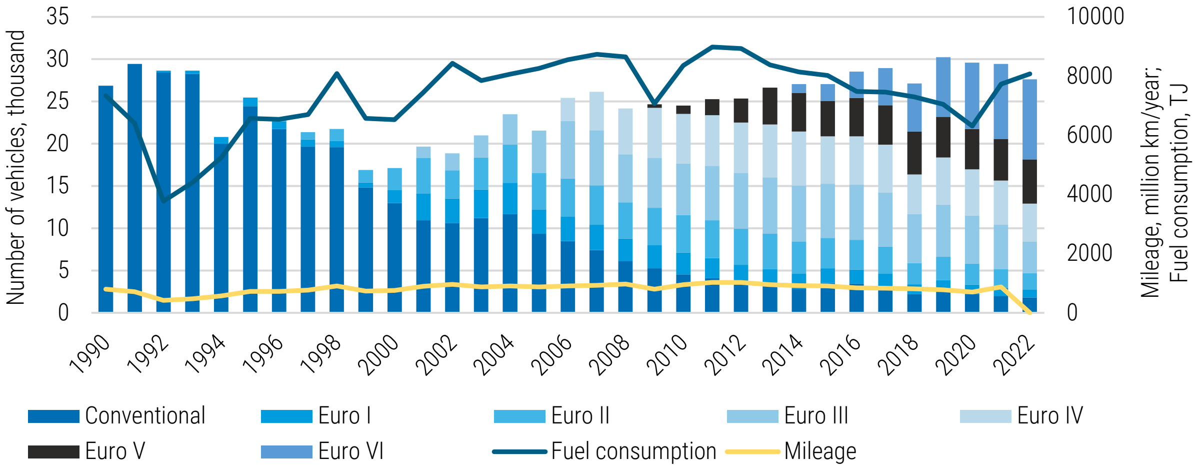

Figure 3.48 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

Return to the Table of Contents

Motorcycles and mopeds (1A3biv)

The exhaust emissions of this subsector contribute only a marginal share of the total road transport sector emissions: 0.2% of NO_x, 6.0% of NMVOC, 0.3% of SO_2, 0.2% of NH_3, 0.4% $PM_{2.5}$, 0.4% of PM_{10}, 0.4% of TSP, 0.1% of BC and 6.8% of CO in 2022.

The number of motorcycles has grown over the last decades from 2 thousand vehicles to 52 thousand. Annual mileage and fuel consumption increased approximately twelve times in this subsector between 1990 and 2022 (see Figure 3.49).

During this period, NO_x and NMVOC emissions increased by approximately 5 times and CO emissions increased by approximately 3 times. Although, all the activity data and main pollutant emissions increased in the same time SO_2 emissions declined by 95.6%.

During this period, NO_x and NMVOC emissions increased by approximately 5 times and CO emissions increased by approximately 3 times. Although, all the activity data and main pollutant emissions increased in the same time SO_2 emissions declined by 95.4%.

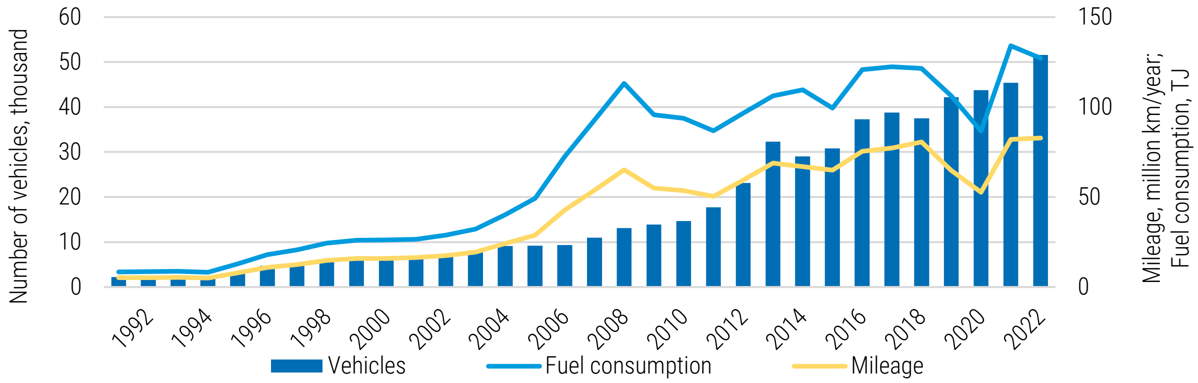

Figure 3.49 Motorcycles and mopeds: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2022

Recalculations

All the emissions from road transport have been recalculated for the period 1990-2022. Recalculations entail updated emission factors, and the taking into use of an improved new edition of the COPERT 5 program (version 5.7.2) for emission calculations. An overview of the updated data is given in Chapter 8.

Table 3.43 Emissions from road transport in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	25.53	17.41	3.213	0.016	NR	NR	2.346	NR	117.70
1995	15.73	10.92	2.593	0.026	NR	NR	1.725	NR	62.80
2000	14.24	8.88	2.553	0.098	0.777	1.101	1.690	0.237	57.31
2005	13.28	5.31	0.063	0.203	1.060	1.525	2.385	0.343	40.41
2010	9.72	3.07	0.006	0.206	0.904	1.397	2.308	0.260	23.95
2015	8.30	1.63	0.009	0.151	0.901	1.459	2.495	0.222	12.76
2016	7.91	1.57	0.008	0.149	0.923	1.512	2.607	0.214	12.72
2017	7.52	1.36	0.009	0.145	0.933	1.547	2.692	0.201	11.31
2018	7.21	1.27	0.010	0.139	0.958	1.606	2.815	0.193	10.49
2019	6.91	1.22	0.008	0.139	0.962	1.619	2.846	0.188	10.03
2020	6.42	0.98	0.011	0.111	0.919	1.551	2.731	0.179	7.55
2021	6.31	0.86	0.007	0.095	0.911	1.554	2.751	0.163	6.68
	5.83	0.72	0.008	0.093	0.861	1.481	2.618	0.150	5.45
Change 1990-2022, %	**-77.2**	**-95.9**	**-99.8**	**479.5**	**10.8**	**34.6**	**11.6**	**-36.7**	**-95.4**
Change 2021-2022, %	**-7.6**	**-16.1**	**19.4**	**-2.6**	**-5.4**	**-4.7**	**-4.8**	**-8.3**	**-18.5**

Table 3.43 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	73.86	0.004	0.005	0.010	0.333	7.21	0.051	0.006	2.21
1995	24.13	0.002	0.003	0.006	0.200	4.33	0.031	0.003	1.35
2000	5.30	0.003	0.003	0.007	0.216	4.68	0.033	0.004	1.45
2005	2.66	0.003	0.004	0.009	0.290	6.27	0.044	0.005	1.98
2010	0.84	0.004	0.004	0.009	0.306	6.61	0.047	0.005	2.06
2015	0.88	0.004	0.005	0.010	0.335	7.24	0.051	0.006	2.26
2016	0.92	0.004	0.005	0.011	0.348	7.52	0.053	0.006	2.35
2017	0.95	0.004	0.005	0.011	0.360	7.80	0.055	0.006	2.44
2018	0.99	0.004	0.005	0.011	0.377	8.15	0.057	0.006	2.56
2019	1.00	0.004	0.005	0.012	0.379	8.20	0.058	0.006	2.57
2020	0.95	0.004	0.005	0.011	0.362	7.84	0.055	0.006	2.46
2021	1.00	0.004	0.005	0.012	0.380	8.23	0.058	0.006	2.59
2022	1.05	0.005	0.005	0.012	0.398	8.61	0.061	0.007	2.76
Change 1990-2022, %	**-98.6**	**19.9**	**-12.2**	**19.2**	**19.6**	**19.5**	**18.8**	**24.2**	**25.1**
Change 2021-2022, %	**4.7**	**5.3**	**1.3**	**4.8**	**4.6**	**4.7**	**4.9**	**6.1**	**6.7**

Table 3.43 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					kg	
1990	0.281	0.006	0.015	0.013	0.010	0.044	0.00020	0.00006
1995	0.166	0.004	0.009	0.007	0.006	0.027	0.00012	0.00004
2000	0.197	0.004	0.009	0.008	0.006	0.027	0.00016	0.00004
2005	0.272	0.007	0.012	0.010	0.008	0.038	0.00025	0.00006
2010	0.312	0.008	0.013	0.012	0.009	0.041	0.00031	0.00006
2015	0.307	0.011	0.015	0.014	0.011	0.050	0.00030	0.00006
2016	0.289	0.011	0.016	0.014	0.011	0.052	0.00028	0.00006
2017	0.277	0.011	0.016	0.014	0.011	0.053	0.00027	0.00005
2018	0.267	0.012	0.016	0.014	0.012	0.054	0.00026	0.00005
2019	0.261	0.012	0.016	0.014	0.012	0.054	0.00026	0.00005
2020	0.253	0.012	0.016	0.014	0.012	0.054	0.00025	0.00005
2021	0.217	0.012	0.017	0.015	0.013	0.057	0.00021	0.00004
2022	0.204	0.013	0.018	0.016	0.013	0.059	0.00020	0.00004
Change 1990-2022, %	**-27.2**	**108.2**	**17.8**	**23.4**	**31.0**	**35.0**	**0.5**	**-37.9**
Change 2021-2022, %	**-6.0**	**3.4**	**3.5**	**5.4**	**1.3**	**3.6**	**-6.1**	**-6.4**

3.3.3.2. Methodological Issues

Fuel combustion

Emission calculations from road transport are based on the Tier 3 method, whereby exhaust emissions are calculated by using a combination of reliable technical and detailed activity data. Tier 3 is implemented in the COPERT 5 program (Computer Program to calculate Emissions from Road Transport, COPERT 5 version 5.7.2), which is used for the calculations and distributed by the EEA. Total emissions are calculated through a combination of default COPERT emission factors and activity data (e.g. number of vehicles, annual mileage per vehicle, average trip, speed, fuel consumption, monthly temperatures, driving and evaporation share). The vehicle classes are defined by the vehicle category, fuel type, weight class, environmental class and, in some instances, the engine type and/or the emission reduction technology. Therefore, the calculation of emissions from road vehicles is a very complicated and demanding procedure that requires good quality activity data and detailed emission factors.

Meteorological data is obtained from the Estonian Weather Service and fuel consumption data from Statistics Estonia. Calculations also require annual mileage per vehicle category (see Table 3.47) and the number of vehicles (see Table 3.48), which is supplied by the Estonian Road Administration. Annual mileage per vehicle category is based on odometer readings taken during the annual technical inspection. The number of vehicles is not taken directly from statistics; this is a combination of Estonian vehicle register and technical inspection data. This approach was proposed and formulated by the scientists of the Tallinn University of Technology during the project "Calculation and analysis of the pollution of mobile sources". This suggested approach presumes that the older vehicles in the Estonian vehicle register are not actually taking part of every-day traffic; therefore, periodic technical inspections data is used. On the other hand, new vehicles do not have to be examined by technical inspection every year; therefore, the Estonian vehicle register data is used. These improved statistics are available from 2001 and data for the years 1990–2000 is extrapolated. However, changes have been implemented in Estonian vehicle register procedures since 2015, where vehicles that had not had a technical inspection for two years or more were marked as "stopped" and removed during the data export from the register. From now on, there is no need to combine different datasets. This change in data helped improve the quality of activity data and prevent mistakes in data management.

Emissions from different type of vehicles are heavily dependent on the engine operation conditions. Driving situations impose different engine operating conditions and therefore a distinct emission performance. Different activity data and emission factors are attributed to each driving situation. Total emissions are calculated by combining activity data for each vehicle category with appropriate emission factors. The emission factors vary according to the input data (driving situations, climatic conditions etc.). In this calculation method, total exhaust emissions from road transport are calculated as the sum of hot and cold emissions:

$$E_{TOTAL} = E_{HOT} + E_{COLD}$$

where

E_{TOTAL} – total emissions of any pollutant for the spatial and temporal resolution of the application;
E_{HOT} – emissions during stabilised (hot) engine operation when the engine is at its normal operating temperature;
E_{COLD} – emissions during transient engine operation (cold start).

Exhaust emissions of CO, NMVOC, NO_x, NH_3 and PM in these source categories depend on fuel type, emission reduction technology, vehicle type and vehicle use. These emissions are calculated on the basis of vehicle kilometres and specific emission factors for a variation of different vehicle classes and for three different road types (urban, rural, highway).

Emissions of SO_2 and heavy metals are dependent on fuel consumption and fuel type. SO_2 and heavy metals emissions are calculated by multiplying statistical fuel use (see Table 3.49) by emission factors (see Tables 3.44-3.46). The emission factors are based on the sulphur and heavy metal content of the fuels.

SO_2 emissions are estimated on the assumption that all sulphur in the fuel is completely transformed into SO_2. Since the beginning of 2010, the country-specific average sulphur content is used for SO_2 emission calculations. Average sulphur content in fuel (see Table 3.44) is derived from fuel quality monitoring reports, which are submitted to the European Commission every year as established by the Fuel Quality Directive (2009/30/EC). Equation:

$$E_{SO2} = 2 \times k \times FC$$

where

E_{SO2} – SO_2 emissions;
k – weight-related sulphur content in fuel (kg/kg fuel);
FC – fuel consumption.

Table 3.44 Sulphur content in fuel (mg/kg)

Year	Petrol	Diesel
1990	1000	5000
2001	500	500
2003	150	350
2004	130	300
2005	50	50
2006	10	40
2007	8	40
2009	8	10
2010	5	4.8
2011	5.5	6.2
2012	6.3	7.1
2013	5.9	6.1
2014	5.9	5.4
2015	5.9	6.6
2016	5.3	5.2
2017	5.4	6.6
2018	6.0	6.6
2019	5.1	5.6
2020	5.3	8.6
2021	3.8	4.6
2022	4.7	5.3

Pb emissions from leaded fuel are estimated according to the calculation that 75% of lead contained in petrol is emitted into the atmosphere (three quarters of the total). In unleaded petrol the full total quantity of lead is presumed to be emitted into the atmosphere.

Equation:

$$E_{Pb} = 0.75 \times k \times FC$$

where
E_{Pb} – Pb emissions;
k – weight-related lead content of petrol (kg/kg);
FC – fuel consumption.

Table 3.45 Lead content in fuel (mg/kg)

Fuel	Leaded petrol	Unleaded petrol	Diesel
1990	200	17.3	0.0005
2003	-	6.7	0.0005
2006	-	4	0.0005
2010	-	0.027	0.0005
2014	0.0016	0.0016	0.0005

Emissions of other heavy metals are estimated on the assumption that the total quantity is emitted into the atmosphere. Equation:

$$E_{Heavy\ metal} = k \times FC$$

where

k – weight-related content of heavy metal in fuel (kg/kg);

FC – fuel consumption.

Table 3.46 Heavy metals content in fuel and lubricant oil (mg/kg)

Fuel	Cd	Cu	Cr	Ni	Se	Zn	Hg	As	Pb
Petrol	0.00020	0.0045	0.0063	0.0023	0.0002	0.0330	0.0057	0.0003	equation
Diesel	0.00005	0.0057	0.0085	0.0002	0.0001	0.0180	0.0053	0.0001	equation
Lubricant oil	4.56	778	19.2	31.89	4.54	450.2	0	0	0.0322

Table 3.47 Annual mileage driven in the road transport sector (million km per year)

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	5,728.9	695.5	1,601.1	6.8	8,032.4
1995	3,877.2	443.9	836.1	7.8	5,165.0
2000	4,133.7	502.8	893.2	15.9	5,545.6
2005	5,822.3	954.2	892.0	28.8	7,697.3
2010	6,445.5	752.9	966.8	53.5	8,218.8
2015	7,388.2	813.8	914.5	65.0	9,181.5
2016	7,676.0	1,007.2	852.0	75.5	9,610.6
2017	7,986.4	1,093.3	846.1	77.2	10,003.0
2018	8,354.0	1,235.7	824.2	80.5	10,494.4
2019	8,494.7	1,252.3	796.1	64.8	10,607.9
2020	8,121.9	1,252.1	719.2	52.7	10,146.0
2021	8,086.1	1,395.3	905.9	82.0	10,469.2
2022	7,678.1	1356.0	964.0	82.8	10,080.9

Table 3.48 Number of vehicles in the road transport sector (thousand)

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	240.9	31.1	44.5	2.2	318.7
1995	383.4	30.1	42.5	3.3	459.4
2000	273.1	19.5	29.1	6.7	328.5
2005	354.7	33.5	26.0	9.2	423.4
2010	422.2	36.2	26.9	14.7	500.0
2015	537.1	42.3	29.1	30.8	639.3
2016	564.2	58.5	30.6	37.3	690.6
2017	584.6	63.2	30.9	38.8	717.5
2018	582.8	67.3	28.6	37.5	716.2
2019	627.6	73.6	31.9	42.2	775.4
2020	625.4	76.4	31.2	43.8	776.8
2021	635.3	79.5	31.1	45.4	791.3
2022	641.8	83.9	30.9	51.6	808.2

Table 3.49 Fuel consumption in the road transport sector (TJ)

Year	Petrol	Diesel	Bioethanol	Biodiesel	LPG	CNG	Biomethane	Total
1990	21,567.0	9,473.1	0	0	9.1	0	0	30,915.3
1995	10,734.2	8,935.4	0	0	15.9	0	0	19,685.6
2000	12,131.0	8,487.5	0	0	31.9	0	0	20,650.3
2005	12,522.4	14,709.2	0	6.5	62.2	0	0	27,300.3
2010	11,945.6	16,269.4	183.8	136.4	94.6	1.8	0	28,631.6
2015	9,921.7	20,046.5	107.0	0	227.8	116.1	0	30,419.1
2016	10,486.8	20,338.4	84.1	0	255.7	172.8	0	31,337.7
2017	11,010.9	20,773.1	39.4	6.3	306.5	190.6	0	32,326.8
2018	11,233.2	20,991.1	204.4	526.3	369.4	171.9	126.0	33,622.1
2019	11,266.5	20,416.0	308.9	838.0	440.0	197.0	188.2	33,654.5
2020	8,840.2	20,170.3	259.1	1,370.7	423.2	364.5	285.9	31,713.8
2021	8,234.2	22,280.9	176.2	1,735.2	436.8	225.4	494.6	33,583.2
2022	8,711.7	22,990.9	85.0	1,088.0	455.0	910.0	539.0	34,779.6

Automobile tyre wear, brake wear and road abrasion

Tyre wear, brake wear, and road surface wear are abrasion processes. Emission calculations cover those particles emitted as a direct result of the wear of tyres, brakes, or surfaces.

Airborne particles are produced as a result of the interaction between a vehicle's tyres and the road surface, as well as when the brakes are applied to decelerate the vehicle. A secondary mechanism involves the evaporation of material from surfaces at the high temperatures developed during contact. Emissions from these sectors are considered in relation to the general vehicle classes (1A3bi-iv) and depend on annual mileage.

$PM_{2.5}$, PM_{10} and TSP emissions from automobile tyre and brake wear calculations are based on the Tier 2 method and use the COPERT 5 model (EMEP/EEA Guidebook 2023). Nevertheless, PAHs emissions from the tyre and brake wear sector is not included in the COPERT model and therefore these emissions are calculated separately by using appropriate default emission factors from the EMEP/EEA Guidebook 2023 (see Table 3.50).

Table 3.50 Brake and tyre debris-bound PAHs (ppm wt.)

	Tyre wear	Brake wear
Benzo(a)pyrene	3.9	0.74
Benzo(b)fluoranthene	0	0.42
Benzo(k)fluoranthene	0	0.62
Indeno(1,2,3-cd)pyrene[4]	0	2.6

The methodology for emissions calculations in regards to automobile road abrasion was improved based on Finland IIR 2022.

Fuel evaporation

This sector includes NMVOC evaporative fuel-related emissions from petrol vehicles, which are not derived from fuel combustion. Most evaporative emissions of NMVOCs emanate from the fuel systems (tanks, injection systems, and fuel lines) of petrol vehicles. Evaporative emissions from diesel vehicles are considered negligible.

Fuel evaporation calculations are based on the Tier 3 method and use the COPERT 5 model (EMEP/EEA Guidebook 2023).

Lubricant consumption

The emissions estimation also covers heavy metals (lead, arsenic, cadmium, copper, chromium, mercury, nickel, selenium, and zinc) which is contained in lubricant oils. At first, lubricant oil consumption needs to be calculated by taking into account oil consumption factors for different vehicle types, fuel used, the engine category, and the vehicle age (see Table 3.51). Necessary lubricant metal content factors for heavy metal emissions calculations are provided in Table 3.46. The full total of heavy metals in fuel is presumed to be emitted into the atmosphere.

Table 3.51 Lubricant oil consumption rate for different vehicle types, fuel and age (kg/10 000km)

Category	Fuel/engine category	Age	Lubricant oil consumption
Passenger cars	Petrol	Old	1.45
	Petrol	New	1.28
	Diesel	Old	1.49
	Diesel	New	1.28
Light duty vehicles	Petrol	Old	1.45
	Petrol	New	1.28
	Diesel	Old	1.49

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[4] Luhana, L., Sokhi, R., Warner, L., Mao, H., Boulter, P., McCrae, I., Wright, J., Reeves, N., Osborn, D. 2004, 'Non-exhaust particulate measurements: results'. Deliverable 8 of the European Commission DG TREN 5th Framework Particulates project.

Return to the Table of Contents

Category	Fuel/engine category	Age	Lubricant oil consumption
	Diesel	New	1.28
Heavy duty vehicles	Diesel	All	1.56
Buses, coaches	Diesel	Old	1.91
	Diesel	New	1.70
Mopeds	Petrol	Old	10.20
	Petrol	New	6.80
Motorcycles	Petrol	All	0.43

3.3.3.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for main pollutants, particulate matter, and heavy metals from the road transport sector is estimated to be 20–30%, for POPs 100–250%, and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.52.

Table 3.52 Uncertainties in the road transport sector

Pollutant	Emissions, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	5.83	kt	24.89	3.02	0.58
NMVOC	0.72	kt	2.72	0.33	1.33
SO_x	0.01	kt	0.05	0.01	0.01
NH_3	0.09	kt	0.91	0.16	0.07
$PM_{2.5}$	0.86	kt	17.54	2.46	0.91
PM_{10}	1.48	kt	16.43	2.46	0.69
TSP	2.62	kt	16.39	2.72	0.16
BC	0.15	kt	12.76	1.55	1.21
CO	5.45	kt	5.12	0.81	3.38
Pb	1.05	t	25.15	7.56	0.19
Cd	0.005	t	1.01	0.30	0.03
Hg	0.005	t	2.43	0.34	0.05
PCDD/F	0.20	g I-TEQ	4.94	9.85	2.28
B(a)p	0.01	t	1.19	1.68	0.54
B(b)f	0.02	t	1.77	2.26	0.51
B(k)f	0.02	t	2.35	2.93	0.84
I(1,2,3-cd)p	0.01	t	1.27	1.79	0.61
HCB	0.0002	kg	0.04	0.08	0.01
PCBs	0.00004	kg	0.01	0.01	0.001

3.3.3.4. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends was carried out.

3.3.3.5. Source-Specific Planned Improvements

Include more detailed vehicle subsectors in emission calculations: light duty vehicles, heavy duty vehicles, mopeds, hybrid and LPG/CNG vehicles. Specify activity data and recalculate, if necessary.

It is also necessary to estimate the share of two-stroke and four-stroke engines out of the total number of mopeds and motorcycles on the road. Currently, an assumption has been made in terms of emissions calculations that all mopeds and motorcycles operate with a four-stroke engine. However, this has minor importance for the overall road transportemissions figures.

3.3.4. Railways (NFR 1A3c)

3.3.4.1. Source Category Description

Railway transport in Estonia is a small emission source in transport sector. This sector concerns the movement of goods or people that is mostly performed by diesel locomotives.

There are more than 2,000 km of railways in Estonia, most of which are owned by state-controlled businesses. The railways in Estonia today are mainly used for freight transport, but a good deal of passenger traffic is also handled.

Nowadays, emissions from rail use originate primarily from the combustion by locomotives of diesel and light fuel oil. Coal-powered railway locomotives were only used in the period between 1990-2002. Since emissions from the railway sector are calculated by using the Tier 2 method which takes into account the amount of fuel consumed by different locomotive types and default emission factors, deviations in the time series can be explained by statistical fuel consumption deviations in the railway sector.

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 9.3%, 5.4% and 2.7% respectively (see Figure 3.33), in the transport sector in 2022. The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 73.0%, 74.1% and 76.2% respectively. During the same period, fuel consumption decreased 72.8%.

In 2022, liquid fuel consumption increased by 0.8% when compared to 2021, and a similar increase in emissions for this period can be observed. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have increased by 0.8% during that period (see Figure 3.50). The trend of all the emissions is given in Table 3.53.

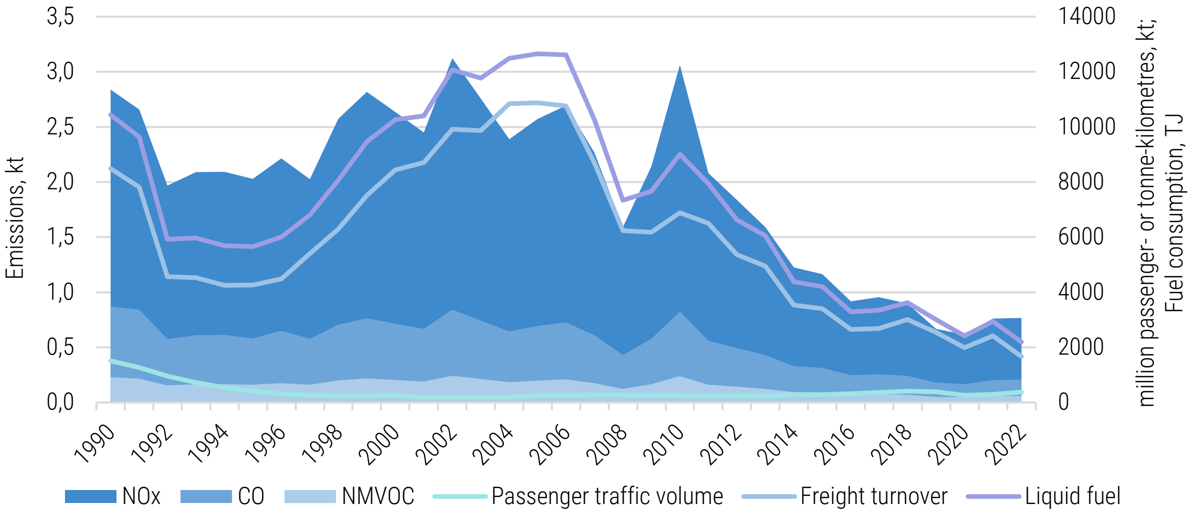

Figure 3.50 NOx, NMVOC and CO emissions from the railway sector

Table 3.53 Emissions from railway transport in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	2.838	0.229	0.5671	0.0005	NR	NR	0.110	NR	0.871
1995	2.028	0.161	0.3651	0.0003	NR	NR	0.073	NR	0.582
2000	2.634	0.205	0.1774	0.0004	0.056	0.060	0.090	0.036	0.716
2005	2.572	0.200	0.1680	0.0004	0.054	0.058	0.087	0.035	0.694
2010	3.062	0.238	0.0703	0.0005	0.064	0.069	0.103	0.042	0.826

Year	NO$_x$	NMVOC	SO$_2$	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO
					kt				
2015	1.164	0.090	0.0004	0.0002	0.024	0.026	0.039	0.016	0.314
2016	0.919	0.071	0.0003	0.0002	0.019	0.021	0.031	0.013	0.248
2017	0.956	0.074	0.0003	0.0002	0.020	0.022	0.032	0.013	0.258
2018	0.897	0.070	0.0003	0.0001	0.019	0.020	0.030	0.012	0.242
2019	0.668	0.052	0.0002	0.0001	0.014	0.015	0.023	0.009	0.180
2020	0.615	0.048	0.0002	0.0001	0.013	0.014	0.021	0.008	0.166
2021	0.760	0.059	0.0002	0.0001	0.016	0.017	0.025	0.010	0.206
2022	0.766	0.060	0.0003	0.0001	0.016	0.017	0.026	0.010	0.207
Change 1990-2022, %	**-73.0**	**-74.1**	**-100.0**	**-72.8**	**-71.4**	**-71.4**	**-76.6**	**-71.1**	**-76.2**
Change 2021-2022, %	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**

Table 3.53 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	0.016	0.001	0.001	0.000	0.004	0.080	0.005	0.001	0.070
1995	0.005	0.000	0.000	0.000	0.002	0.057	0.003	0.000	0.041
2000	0.001	0.000	0.000	0.000	0.002	0.073	0.003	0.000	0.044
2005	NE	0.000	NE	NE	0.002	0.071	0.003	0.000	0.042
2010	NE	0.001	NE	NE	0.003	0.085	0.004	0.001	0.050
2015	NE	0.000	NE	NE	0.001	0.032	0.001	0.000	0.019
2016	NE	0.000	NE	NE	0.001	0.026	0.001	0.000	0.015
2017	NE	0.000	NE	NE	0.001	0.027	0.001	0.000	0.016
2018	NE	0.000	NE	NE	0.001	0.025	0.001	0.000	0.015
2019	NE	0.000	NE	NE	0.001	0.019	0.001	0.000	0.011
2020	NE	0.000	NE	NE	0.001	0.017	0.001	0.000	0.010
2021	NE	0.000	NE	NE	0.001	0.021	0.001	0.000	0.012
2022	NE	0.000	NE	NE	0.001	0.021	0.001	0.000	0.013
Change 1990-2022, %	**-100.0**	**-81.5**	**-100.0**	**-100.0**	**-84.0**	**-73.5**	**-81.6**	**-81.5**	**-82.1**
Change 2021-2022, %	**NE**	**0.8**	**NE**	**NE**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**

Table 3.53 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq			t			kg	
1990	0.024	0.0068	0.009	0.0044	0.0026	0.023	0.000074	0.020
1995	0.008	0.0028	0.004	0.0021	0.0010	0.010	0.000024	0.007
2000	0.001	0.0016	0.003	0.0016	0.0005	0.006	0.000004	0.001
2005	NE	0.0013	0.002	0.0014	0.0003	0.005	NA	NA
2010	NE	0.0015	0.003	0.0017	0.0004	0.006	NA	NA
2015	NE	0.0006	0.001	0.0007	0.0002	0.002	NA	NA
2016	NE	0.0005	0.001	0.0005	0.0001	0.002	NA	NA
2017	NE	0.0005	0.001	0.0005	0.0001	0.002	NA	NA
2018	NE	0.0004	0.001	0.0005	0.0001	0.002	NA	NA
2019	NE	0.0003	0.001	0.0004	0.0001	0.001	NA	NA
2020	NE	0.0003	0.001	0.0003	0.0001	0.001	NA	NA
2021	NE	0.0004	0.001	0.0004	0.0001	0.002	NA	NA
2022	NE	0.0004	0.001	0.0004	0.0001	0.002	NA	NA
Change 1990-2022, %	**-100.0**	**-94.5**	**-93.3**	**-90.2**	**-96.1**	**-93.4**	**-100.0**	**-100.0**
Change 2021-2022, %	**NE**	**0.8**	**0.8**	**0.7**	**1.0**	**0.8**	**NA**	**NA**

3.3.4.2. Methodological Issues

All the main pollutant emission calculations are based on the Tier 2 method. Emissions from the railway sector are calculated by multiplying the statistical fuel consumption which is apportioned by different generic locomotive technology types (see Table 3.56) by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Guidebook 2023 and are presented in Table 3.54.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.56) by emission factors (see Table 3.55). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation:

$$E_{SO2} = 2\ x\ k\ x\ FC$$

where

E_{SO2} – emissions of SO_2;
k – weight related sulphur content in fuel (kg/kg fuel);
FC – fuel consumption.

Table 3.544 Emission factors for railway transport

Pollutant	Diesel / light fuel oil				Coal	
	Unit	Line-haul locomotives	Shunting locomotives	Rail cars	Unit	Value
		Value	Value	Value		
NO_x	kg/t	63.0	54.4	39.9	g/GJ	173
NMVOC	kg/t	4.8	4.6	4.7	g/GJ	88.8
SO_2	kg/t	equation	equation	equation	g/GJ	900
NH_3	kg/t	0.0	0.0	0.0	g/GJ	NE
$PM_{2.5}$	kg/t	1.1	2.0	1.0	g/GJ	108
PM_{10}	kg/t	1.2	2.1	1.1	g/GJ	117
TSP	kg/t	1.8	3.1	1.5	g/GJ	124
BC	kg/t	1.2	2.0	1.0	g/GJ	6.912
CO	kg/t	18.0	10.8	10.8	g/GJ	931
Pb	g/t	NE	NE	NE	mg/GJ	134
Cd	g/t	0.01	0.01	0.01	mg/GJ	1,8
Hg	g/t	NE	NE	NE	mg/GJ	7,9
As	g/t	NE	NE	NE	mg/GJ	4
Cr	g/t	0.05	0.05	0.05	mg/GJ	13.5
Cu	g/t	1.70	1.70	1.70	mg/GJ	17.5
Ni	g/t	0.07	0.07	0.07	mg/GJ	13
Se	g/t	0.01	0.01	0.01	mg/GJ	1.8
Zn	g/t	1.00	1.00	1.00	mg/GJ	200
PCDD/F	TEQµg /t	NE	NE	NE	ng I-TEQ/GJ	203
B(a)p	g/t	0.03	0.03	0.03	mg/GJ	45.5
B(b)f	g/t	0.05	0.05	0.05	mg/GJ	58.9
B(k)f	g/t	0.034	0.034	0.034	mg/GJ	23.7
I(1,2,3-cd)p	g/t	0.008	0.008	0.008	mg/GJ	18.5
HCB	mg/t	NA	NA	NA	µg/GJ	0.62
PCBs	mg/t	NA	NA	NA	µg/GJ	170

Table 3.55 Sulphur content of fuel (by weight)

Fuel	1990	2000	2001	2003	2004	2005	2006	2008	2009	2012
Light fuel oil	0.5%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.001%
Diesel	0.5%	0.5%	0.05%	0.035%	0.030%	0.005%	0.004%	0.004%	0.001%	0.001%

Return to the Table of Contents

Table 3.56 Fuel consumption, passenger traffic volume and freight turnover in the railway sector

Year	Fuel consumption			Passenger traffic volume million passenger-km	Freight turnover million tonne-km
	Coal	Diesel	Light fuel oil		
	TJ				
1990	119	0	1,946	1,510	6,977
1995	39	0	1,396	408	3,851
2000	6	0	1,819	261	8,186
2005	0	0	1,777	247	10,629
2010	0	635	1,481	248	6,642
2015	0	804	0	289	3,114
2016	0	635	0	316	2,339
2017	0	660	0	366	2,325
2018	0	619	0	417	2,594
2019	0	462	0	392	2,160
2020	0	425	0	263	1,729
2021	0	525	0	290	2,128
2022	0	529	0	382	1,287

3.3.4.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for NO_x, NMVOC and CO from railways is estimated to be 100%, for SO_x, NH_3 and heavy metals 50%, for particulate matter 100%, for POPs 100-250% and in the activity data 2%. Uncertainty estimates for railway sector are described together with non-road mobile machinery sector in Table 3.67.

3.3.4.4. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

3.3.4.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

3.3.5. National Navigation (NFR 1A3dii)

3.3.5.1. Source Category Description

Domestic navigation includes the most important domestic water transport in Estonia: merchant ships, passenger and technical ships, pleasure and tour ships and other inland vessels.

National navigation in Estonia is also a small emission source in the transport sector. The share of navigation transport in total transport emissions in 2022 was: NO_x – 5.5%, NMVOC – 1.5%, CO – 0.6% (see Figure 3.33). Detailed emission data are provided in Table 3.57.

Fuel consumption decreased 2.6% in 2022 compared to 2021 therefore all the emissions also decreased (see Figure 3.51).

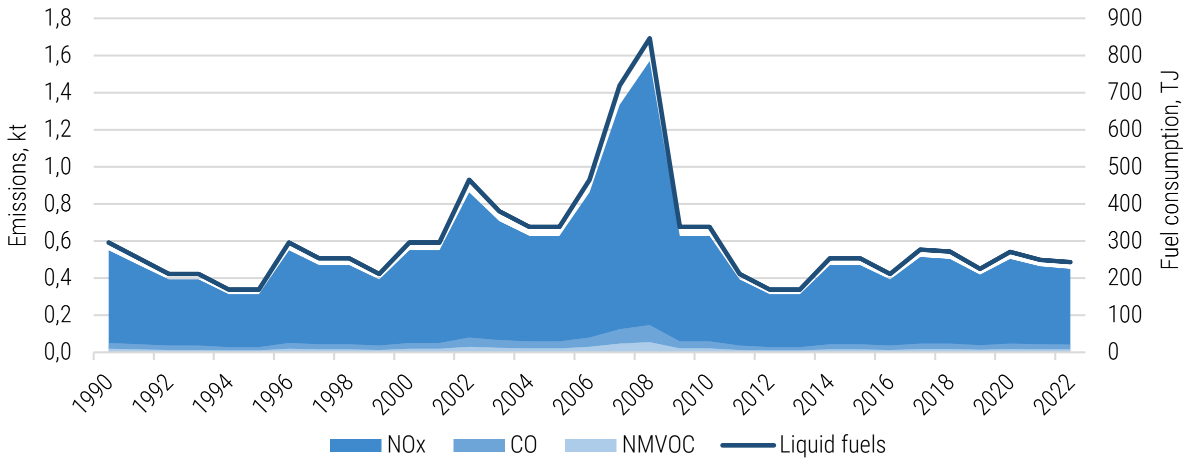

Figure 3.51 NO$_x$, NMVOC and CO emissions from the national navigation sector

Table 3.57 Emissions from national navigation in the period of 1990-2022

Year	NO$_x$	NMVOC	SO$_2$	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO
					kt				
1990	0.550	0.020	0.070	NE	NR	NR	0.011	NR	0.052
1995	0.314	0.011	0.040	NE	NR	NR	0.006	NR	0.030
2000	0.550	0.020	0.028	NE	0.010	0.011	0.011	0.003	0.052
2005	0.628	0.022	0.032	NE	0.011	0.012	0.012	0.004	0.059
2010	0.628	0.022	0.016	NE	0.011	0.012	0.012	0.004	0.059
2015	0.471	0.017	0.012	NE	0.008	0.009	0.009	0.003	0.044
2016	0.393	0.014	0.010	NE	0.007	0.008	0.008	0.002	0.037
2017	0.514	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2018	0.504	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2019	0.418	0.015	0.011	NE	0.007	0.008	0.008	0.002	0.039
2020	0.503	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.047
2021	0.463	0.017	0.012	NE	0.008	0.009	0.009	0.003	0.044
2022	0.451	0.016	0.011	NE	0.008	0.009	0.009	0.003	0.043
Change 1990-2022, %	**-17.9**	**-17.9**	**-83.6**	**NE**	**-17.9**	**-17.9**	**-17.9**	**-17.9**	**-17.9**
Change 2021-2022, %	**-2.6**	**-2.6**	**-2.6**	**NE**	**-2.6**	**-2.6**	**-2.6**	**-2.7**	**-2.6**

Table 3.57 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	0.0009	0.0001	0.0002	0.0003	0.0004	0.0014	0.0070	0.0001	0.0084
1995	0.0005	0.0000	0.0001	0.0002	0.0002	0.0008	0.0040	0.0000	0.0048
2000	0.0009	0.0001	0.0002	0.0003	0.0004	0.0014	0.0070	0.0001	0.0084
2005	0.0010	0.0001	0.0002	0.0003	0.0004	0.0016	0.0080	0.0001	0.0096
2010	0.0010	0.0001	0.0002	0.0003	0.0004	0.0016	0.0080	0.0001	0.0096
2015	0.0008	0.0001	0.0002	0.0002	0.0003	0.0012	0.0060	0.0001	0.0072
2016	0.0007	0.0001	0.0002	0.0002	0.0003	0.0010	0.0050	0.0001	0.0060
2017	0.0009	0.0001	0.0002	0.0003	0.0003	0.0013	0.0065	0.0001	0.0079
2018	0.0008	0.0001	0.0002	0.0003	0.0003	0.0013	0.0064	0.0001	0.0077
2019	0.0007	0.0001	0.0002	0.0002	0.0003	0.0011	0.0053	0.0001	0.0064
2020	0.0008	0.0001	0.0002	0.0003	0.0003	0.0013	0.0064	0.0001	0.0077
2021	0.0008	0.0001	0.0002	0.0002	0.0003	0.0012	0.0059	0.0001	0.0071
2022	0.0007	0.0001	0.0002	0.0002	0.0003	0.0011	0.0057	0.0001	0.0069
Change 1990-2022, %	**-15.7**	**-15.7**	**-15.7**	**-15.7**	**-15.7**	**-15.7**	**-15.7**	**-15.7**	**-15.7**
Change 2021-2022, %	**-7.9**	**-7.8**	**-7.8**	**-7.8**	**-8.1**	**-8.0**	**-8.0**	**-7.8**	**-8.0**

Table 3.57 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	Total PAHs	HCB	PCBs
	g I-Teq	t					kg	
1990	0.000910	0.000014	0.000070	0.000070	0.000007	0.000161	0.000560	0.000266
1995	0.000520	0.000008	0.000040	0.000040	0.000004	0.000092	0.000320	0.000152
2000	0.000910	0.000014	0.000070	0.000070	0.000007	0.000161	0.000560	0.000266
2005	0.001040	0.000016	0.000080	0.000080	0.000008	0.000184	0.000640	0.000304
2010	0.001040	0.000016	0.000080	0.000080	0.000008	0.000184	0.000640	0.000304
2015	0.000780	0.000012	0.000060	0.000060	0.000006	0.000138	0.000480	0.000228
2016	0.000650	0.000010	0.000050	0.000050	0.000005	0.000115	0.000400	0.000190
2017	0.000851	0.000013	0.000065	0.000065	0.000007	0.000150	0.000524	0.000249
2018	0.000835	0.000013	0.000064	0.000064	0.000006	0.000147	0.000514	0.000244
2019	0.000693	0.000011	0.000053	0.000053	0.000005	0.000122	0.000426	0.000203
2020	0.000833	0.000013	0.000064	0.000064	0.000006	0.000147	0.000513	0.000244
2021	0.000767	0.000012	0.000059	0.000059	0.000006	0.000136	0.000472	0.000224
2022	0.000747	0.000011	0.000057	0.000057	0.000006	0.000132	0.000460	0.000218
Change 1990-2022, %	-17.9	-21.4	-18.6	-18.6	-14.3	-18.0	-17.9	-18.0
Change 2021-2022, %	-2.6	-8.3	-3.4	-3.4	0.0	-2.9	-2.5	-2.7

3.3.5.2. Methodological Issues

All the emission calculations are based on the Tier 1 method. Emissions in the national navigation sector are calculated by multiplying the statistical fuel consumption (see Table 3.60) by respective emission factors. Default emission factors for the main pollutants are taken from EMEP/EEA Guidebook 2023 and are presented in Table 3.58.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.60) by emission factors (see Table 3.59). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation:

$$E_{SO2} = 20\ x\ k\ x\ FC$$

where

E_{SO2} – emissions of SO_2;
k –sulphur content in fuel (% by mass);
FC – fuel consumption.

Table 3.58 Emission factors for national navigation transport

Pollutant	Unit	Diesel / light fuel oil	Petrol
NO_x	kg/t	78.5	9.4
NMVOC	kg/t	2.8	181.5
$PM_{2.5}$	kg/t	1.4	9.5
PM_{10}	kg/t	1.5	9.5
TSP	kg/t	1.5	9.5
BC	kg/t	0.465	0.475
CO	kg/t	7.4	573.9
Pb	g/t	0.13	NE
Cd	g/t	0.01	NE
Hg	g/t	0.03	NE
As	g/t	0.04	NE
Cr	g/t	0.05	NE
Cu	g/t	0.20	NE
Ni	g/t	1.00	NE
Se	g/t	0.01	NE
Zn	g/t	1.20	NE

Return to the Table of Contents

Pollutant	Unit	Diesel / light fuel oil	Petrol
PCDD/F	TEQµg /tonne	0.13	NE
B(a)p	g/t	0.002	NE
B(b)f	g/t	0.01	NE
B(k)f	g/t	0.01	NE
I(1,2,3-cd)p	g/t	0.001	NE
HCB	mg/t	0.08	NE
PCBs	mg/t	0.038	NE

Table 3.59 Sulphur content of fuel (by weight)

	1990	2000	2006	2010	2012
Marine diesel oil/ Marine gas oil	0.5%	0.2%		0.1%	0.001%
Bunker fuel oil	2.7%		1.5%		

Table 3.60 Fuel consumption in the navigation sector in the period of 1990-2022 (TJ)

Year	Marine gas oil	Marine diesel oil	Total
1990	0	296	296
1995	0	169	169
2000	85	212	296
2005	0	338	338
2010	85	254	338
2015	0	254	254
2016	0	212	212
2017	0	277	277
2018	0	272	272
2019	0	225	225
2020	0	271	271
2021	0	250	250
2022	0	243	243

3.3.5.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for NO_x, NMVOC and CO from national navigation is estimated to be 100%, for SO_x and heavy metals 50%, for particulate matter 100%, for POPs 100-250% and in the activity data 2%. Uncertainty estimates for national sector are described together with non-road mobile machinery sector in Table 3.67.

3.3.5.4. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

3.3.5.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

Return to the Table of Contents

3.3.6. Other Non-Road Mobile Machinery

This chapter covers several mobile sources: industrial machinery (NFR 1A2gvii), commercial machinery (NFR 1A4aii), household and gardening machinery (NFR 1A4bii), agricultural machinery (NFR 1A4cii) and national fishing (NFR 1A4ciii) sector.

All these mobile sources are aggregated in one chapter because each of these sectors have minor importance into total transport emissions.

3.3.6.1. Source Category Description

Other non-road machinery includes following sectors and activities:

- The industrial machinery sector (NFR 1A2gvii) includes mobile combustion in manufacturing industries and construction land-based mobile machinery: tractors, cranes and any other mobile machine that run on petroleum fuels.
- Commercial sector (NFR 1A4aii) includes different small petrol and diesel working machinery in the residential sector.
- The household and gardening sector (NFR 1A4bii) include various machinery: trimmers, lawn mowers, chain saws snow mobiles, other vehicles and equipment.
- The agricultural sector (NFR 1A4cii) includes off-road vehicles and other machinery used in agriculture/forestry (agricultural tractors, harvesters, combines, etc.).
- National fishing sector (NFR 1A4ciii) covers activities from inland, coastal and deep-sea fishing.

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 13.4%, 26.5% and 23.8% respectively, in the transport sector in 2022.

As the emissions depend on the amount of fuel used, emissions from the other non-road mobile machinery sector show trends similar to fuel consumption. All the emissions have decreased in the period 1990 to 2022, where the emissions of nitrogen oxides, non-methane volatile compounds, sulphur oxide and carbon monoxide have decreased by approximately 76.1%, 87.2%, 99.8% and 93.7% compared to 1990. Also, the amount of fuel consumed decreased by 41.6% during that period. Therefore, deviations of time series can be explained by changing statistical fuel consumption in non-road machinery sector (see Figures 3.52-3.54 and the share of some specific sector in total non-road machinery emissions. Detailed emission data are provided in Table 3.61.

In 2022, fuel consumption increased by approximately 25.2% when compared to 2021's figures. As a result of this, NO_x and NMVOC emissions increased by 24.0% and 8.2% respectively. The decrease in CO emission was 10.6%, which occurred due to a shift to advanced engine technology which emit lower levels of CO emissions.

Diesel is the dominant fuel type for non-road mobile machinery, accounting for 95% of the total energy use in 2022.

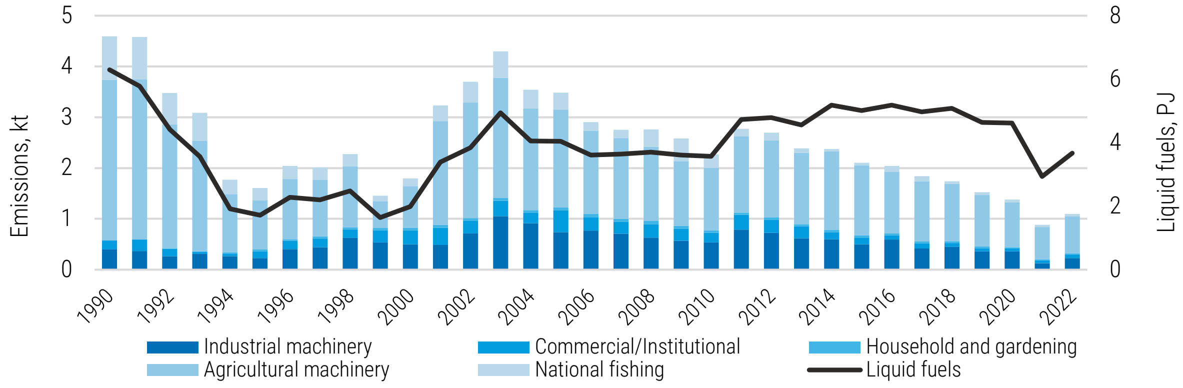

Figure 3.52 NO_x emissions from other non-road machinery

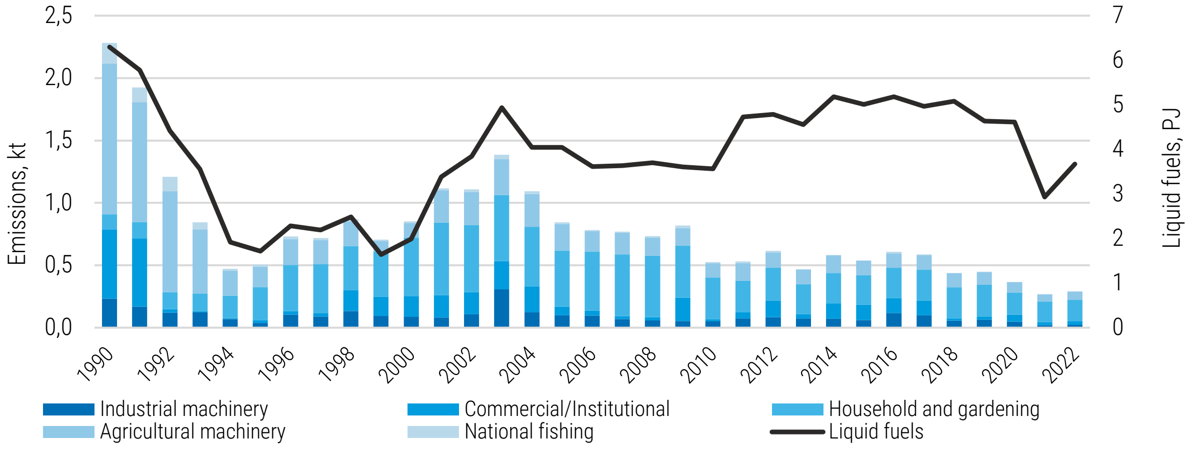

Figure 3.53 NMVOC emissions from other non-road machinery

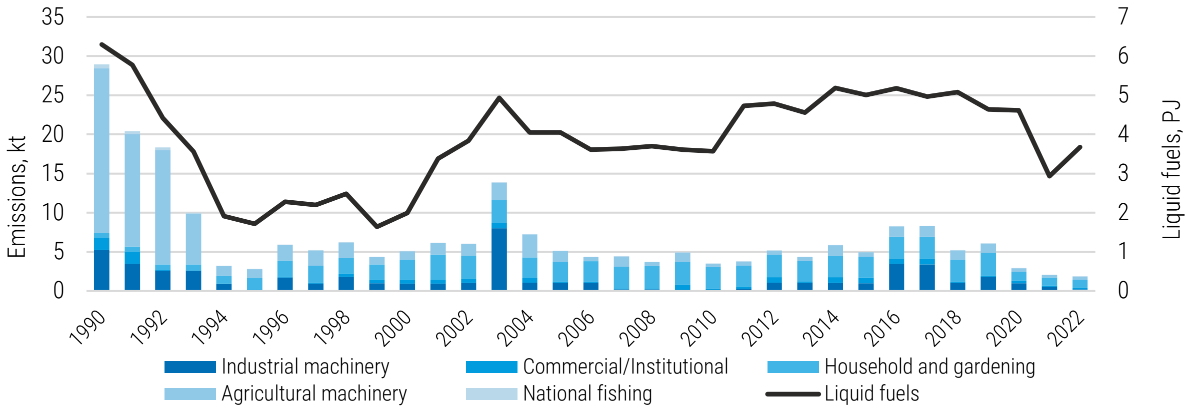

Figure 3.54 CO emissions from other non-road machinery

Table 3.61 Emissions from other non-road machinery in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	4.592	2.281	1.213	0.0009	NR	NR	0.529	NR	28.965
1995	1.604	0.505	0.381	0.0003	NR	NR	0.141	NR	2.837
2000	1.798	0.851	0.150	0.0003	0.136	0.137	0.137	0.070	5.093
2005	3.482	0.843	0.099	0.0007	0.198	0.198	0.198	0.110	5.157
2010	2.272	0.526	0.013	0.0006	0.116	0.116	0.116	0.069	3.501
2015	2.107	0.537	0.004	0.0009	0.098	0.098	0.098	0.058	4.961
2016	2.041	0.607	0.005	0.0009	0.095	0.095	0.095	0.055	8.275
2017	1.840	0.587	0.005	0.0009	0.084	0.084	0.084	0.048	8.308

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
2018	1.739	0.437	0.004	0.0009	0.078	0.078	0.078	0.047	5.181
2019	1.523	0.448	0.003	0.0008	0.068	0.068	0.068	0.040	6.059
2020	1.378	0.365	0.003	0.0008	0.061	0.061	0.061	0.036	2.922
2021	0.885	0.269	0.003	0.0005	0.039	0.039	0.039	0.022	2.055
2022	1.097	0.291	0.003	0.0006	0.048	0.049	0.049	0.028	1.837
Change 1990-2022, %	-76.1	-87.2	-99.8	-26.1	-64.5	-64.5	-90.8	-59.6	-93.7
Change 2021-2022, %	24.0	8.2	7.5	19.6	23.0	23.0	23.0	28.9	-10.6

Table 3.61 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	4.8170	0.0015	0.00033	0.00043	0.0073	0.2333	0.0203	0.0015	0.1490
1995	0.4518	0.0004	0.00009	0.00012	0.0020	0.0643	0.0056	0.0004	0.0411
2000	0.0816	0.0005	0.00006	0.00008	0.0023	0.0766	0.0051	0.0005	0.0472
2005	0.0292	0.0010	0.00013	0.00017	0.0048	0.1560	0.0106	0.0010	0.0963
2010	0.0197	0.0008	0.00010	0.00014	0.0042	0.1379	0.0091	0.0008	0.0848
2015	0.0278	0.0012	0.00002	0.00003	0.0059	0.1999	0.0089	0.0012	0.1183
2016	0.0486	0.0012	0.00004	0.00006	0.0061	0.2052	0.0099	0.0012	0.1223
2017	0.0492	0.0012	0.00004	0.00005	0.0059	0.1970	0.0094	0.0012	0.1173
2018	0.0287	0.0012	0.00002	0.00003	0.0060	0.2027	0.0090	0.0012	0.1199
2019	0.0350	0.0011	0.00002	0.00003	0.0055	0.1848	0.0083	0.0011	0.1094
2020	0.0256	0.0011	0.00002	0.00003	0.0053	0.1805	0.0081	0.0011	0.1069
2021	0.0195	0.0007	0.00002	0.00003	0.0034	0.1139	0.0053	0.0007	0.0677
2022	0.0191	0.0008	0.00002	0.00002	0.0042	0.1435	0.0064	0.0008	0.0849
Change 1990-2022, %	-99.6	-45.4	-94.8	-94.9	-42.6	-38.5	-68.4	-45.3	-43.0
Change 2021-2022, %	-1.8	18.6	-10.5	-12.0	24.7	26.0	21.1	18.7	25.5

Table 3.61 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq			t			kg	
1990	0.00141	0.00442	0.00659	0.000108	0.000011	0.01113	0.00087	0.00041
1995	0.00039	0.00116	0.00187	0.000030	0.000003	0.00307	0.00024	0.00011
2000	0.00026	0.00141	0.00220	0.000020	0.000002	0.00363	0.00016	0.00007
2005	0.00055	0.00280	0.00455	0.000042	0.000004	0.00740	0.00034	0.00016
2010	0.00045	0.00247	0.00403	0.000034	0.000003	0.00654	0.00027	0.00013
2015	0.00009	0.00358	0.00583	0.000007	0.000001	0.00942	0.00006	0.00003
2016	0.00019	0.00372	0.00595	0.000015	0.000001	0.00968	0.00012	0.00006
2017	0.00017	0.00357	0.00570	0.000013	0.000001	0.00929	0.00010	0.00005
2018	0.00008	0.00363	0.00591	0.000006	0.000001	0.00955	0.00005	0.00002
2019	0.00009	0.00333	0.00537	0.000007	0.000001	0.00871	0.00005	0.00003
2020	0.00009	0.00321	0.00528	0.000007	0.000001	0.00851	0.00005	0.00003
2021	0.00008	0.00203	0.00333	0.000006	0.000001	0.00537	0.00005	0.00002
2022	0.00007	0.00251	0.00417	0.000006	0.000001	0.00679	0.00005	0.00002
Change 1990-2022, %	-94.8	-43.3	-36.7	-94.4	-90.9	-39.0	-94.8	-94.9
Change 2021-2022, %	-11.0	23.5	25.3	0.0	0.0	26.4	-11.8	-12.5

3.3.6.2. Methodological Issues

All the NO_x, NMVOC, NH_3, PM and CO emission calculations for 1A2gvii, 1A4aii, 1A4bii and 1A4cii sectors are based on the Tier 2 method from the EMEP/EEA Guidebook 2019, whereas all other fuel derived pollutants (such as sulphur oxide, particulate matter, heavy metals and POPs) emissions are calculated by using Tier 1 methodology. Emissions from these sectors are calculated by multiplying the statistical fuel consumption by respective emission factors (see Table 3.62 and Table 3.63). Default Tier 2 emission factors for the particulate matter, NO_x, NMVOC, NH_3 and CO are split by different EU emission legislation stages set on equipment technology (e.g. < 1981, 1981–1990, 1991 – Stage I, Stage I, Stage II, Stage IIIA, Stage IV, Stage V). In order to apply Tier 2 methodology, there is a need to evaluate the proportion of different engine technology in use in every particular year. This has been done by using aggregated fuel split data in an annex to the EMEP/EEA Guidebook 2019, in the chapter on non-road machinery.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.66) by emission factors (see Table 3.64). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation (1) can be applied to industrial, commercial, household/gardening and agricultural sectors, equation (2) only for national fishing sector:

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

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

where

E_{SO2} – emissions of SO_2;
k – weight related sulphur content in fuel (kg/kg fuel);
S – sulphur content in fuel (% by mass);
FC – fuel consumption.

Pb emissions are estimated by assuming that 75% of the lead contained in petrol is emitted into the air (see Table 3.65). Equation:

$$E_{Pb} = 0.75 \text{ x } k \text{ x } FC$$

Table 3.62 Tier 2 emission factors for other mobile sources (g/t)

Fuel	NFR	Pollutant	Technology								
			<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V
Diesel	1A2gvii/ 1A4aii/ 1Abii	NO_x	26.552	33.942	43.552	31.077	22.101	15.653	11.933	1.570	7.663
		NMVOC	8.077	6.962	5.851	1.725	1.587	1.470	625	536	930
		NH_3	7	7	8	8	8	8	8	8	8
		PM	6.207	4.308	3.642	1.005	1.034	950	98	98	116
		BC	3.414	2.369	2.001	800	825	758	78	78	56
		CO	20.690	18.890	16.258	6.639	7.135	6.826	6.445	6.019	7.352
	1A4cii Agriculture	NO_x	29.901	37.383	49.002	30.799	20.612	12.921	9.318	1.587	1.861
		NMVOC	7.760	6.439	4.493	1.544	1.181	1.173	544	530	526
		NH_3	7	7	8	8	8	8	8	8	8
		PM	5.861	4.047	1.974	947	624	550	99	99	59
		BC	3.221	2.221	1.074	727	483	416	74	73	9
		CO	19.804	17.566	14.147	6.463	6.104	6.035	6.087	6.024	6.077
	1A4cii Forestry	NO_x	33.028	44.030	49.963	31.344	20.593	12.845	9.454	1.586	1.915
		NMVOC	7.423	5.827	4.907	1.420	1.160	1.161	514	515	542
		NH_3	7	7	8	8	8	8	8	8	8
		PM	5.493	3.731	2.130	789	595	573	99	99	59
		BC	3.021	2.052	1.172	607	456	437	74	74	9
		CO	19.014	16.045	14.239	5.919	5.940	5.947	5.940	5.947	6.008
Petrol	1A2gvii/ 1A4aii/ 1A4bii/ 1A4cii Petrol 2-stroke	NO_x	1.050	1.682	1.852	3.445	2.495				2.490
		NMVOC	298.703	258.562	229.630	225.579	113.157				111.450
		NH_3	2	3	3	4	4				4
		PM	7.037	47.86	3.869	3.683	4.299				4.278
		BC	352	239	193	184	215				214
		CO	754.523	699.494	621.083	620.519	695.237				694.870
	1A2gvii/ 1A4aii/ 1A4bii/ 1A4cii	NO_x	2.429	5.743	7.129	7.088	6.676				5.354
		NMVOC	20.182	25.852	19.082	18.469	16.126				13.293
		NH_3	4	4	4	4	4				4
		$PM_{2.5}$	148	147	157	159	159				159
		BC	7	7	8	8	8				8

Fuel	NFR	Pollutant	Technology								
			<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V
	Petrol 4-stroke	CO	1,214.855	836,966	768,445	774,457	8041.57				778,282

Table 3.63 Tier 1 emission factors for other mobile sources

Pollutant	Unit	1A2gvii, 1A4aii, 1A4bii, 1A4cii		1A4ciii	
		Diesel/ light fuel oil	Petrol 4-stroke	Diesel/ light fuel oil	Petrol
NO_x	kg/t			78.5	9.4
NMVOC	kg/t			2.8	181.5
NH_3	kg/t			NE	NE
$PM_{2.5}$	kg/t			1.4	9.5
PM_{10}	kg/t			1.5	9.5
TSP	kg/t			1.5	9.5
BC	kg/t			0.465	0.475
CO	kg/t			7.4	573.9
Pb	g/t	NE	NE	0.13	NE
Cd	g/t	0.01	0.01	0.01	NE
Hg	g/t	NE	NE	0.03	NE
As	g/t	NE	NE	0.04	NE
Cr	g/t	0.05	0.05	0.05	NE
Cu	g/t	1.7	1.7	0.20	NE
Ni	g/t	0.07	0.07	1.00	NE
Se	g/t	0.01	0.01	0.01	NE
Zn	g/t	1.0	1.0	1.20	NE
PCDD/F	TEQµg /t	NE	NE	0.13	NE
B(a)p	g/t	0.03	0.04	0.002	NE
B(b)f	g/t	0.05	0.04	0.01	NE
B(k)f	g/t	NE	NE	0.01	NE
I(1,2,3-cd)p	g/t	NE	NE	0.001	NE
HCB	mg/t	NA	NA	0.08	NA
PCB	mg/t	NA	NA	0.038	NA

Table 3.64 Sulphur content of fuel (by weight)

NFR	Fuel	1990	2000	2001	2003	2004	2005	2006	2009	2010	2012
1A2gvii 1A4aii 1A4bii	Petrol	0.1%	0.1%	0.05%	0.015%	0.013%	0.005%	0.002%	0.002%	0.002%	0.001%
1A4cii	Diesel	0.5%	0.5%	0.05%	0.035%	0.030%	0.005%	0.004%	0.002%	0.002%	0.001%
1A4ciii	Light fuel oil	0.5%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.001%

Table 3.65 Lead content in fuel

NFR	Fuel	Unit	1990	2000	2004
1A2gvii 1A4aii 1A4bii 1A4cii 1A4ciii	Petrol	g/l	0.15	0.013	0.005
1A4ciii	Diesel/ Light fuel oil	g/t	0.13	0.13	0.13

Table 3.66 Total fuel consumption in other mobile sectors for the period of 1990-2022 (TJ)

Year	Diesel	Petrol	Total
1990	4,852	1,445	6,297
1995	1,584	134	1,718
2000	1,714	277	1,991
2005	3,798	251	4,048
2010	3,397	169	3,566
2015	4,767	242	5,009
2016	4,755	425	5,180
2017	4,537	429	4,966
2018	4,827	251	5,077
2019	4,330	306	4,635
2020	4,390	224	4,613
2021	2,764	170	2,934
2022	3,507	167	3,674

3.3.6.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for main pollutants, particulate matter and heavy metals from non-road mobile machinery sector is estimated to be 50-100%, for SO_x 20-50%, for POPs 100-250% and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.67.

Table 3.67 Uncertainties in non-road mobile machinery sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	2.31	kt	9.88	4.14	0.54
NMVOC	0.37	kt	1.39	0.42	0.40
SO_x	0.01	kt	0.10	0.04	0.01
NH_3	0.00	kt	0.01	0.00	0.00
$PM_{2.5}$	0.07	kt	1.48	0.47	0.13
PM_{10}	0.07	kt	0.82	0.27	0.03
TSP	0.08	kt	0.52	0.19	0.01
BC	0.04	kt	3.51	1.22	1.14
CO	2.09	kt	1.96	0.58	1.87
Pb	0.02	t	0.48	0.18	0.02
Cd	0.001	t	0.21	0.06	0.00
Hg	0.0002	t	0.10	0.04	0.01
PCDD/F	0.001	g I-TEQ	0.02	0.05	0.21
B(a)p	0.003	t	0.27	0.33	0.16
B(b)f	0.005	t	0.48	0.59	0.14
B(k)f	0.0005	t	0.07	0.13	0.15
I(1,2,3-cd)p	0.0001	t	0.01	0.02	0.15
HCB	0.001	kg	0.10	0.09	0.14
PCBs	0.0002	kg	0.04	0.04	0.05

3.3.6.4. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

3.3.6.5. Source-Specific Planned Improvements

More detailed emission calculations for other non-road machinery sectors. The improvements to be carried out in the inventory methodology will depend on how possible it is to attain detailed information from Statistics Estonia and other authorities.

Return to the Table of Contents

Continue working to improve the transparency of the inventory. Fuel consumption data used in emission calculations is obtained by Statistics Estonia from companies under specific subsectors. Statistics Estonia has to do further analysis to understand why the large variations occur. There are plans to double-check fuel consumption data presented in the energy balance and try to explain emission fluctuations for the time series in next year's submission.

3.3.7. International Maritime Navigation (NFR 1A3di(i))

3.3.7.1. Source Category Description

International maritime navigation comprise the carriage of goods and passengers in sea-going vessels and cover vessels of all flags engaged in international water-borne navigation. Emissions from international navigation are reported as a memo item and are not included in the national totals.

In general, the total energy use in the international maritime navigation sector has fluctuated throughout the time series. The total fuel consumption in this sector increased by 43.5% between 1990 and 2022. As of 2012, a significant increase in fuel consumption is apparent: fuel consumption is more than twice higher (7 643 to 16 384 TJ) compared to 2011. This can be explained by the structural changes in the statistical information collection by Statistics Estonia – since 2012, data for imports and exports also include re-exports data.

As emission levels depend upon the amount of fuel being used, emissions from the international maritime navigation sector show trends similar to those for fuel consumption. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have increased by approximately 33.9%, 46.0%, and 42.7% in comparison to 1990's figures. Sulphur oxide emissions have decreased by 39.1% during the same period due to stringent measures having been adopted by the IMO in relation to sulphur content in marine fuels. The dominant fuel in this sector is bunker fuel oil. But recent years have shown a rise in marine diesel and gas oil consumption at the expense of bunker fuel oil. Therefore a decrease in SO_2 emissions has occurred, since marine diesel and gas oil has a lower sulphur content in fuel. Detailed emissions data are provided in Table 3.68.

In 2022, emissions from the international maritime navigation sector have decreased compared to 2021. This increase in emissions occurred due to lower fuel consumption in 2022. The emissions of NO_x, NMVOC, SO_x and CO decreased 8.7%, 8.5%, 5.6% and 8.3% in comparison to 2021's figures.

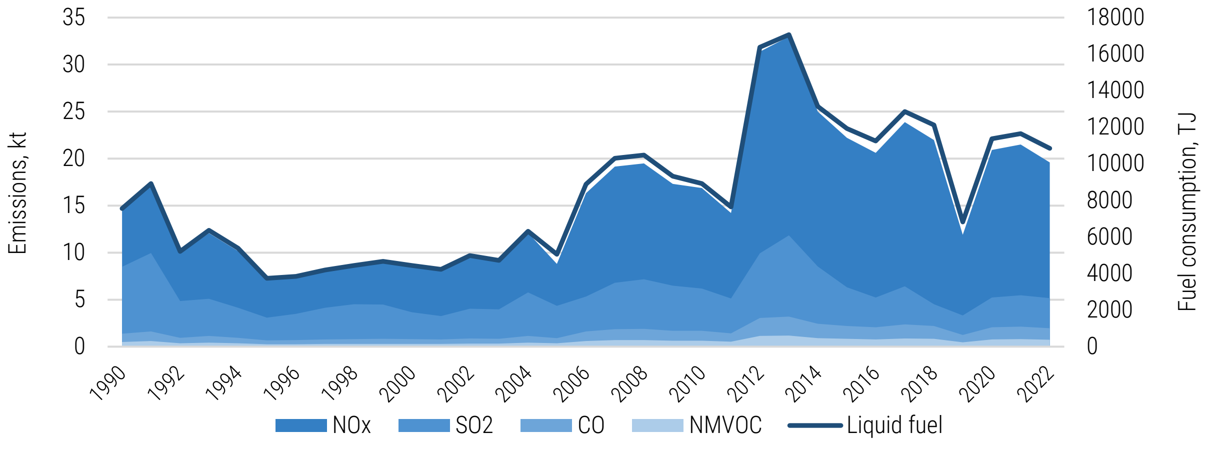

Figure 3.55 NO_x, NMVOC, SO_x and CO emissions from the international maritime navigation sector

Return to the Table of Contents

Table 3.68 Emissions from the international maritime navigation sector in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	14.643	0.503	8.494	NE	NR	NR	0.987	NR	1.369
1995	7.105	0.247	3.100	NE	NR	NR	0.370	NR	0.666
2000	8.452	0.293	3.678	NE	0.423	0.466	0.466	0.062	0.792
2005	8.810	0.345	4.338	NE	0.491	0.522	0.522	0.071	0.903
2010	16.864	0.623	6.192	NE	1.173	1.274	1.274	0.147	1.672
2015	22.197	0.822	6.334	NE	1.268	1.371	1.371	0.177	2.198
2016	20.631	0.772	5.232	NE	1.081	1.163	1.163	0.160	2.057
2017	23.884	0.883	6.434	NE	1.307	1.413	1.413	0.187	2.361
2018	21.974	0.832	4.514	NE	0.995	1.061	1.061	0.162	2.198
2019	11.893	0.477	3.306	NE	0.673	0.709	0.709	0.098	1.251
2020	20.911	0.783	5.238	NE	1.087	1.169	1.169	0.162	2.079
2021	21.493	0.802	5.476	NE	1.131	1.218	1.218	0.167	2.131
2022	19.601	0.734	5.176	NE	1.058	1.139	1.139	0.154	1.954
Change 1990-2022, %	33.9	46.0	-39.1	NE	150.3	144.4	15.4	148.6	42.7
Change 2021-2022, %	-8.8	-8.4	-5.5	NE	-6.4	-6.5	-6.5	-7.6	-8.3

Table 3.68 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	0.032	0.003	0.004	0.009	0.110	0.037	4.866	0.006	0.222
1995	0.014	0.001	0.002	0.004	0.038	0.018	1.640	0.002	0.108
2000	0.017	0.002	0.003	0.005	0.049	0.021	2.122	0.003	0.128
2005	0.020	0.002	0.003	0.006	0.058	0.024	2.509	0.004	0.146
2010	0.040	0.004	0.005	0.011	0.149	0.045	6.581	0.008	0.271
2015	0.049	0.005	0.007	0.014	0.152	0.059	6.652	0.009	0.356
2016	0.044	0.004	0.007	0.013	0.126	0.056	5.455	0.008	0.334
2017	0.052	0.005	0.008	0.015	0.155	0.064	6.736	0.009	0.383
2018	0.046	0.004	0.008	0.013	0.109	0.059	4.637	0.007	0.356
2019	0.027	0.003	0.004	0.008	0.079	0.034	3.455	0.005	0.203
2020	0.045	0.004	0.007	0.013	0.126	0.056	5.458	0.008	0.337
2021	0.046	0.005	0.007	0.013	0.132	0.058	5.713	0.008	0.346
2022	0.043	0.0043	0.0063	0.0122	0.1244	0.0528	5.4100	0.0076	0.317
Change 1990-2022, %	34.9	28.0	55.0	37.1	12.7	42.7	11.2	19.4	42.7
Change 2021-2022, %	-7.7	-7.1	-9.1	-7.9	-5.5	-8.3	-5.3	-6.3	-8.3

Table 3.68 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq			t			kg	
1990	0.075	0.001	0.005	0.003	0.001	0.010	0.024	0.087
1995	0.029	0.000	0.002	0.001	0.000	0.004	0.010	0.030
2000	0.036	0.000	0.002	0.002	0.001	0.005	0.012	0.039
2005	0.042	0.000	0.003	0.002	0.001	0.006	0.014	0.046
2010	0.099	0.001	0.006	0.004	0.002	0.014	0.030	0.118
2015	0.108	0.001	0.007	0.005	0.002	0.015	0.036	0.120
2016	0.093	0.001	0.006	0.004	0.002	0.013	0.032	0.099
2017	0.112	0.001	0.007	0.005	0.002	0.016	0.038	0.122
2018	0.086	0.001	0.006	0.004	0.001	0.013	0.032	0.086
2019	0.058	0.001	0.004	0.003	0.001	0.008	0.020	0.063
2020	0.093	0.001	0.006	0.004	0.002	0.013	0.033	0.100
2021	0.097	0.001	0.006	0.005	0.002	0.014	0.034	0.104
2022	0.091	0.001	0.006	0.004	0.002	0.013	0.031	0.098
Change 1990-2022, %	20.4	24.7	22.4	28.0	14.3	23.3	30.3	12.6
Change 2021-2022, %	-6.4	-6.8	-6.6	-7.1	-5.7	-6.7	-7.3	-5.5

3.3.7.2. Methodological Issues

All the emission calculations are based on the Tier 1 method for the period of 1990–2004. Detailed activity data (annual number of vessels per vessel category) is available from 2005. Therefore, detailed emission calculations for NO_x, NMVOC and PM from hotelling and manoeuvring of the ships are included in the submission from 2005.

Emission calculations from hotelling and manoeuvring activities are calculated by using statistical data. such as the number of vessels and vessel size per category (see Tables 3.71-3.72). Although, there are no activity data available at the level required by the Tier 3 methodology, adjustments, suggested by the EMEP/EEA Guidebook 2019 (e.g. engine size and technology, power installed or fuel use, hours in different activities) have been made.

Cruise emissions are calculated by the Tier 1 method, where the statistical fuel consumption (see Table 3.73) is multiplied by respective emission factors (see Table 3.69). Default emission factors for the main pollutants and heavy metals are taken from the EMEP/EEA Guidebook 2019.

SO_2 emissions are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.73) by emission factors (see Table 3.70). SO_2 emissions are estimated based on the assumption that all sulphur in the fuel is completely converted into SO_2. Equation:

$$E_{SO2} = 20\ x\ k\ x\ FC$$

Table 3.69 Emission factors for the international maritime navigation sector, (kg/t)

Pollutant	Unit	Bunker fuel oil	Marine diesel oil
		Value	Value
NO_x	kg/t	79.3	78.5
NMVOC	kg/t	2.7	2.8
$PM_{2.5}$	kg/t	5.6	1.4
PM_{10}	kg/t	6.2	1.5
TSP	kg/t	6.2	1.5
BC	kg/t	0.672	0.434
CO	kg/t	7.4	7.4
Pb	g/t	0.18	0.13
Cd	g/t	0.02	0.01
Hg	g/t	0.02	0.03
As	g/t	0.05	0.04
Cr	g/t	0.72	0.05
Cu	g/t	0.20	0.20
Ni	g/t	32	1
Se	g/t	0.04	0.01
Zn	g/t	1.2	1.2
PCDD/F	TEQµg /tonne	0.47	0.13
B(a)p	g/t	0.005	0.002
B(b)f	g/t	0.03	0.01
B(k)f	g/t	0.02	0.01
I(1,2,3-cd)p	g/t	0.009	0.001
HCB	mg/t	0.14	0.08
PCBs	mg/t	0.57	0.038

Table 3.70 Sulphur content of fuel (by weight)

Fuel	1990	2000	2006	2008
Marine diesel oil	0.5%	0.2%		0.1%
Bunker fuel oil	2.7%		1.5%	

Return to the Table of Contents

Table 3.71 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2022

Year	Liquid bulk ships	Dry bulk carriers	Container	General cargo	Passenger	Fishing	Other	Total
2005	961	2,026	495	1,466	10,581	2	9	15,540
2010	970	1,688	338	1,654	6,201	0	32	10,883
2015	819	1,007	359	2,653	6,303	0	4	11,145
2016	900	876	374	2,721	6,533	0	6	11,410
2017	904	1,000	350	2,731	6,495	0	32	11,512
2018	944	159	295	9,322	342	26	250	11,338
2019	991	175	263	9,299	340	66	300	11,434
2020	987	202	179	8,662	4	27	206	10,267
2021	901	197	131	8,773	47	38	218	10,305
2022	718	108	156	8,277	225	23	177	9,684

Table 3.72 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2022 (thousand)

Year	Liquid bulk ships	Dry bulk carriers	Container	General cargo	Passenger	Fishing	Other	Total
2005	21,677	8,704	3,131	9,880	114,704	24	11	158,132
2010	21,316	7,237	4,045	14,505	164,731	0	61	211,895
2015	15,058	4,715	4,989	29,621	195,666	0	7	250,056
2016	13,617	4,711	5,664	30,047	205,522	0	10	259,571
2017	13,768	5,421	5,126	31,618	223,137	0	98	279,168
2018	14,073	3,473	4,467	247,310	24,028	10	2,071	295,431
2019	14,401	4,032	4,054	246,109	24,878	28	2,291	295,793
2020	14,883	4,783	2,533	223,071	162	12	2,125	247,569
2021	14,683	4,641	1,859	227,066	4,713	21	2,252	255,235
2022	10,733	2,803	2,626	220,003	15,642	10	1,838	253,655

Table 3.73 Fuel consumption in the international maritime navigation sector in the period of 1990-2022 (TJ)

Year	Bunker fuel oil	Marine diesel oil/ Marine gas oil	Total
1990	5,995	1,438	7,433
1995	1,985	1,692	3,677
2000	2,581	1,777	4,357
2005	3,057	1,904	4,960
2010	8,139	888	9,027
2015	8,040	3,892	11,932
2016	6,550	4,695	11,245
2017	8,119	4,738	12,856
2018	5,491	6,641	12,132
2019	4,160	2,665	6,825
2020	6,554	4,822	11,376
2021	6,868	4,780	11,648
2022	6,706	4,145	10,851

3.3.7.3. Uncertainty

No uncertainty estimation for international maritime navigation has been carried out.

3.3.7.4. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends has been carried out.

3.3.7.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

Return to the Table of Contents

3.4. Fugitive Emissions (NFR 1B)

3.4.1. Overview of the Sector

Under fugitive emissions from fuels, Estonia reports on NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, NH_3, NO_x, SO_2 and HMs emissions from the following activities (see Table 3.74):

Table 3.74 Fugitive emissions activities

NFR	Source	Description	Emissions reported
1B	**Fugitive emissions from fuel**		
	1c Other fugitive emissions from solid fuels	Includes emissions from open oil shale mining activity, mainly explosive works. Only point sources data.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO
	2aiv Refining / storage	Includes emissions from product process and storage and handling in oil shale oil industry. Only point sources data.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO
	2av Distribution of oil products	Includes emissions from liquid fuel distribution. Data of point and diffuse sources.	NMVOC
	2b Natural gas	Includes emissions from gas distribution networks. Only diffuse sources data.	NMVOC
	2c Venting and flaring	Waste gas incineration. Only two point sources data.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cu, Cr, Ni, Zn, PCDD/PCDF, PAHs

NMVOC emissions from this sector (NFR 1B) contribute 2.7% to total national emissions and have decreased by about 71% up to 2022 compared to 1990 due to decreasing emissions from gasoline distribution and has decreased (by 7.7%) in comparison with 2021 due mainly to the decrease emissions from oil distribution sector (see Figure 3.56, Figure 3.58 and Table 3.76) and also from storage in refining activities. Emissions of other pollutants are very small compared to the emissions from the other sectors (see Table 3.75).

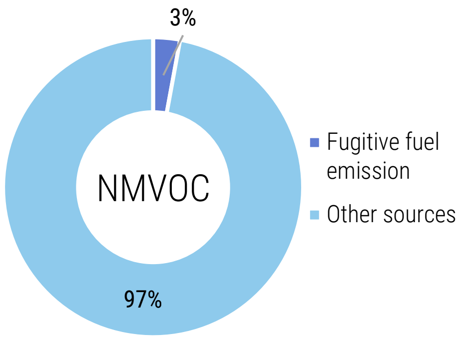

Figure 3.56 NMVOC emission distribution in 2022

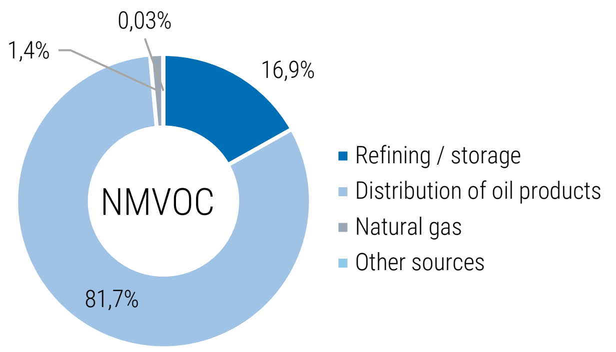

Figure 3.57 NMVOC emission distribution within the fuel fugitive emission sector in 2022

Figure 3.57 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (81.7%).

The emission data for 1B1c Other fugitive emissions from solid fuels (oil shale mining industry), 1B2aiv Refining/storage and 1B2c Venting and flaring are obtained from the point sources database. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

Table 3.75 Fugitive emission in the period of 1990-2022 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.107	2.474	0.043	0.033	NR	NR	0.817	NR	0.494
1995	0.062	1.632	0.023	0.017	NR	NR	0.487	NR	0.283
2000	0.065	4.326	0.019	0.012	0.289	0.298	0.569	NA	0.293
2005	0.088	4.198	0.024	0.014	0.403	0.425	0.806	NA	0.389
2010	0.117	1.402	0.030	0.017	0.548	0.594	1.118	0.0002	0.512
2015	0.149	1.142	0.033	0.012	0.732	0.763	1.455	0.0001	0.653
2016	0.142	1.168	0.026	0.008	0.713	0.743	1.412	0.0001	0.613
2017	0.169	1.080	0.031	0.011	0.843	0.877	1.668	0.00003	0.731
2018	0.170	1.038	0.032	0.012	0.841	0.871	1.664	0.00005	0.734
2019	0.118	0.792	0.026	0.010	0.573	0.596	1.136	0.00002	0.511
2020	0.070	0.848	0.019	0.010	0.322	0.340	0.645	0.00002	0.309
2021	0.070	0.779	0.018	0.010	0.330	0.350	0.663	0.00001	0.314
2022	0.099	0.718	0.021	0.010	0.487	0.513	0.972	0.00000	0.437
Change 1990-2022, %	-7.5	-71.0	-49.8	-70.8			-18.8		-11.7
Change 2021-2022, %	41.4	-7.7	16.5	-6.1	47.5	46.3	46.6		39.1

3.4.2. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for main pollutants from fugitive emission sector is estimated in the range from 50% to 200%; for the activity data uncertainty is 2%. Uncertainty estimates for fugitive emission sector are given in Table 3.76.

Table 3.76 Uncertainties in fugitive emission sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NOx	0.10	kt	0.42	0.21	0.04
NMVOC	0.72	kt	2.72	1.13	0.32
SOx	0.02	kt	0.15	0.03	0.001

Return to the Table of Contents

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NH3	0.01	kt	0.09	0.05	0.01
PM2.5	0.49	kt	9.93	9.75	3.34
PM10	0.51	kt	5.69	5.47	1.48
TSP	0.97	kt	6.09	5.89	0.34
BC	0.000003	kt	0.0003	0.0001	0.0001
CO	0.44	kt	0.41	0.41	0.09
Pb	0.0001	t	0.0027	0.0027	0.0001
Cd	0.0000001	t	0.00002	0.00001	0.000001
Hg	0.0000001	t	0.00003	0.00001	0.000002
PCDD	0.000005	g I-TEQ	0.0001	0.0002	0.0001
benzo(a) pyrene	0.000001	t	0.00005	0.0001	0.00004
benzo(b) fluoranthene	0.000001	t	0.00005	0.0001	0.00003
benzo(k) fluoranthene	0.000001	t	0.0001	0.0002	0.0001
Indeno	0.000001	t	0.0001	0.0001	0.0001
HCB	NA	kg	NA	NA	NA
PCB	NA	kg	NA	NA	NA

3.4.3. Distribution of Oil Products (NFR 1B2av)

3.4.3.1. Source Category Description

In the past, emissions from this source category have contributed significantly to total anthropogenic NMVOC emissions. However, European Directive 94/63/EC (EU. 1994) has mandated vapour collection and recovery during the loading of gasoline transport equipment (i.e. tank trucks, rail tank cars and barges) and during the discharge of tank trucks into storage at service stations. It has also imposed emission controls on all gasoline storage tanks at terminals, dispatch stations and depots. The result of these controls has been a very significant reduction in NMVOC emissions from this sector in the EU.

Emissions of NMVOCs into the atmosphere occur in nearly every element of the oil product distribution chain. The vast majority of emissions occur during the storage and handling of gasoline due to its much higher volatility compared to other fuels such as gasoil, kerosene, etc.

In Estonia, oil terminals and service stations must have permits when the total loading turnover exceeds 10 000 m^3 per year[5] (before 2017 was 2000 m^3 per year). That means the smallest service stations are regarded as diffuse sources. Since 2005, all gasoline distribution stations are treated as diffuse sources and the method for estimating emissions is described in chapter 3.4.3.2. Emissions from oil terminals are based only on the facilities data. 20 terminals presented reports on emissions in 2022. In the table below NMVOC emissions from gasoline distribution and terminals are presented.

Table 3.77 NMVOC emissions from liquid fuel distribution in the period of 1990-2022 (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Gasoline distribution	2.055	0.971	1.108	0.381	0.413	0.434	0.433	0.405	0.399	0.429	0.451
Terminals	0.323	0.625	3.157	3.199	2.626	1.2	0.629	0.799	0.644	1.265	0.854
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Gasoline distribution	0.419	0.380	0.353	0.357	0.363	0.372	0.382	0.296	0.281	0.268	
Terminals	0.74	0.737	0.594	0.642	0.521	0.474	0.262	0.414	0.336	0.319	

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[5] Emission levels of pollutants and capacities of plants used, beyond which an ambient air pollution and special pollution permit are required. Regulation No. 67 of the Minister of Environment of 14 December 2016. https://www.riigiteataja.ee/akt/122122016005

Return to the Table of Contents

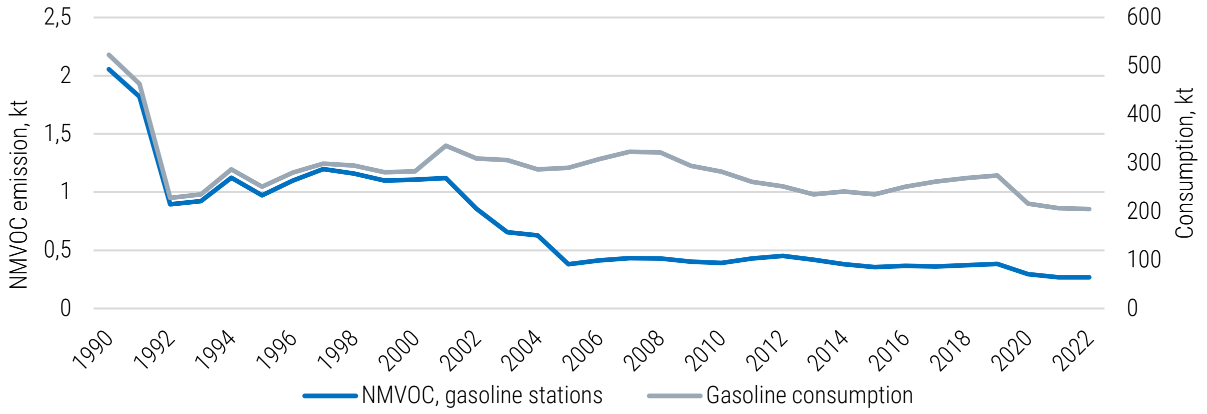

Figure 3.58 NMVOC emission and gasoline distribution in the period of 1990-2022

European Directive 94/63/EC has mandated vapour collection and recovery for the discharge of tank trucks into storage at service stations (Stage 1.B). In Estonia, the regulation on implementation of the requirements of the EU Directive 94/63/EC came into force in 1998.

The timetable for the implementation of Stage 1.B vapour collection and recovery equipment according the requirements is the following:

- from 1 January 2001 for existing service stations with a turnover over 1000 m^3 and all others situated in densely populated or industrial areas;
- from January 2004 for service stations with a turnover over 500 m^3;
- from January 2005 for service stations with a turnover over 100 m^3.

3.4.3.2. Methodological Issues

EMEP/CORINAIR methodology is used to estimate fugitive NMVOC emissions from operations with gasoline in the period 1990-2004.

For the period 2005-2022, the Tier 2 methodology from the EMEP/EEA Guidebook 2023 is used.

As the plan was to improve data for this sector, a recalculation of NMVOC emissions from gasoline distribution stations for the period 2005-2020 was made. Until 2004, the emissions calculated according to the old method, which takes into account the average RVP and temperature over several years, remain in force. Since 2005, emissions have been calculated for each year by the Tier 2 methodology, using the average annual RVP data (according to the Register of Fuel Monitoring data), shown in table 3.78, which also presents the average annual temperature. Firstly, true vapor pressure (TVP) was calculated using the formula given in the Guidebook, then the emissions factor for each activity was calculated (Chapter 1.B.2.a.v, Tables 3.8–3.11). One integrated emission factor representing all activities was used to calculate emissions.

Emission factors for diffuse sources

As the situation regarding the requirements of vapour recovery equipment has changed over the years, different emission factors are used for different periods.

1) For the period 1990-2000. the emission factor from Corinair 2007 is applied (3930 g NMVOC/Mg of total gasoline handled);

- For 2001 – 3350 g/Mg;

- For 2002 – 2770 g/Mg;
- For 2003–2004 – 2190 g/Mg.

2) For the period 2005-2022, the Tier 2 technology specific emission factors for Service Stations from the EMEP/EEA Guidebook 2023 is applied (Chapter 1.B.2.a.v, Tables 3.8–3.11). As the majority of the emissions at service stations are from gasoline storage and refuelling (compared to emissions from gasoil), emission factors are only provided for gasoline

Abatement

In the previous chapter, the Stage 1.B abatement technology requirement is described. The resulting emission can be calculated by replacing the technology specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology.abated} = (1-\eta_{abatement}) \times EF_{technology.unabated}$$

The Abatement efficiencies ($\eta_{abatement}$) for source category 1B2av Distribution of oil products. Service stations. Storage tank filling from the EMEP/EEA Guidebook 2019 is applied (default value is 95%).

The emission factors depend on the True Vapour Pressure (TVP). This pressure is the vapour pressure at loading, and it depends on the loading temperature. The definition of the TVP is as follows:

$$TVP = RVP\ 10^{AT+B}$$

where

A = 0.000007047 RVP + 0.0132 and B = 0.0002311 RVP - 0.5236. T is the temperature (in °C) and RVP is the Reid Vapour Pressure (in kPa).

The annual average loading temperature at terminals can be assumed to equal the average annual ambient temperature.The annual average temperature in Estonia is equal to 5 ˚C[6].

The RVP for gasoline (gasoline 95/98) in Estonia according to the Register of Fuel Monitoring in the period 2005-2022 is presented in the following Table 3.78.

Table 3.78 Annual average RVP of gasoline 95/98, annual average temperature in Estonia, TVP and NMVOC EF in the period 2005-2022

Year	Annual average RVP, kPa	True Vapour Pressure (TVP), kPa	Calculated NMVOC emission factor for gasoline, g/m^3 throughput
2005	72.3	22.20	959.16
2006	73.65	22.65	978.60
2007	73.78	22.70	980.65
2008	73.78	22.71	981.23
2009	75	23.07	996.68
2010	76.27	23.45	1013.24
2015	74.62	22.99	993.07
2016	74.37	22.88	988.51
2017	74.04	22.77	983.68
2018	74.41	22.71	981.10
2019	74.67	23.00	993.77
2020	74.05	22.83	986.06
2021	73.45	22.59	975.70
2022	71.13	21.68	936.77

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[6] Estonian Weather Service (http://www.ilmateenistus.ee/?lang=en)

Activity data

Activity data on the subject of gasoline consumption is available from Statistics Estonia (see Table 3.79).

Table 3.79 Consumption of motor gasoline in the period of 1990-2022 (kt)

Year	Gasoline consumption
1990	523
1995	251
2000	283
2005	290
2010	282
2015	235
2016	251
2017	261.5
2018	269
2019	274
2020	216
2021	207
2022	205.04

3.4.3.3. Source-Specific QA/QC and Verification

Statistical quality checking related to the assessment of emission, activity data and trends has been carried out.

3.4.3.4. Source-Specific Planned Improvements

No improvements planned for next year.

3.4.4. Natural Gas (NFR 1B2b)

3.4.4.1. Source Category Description

The term "fugitive emissions" is broadly applied here to mean all greenhouse gas emissions from gas systems, except contributions from fuel combustion. Natural gas systems comprise all infrastructure required to produce, collect, process or refine and deliver natural gas and petroleum products to the market. The system begins at the wellhead, or oil and gas source, and ends at the final sales point to the consumer.

The sources of fugitive emissions on gas systems include, but are not limited to, equipment leaks, evaporation and flashing losses, venting, flaring, incineration and accidental releases (e.g. pipeline dig-ins. well blow-outs and spills). While some of these emission sources are engineered or intentional (e.g. tank, seal and process vents, and flare systems), and therefore relatively well characterized, the quantity and composition of the emissions is generally subject to significant uncertainty.

Imports of natural gas (90% from Latvia) in 2022 approximately doubled compared to 2021, half of which were exported to Finland. Gas consumption at the same time decreased by 26%.

The Estonian gas transmission network was built between 1951 and 2006, and is part of the former Soviet Union's transmission network. The construction of the natural gas pipeline to the towns of Pärnu and Sindi was completed in 2006. The natural gas pipelines also reached customers in the county town of Rapla and the town of Püssi.[7]

Estonia has operational interconnections with the Russian natural gas network in Värska, and with Latvia in Karksi, with a maximum capacity of 11 mcm/d.

The gas network in Estonia is 2314 km long, of which 878 km are for transmission and 1436 km for distribution. There are three GMSs in Värska, Karksi and Misso and 36 gas distribution stations. The system is owned by Eesti Gaas AS, and operated by EG Võrguteenus, which provides transmission and distribution services, and operates the gas metering systems on the Estonian border. Eesti Gaas AS owns the entire gas transmission and distribution system and supplies gas to all the wholesale markets and the majority of the retail markets (see Figure 3.59).

Figure 3.59 Map of high-pressure gas distribution pipelines in Estonia

The gas pipeline passes through ten counties: Ida-Viru, Lääne-Viru, Harju, Rapla, Jõgeva, Tartu, Põlva, Võru, Viljandi and Pärnu. There are gas consumers in every county.

The main reason for the reduction of NMVOC emissions in 2022 compared to 1990 and to 2021 is a decrease in gas consumption over the same period (see Table 3.80, Table 3.83 and Figure 3.60).

Table 3.80 NMVOC emissions from gas distribution in the period of 1990-2022 (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
NMVOC	0.096	0.036	0.031	0.028	0.028	0.028	0.027	0.018	0.019	0.018	0.019
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
NMVOC	0.019	0.015	0.013	0.014	0.014	0.014	0.013	0.012	0.014	0,01	

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[7] Eesti Gaas. Annual Report 2006

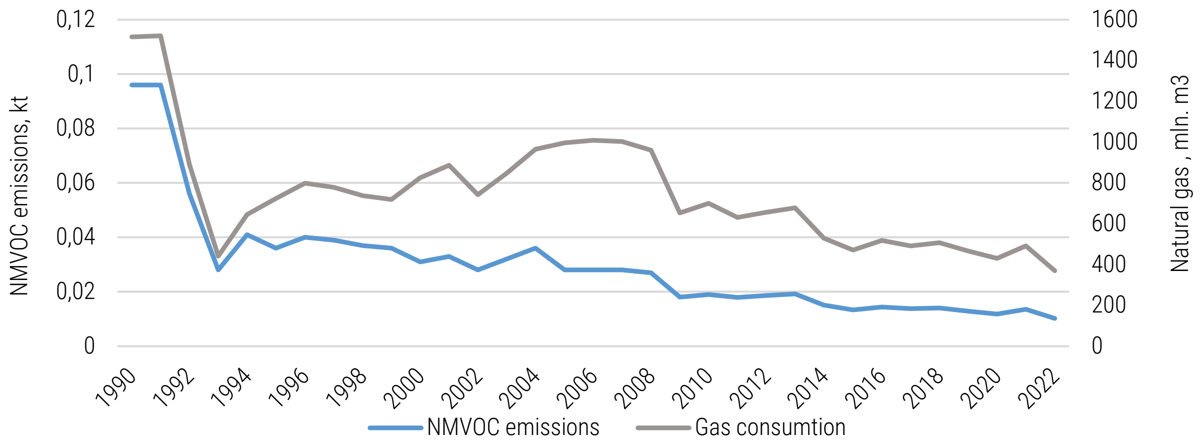


Figure 3.60 NMVOC emission from natural gas distribution in the period of 1990-2022

3.4.4.2. Methodological Issues

Emission factors

For NMVOC calculations from gas distribution the IPCC Guidelines for National Greenhouse Gas Inventories (2006) are used.

Tier 1 emission factors are used (Equation 1).

The activity rate for this sector is natural gas consumption. Unit: million m^3.

Emission factor unit: Gg per 10^6 of marketable gas/Utility sales.

The available default emission factors are presented below in Tables 3.81-3.82. While some types of fugitive emissions correlate poorly with, or are unrelated to, throughput on an individual source basis (e.g. fugitive equipment leaks), the correlations with throughput become more reasonable when large populations of sources are considered. Furthermore, throughput statistics are the most consistently available activity data for use in Tier 1 calculations.

Table 3.81 Tier 1 NMVOC emission factors for fugitive emissions (including venting and flaring) from gas operations

Category	Sub-category	Emission source	IPCC Code	Developed countries		Developing countries and countries with economies in transition		Units of measure
				Value	Uncertainty value (% of value)	Value	Uncertainty value (% of value)	
Gas transmission & Storage	Trans-mission	Fugitives	1.B.2.b	7.0E-06	+-100%	7.0E-06 to 1.6E-05	-40 to +250%	Gg per 10^6 m^3 of marketable gas
		Venting	1.B.2.b	4.6E-06	+-75%	4.6E-06 to 1.1E-05	-40 to +250%	Gg per 10^6 m^3 of marketable gas
Gas Distribution	All	All	1.B.2.b	1.6E-05	-20 to +500%	1.6E-05 to 3.6E-5	-20 to +500%	Gg per 10^6 m^3 of utility sales

Table 3.82 Tier 1 emission factors for fugitive emissions (including venting and flaring) from gas operations for different years

Category	Sub-category	Emission source	IPCC Code	1990	1995	2000	2005-2016	Units of measure
Gas transmission & Storage	Trans-mission	Fugitives	1.B.2.b	1.6E-05	1.3E-05	9.6E-06	7.0E-06	Gg per 10^6 m^3 of marketable gas
		Venting	1.B.2.b	1.1E-05	8.7E-06	6.4E-06	4.6E-06	Gg per 10^6 m^3 of marketable gas
Gas Distribution	All	All	1.B.2.b	3.6E-05	2.9E-05	2.2E-05	1.6E-05	Gg per 10^6 m^3 of utility sales
Total	-	-	-	6.3E-05	5.0E-05	3.8E-05	2.8E-05	Gg per 10^6 m^3 of utility sales

Return to the Table of Contents

The Estonian economy up to 2004 can be classified as an economy in transition. The emission factors are chosen accordingly. For the transition period from 1990 to 2004, the emission factor for countries with economies in transition is used. It is expected that the emissions have decreased equally within this period.

Activity data

Activity data on the subject of annual natural gas consumption are available from Statistics Estonia (see Table 3.83).

Table 3.83 Gas consumption in the period 1990-2022 (mln m^3)

1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
1,516	723	826	997	1,009	1,003	961	653	701	632	657
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
678	530	471	518	492	508	467	430	492	370	

3.4.4.3. Source-specific QA/QC and Verification

Statistical quality checking related to the assessment of emission, activity data and trends has been carried out.

3.4.4.4. Source-specific Planned Improvements

Not planned for the next submission.

3.4.5. Other fugitive emissions from solid fuels (NFR 1B1c)

3.4.5.1. Source Category Description

The sector contains data from oil shale mining enterprises, mainly emissions from blasting.

Currently, no more than 20 million tons of oil shale are allowed to be mined in Estonia annually. The largest amount of oil shale - 29.7 million tons - was mined in 1980; in 1990, 22.5 million tons was mined.

In 2022, three companies (Enefit Power, Viru Keemia Grupp and Kiviõli Keemiatööstus) produced a total of 10.7 million tonnes of oil shale, which was 16.2% more than in 2021. Compared to 1990, oil shale production has halved. Approximately 60% of oil shale is extracted by underground methods and 40% from quarries using open pit methods.

Since data from enterprises are available only from 2000, and for some substances only since 2008, this year emissions for the period from 1990 to 1999 were estimated based on data on oil shale mining and average emission factors calculated on the basis of data from enterprises of the last few years. The methodology is described in section 3.4.5.2.

Table 3.84 Pollutants emission from NFR 1B1c, kt

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
1990	0.11	NA	0.04	0.03	NR	NR	0.82	0.49
1995	0.06	NA	0.02	0.02	NR	NR	0.49	0.28
2000	0.07	NA	0.02	0.01	0.29	0.30	0.57	0.29
2005	0.09	NA	0.02	0.01	0.40	0.41	0.78	0.39
2010	0.11	NA	0.03	0.02	0.53	0.54	1.03	0.51
2015	0.15	NA	0.03	0.01	0.72	0.74	1.42	0.64
2016	0.14	NA	0.02	0.01	0.70	0.72	1.38	0.61
2017	0.17	NA	0.03	0.01	0.84	0.86	1.64	0.73
2018	0.17	NA	0.03	0.01	0.83	0.86	1.64	0.73
2019	0.12	NA	0.02	0.01	0.57	0.58	1.11	0.51
2020	0.07	NA	0.02	0.01	0.32	0.33	0.62	0.30
2021	0.07	NA	0.02	0.01	0.32	0.33	0.63	0.31
2022	0.10	NA	0.02	0.01	0.48	0.49	0.94	0.43
Change 1990-2022, %	-7.5		-51.1	-71.1			15.1	-12.6
Change 2021-2022, %	41.5		17.4	-6.1	48.4	48.2	48.2	39.6

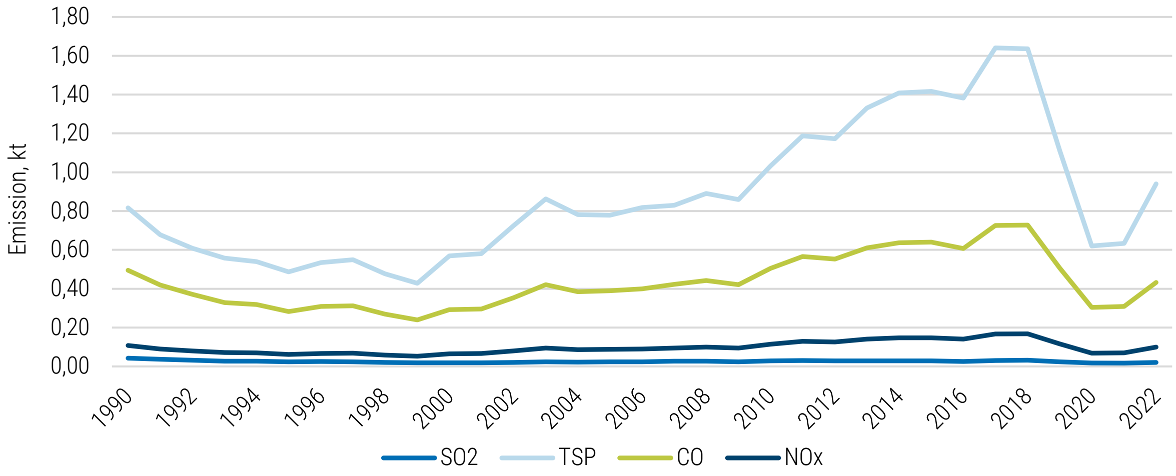


Figure 3.61 Pollutants emission from oil shale mining in the period of 1990-2022

3.4.5.2. Methodological Issues

Emission factors

The table 3.84 includes data from enterprises: for NO_x, SO_2, CO and NH_3 since 2008, TSP and CO since 2000. Data for earlier years starting from 1990 are calculated on the basis of average emission factors calculated on the basis of data on the facilities and shale mining statistics.

Since enterprises do not report fine particle emissions, the latter were calculated based on the percentage of TSP.

Last year, the first recalculation of emissions was made for the period from 1990 to 1999, using emission factors calculated based of enterprise data. This year a new recalculation was done, since one enterprise (Estonia Kaevandus, Enefit Power) provided data using a new methodology and the results were higher for the main substances, with the exception of ammonia, which is now not taken into account from blasting operations.

Thus, emissions from the Estonia Kaevandus are recalculated based on the emission factors and the amount of oil shale produced for this enterprise. From the remaining amount of oil shale mined, emissions are calculated based on emission factors from Viru Keemia Grupp.

Emission factors used in the calculations are presented in the tables 3.85 and 3.86.

Table 3.85 Average pollutants EF, kg/t of oil shale

	NO_x	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
Estonia Kaevandus	16.155	2.019		85.319	87.636	167.159	68.659
VKG Keemia Grupp	1.641	1.858	1.873	0.025	0.248	0.508	9.216

Table 3.86 $PM_{2.5}$ and PM_{10} EF, %TSP

$PM_{2.5}$	PM_{10}
5	49

Activity data

Data on oil shale production are presented in Table 3.87 (Source: Estonian Statistics).

Table 3.87 Oil shale mining, kt

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
22486	19612	17030	14262	14018	12102	13067	12860	10913	9602	9970	9894	10513	12608	11736	12349	11977
2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
13992	13706	12605	15109	15865	14944	15028	14959	14908	12691	15633	15944	12128	9195	9209	10707.5	

Return to the Table of Contents

Kunda Nordic Tsement (Source: www.knc.ee)

4.INDUSTRIAL PROCESSES AND PRODUCT USE (NFR 2)

Return to the Table of Contents

4.1. Industrial Processes

4.1.1. Source Category Description

In Estonia, the share of the industrial sector in the economy on the basis of value added is slightly smaller than the EU average (approximately 15%).

The volume of industrial production fell by several percent in 2022, influenced by the ongoing economic crisis and the war in Ukraine. The number of employed individuals continued to decline, but financially, the year ended with relatively good results.

The sector heavily relies on external markets, which account for over 60% of the product sales. Finland and Sweden are the main export markets, where the majority (over half) of the direct foreign investments in Estonian production are also directed. The overall picture across industrial sectors is heterogeneous.

The main activities in the industrial processes sector in Estonia include paper, wood processing, manufacturing and processing of mineral products, and food production. The share of the chemical industry has significantly declined. In recent years, the industry has undergone significant changes. The industrial sector's contribution to overall emissions is no longer as significant as before, mainly due to a decrease in production volume.

The Estonian inventory of air pollutants from industrial processes presently includes emissions from the chemical, pulp, paper, food, metal and mineral products industries, as listed in Table 4.1.

Table 4.1 Industrial processes reporting activities

NFR	Source	Description	Emissions reported
2A	Mineral Products		
2A1	Cement production	Includes emissions from cement production. Data reported by one operator.	TSP, PM_{10}, $PM_{2.5}$, BC
2A2	Lime production	Includes emissions from lime production. Data reported by one operator.	TSP, PM_{10}, $PM_{2.5}$, BC
2A3	Glass production	Includes particles emissions from one operator.	TSP, PM_{10}, $PM_{2.5}$, BC
2A5a	Quarrying and mining of minerals other than coal	Includes emissions from quarrying and mining of limestone and dolomite; from crushed stone production. Data reported by operators.	NO_x, SO_x, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO
2A5b	Construction and demolition	Includes emissions from construction and demolition, only diffuse sources	TSP, PM_{10}, $PM_{2.5}$
2A5c	Storage, handling and transport of mineral products	Includes emissions mainly bitumen asphalt, cement loading and other bulk product storage. Data reported by operators.	NMVOC, TSP, PM_{10}, $PM_{2.5}$
2B	Chemical industry		
2B10a	Other chemical industry	Includes emission from benzoic acid, sodium benzoate, plasticizers production; urea and formaldehyde production, explosives manufacturing. Data reported by operators.	NO_x, NMVOC, SO_x, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO
2B10b	Storage, handling and transport of chemical products	Includes emission from storage, handling and transport of chemical products. Data reported by operators.	NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC
2C	Metal Production		
2C1	Iron and steel production	Includes emission from Iron and steel production. Calculated on the basis of statistical data.	NO_x, NMVOC, SO_x, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/PCDF, PCB
2C3	Aluminium production	Includes emission from secondary aluminium production. Data reported by 1 operator.	NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, PCDD/PCDF, HCB

NFR		Source	Description	Emissions reported
	2C5	Lead production	Includes emission from lead battery and accumulators recycling plant. Data reported by operators.	SO_x, TSP, PM_{10}, $PM_{2.5}$, Pb, PCDD/PCDF, PCB
	2C6	Zinc production	Includes emission from zinc plating. Data reported by operators.	TSP, PM_{10}, $PM_{2.5}$, Zn, PCDD/PCDF, PCB
	2C7c	Other metal production	Includes emission from galvanizing and electroplating. Also from welding, plasma and gas cutting, metal surface cleaning and some other activities of metal production or mechanical treatment. Data reported by operators.	NO_x, NMVOC, SO_x, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cr, Cu, Ni, Zn
2D	Industry			
	2D3b	Road paving with asphalt	Includes emissions from road paving with asphalt, only diffuse sources.	NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC
2H	Pulp, paper and food industries			
	2H1	Pulp and paper	Includes emission from pulp, paper and chipboard production. Data reported by operators.	NO_x, NMVOC, SO_x, TSP, PM_{10}, $PM_{2.5}$, BC, CO
	2H2	Food and drink	Includes emission from the food and drink industry. Data reported by 17 operators, includes statistical data also.	NO_x, NMVOC, SO_x, TSP, PM_{10}, $PM_{2.5}$, CO
2I	2I	Wood processing	Includes emission from wood processing. Data reported by 83 operators.	NO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, CO
2L	2L	Other production, consumption, storage, transportation or handling of bulk products	Includes emission from storage and handling of peat, bulk, etc on the terminals. Refrigeration equipment also (NH_3). Data reported by operators.	NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO

The Industrial processes sector includes emissions from SNAP 04 activities. Emissions from combustion processes in manufacturing industry are included under NFR 1A2, which are the main sources of emissions from industrial sector.

Emissions data from the manufacturing industry are based on the facilities data (Tier 3 method). Emission calculations for NMVOC emissions from the food industry and for NMVOCs and particulates from road paving with asphalt are calculated as diffuse sources and are based on statistical data and emission factors from the EMEP/EEA Guidbook 2023 (Tier 2 and Tier 1methods) are used for these calculations. Particulates emissions from constructions and demolition are also calculated as diffuse sources (EMEP/EEA Guidebook 2023 Tier 1 method).

BC emissions from industry are calculated for the period 2000–2022.

The share of industrial sources in total emissions in 2022 was: NO_x - 0.3%, NMVOC - 3.7%, $PM_{2.5}$ - 6.1%, PM_{10} - 21.3% and TSP about 38.1%. The shares of other pollutants were not so significant. The emissions of NMVOC, NH_3 and NO_x decreased compared to 1990 by 93,7%, 89,2% and 62,4%, respectively. The main reason is that during the period of 1990–2022, the production of chemical products fell.

Compared to 2021, in 2022, emissions of PM_{10} and TSP decreased significantly, by almost one-third, 36% and 38% respectively. The reason for the decrease was attributed to a reduction in construction activity and changes in the methodology for calculating emissions during the dismantling of building structures.

The trend of NMVOC and PM emissions in industrial sector are given in Figure 4.1 and Figure 4.4. The distribution of NMVOC and PM_{10} emissions by sources of pollution inside of manufacturing industry sector in 2022 are shown in Figure 4.2 and Figure 4.3. The biggest polluter of NMVOC emissions were Pulp, paper and food industries – 82.2% (mainly food production), the chemistry industry is responsible for the 4% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (78%, mainly construction and demolition sector).

Table 4.2 Pollutant emissions from the industrial sector in the period of 1990-2022 (kt; heavy metals in t)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2,5}$	PM_{10}	TSP	BC	CO
	kt								
1990	0.191	15.341	0.000	0.667	NR	NR	8.275	NR	0.340
1995	0.070	4.379	0.000	0.291	NR	NR	2.160	NR	0.030
2000	0.201	2.082	0.042	0.134	0.357	1.393	3.981	0.005	0.534
2005	0.178	1.594	0.131	0.197	0.631	2.765	8.168	0.008	0.354
2010	0.037	0.871	0.030	0.072	0.450	2.523	7.762	0.004	0.462
2015	0.045	0.810	0.002	0.065	0.346	2.524	8.164	0.002	0.405
2016	0.045	0.770	0.001	0.071	0.302	2.154	6.986	0.001	0.378
2017	0.057	0.792	0.0002	0.082	0.370	2.149	6.828	0.002	0.451
2018	0.054	0.807	0.0002	0.097	0.341	2.393	7.774	0.001	0.553
2019	0.067	0.887	0.0002	0.089	0.296	2.101	6.816	0.001	0.630
2020	0.066	0.875	0.0003	0.079	0.400	2.931	9.524	0.001	0.631
2021	0.063	0.937	0.0004	0.102	0.403	3.022	9.885	0.001	0.650
2022	0.071	0.969	0.0003	0.072	0.298	1.917	6.077	0.001	0.677
Change 1990-2022, %	-62.5	-93.7	4.7	-89.1	12.9		-26.6		99.1
Change 2021-2022, %	13.8	3.5	-14.2	-28.8	-26.1	-36.6	-38.5	-6.0	4.1

Table 4.2 continues

Year	Pb	Cd	Cr	Cu	Ni	Zn	PCCD/F	HCB	PCB
	t						g I-Teq	kg	
1990	0.012	0.001	0.0005	0.000	0.003	0.019	0.014	IE	0.00006
1995	0.005	0.0004	0.0002	0.000	0.001	0.007	0.006	IE	0.00001
2000	0.037	0.0002	0.018	0.024	0.015	0.024	0.025	IE	0.00003
2005	0.009	0.0001	0.075	0.012	0.027	0.112	0.042	IE	0.00004
2010	0.015	0.0001	0.129	0.009	0.013	0.047	0.056	0.002	0.00005
2015	0.010	0.00001	0.069	0.003	0.021	0.182	0.031	0.002	0.00003
2016	0.011	0.00001	0.048	0.002	0.012	0.177	0.031	0.003	0.00003
2017	0.015	0.00002	0.037	0.006	0.023	0.175	0.032	0.002	0.00003
2018	0.009	0.00002	0.037	0.003	0.014	0.157	0.030	0.002	0.00003
2019	0.007	0.00002	0.029	0.006	0.013	0.150	0.030	0.001	0.00003
2020	0.006	0.00001	0.033	0.009	0.014	0.141	0.035	0.001	0.00003
2021	0.006	0.00001	0.024	0.012	0.010	0.143	0.031	0.002	0.00003
2022	0.005	0.00000	0.008	0.016	0.001	0.146	0.029	0.002	0.00003
Change 1990-2022, %	-63.3	-100.0	1 566.7	4 267.0	-63.2	683.6	103.1		-53.4
Change 2021-2022, %	-20.9	-100.0	-67.0	37.7	-88.2	2.2	-5.2	13.2	-5.1

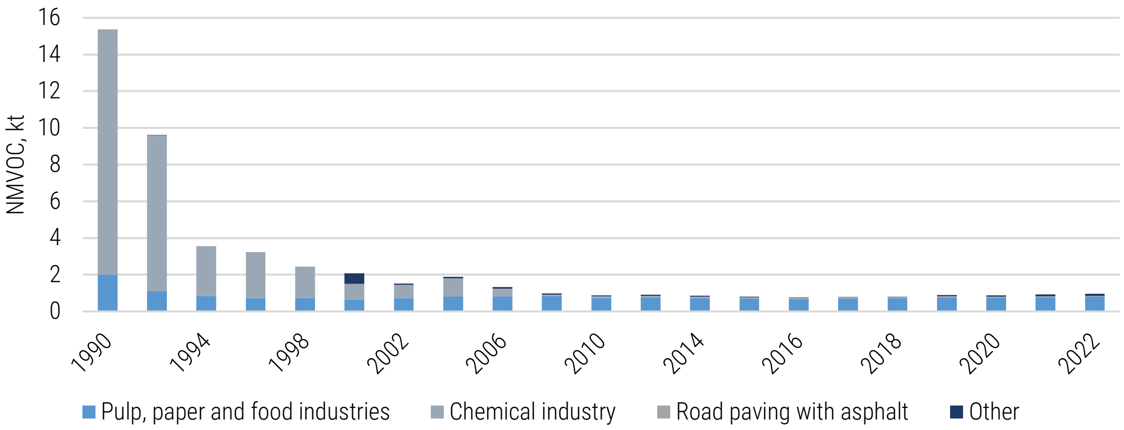


Figure 4.1 NMVOC emissions from the industrial sector in the period of 1990-2022

Return to the Table of Contents

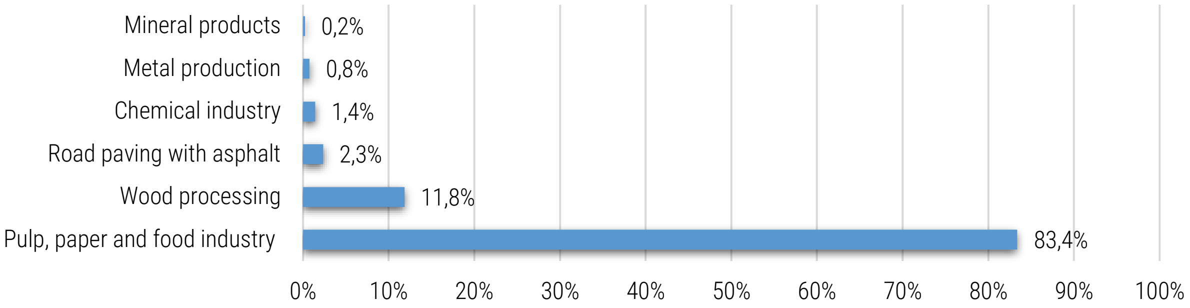


Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2022

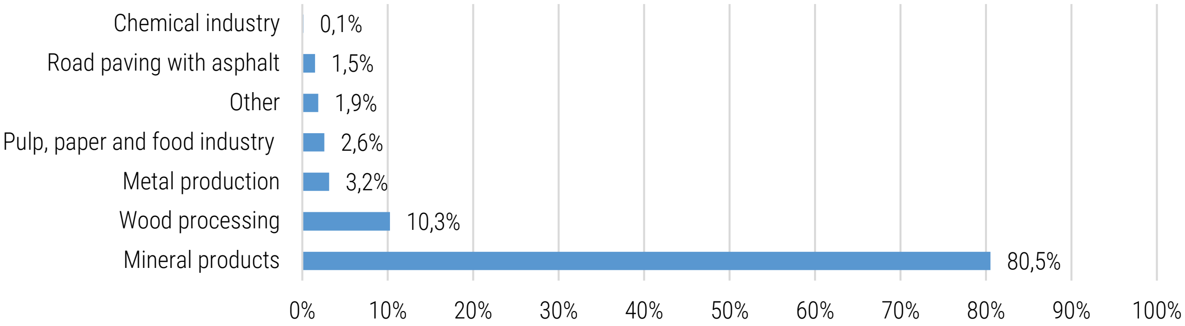


Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2022

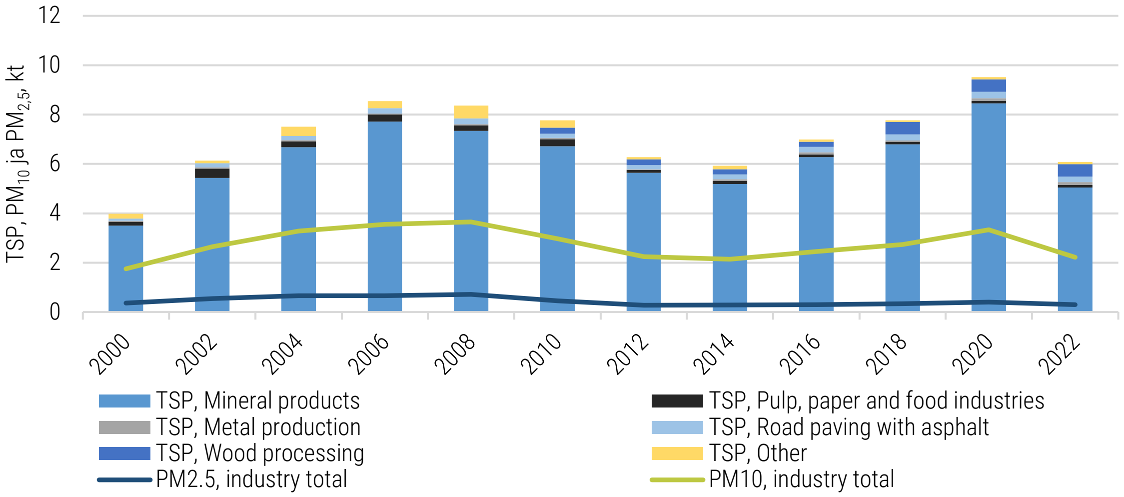


Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2022

4.1.2. Mineral Products (NFR 2A)

4.1.2.1. Source Category Description

This chapter includes activities data and emissions from the following processes:

- Cement production;
- Lime production;
- Limestone and dolomite use;
- Quarrying and mining of minerals other than coal;
- Construction and demolition;
- Storage, handling and transport of mineral products.

In Estonia, the only enterprise that produces cement was Heidelberg Materials Kunda AS (former Kunda Nordic Tsement AS). Cement was produced by the standard wet process. The production process was energy-intensive and produced large emissions of CO_2, SO_x, NO_x and dust. At the beginning of 2020, the production of clinker was stopped, which is now imported from Sweden. The factory continues its production of cement grinding and gravel.

There are two facilities for lime production, one of which presents an annual report on emissions (Nordkalk AS). The other company´s production volumes are very small. In Estonia, Nordkalk AS excavates Silurian dolomite from the Kurevere quarry. The chemical composition of this 400-million-year old dolomite makes it suitable for fertiliser and other industrial applications as well as for soil improvement.

Currently in Estonia, only one container glass manufacturing facility. Emissions of particlulates not related to fuel combustion are presented in NFR 2A3.

The quarrying and mining of minerals in Estonia include limestone and dolomite extraction as well as crushed stone production.

The Estonian construction sector has remained largely oriented on the domestic market and therefore developments in the construction market are closely related to general economic development. If the situation in the economy as a whole is good, the volumes and prices of construction grow quickly. Thus the economic situation in the country has a direct impact on economic results of the construction industry and the areas dependent thereon, such as construction consulting services, real estate services, construction materials industry, etc. There are approximately 10,000 construction companies operating in Estonia, 91% of whom are micro-enterprises with fewer than ten employees. The large share of micro-enterprises is characteristic to the construction sector in all of Europe, whereas the EU average rate is nearly 94%.

The TSP, PM_{10} and $PM_{2.5}$ emissions from mineral products decreased noticeably in 2022 compared to 2021 (see Table 4.3). The main source of BC emission was clinker production and the cessation of its production was the reason for the reduction of emissions.

The limestone blasting is a main source of NO_x, SO_x, ammonia and CO, but emissions are very insignificant. Emissions from combustion processes from mineral industry are reported in the Energy chapter.

Table 4.3 Pollutant emissions from mineral products in the period of 1990-2022 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	IE	IE	IE	NE	NR	NR	7.077	NR	IE
1995	IE	IE	IE	NE	NR	NR	1.599	NR	IE
2000	IE	0.570	IE	NE	0.163	1.077	3.500	0.0002	0.040
2005	0.010	0.080	IE	NE	0.334	2.274	7.414	0.0003	0.020
2010	0.006	0.000	0.000	NE	0.211	2.077	6.715	0.0001	0.005

Return to the Table of Contents

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2015	0.006	0.000	0.000	NE	0.226	2.269	7.437	0.00003	0.006
2016	0.006	0.001	0.000	NE	0.191	1.911	6.276	0.00004	0.006
2017	0.007	0.002	0.000	NE	0.180	1.804	5.920	0.00004	0.008
2018	0.006	0.002	0.000	NE	0.206	2.065	6.790	0.0001	0.007
2019	0.006	0.003	0.000	0.000	0.179	1.793	5.849	0.0001	0.008
2020	0.006	0.002	0.000	0.001	0.256	2.577	8.458	0.0001	0.010
2021	0.005	0.003	0.000	0.001	0.265	2.679	8.832	0.00013	0.013
2022	0.006	0.002	0.000	0.001	0.152	1.544	5.046	0.00009	0.013
Change 2005-2022, %		-44.8	-97.3			-54.4			
Change 2021-2022, %	5.5	-15.8	1.9	-26.8	-42.7	-42.4	-42.9	-26.9	-0.9

4.1.2.2. Methodological Issues

As was mentioned above (overview of the industrial sector), emissions data for most activities are based on data from facilities (Tier 3 method). The operator submits data concerning the facility as a whole, as well as separately on sources of emissions by SNAP codes. Basically, all emissions from the mineral industry are included in the combustion activity – NFR 1A2f, excluding fugitive emissions, emissions from construction and excavations and storage and handling activities. In recent years, the cement industry have not been the key source of pollution because very large efforts were made for the reduction of pollutant emissions as well as in connection with the cessation of clinker production in the spring of 2020. The emission of dust from Kunda Nordic Tsement during the period 1990-2009 was reduced by 99.7%.

The enterprise has been presenting data regarding heavy metal emissions since 2004 on the basis of measurements; therefore, emissions for the period 1990-2003 have been calculated on the basis of national emissions factors and clinker production data (see Table 4.4).

Table 4.4 Clinker production and heavy metal emission factors

Year	Clinker, thousand tonnes	Heavy metals EF, g/t of clinker					
		Pb	Cd	Hg	Cu	Ni	Zn
1990	790.0	78.125	4.060	0.088	2.687	0.313	18.000
1991	773.0	78.125	4.060	0.088	2.687	0.313	18.000
1992	517.0	78.125	4.060	0.088	2.687	0.313	18.000
1993	378.0	78.125	4.060	0.088	2.687	0.313	18.000
1994	540.0	78.125	4.060	0.088	2.687	0.313	18.000
1995	571.0	43.750	2.275	0.049	1.505	0.175	10.080
1996	590.0	12.500	0.650	0.014	0.430	0.050	2.880
1997	651.0	0.780	0.040	0.004	0.030	0.003	0.180
1998	659.0	0.780	0.040	0.004	0.030	0.003	0.180
1999	590.0	0.780	0.040	0.004	0.030	0.003	0.180
2000	620.0	0.780	0.040	0.004	0.030	0.003	0.180
2001	629.0	0.780	0.040	0.004	0.030	0.003	0.180
2002	590.0	0.780	0.040	0.004	0.030	0.003	0.180
2003	560.0	0.780	0.040	0.004	0.030	0.003	0.180

The dioxin emissions from the mineral industry (cement, lime and brick) have been calculated on the basis of productions and the UNEP "Standardized Toolkit for Identification of Dioxin and Furan Releases" emissions factors. For cement production, Toolkit EF was used from 1990 to 1996, and from 1997 to 2010 calculations were carried out on the basis of results from the "Dioxin in Candidate Countries" project, in which frameworks for the measurements of dioxins from technological equipment have been implemented (see Table 4.5). Now, Kunda Nordic is obliged to carry out measurements twice a year and report on dioxin emissions. It must be noted that the measured dioxin emissions are much less than the emissions calculated on the basis of the emissions factor.

Table 4.5 Dioxins emission factors for the mineral industry

Year	Cement			Lime			Bricks and tiles		
	Production, thousand tonnes	EF, µg I-TEQ/t	Emission, g	Production, thousand tonnes	EF, µg I-TEQ/t	Emission, g	Production, thousand tonnes	EF, µg I-TEQ/t	Emission, g
1990	938.000	0.6	0.563	185.000	0.07	0.0130	541.401	0.2	0.108
1995	417.600	0.6	0.251	16.800	0.07	0.0010	81.343	0.2	0.016
2000	329.100	0.07	0.023	21.200	0.07	0.0010	45.072	0.2	0.009
2005	726.000	0.07	0.051	37.200	0.07	0.0020	69.342	0.2	0.014
2010	536.700	0.07	0.037	27.200	0.07	0.0019	56.500	0.2	0.011
2015	356.287	0.036	0.013	43.018	0.07	0.0030	61.341	0.2	0.012
2016	422.800	0.0175	0.0074	42.084	0.07	0.0029	54.407	0.2	0.011
2017	503.000	0.323	0.1625	69.324	0.07	0.00485	54.94	0.2	0.011
2018	527.000	0.238	0.125	53.714	0.07	0.0038	49.870	0.2	0.010
2019	405.700	0.345	0.140	45.728	0.07	0.003	68.542	0.2	0.014
2020	253.360	0.201	0.007	26.955	0.07	0,0019	50.406	0.2	0.001
2021				39.713	0.07	0.0028	65.875	0.2	0.013
2022				32.010	0.07	0.0022	65.875	0.2	0.013

Emissions from blasting are calculated and reported by blasting operators. The methodology approved by the Ministry of the Environment (since July 1, 2023 Ministry of Climate) is used to calculate emissions. It is important to mention that in addition to the PM emissions specified in Guidebook 2023, the use of the reported explosives also produces NH_3, NO_x and SO_x emissions. Despite the fact that they emissions are very small low, they are shown under NFR 2A5a with TSP, $PM_{2,5}$ and PM_{10} emissions.

Emission calculations from construction and demolition (2A5b) sectors are based on new residential and non-residential building starts, as well as renovated or expanded areas, particulate emissions from road construction are also calculated.

The handling of bitumen, as well as the handling and storage of bulk materials, necessary and technologically related to the production of asphalt are all presented together under NFR 2A5c. Considering that operators calculate and report not only particulate matter emissions but also NMVOC emissions in their reports, we also present them together with particulate matter emissions under NFR 2A5c.

Emissions from other activities related to the processing, storage and use of bulk materials, such as bulk materials handling in ports, are presented in sector 2L.

This year, construction calculations were made based on data on new residential and non-residential buildings put into operation, as well as reconstructed or expanded areas. Additionally, emissions of particulate matter are calculated from road construction. The activity data is given in the „Activity"section. The construction sector is currently one of the key sources of particulate matter emissions (Figure 4.5).

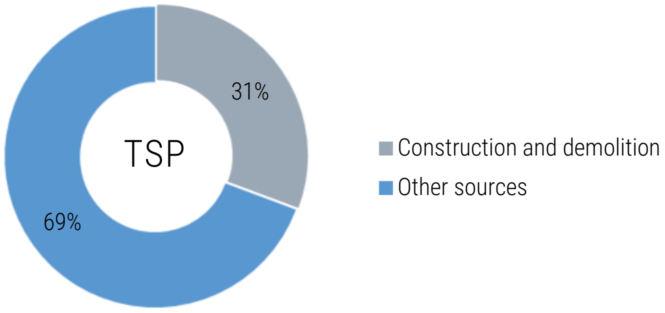


Figure 4.5 The share of construction and demolition sector in total TSP emissions in 2022

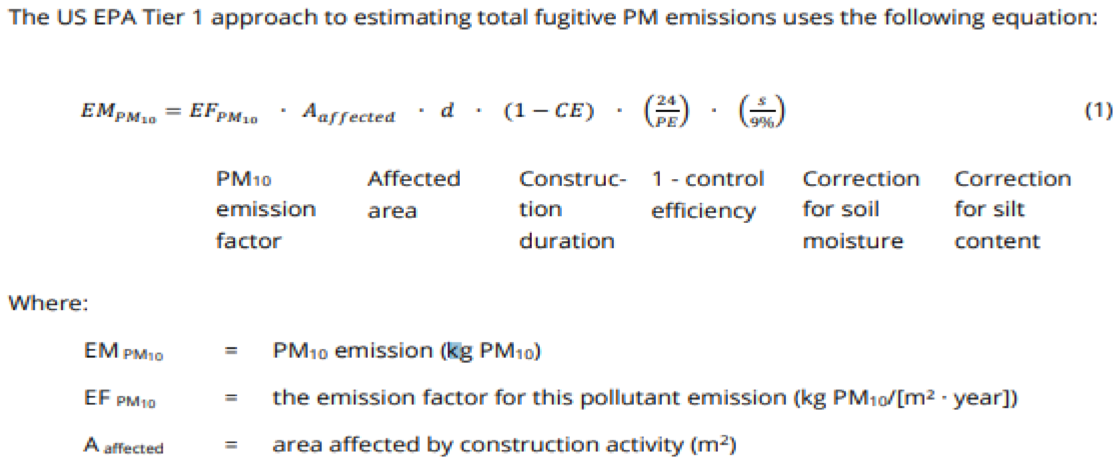
Emission calculations from construction and demolition (2A5b) sectors are based on the Tier 1 method from the EMEP/EEA Guidebook 2023. The Tier 1 method uses readily available statistical data and default emission factors (see Table 4.6).

Table 4.6 PM emission factors for construction and demolition, NFR 2A5b

NFR	Unit	$PM_{2.5}$	PM_{10}	TSP
Construction and demolition of houses	kg/m²/year	0.0086	0.086	0.29
Construction and demolition of apartment buildings	kg/m²/year	0.03	0.3	1
Non-residential construction and demolition	kg/m²/year	0.1	1	3.3
Construction and demolition – Road construction	kg/m²/year	0.23	2.3	7.7

It should be noted that in the previous submission, calculations of emissions from the construction of buildings were incorrect, since they did not take into account correction factors such as duration of construction, efficiency of emission control measures, precipitation-evaporation index and soil silt content, which take into account national characteristics and which affect the calculation results.

Below is the calculation formula and correction factors for Estonia.



The US EPA Tier 1 approach to estimating total fugitive PM emissions uses the following equation:

$$EM_{PM_{10}} = EF_{PM_{10}} \cdot A_{affected} \cdot d \cdot (1 - CE) \cdot \left(\frac{24}{PE}\right) \cdot \left(\frac{s}{9\%}\right) \qquad (1)$$

PM10 emission factor

Affected area

Construction duration

1 - control efficiency

Correction for soil moisture

Correction for silt content

Where:

$EM_{PM_{10}}$ = PM_{10} emission (kg PM_{10})

$EF_{PM_{10}}$ = the emission factor for this pollutant emission (kg PM_{10}/[m² · year])

$A_{affected}$ = area affected by construction activity (m²)

d = duration of construction (year)

CE = efficiency of emission control measures

PE = 128, Thornthwaite precipitation-evaporation index

S = 20%, soil silt content

	House	Apartment	Non-residential housing	Road	Railway
d	0.5	0.75	0.83	1	0.75
CE	0	0	0.5	0.5	0.5

The Transport Administration agrees with the duration of construction default value (1 year). Since the construction/reconstruction of railway tracks is carried out only in the period from April to December, in this case the coefficient d is taken equal to 0.75.

4.1.2.3. Activity Data

Information regarding completed dwelling (houses and apartments) and non-residential buildings, new construction and demolition for the years 2000-2022 is available from Statistics Estonia (www.stat.ee). Data on the years 1994-2001 were obtained from the Statistical Yearbooks 1994-2001. Data on permits for the period from 1990 to 1993 for dwelling construction are an expert judgement and have been calculated by using of surrogate data. The same way was used to get data for non-residential construction permits for

1990-1995. Data regarding demolition permits are available in the statistical database only since 2003. The data for the period 1990-2002 have been calculated also by using of surrogate data (see Table 4.7).

Data about road construction were obtained from Transport Administration, railway construction from Estonian Railways Ltd.

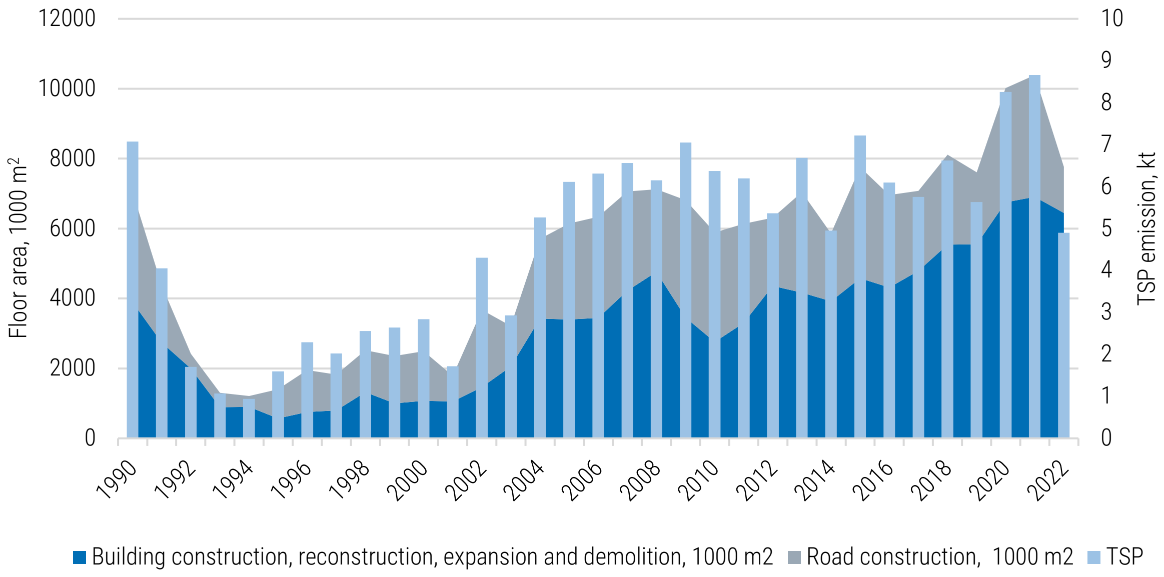


Figure 4.6 The completed dwelling and non-residential building, new construction and demolition and TSP emission in the period of 1990-2022

Table 4.7 Activity data for PM emission calculations from the construction sector in the period of 1990-2022 (1000 m^2 floor area)

Year	Completed dwellings (houses), new construction, reconstruction, expansion and demolition, 1000 m2	Completed dwellings (apartments), new construction, reconstruction, expansion and demolition, 1000 m2	Completed non-residential building, new construction, reconstruction, expansion and demolition, 1000 m2	Construction and reconstruction of paved and gravel roads, bridges	Railway construction and reconstruction
1990	80.6	562.5	3 252.6	3 135.0	9.5
1995	85.7	58.2	427.7	822.8	9.5
2000	65.5	45.0	959.7	1 406.3	15.6
2005	212.2	398.3	2 783.8	2 689.0	61.1
2010	194.2	224.7	2 334.9	2 970.8	159.8
2015	358.7	1 137.5	3 082.3	3 134.9	46.4
2016	422.2	1 306.9	2 589.4	2 527.5	110.6
2017	469.1	1 449.6	2 870.5	2 182.0	112.1
2018	474.7	1 547.7	3 516.0	2 501.1	78.7
2019	584.2	1 834.2	3 128.0	1 878.0	188.4
2020	671.9	1 781.6	4 298.6	3 170.0	98.4
2021	608.4	2 111.5	4 189.1	3 454.0	27.6
2022	609.1	2 089.6	3 750.1	1 215.0	101.2

4.1.3. Chemical Industry (NFR 2B)

4.1.3.1. Source Category Description

The unique part of the Estonian chemical industry is the oil shale-based industry; however, the majority of the sector is formed by other subsectors such as construction or consumer chemical industry. The smallest subsector (with a few hundred employees) is the pharmaceutical industry.

There are over a hundred companies operating in the Estonian chemical industry. About a half of the chemical industry is located in Ida-Virumaa, a third of the employees are in Tallinn and Harjumaa. The largest companies of the chemical industry are VKG Oil AS and KIVIÕLI KEEMIATÖÖSTUSE OÜ (manufacture of shale oil, Enefit Power AS is also involved in manufacturing oil on the side of energy production), Akzo Nobel Baltics AS, AS Tikkurila and AS Eskaro (paints and varnishes), NPM Silmet OÜ (rare metals), OÜ EUROBIO LAB (manufacture of cosmetics), AS Novotrade Invest (reprocessing of oil products), OÜ Krimelte and Henkel Balti Operations OÜ (assembly foams), Eastman Specialties OÜ (benzoic acid, sodium benzoate, plasticizers).

Large investments in the oil industry are creating new jobs, but the industry is highly dependent on world oil prices, climate policy, and recently the war in Ukraine and associated economic sanctions and restrictions, so it is difficult to assess whether plans for construction of new processing plants.

Estonia's only producer of fertiliser, Nitrofert AS, halted operations since 2014.

The share of NMVOC emissions from the chemical industry in the total country emissions amounted to approximately 21% in 1990 and only 0,1% in 2022 (see Figure 4.7). The main reason for this is the decrease in the manufacturing of chemical production at shale oil enterprises.

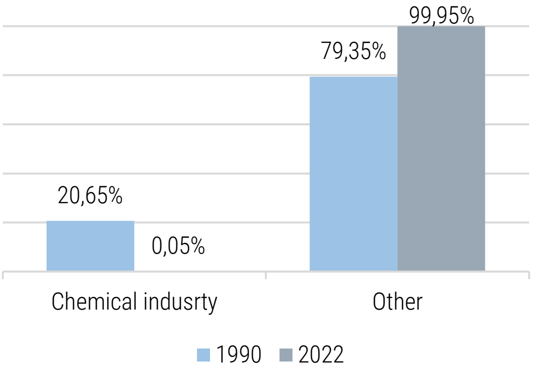


Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2022

Table 4.8 Emissions from the chemical industry in the period of 1990-2022 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.190	13.305	NA	0.370	NR	NR	0.9400	NR	0.340
1995	0.070	3.532	NA	0.140	NR	NR	0.4900	NR	0.030
2000	0.189	0.845	NA	0.044	0.0892	0.1626	0.1900	0.0026	0.340
2005	0.156	0.716	NA	0.132	0.1462	0.2661	0.3100	0.0044	0.300
2010	0.000	0.071	0.000	0.010	0.0046	0.0138	0.0417	0.0001	0.405
2015	0.000	0.046	0.000	0.007	0.0008	0.0023	0.0070	0.0001	0.353
2016	0.000	0.054	0.000	0.007	0.0010	0.0033	0.0091	0.0000	0.328
2017	0.000	0.041	NO	0.007	0.0009	0.0032	0.0082	0.0000	0.420
2018	NO	0.037	NO	0.014	0.0007	0.0021	0.0063	0.0000	0.514
2019	NO	0.034	NO	0.017	0.0008	0.0025	0.0075	0.0000	0.588
2020	NO	0.033	NO	0.016	0.0010	0.0031	0.0095	0.0000	0.573
2021	NO	0.037	NO	0.016	0.0011	0.0033	0.0095	0.00002	0.582

Year	NO_X	NMVOC	SO_X	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2022	NO	0.014	NO	0.004	0.0014	0.0026	0.0088	0.00003	0.606
Change 1990-2022, %		-99.9		-98.8			-99.1		78.3
Change 2021-2022, %			-62.6		-72.8	31.9	-20.0	-7.2	31.8

During 1990-2022 emissions of all substances were reduced considerably, except carbon monoxide emission. The main source of CO, particulates and NMVOC emissions is facility for benzoic acid, sodium benzoate, plasticizers production and also storage in shale oil industry. The main sources in 2B sector NH_3 is bitumen emulsion and ammonia storage in terminals.

4.1.3.2. Methodological Issues

All the largest facilities as well as the facilities in which emissions exceed thresholds established by the decision of the Minister of the Environment (since July 1, 2023 Ministry of Climate) are obliged to deliver annual reports on emissions. Therefore, all the data pertaining to emissions presented to this section are based on the data of the enterprises (Tier 3 method). Emissions data are based on measurements or calculation methods. For some enterprises, such as oil shale chemistry, part of the emissions is included in the energy sector (SNAP 010406 and 010407 – coke furnaces and coal gasification or liquefaction). BC emission have been calculated on the base EMEP/EEA Guidebook 2013 emission factors.

SO_2 emissions were reported until 2017 only by the enterprise producing explosive materials. Since 2017, the production technology has been changed and the company has justified that after the change in technology and the introduction of measures to reduce emissions, emissions of substances do not exceed the threshold values that require an emission permit and accordingly, reporting. The technological process of the production of emulsion explosives takes place in a closed cycle isolated from the air of the workplace, therefore the release of pollutants into the air of the production room from the technological tanks is minimal. This has been demonstrated by calculation and monitoring results. Also, air quality limit or target values are not exceeded outside the production area of the installation. The total NMVOC emissions from admission to storage tanks and from the technological process are about 0.038 t. The total ammonia emissions from the ventilation system are about 0.024 t. The maximum particulate emission from the technological process is 0.021 t. Fugitive emissions from the testing explosive cartridges into the ambient air (CO, NH_3, H_2S, SO_2) are significantly lower than the threshold emissions values, from which the ambient air pollution permit is required. Based on this, the Environmental Board decided that the operator may not submit reports on emissions into the air starting from 2017. In connection with the above, data on SO_2 and other substances from this enterprise are not reflected in the NFR tables.

4.1.4. Metal Production (NFR 2C)

4.1.4.1. Source Category Description

The metal industry is involved in several areas, such as secondary metal production, manufacture and construction of machinery and equipment and various metal mechanical treatment. Metal industry companies employ more than 14.000 people in Estonia, thus being one of the largest industry after the wood industry and next to the food industry. The branch has more than 1.400 companies. The metal industry is concentrated in Tallinn and its vicinity (60% of the workforce) and in Ida-Viru, Pärnu and Tartu county (approximately one tenth of the workforce).

Emissions from the metal industry are presented in Table 4.9. The share of this sector in total Estonian emission is insignificant. The main sources of ammonia emission is rare-earth metals factory in Sillamäe.

Table 4.9 Emissions from the metal production sector in the period of 1990-2022 (kt, heavy metals in t)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.001	0.000	0.000	0.160	NR	NR	0.001	NR	0.00001
1995	0.000	0.000	0.000	0.100	NR	NR	0.000	NR	0.00000
2000	0.003	0.002	0.008	0.050	0.019	0.024	0.040	0.00007	0.014
2005	0.012	0.001	0.011	0.056	0.023	0.030	0.050	0.00008	0.014
2010	0.013	0.0002	0.006	0.052	0.020	0.027	0.044	0.00009	0.009
2015	0.023	0.0001	0.008	0.058	0.027	0.035	0.058	0.00011	0.027
2016	0.025	0.0001	0.010	0.051	0.040	0.053	0.088	0.00025	0.026
2017	0.033	0.0001	0.013	0.066	0.124	0.160	0.268	0.00075	0.011
2018	0.046	0.0001	0.007	0.074	0.028	0.036	0.060	0.00010	0.015
2019	0.060	0.0001	0.017	0.067	0.022	0.028	0.048	0.00008	0.017
2020	0.058	0.0001	0.008	0.057	0.044	0.058	0.097	0.00017	0.019
2021	0.055	0.0001	0.008	0.079	0.039	0.053	0.103	0.00014	0.018
2022	0.064	0.0001	0.007	0.061	0.039	0.060	0.126	0.00016	0.021
Change 2005-2022, %	423.1	-91.7	-31.5	9.15	67.88				
Change 2021-2022, %	15.6	-53.3	-9.2	-23.0	0.5	14.4	22.9	11.3	16.2

Table 4.9 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
				t				
1990	0.012	0.001	0.0002	0.0001	0.0005	0.0004	0.003	0.019
1995	0.005	0.000	0.0001	0.0000	0.0002	0.0001	0.001	0.007
2000	0.037	0.00022	0.0001	0.00002	0.018	0.014	0.015	0.024
2005	0.009	0.00008	0.0000	0.00001	0.075	0.012	0.027	0.112
2010	0.015	0.00006	0.00002	0.00001	0.129	0.009	0.013	0.047
2015	0.010	0.00001	0.000003	0.000001	0.069	0.003	0.021	0.182
2016	0.011	0.00001	0.000003	0.000001	0.048	0.002	0.012	0.177
2017	0.015	0.00002	0.0000	0.00000	0.037	0.006	0.023	0.175
2018	0.009	0.00002	0.0000	0.00000	0.037	0.003	0.014	0.157
2019	0.007	0.00002	0.0000	0.00000	0.029	0.006	0.013	0.150
2020	0.006	0.00001	0.0000	0.00000	0.033	0.009	0.014	0.141
2021	0.006	0.00001	0.0000	0.00000	0.024	0.012	0.010	0.143
2022	0.005	0.000	0.000	0.000	0.008	0.016	0.001	0.146
Change 2005-2022, %								
Change 2021-2022, %	-20.9	-100.0	-96.7	-100.0	-67.0	37.7	-88.2	2.2

Table 4.9 continues

Year	PCCD/F	HCB	PCB
	g I-Teq	kg	
1990	0.014	NE	0.00006
1995	0.006	NE	0.00001
2000	0.025	NE	0.00003
2005	0.042	NE	0.00004
2010	0.056	0.002	0.00005
2015	0.031	0.002	0.00003
2016	0.031	0.003	0.00003
2017	0.032	0.002	0.00003
2018	0.030	0.002	0.00003
2019	0.030	0.001	0.00003
2020	0.035	0.001	0.00003
2021	0.031	0.002	0.00003
2022	0.029	0.002	0.00003
Change 2005-2022, %			
Change 2021-2022, %	-5.2	13.2	-5.1

Emissions data presented in the table are data mainly provided by enterprises, excluding POPs, which are additionally calculated for secondary aluminium, zinc and lead production on the basis of activities data provided by operators and Guidebook 2023 emission factors.

The NFR 2C1 includes emissions from Iron and steel processing and are calculated based on statistical data for metals production and Guidebook 2023 emission factors.
The NFR 2C3 includes data from secondary aluminium production, 2C6 – from secondary zinc production and plating.

The NFR 2C5 includes emission from lead battery and accumulators recycling.

The NFR 2C7c includes mainly emissions from welding, plasma and gas cutting, metal surface cleaning and some other activities of metal production or mechanical treatment.

4.1.4.2. Methodological Issues

All the largest facilities as well as the facilities in which emissions exceed thresholds established by the decision of the Minister of the Environment (since July 1, 2023 Ministry of Climate) are obliged to deliver annual reports on emissions. Therefore, mainly all the data pertaining to emissions presented to this section are based on the data of the enterprises (Tier 3 method). Emissions data are based on measurements or calculation methods. Only for the sector NFR 2C1 emissions for all substances were calculated on the base of statistical data for metals production and Tier 2 Guidebook 2023 emission factors. The emissions from welding, plasma and gas cutting, metal surface cleaning and some other activities of metal production or mechanical treatment are presented in NFR 2C7c. Activity data for the sector 2C1 are presented in the Table 4.10 and emission factors used for calculation in the Table 4.11. Since production data for the periood 1991-1994 are not available, they have been obtained by interpolation.

Table 4.10 Secondary steel and iron production in the period of 1990-2022 (kt)

Year	Iron casting	Steel casting
1990	18.100	4.800
1995	3.300	1.900
2000	3.800	1.100
2005	2.600	0.400
2010	1.000	0.300
2015	0.448	0.051
2016	0.299	0.059
2017	0.000	0.081
2018	0.400	0.088
2019	1.139	0.097
2020	0.979	0.064
2021	1.049	0.056
2022	1.034	0.00

Table 4.11 Pollutant EF for sector 2C1

Pollutant	Unit	Secondary steel production Tier 2, Electric furnace steel plant Table 3-15	Secondary iron production Tier 2 Table 3-8
NOx	g/Mg steel/pig iron	130	
CO	g/Mg steel/pig iron	1.7	
NMVOC	g/Mg steel/pig iron	46	
SO2	g/Mg steel/pig iron	60	
TSP	g/Mg steel/pig iron	30	50
PM10	g/Mg steel/pig iron	24	40
PM2.5	g/Mg steel/pig iron	21	25
BC	% of $PM_{2.5}$	0.36	2.4
Pb	g/Mg steel/pig iron	2.6	0.0006
Cd	g/Mg steel/pig iron	0.2	
Hg	g/Mg steel/pig iron	0.05	0.0001
As	g/Mg steel/pig iron	0.015	

Return to the Table of Contents

Pollutant	Unit	Secondary steel production Tier 2, Electric furnace steel plant	Secondary iron production Tier 2
Cr	g/Mg steel/pig iron	0.1	0.0003
Cu	g/Mg steel/pig iron	0.02	0.015
Ni	g/Mg steel/pig iron	0.7	
Zn	g/Mg steel/pig iron	3.6	0.073
PCDD	µg I-TEQ/Mg steel/pig iron	3	0.002
PCB	mg/Mg steel/pig iron	2.5	2.5

BC emission have been calculated on the base EMEP/EEA Guidebook 2023 emission factors.

Emissions of POPs are additionally calculated for secondary aluminium, zinc and lead production on the basis of activities data provided by operators and Guidebook 2023 emission factors (see Table 4.12).

Table 4.12 POPs EF for metal production

Pollutant	Unit	EF
PCCD/F	µg I-TEQ/Mg aluminium	35.0
HCB	g/Mg aluminium	5.0
PCCD/F	µg/Mg lead	3.2
PCB	µg/Mg lead	2.6
PCCD/F	µg I-TEQ/Mg zinc	5.0
PCB	µg/Mg zinc	3.6
PCCD/F	µg I-TEQ/Mg zinc	5.0

In NFR 2C3 only one operator involved in aluminum production and processing since 2017. The operator calculates and presents the report of all emissions associated with casting and secondary processing of aluminum, except for HCB and PCDB/PCDF, these are calculate on the base EMEP/EEA Guidebook 2023 emission factors for NFR 2C3. Reduction of emissions from 2017 due to the fact that now only one operator is connected to NFR 2C3 and thus the emissions of TSP particles, $PM_{2.5}$ and PM_{10} changed. The TSP, $PM_{2,5}$ ja PM_{10} emissions shown here are emitted only from aluminum production and processing processes (040301). Thanks to this, PM, PM $_{2.5}$ and PM_{10} also decreased.

4.1.5. Road Paving with Asphalt (NFR 2D3b)

4.1.5.1. Source Category Description

Emission calculations from road paving with asphalt (NFR 2D3b) sectors are based on the Tier 1 method from the EMEP/EEA Guidebook 2023. Emissions from the road paving with asphalt are presented in Table 4.13 and Figure 4.8.

Table 4.13 Emissions from the road paving with asphalt in the period of 1990-2022 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
1990	0.02700	NR	NR	0.25665	NR
1995	0.00800	NR	NR	0.07125	NR
2000	0.0110	0.0007	0.0133	0.1001	0.00004
2005	0.0190	0.0012	0.0233	0.1746	0.00007
2010	0.0180	0.0011	0.0224	0.1677	0.00006
2015	0.0232	0.0015	0.0291	0.2180	0.00008
2016	0.0232	0.0015	0.0291	0.2179	0.00008
2017	0.0264	0.0017	0.0330	0.2477	0.00009
2018	0.0253	0.0016	0.0316	0.2368	0.00009
2019	0.0260	0.0016	0.0325	0.2441	0.00009
2020	0.0274	0.0017	0.0343	0.2573	0.00010
2021	0.0271	0.0017	0.0339	0.2545	0.00010
2022	0.0227	0.0014	0.0284	0.2130	0.00008
Change 2005-2022, %	19.6	22.4			
Change 2021-2022, %	-16.3	-16.3	-16.3	-16.3	-16.5

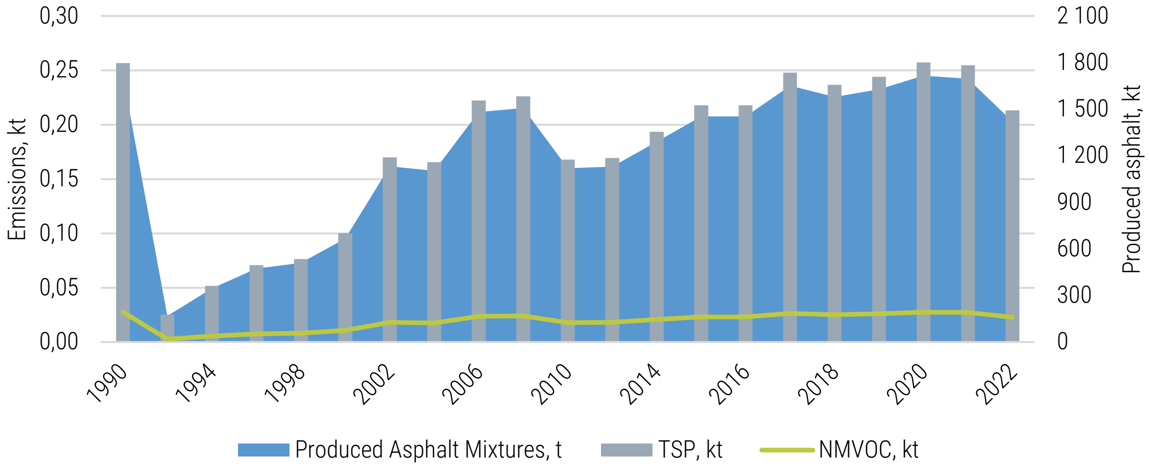


Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production in the period of 1990-2022

4.1.5.2. Methodological Issues

The default emission factors for road paving with asphalt are constructed based on an assessment of the available emission factors from a detailed review of the hot mix industry (US EPA, 2004). The emission factor represents an average between the batch mix and the drum mix hot mix asphalt plants. Emissions are calculated using asphalt production data obtained from the Estonian Asphalt Pavement Association (www. Asfaldiliit.ee) and default emission factors (see Table 4.14).

Return to the Table of Contents

Table 4.14 NMVOC emission factors for road paving with asphalt and PM emission factors for construction and demolition

NFR	Unit	NMVOC	PM_{10}	$PM_{2.5}$	BC	TSP
2D3b Road paving with asphalt	g/Mg asphalt	16	2 000	100	5.7 % of $PM_{2.5}$	15000

4.1.5.3. Activity Data

Information regarding asphalt production and laying is available from the Estonian Asphalt Pavement Association (www.asfaldiliit.ee) for the years 1990-2022 (see Table 4.15). According to the Asphalt Pavement Association, all production companies but not all asphalt laying companies are members of the association. The value of the asphalt produced is higher than the quantity of laid asphalt. For that reason, asphalt production values are used for emission calculations from road paving with asphalt.

Table 4.15 Activity data for NMVOC emission calculations from asphalt production in the period of 1990-2022 (t)

Year	Produced Asphalt Mixtures
1990	1,711.000
1995	475.000
2000	667.000
2005	1,164.000
2010	1,118.187
2015	1,453.025
2016	1,452.025
2017	1,651.228
2018	1,578.371
2019	1,627.448
2020	1,715.151
2021	1,696.543
2022	1,420.305

4.1.6. Pulp, Paper and Food Industry (NFR 2H)

4.1.6.1. Source Category Description

This chapter includes the pollutant emissions from pulp and paper, food and drink, wood and furniture industries.

The pulp and paper industry in Estonia has a long tradition, having been established as far back as the 17th century. The high level of automation and modern technology has made the production of pulp one of the highest productivity sectors in Estonia. There are about 60 companies in Estonia that manufacture paper, pulp or paper products. The sector's main players in Estonia are two companies: pulp producer AS Estonian Cell and the paper and cardboard producer Horizon Tselluloosi ja Paberi AS. Together they provide more than two-thirds of the sector's sales revenue.

In recent years, both of the largest companies in the sector have implemented large-scale investment programmes and started using more renewable energy.

The paper industry is a heavily concentrated industry in Estonia. Horizon Tselluloosi ja Paberi AS is the largest paper and cardboard producer. Horizon Tselluloosi ja Paberi AS produces a wide range of high-quality paper products for the packaging industry. The product range is completely based on 100% virgin long fibre softwood pulp – the raw material that has brought Nordic sack craft qualities to the fore globally.

Return to the Table of Contents

Horizon Tselluloosi ja Paberi AS manufactures only unbleached varieties. Estonian Cell AS, an aspen pulp factory in Kunda (established in 2006), is the largest pulp producer.

The wood industry is one of largest industries. Wood is one of the most important natural resources in Estonia besides oil shale and makes a significant contribution to the balancing of foreign trade.

More than one thousand companies are operating in wood processing and manufacture of wood products. The larger companies in the sector have modern technology and are highly competitive in domestic and foreign markets. Timber industry has a wide range of products, from the manufacture and processing of lumber to the manufacture of wooden houses, windows and doors. Furniture industry has also long traditions in Estonia. The larger companies of furniture industry in terms of the number of employees are located mainly in North and South Estonia.

The food industry is one of the largest ones in Estonia in terms of production volume and it is the main activity of more than 700 companies.

The food industry consists of two major sectors: food and beverage production. The emissions from sector NFR 2H are presented in Table 4.16. The main source of NMVOC emissions is the food industry and the small decrease in emissions between 1990 and 2022 was due to small decrease in production volumes in this sector. There were no significant changes in production in the pulp and food industries in 2022, so emissions in the NFR 2H in 2022 did not change noticeably and remained at the 2021 level.

Table 4.16 Pollutant emissions from the pulp, paper and food industries in the period of 1990-2022 (kt)

Year	NOx	NMVOC	SOx	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	NA	2.008	NA	NR	NR	NA	NR	NA
1995	NA	0.839	NA	NR	NR	NA	NR	NA
2000	0.010	0.649	0.040	0.085	0.115	0.15000	0.002	0.140
2005	NA	0.769	0.130	0.127	0.171	0.22000	0.003	0.020
2010	0.018	0.739	0.028	0.158	0.217	0.29004	0.004	0.028
2015	0.015	0.706	0.002	0.057	0.085	0.13384	0.001	0.004
2016	0.013	0.673	0.001	0.037	0.059	0.10362	0.001	0.001
2017	0.015	0.707	0.000	0.032	0.052	0.09420	0.001	0.010
2018	0.002	0.727	0.000	0.040	0.062	0.10461	0.001	0.012
2019	0.002	0.760	0.000	0.030	0.051	0.09956	0.001	0.013
2020	0.002	0.748	0.000	0.031	0.054	0.10468	0.001	0.022
2021	0.002	0.767	0.000	0.031	0.053	0.09947	0.001	0.030
2022	0.002	0.808	0.000	0.030	0.050	0.09746	0.001	0.027
Change 2005-2022, %		**5.1**	**-100.0**	**-76.6**				
Change 2021-2022, %	**-11.9**	**5.3**	**250.0**	**-2.8**	**-6.7**	**-2.0**	**-5.1**	**-9.7**

The emissions of NMVOC and particulates from the wood processing (NFR 2I) are presented in Table 4.17; emissions of other substances from this sector are insignificant and aren't given in the table.

Table 4.17 NMVOC and PM emission from the wood processing (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
2009	0.009	0.024	0.072	0.219
2010	0.014	0.027	0.082	0.248
2011	0.013	0.026	0.079	0.240
2012	0.01	0.026	0.077	0.233
2013	0.01	0.023	0.073	0.21
2014	0.002	0.023	0.076	0.212
2015	0.003	0.025	0.074	0.226
2016	0.002	0.023	0.069	0.210
2017	0.003	0.024	0.072	0.221
2018	0.008	0.056	0.169	0.516
2019	0.047	0.055	0.163	0.497

Return to the Table of Contents

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
2020	0.057	0.056	0.166	0.509
2021	0.094	0.057	0.169	0.518
2022	0.115	0.066	0.197	0.508

4.1.6.2. Methodological Issues

Emissions data from these branches of industry are based on facilities data (Tier 3 method) and only NMVOC emissions from the food industry are calculated as diffuse sources on the basis of statistical data and renewed EMEP/EEA Guidebook 2023 default emission factors (Tier 2 method).

According to the assessment of the Estonian inventory team, SO_x and NO_x emissions are related to the burning of fuels in boilers and not to the technological processes of pulp and paper production, and that is why starting from 2018 they are shown under other NFRs, e.g. 1A2d and in NFR 2H1 SO_x and NO_x emissions are marked NA. Solid particles are released from the melting tank of the "HORIZON" CELLULOSE AND PAPER JOINT STOCK COMPANY and from the production of sulphite-free chemical-mechanical paper pulp of the Estonian Cell Aktiaselts shown under NFR 2H1.

Emissions from food manufacturing include all processes in the food production chain, which occur after the slaughtering of animals and the harvesting of crops. Emissions from drinks manufacturing include the production of alcoholic beverages, especially wine, beer and spirits. Emissions from the production of other alcoholic drinks are not covered.

It is recommended to use the product-based default emission factors (not background emission factors), since relevant activity statistics for these factors are more likely to be available.

Emission factors presented in this section are based on the following assumptions:

- 0,15 tonne of grain is required to produce 1 tonne of beer (Passant, 1993).
- Malt whiskies typically need ten years to mature. Grain whiskies typically require six years to mature. It is assumed that brandy matures in three years and that other spirits do not mature.
- Beer is considered to be typically 4% alcohol by volume and to weigh 1 tonne per m^3.
- If no better data are available, spirits are assumed to be 40% alcohol by volume.
- Alcohol (ethanol) has a density of 789 kg/m^3.

Tier 2 emission factors are used for emission calculations. The relevant emission factors are given in the tables below (see Table 4.18). The emission factor for rye bread and white bread production is the same (EF 5 kg/Mg NMVOC bread). Statistical data for white bread production (shortened process, emission factor 2 kg/Mg NMVOC bread), wholemeal bread production (EF 3 kg/Mg NMVOC bread) and light rye bread production (EF 3 kg/Mg NMVOC bread) are not available.

For spirits, the emission factor 0.4 kg/hl alcohol is chosen, since Estonia mainly produces vodka, the production of which does not involve maturation processes.

There are also some permitted fish processing companies (mainly smoking) that report NMVOC emissions. Some permit applications were studied (for example Maseko in Harju County) and it was found that NMVOC emission originates from smoke generators as a result of incomplete combustion and not from the fish processing itself. Therefore, these emissions are different from the calculated NMVOC emission, which primarily occur from the cooking of meat, fish and poultry, releasing mainly fats and oils and their degradation products.

Table 4.18 NMVOC emission factors for the food and drink industries

Product group (food and drink)	Emission factor	Unit
Bread	4.5	kg/Mg bread
Cakes, biscuits and breakfast cereals	1	kg/Mg product
Meat, fish and poultry etc. frying/curing	0.3	kg/Mg product
Meat processed	0.3	kg/Mg product
Fish processed	0.3	kg/Mg product
Margarine and solid cooking fats	10	kg/Mg product
Solid cooking fats	10	kg/Mg product
Margarine	10	kg/Mg feed
Animal feed	1	kg/Mg product
Wine	0.08	kg/hl wine
Beer	0.035	kg/hl beer
Other sprits	0.4	kg/hl alcohol
Crude spirits	0.4	kg/hl alcohol
Distilled spirits	0.4	kg/hl alcohol

4.1.6.3. Activity Data

Information regarding food and drink production is available from Statistics Estonia (www.stat.ee) for the years 1990-2022 (see Table 4.19-4.20).

Table 4.19 Activity data for the food industries in the period of 1990-2022 (thousand tonnes)

Year	Bread and pastry	Flour confectionery	Meat total (slaughter weight)	Fish total	Solid cooking fats	Margarine	Concentrated feeding stuffs
1990	151.0	14.9	182.5			6.6	851.8
1995	99.7	5.0	67.7	132.0	3.6	0.1	162.8
2000	76.5	4.4	53.3	113.4	0.8		133.3
2005	72.4	..	67.1	99.3	1.2		177.0
2010	73.7	8.4	75.4	96.0	..	..	203.0
2015	78.9	11.2	85.6	73.7	..	..	127.4
2016	76.98	10.69	77.9	76.4	..	..	109.9
2017	79.93	13.3	71.5	83.4	..	..	160.9
2018	81.85	11.04	74.4	88.2	..	..	176.2
2019	84.99	11.44	73.3	88.0	..	..	168.5
2020	80.58	11.26	73.4	75.3	..	..	176.6
2021	83.61	11.56	72.31	73.11			180.34
2022	86.85	11.82	72.0	73.0			227.63

Table 4.20 Activity data for the drinks industries in the period of 1990-2022 (thousand hl)

Year	Wine of fruits and berries	Beer	Crude spirits	Distilled spirits
1990	37.0	769.0	82	147.0
1995	14.0	499.6	91	176.0
2000	32.6	950.1	20.4	86.4
2005	88.8	1.342.5	37.1	167.9
2010	64.7	1.291.7	0.1	150.7
2015	107.7	1.446.9	18.1	157.3
2016	117.45	1.419.1	20.2	150.9
2017	97.77	1.389.9	23.7	142.96
2018	82.6	1.372.5	23.7	125.5
2019	120.5	1.410.2	23.7	137.5
2020	72.6	1.379.9		131.9
2021	84.56	1.453.3		139.7
2022	85.1	1.351.8		166.6

4.1.7. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for NO_x, NMVOC and SO_x from industrial processes is estimated in the range from 20% to 50%, for ammonia 20-200%, for particulates 20-100%; in the activity data in the range from 2% to 5%. Uncertainty estimates for stationary combustion are given in Table 4.21.

Table 4.21 Uncertainties in industrial processes sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NOx	0.0715	kt	0.31	0.14	0.06
NMVOC	0.9690	kt	3.66	1.46	4.22
SOx	0.0003	kt	0.002	0.0003	0.00002
NH_3	0.0723	kt	0.71	1.21	0.53
$PM_{2.5}$	0.2983	kt	6.08	3.52	1.57
PM_{10}	1.9174	kt	21.27	18.43	5.99
TSP	6.0768	kt	38.05	34.49	2.14
BC	0.0009	kt	0.08	0.03	0.07
CO	0.6768	kt	0.64	0.29	0.09
Pb	0.0046	t	0.11	0.05	0.001
Cd	0.0000	t	0.00	0.00	0.0011065
Hg	0.0000	t	0.00005	0.00003	0.002
PCDD	0.0293	g I-TEQ	0.71	0.63	0.24
HCB	0.0018	kg	0.36	0.36	0.33

4.1.8. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends was carried out.

Data from operators was checked by the EEB and also by the ESTEA.

4.1.9. Recalculations

As a result of clarification of emissions from production processes, emissions were relocated between different NFR codes and the following recalculations were made in the 2024 view:

- emission of NH_3 for the period 2007-2021 were relocated from NFR 5A to NFR 2H2;
- emission of NH_3 for the period 2009-2021 were relocated from NFR 5C1bv to NFR 2H2;
- emission of NMVOC for the period 2004-2021 were added to NFR 2H2;
- emission of NMVOC for 2014 have been adjusted for NFR 2H1;
- emission of $PM_{2.5}$, PM_{10} and TSP for the period 2019-2021 have been adjusted for NFR 2I;
- emissions of NMVOC and CO for the period 2013-2021 were recalculated and relocated from NFR 2H1 to NFR 2I.

4.1.10. Source-Specific Planned Improvements

- For sector 2C6, conduct an analysis of processes and SNAP codes according to which operators report emissions. If necessary, relocate emissions to the correct SNAP code and NFR. This adjustment process may require changes to the national database of point sources.

- For sector 2C6, conduct an analysis of processes and SNAP codes according to which operators report emissions. If necessary, relocate emissions to the correct SNAP code and NFR. This adjustment process may require changes to the national database of point sources.
- For sector 2H1, conduct an analysis and clarifies the emissions data for previous years presents them to the 2025 inventory.

4.2. Solvent and Other Product Use

4.2.1. Source Category Description

This chapter describes NMVOC emissions from solvents and other product use. In addition to NMVOC emissions, this sector also includes the emissions of particulate matter from painting, degreasing, use of chemical products, printing, tobacco smoking and the use of fireworks. The heavy metals, CO, SO_x, NH_3, NO_x and POPs emissions from tobacco smoking and lubricant use are also calculated.

In 2009-2010, the Estonian Environment Information Centre (nowadays ESTEA) outsourced an expert opinion of the estimation of NMVOC emissions from diffuse sources, including NMVOC emissions from the use of solvents and other products use. The most common method of estimating NMVOC emissions is the use of emission factors. The emissions are estimated based on the production or activity level of the source from which an emission level is calculated using existing emission factors. The main database of emission factors is the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023.

Facilities whose emissions exceed the limits set by the Ministry of the Environment (since July 1, 2023 Ministry of Climate) regulations are required to have an environmental permit to emit polltants into the air and submit an annual air report. Therefore, this section also takes into account emissions data presented in the facilities' annual air reports.

This sector covers emissions from the use of solvents and other products for the following NFR categories: domestic solvent use including fungicides (NFR 2D3a), coating application (NFR 2D3d), degreasing (NFR 2D3e), dry-cleaning (NFR 2D3f), chemical products (NFR 2D3g), printing (NFR 2D3h), other solvent use (NFR 2D3i) and other product use (NFR 2G).

Air pollutants under solvent and other product use sector in the Estonian inventory are presented in Table 4.22.

Table 4.22 Activities and emissions reported from the solvent and other product use sector

NFR	Source	Description	Method	Emissions reported
2D3a	Domestic solvent use including fungicides	Includes emissions from domestic solvent use	Tier 1 / Tier 2	NMVOC
2D3d	Coating application	Includes emissions from domestic and industrial paint application	Tier 2 / Tier 3	NO_x, NMVOC, SO_x, PM_{10}, TSP
2D3e	Degreasing	Includes emissions from degreasing (vapour and cold cleaning), electronic components manufacturing and other industrial cleaning	Tier 2 / Tier 3	NO_x, NMVOC, SO_x, NH_3, PM_{10}, TSP, Pb, Cr, Cu
2D3f	Dry cleaning	Includes emissions from dry cleaning	Tier 1 / Tier 3	NMVOC
2D3g	Chemical products	Includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other use of solvents	Tier 3	NO_x, NMVOC, SO_x, NH_3, PM_{10}, TSP, CO, Cr, Zn
2D3h	Printing	Includes emissions from solvents in printing houses	Tier 1 / Tier 3	NMVOC, TSP
2D3i	Other solvent use	Includes emissions from edible and non-edible oil extraction, application of glues and adhesives, preservation of wood and underseal treatment and conservation of vehicles	Tier 2 / Tier 3	NO_x, NMVOC, SO_x, NH_3, PM_{10}, TSP, Pb Cr, Cu

Return to the Table of Contents

NFR	Source	Description	Method	Emissions reported
2G	Other product use	Emissions from the use of tobacco, the use of fireworks and the use of lubricants	Tier 2 / Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$, PM$_{2.5}$, PM$_{10}$, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total

In 2022, the solvent and other product use sector was the largest pollution source of NMVOC emissions in Estonia, accounting for 48.1% of national total NMVOC emissions.

In the solvent and other product use sector, the largest share was coating applications at 55.0%, followed by the use of domestic solvents (including fungicides) at 28.4%, other solvents (including adhesives) use at 11.5%, printing at 2.7%, chemical products at 1.3%, degreasing at 0.6%, other product use at 0.4%, and dry cleaning at 0.03% (see Figure 4.9).

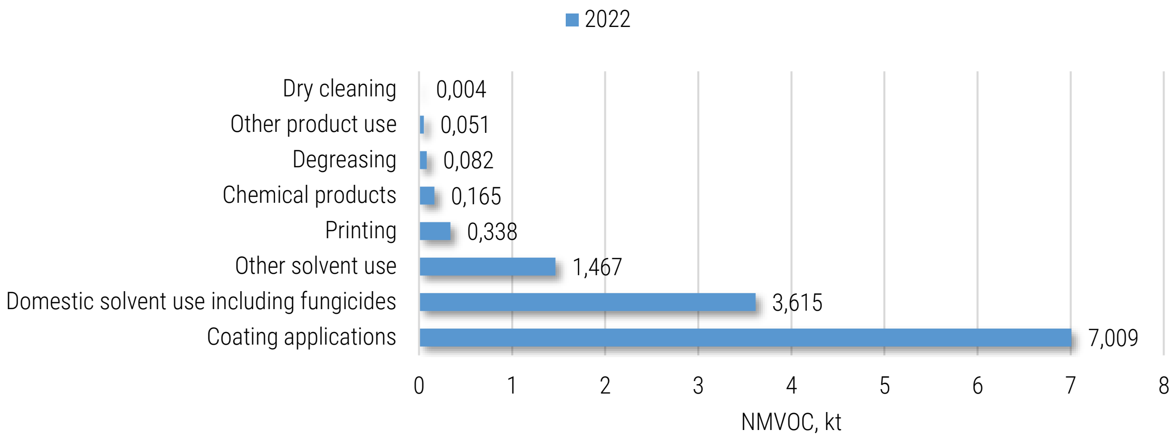


Figure 4.9 NMVOC emissions by sectors in 2022

There has been an increasing trend of NMVOC emissions from solvent and other product use. Compared to 1990, NMVOC emissions from the solvent sector have increased by 51.6%. The major category regarding increases in NMVOC emissions in recent years is the coating application (NFR 2D3d), with NMVOC emissions also increasing in categories 2D3h (Printing) and 2D3i (Other solvent use). The fluctuation of NMVOC emissions in the period of 1990-2022 has mostly occurred due to the welfare of the economic state of the country. The decrease in emissions between 1991 and 1993 was due to the renewed independence of the Republic of Estonia and the cessation of large-scale production that was distinctive of the Soviet Union. Between 1994 and 1998, the economic growth induced the growing usage of NMVOC containing paints in decorative and industrial coating applications. At the end of 1998, the world was struck by an economic crisis that affected the construction sector, resulting in a knock-on effect on the usage of decorative coatings. From 2001, the economy began to grow again until 2008, when the world suffered its worst ever economic depression, which also greatly affected the Estonian economy. As a result, by the year 2010, NMVOC emissions fell. In 2011, there was an increase in NMVOC emissions compared to 2010, which meant that the bottom of the emissions was reached, and henceforward, the emissions have been started to rise again.

In 2004 and 2005, Estonia adopted directives 1999/13/EC and 2004/42/EC into its legislation, but it seems that the economic growth at the time did not have a significant effect on the decrease in NMVOC emissions, which grew steadily until the economic depression. One reason why the possible positive effect of the legislation did not manifest is because the emissions from the point sources, which are calculated more precisely by the facilities than the emissions from the diffuse sources, represent below 20% of total solvent sectors NMVOC emissions. The EMEP/EEA Guidebook emission factors used to calculate NMVOC emissions from diffuse sources do not take into account the implementation of the directives.

In 2022, NMVOC emissions from the use of solvents and other products decreased by 3.7% compared to 2021. The main reason for this decrease was the reduced emissions from consumption of domestic products (9.5%) and other solvents, including adhesives (21.6%). Emissions from printing also decreased (25.5%). The reason for this decrease is the reduction in the amount of chemicals used.

However, the consumption of decorative and industrial coatings continued to increase. In 2022, the consumption of decorative and industrial coatings increased by 3.9% compared to 2021.

NMVOC emissions in the period 1990-2022 by NFRs are presented in Table and Figures below.

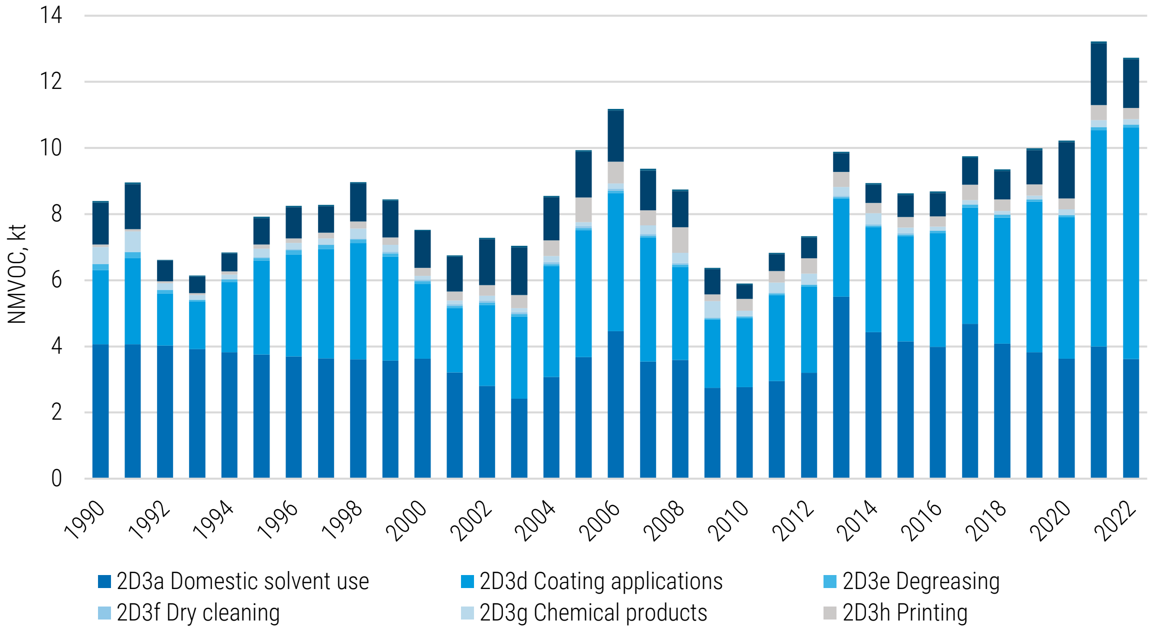


Figure 4.10 NMVOC emissions from the solvent and other product use sector in the period of 1990-2022

Table 4.23 NMVOC emissions from the solvent and other product use sector in the period of 1990-2022(kt)

Year	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G
1990	4.07	2.24	0.18	0.01	0.50	0.08	1.26	0.05
1995	3.75	2.85	0.08	0.02	0.25	0.13	0.81	0.03
2000	3.63	2.26	0.08	0.05	0.11	0.25	1.11	0.03
2005	3.68	3.84	0.05	0.06	0.13	0.75	1.38	0.04
2010	2.77	2.09	0.05	0.01	0.16	0.35	0.42	0.04
2015	4.15	3.18	0.06	0.03	0.18	0.32	0.66	0.05
2016	3.99	3.43	0.08	0.01	0.13	0.31	0.70	0.05
2017	4.69	3.51	0.09	0.01	0.13	0.47	0.81	0.05
2018	4.09	3.81	0.09	0.01	0.11	0.34	0.86	0.05
2019	3.82	4.55	0.07	0.01	0.11	0.34	1.04	0.05
2020	3.63	4.27	0.07	0.01	0.17	0.33	1.71	0.05
2021	3.99	6.55	0.08	0.01	0.21	0.45	1.87	0.05
2022	3.62	7.01	0.08	0.004	0.17	0.34	1.47	0.05
Change 1990-2022, %	-11.1	212.6	-54.1	-72.4	-66.7	324.1	16.1	-5.4
Change 2021-2022, %	-9.5	7.0	-0.7	-23.1	-20.2	-25.5	-21.6	0.9

Return to the Table of Contents

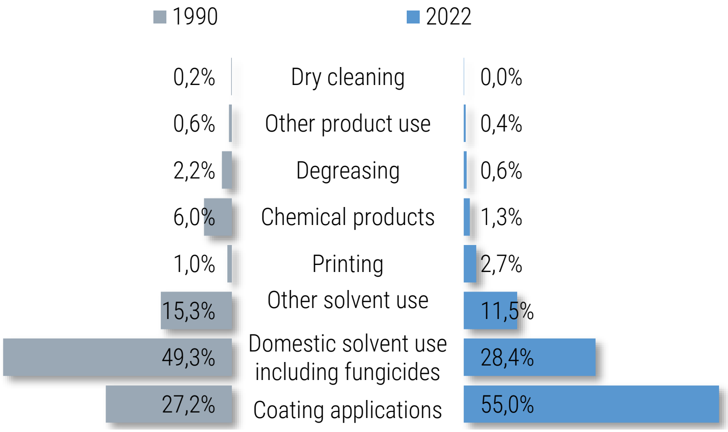


Figure 4.11 The share of NMVOC emissions in 1990 and 2022 by NFR solvent subcategory codes

4.2.2. Methods

NMVOC emission estimations from solvent and other product use are based on several data sources and methods. Emissions from point sources are gathered from the web-based air emissions data system for point sources and the emissions for diffuse sources are calculated from the data received and gathered mainly from Statistics Estonia using international emission factors and expert opinions. Information sources for the NMVOC inventory by different subcategories are presented in the Table 4.24 together with emission sources not included in the inventory.

Table 4.24 Information sources for the NMVOC inventory in solvents sector

**PS – point sources*
**DS – diffuse sources*
**GB – Guidebook*

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
2D3a	Personal care, household cleaning agents, car care products, cosmetics and toiletries, adhesives and sealants, pharmaceutical products	060408	Domestic solvent use (other than paint application)	Statistics Estonia	DS: 2,59 kg/person/year (1990-2000, GB2007); EFs for the years 2001-2003 are interpolated; EFs from Tables 3-4 and 3-5 (2004-2022, GB2023)
		060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: EF from Table 3-5 (2004-2022, GB2023)
2D3d	Coating applications: Solvents in paints	060101	Manufacture of automobiles	Reported by operators (for the years 2005-2007)	PS: facility specific
		060102	Car repairing	Expert estimate for the whole time series (DS); reported by operators (PS, since 2006)	DS: EF from Table 3-7 (1990-2006, GB2023, solvent based), 2007-2022 IEF from the PS; Table 3-7 in combination with Table 3-19 (1990-2007, GB2023, water based), 2008-2022 IEF from the PS; PS: facility specific
		060103	Construction and buildings	Statistics Estonia and expert estimate	DS: Tables 3-4 and 3-5 (1990-2022, GB2023, solvent based); Tables 3-4 and 3-5 in combination with Table 3-17 (1990-2022, GB2023, water based); 149.5 g/kg of paint applied (1990-2022, calculated as an average of SB and WB EFs)
		060104	Domestic use	Statistics Estonia and expert estimate	
		060105	Coil coating	Reported by operators (since 2012)	PS: facility specific
		060106	Boat building	Reported by operators (since 2000)	PS: facility specific
		060107	Wood coating	Reported by operators (since 1993)	PS: facility specific

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		060108	Other industrial paint application	Reported by operators (since 1990)	PS: facility specific
		060109	Other non-industrial paint application	Included under SNAP 060103 and 060104	NA
2D3e	Degreasing: Solvents in products	060200	Degreasing (vapour and cold cleaning)	Statistics Estonia	DS: Table 3-2 in combination with the abatement efficiencies in Table 3-4 (GB2023)
		060201	Metal degreasing (regarded as vapour cleaning)	Reported by operators (since 2001)	PS: facility specific
		060203	Electronic components manufacturing	Reported by operators (since 2000)	PS: facility specific
		060204	Other industrial cleaning	Reported by operators (since 2001)	PS: facility specific
2D3f	Dry cleaning: Chlorinated solvents in products	060202	Dry cleaning	Statistics Estonia; reported by operators (since 2002)	DS: Chapter 3.2.1 (GB2023); PS: facility specific
2D3g	Solvents in chemical products manufacture and processing	060300	Chemical products manufacturing or processing	Aggregated emissions for the whole SNAP 0603**, reported by operators (1990-2005)	PS: facility specific
		060301	Polyester processing	Prolyester resin plastic products fabrication reported under 060314	IE
		060302	Polyvinylchloride processing	Not relevant	NA
		060303	Polyurethane processing	Reported by operators (since 2006)	PS: facility specific
		060304	Polystyrene foam processing	Reported by operators (since 2006)	PS: facility specific
		060305	Rubber processing	Reported by operators (since 2006)	PS: facility specific
		060306	Pharmaceutical products manufacturing	Not included	NA
		060307	Paints manufacturing	Reported by operators (since 2006)	PS: facility specific
		060308	Inks manufacturing	Reported by operators (2007-2010)	PS: facility specific
		060309	Glues manufacturing	Reported by operators (2006-2014)	PS: facility specific
		060310	Asphalt blowing	Not occurring	NO
		060311	Adhesive, magnetic tapes, films and photographs manufacturing	Not included	NA
		060312	Textile finishing	Reported by operators (since 2006)	PS: facility specific
		060313	Leather tanning	Reported by operators (since 2006)	PS: facility specific
		060314	Other	Reported by operators (since 2006)	PS: facility specific
2D3h	Printing ink and solvents in printing houses	060403	Printing industry	Statistics Estonia; reported by operators (since 2001)	DS: Table 3-1 (GB2023); PS: facility specific
2D3i	Other solvent use	060400	Other use of solvents and related activities	Aggregated emissions for the whole SNAP 0604**, except 060405; reported by operators (1990-1999)	PS: facility specific
		060401	Glass wool enduction	Not included	NA
		060402	Mineral wool enduction	Emissions reported by operators	PS: facility specific
		060404	Fat, edible and non-edible oil extraction	Emissions reported by operators (since 2002), activity data is not available	PS: facility specific
		060405	Application of glues and adhesives	Statistics Estonia; reported by operators (since 1990)	DS: Table 3-8 (1990-2000, GB2009, Chapter 3.D.3 Other product use); Table 3-11 (since 2005, GB2023); EFs for the years 2001-2004 are interpolated; PS: facility specific
		060406	Preservation of wood	Reported by operators (since 2000)	PS: facility specific

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		060407	Underseal treatment and conservation of vehicles	Eurostat (1990-2004; since 2005 any occurring emissions are considered negligible)	DS: see Chapter 4.2.10.2 subparagraph 5
		060409	Vehicles dewaxing	Not included (emissions are negligible)	NA
		060412	Other (preservation of seeds,…)	Reported by operators (since 2000)	PS: facility specific
2G	Other product use	060601	Use of fireworks	Statistics Estonia	NA
		060602	Use of tobacco	Statistics Estonia	DS: Table 3-15 (GB2023)
		060603	Use of shoes	Not included	NA
		060604	Other	Lubricant oil consumption is calculated by use the COPERT 5 model	DS: Table 3-17 (GB2023) GB: see Chapter 3.3.3.2

Emissions, other than NMVOC, are taken from the point sources database (reported by operators and are facility-specific), except emissions from fireworks and tobacco use, where Tier 2 emission factors are taken from the EMEP/EEA Guidebook 2023, and lubricant use, where COPERT 5 model are used.

The facilities that are required to have an environmental permit to emit polltants into the air or IPPC permit submit their annual air emissions and activity data in annual reports. The threshold amounts of NMVOC, above which it is necessary to have an environmental permit, are low. For example, until the end of 2017, having an environmental permit was mandatory if NMVOC emissions exceeded 0.1 tons per year. From the end of 2017, having an environmental permit is mandatory if NMVOC emissions exceed 0.5 tons per year. Therefore, it can be assumed that facilities with a significant environmental impact have an environmental permit and submit annual ambient air reports.

The data collected in the annual air emissions report for the solvent use are:

- Class – solvent, varnish, adhesive, paint or other chemicals that do not fall into any other previously named categories, such as hardeners, stains, resins, etc.;
- Type – water based (WB) or solvent based (SB);
- Total NMVOC content of the used chemical in mass%;
- Activity or technological process by the SNAP activity codes where the reported chemical has been used;
- The annual consumption of solvent or solvent containing mixture (i.e. paint, varnish, adhesive or other chemical) in tonnes per year;
- Emissions of pollutants by the used solvent or solvent containing mixture – CAS number, name of the substance, NMVOC emission in tonnes per year;
- The number of a source of pollution on a plan or map of the facility.

4.2.3. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for NMVOC from solvent and other product use is estimated in the range from 20% to 100%, for NO_x and SO_x 50%, for ammonia and particulates 50-100%; in the activity data in the range from 2% to 10%. Uncertainty estimates for solvent and other product use are given in Table 4.25.

Table 4.25 Uncertainties in solvent and other product use sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022 %
NOx	0.003	kt	0.01	0.01	0.0003
NMVOC	12.73	kt	48.13	15.23	5.05
SO_x	0.001	kt	0.01	0.01	0.0003
NH_3	0.01	kt	0.07	0.03	0.01
$PM_{2.5}$	0.06	kt	1.27	0.64	0.18
PM10	0.09	kt	0.95	0.48	0.13
TSP	0.10	kt	0.64	0.29	0.02
BC	0.02	kt	1.42	0.71	0.08
CO	0.08	kt	0.08	0.04	0.00
Pb	0.38	t	9.22	4.63	0.10
Cd	0.02	t	3.34	1.68	0.14
Hg	0.00003	t	0.01	0.01	0.001
PCDD	0.0001	g I-TEQ	0.003	0.01	0.0004
b(a)p	0.0002	t	0.01	0.03	0.002
b(b)f	0.0001	t	0.01	0.01	0.001
b(k)f	0.0001	t	0.01	0.02	0.001
I(1,2,3-cd)p	0.0001	t	0.01	0.01	0.005
HCB	NA	kg	NA	NA	NA
PCB	NA	kg	NA	NA	NA

4.2.4. Domestic Solvent Use Including Fungicides (NFR 2D3a)

4.2.4.1. Source Category Description

Emissions occur due to the evaporation of NMVOCs contained in the products during their domestic use. This category does not include the use of decorative paints, which is covered under NFR 2D3d (Coating applications).

The products sold for public use can be divided into a number of categories presented in Table 4.26.

Table 4.26 Description of the product categories used in the NFR category 2D3a

Category	Description
Cosmetics and toiletries	Products for the maintenance or improvement of personal appearance, health or hygiene.
Household products	Products used to maintain or improve the appearance of household durables.
Construction/DIY	Products used to improve the appearance or the structure of buildings such as adhesives and paint remover. This sector would also normally include coatings; however these products fall outside the scope of this chapter and are therefore omitted.
Car care products	Products used for improving the appearance of vehicles to maintain vehicles, or winter products such as antifreeze.
	De-icing products are not included in the inventory due to the lack of proper activity data.
Pesticides	Pesticides, such as garden fungicides, herbicides and insecticides, and household insecticide sprays may be considered as consumer products. Most agrochemicals, however, are produced for agricultural use and fall outside the scope of this chapter.
Pharmaceutical products	Pharmaceutical products for domestic use, e.g. disinfectants.

In 2022, NMVOC emissions from the NFR sector 2D3a had decreased by 11.1% compared to the year 1990. Compared to 2021, NMVOC emissions in 2022 decreased by 9.5%. The decrease in NMVOC emissions was primarily due to a reduction in the consumption of household products (especially cleaning and washing products) and DIY products. For example, the consumption of chemicals in DIY decreased by about 15.9% and household products decreased by 62.5%. A decrease in the use of pesticides, such as garden fungicides, herbicides and insecticides and household insecticide sprays, could also be observed.

4.2.4.2. Methodological Issues

The Tier 1 default method uses a single emission factor expressed on a per-person basis to derive an emission estimate for the activity by multiplying the emission factor with the population of the country.

Tier 1 emission factor is used for calculations. The following equation is applied:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

where

$E_{pollutant}$ = the emission of the specified pollutant;
$AR_{production}$ = the activity rate for the population;
$EF_{pollutant}$ = the emission factor for this pollutant.

NMVOC emissions for the years 1990–2000 are calculated using the Tier 1 default emission factor for domestic solvent use, 2.59 kg/capita from the EMEP/Corinair Emission Inventory Guidebook 2007, because it probably describes better the situation in the 1990s, when products with a high solvent content were produced and used. The emission factors for the years 2001–2003 are interpolated gradually:

- 2001 – 2.312 kg/capita;
- 2002 – 2.034 kg/capita;
- 2003 – 1.756 kg/capita.

Starting from 2004, statistical data for international trade (import/export) and production has been used to calculate NMVOC emissions from domestic solvent use. Many Combined Nomenclature (CN) codes for a variety of products have been included under different source categories.

The equations for calculating the amounts of used products is:

$$AR_{used} = AR_{import} - AR_{export} + AR_{production}$$

where:

AR_{used} = the amount of used product;
AR_{import} = the amount of imported product;
AR_{export} = the amount of exported product;
$AR_{production}$ = the amount of produced product.

As there is no information on stock data for the end of the year, it is assumed that all products have been used in the specific year.

Table 4.27 presents the EMEP/EEA Guidebook 2023 default Tier 2b emission factors for NFR source category 2D3a for NMVOC by the subcategories. The EMEP/EEA Guidebook 2023 provides the Tier 2b emission factors for NMVOC emission calculations using used product as activity data. Although it also provides the Tier 2b emission factors for NMVOC emission calculations using population as activity data as well, it is recommended that those emission factors are to be used only when the product statistics for the use are not complete in terms of the product types covered by domestic solvent use. As a result, population as activity data have been applied for some source categories.

Table 4.27 Tier 2 emission factors for NFR source category 2D3a domestic solvent use including fungicides

Source category	Pollutant	EF	Unit	Tier	Reference
Household products (all)	NMVOC	16	g/kg product	2b	EMEP/EEA GB2023, Table 3-4
Car care product (except antifreezes)	NMVOC	180	g/kg product	2b	EMEP/EEA GB2023, Table 3-4
Car care product (antifreezes)	NMVOC	303	g/person	2b	EMEP/EEA GB2023, Table 3-5
Cosmetics and toiletries (all)	NMVOC	127	g/kg product	2b	EMEP/EEA GB2023, Table 3-4
DIY/buildings (adhesives)	NMVOC	66	g/kg product	2b	EMEP/EEA GB2023, Table 3-4
DIY/buildings (paint thinner)	NMVOC	205	g/person	2b	EMEP/EEA GB2023, Table 3-5
DIY/buildings (paint and varnish removers, solvents)	NMVOC	68	g/person	2b	EMEP/EEA GB2023, Table 3-5
DIY/buildings (sealants, filling agents)	NMVOC	45	g/kg product	2b	EMEP/EEA GB2023, Table 3-5
Pharmaceutical products	NMVOC	48	g/person	2b	EMEP/EEA GB2023, Table 3-5
Pesticides	NMVOC	150	g/kg product	2b	EMEP/EEA GB2023, Table 3-4

The basic activity statistics for using the Tier 1 and Tier 2b emission factors are national population figures obtained from Statistics Estonia. The amounts of used products for some source categories are also obtained from Statistics Estonia (see Table 4.28). It should be noted that the activity data used for estimating the amounts of used products includes some interpolation and filling data gaps due to the negative balance in international trade data for some years. Statistics Estonia cannot distinguish the products of some categories from similar products used in other categories. For example, it is not possible to distinguish the amounts of antifreeze used in car care, heating systems and other areas of activity.

NMVOC emissions and activity data in the period 1990-2022 are presented in Table below.

Table 4.28 Activity data and NMVOC emissions from domestic solvent use (other than paint application) in the period of 1990-2022 (kt)

Year	Population, mln. inhab.	Used products, kt					
		Cosmetics and toiletries (all)	Household products (all)	Car care product (except antifreezes)	DIY/ buildings (adhesives)	DIY/buildings (sealants, filling agents)	Pesticides
1990	1.57	NA	NA	NA	NA	NA	NA
1995	1.45	NA	NA	NA	NA	NA	NA
2000	1.40	NA	NA	NA	NA	NA	NA
2005	1.36	4.62	14.03	3.11	1.09	26.97	1.14
2010	1.33	3.81	11.82	2.23	3.10	11.11	1.04
2015	1.31	3.85	34.24	2.39	2.39	30.27	2.27
2016	1.32	3.52	54.52	2.02	2.80	19.42	2.82
2017	1.32	3.34	60.24	2.36	3.30	33.93	2.04
2018	1.32	5.61	15.57	2.41	5.42	28.09	1.64
2019	1.32	4.98	11.43	2.04	4.04	26.82	2.27
2020	1.33	2.24	21.48	2.26	2.09	28.40	2.30
2021	1.33	2.17	24.54	2.63	2.83	31.01	2.93
2022	1.33	2.78	9.19	3.04	1.91	26.57	2.77

Table 4.28 continues

Year	NMVOC emissions by domestic solvent use categories. kt							
	Cosmetics and toiletries (all)	Household products (all)	Car care product (except antifreezes)	Car care products (antifreezes)	DIY/ buildings (adhesives)	DIY/ buildings (sealants. filling agents)	DIY/ buildings (paint thinner)	DIY/ buildings (paint and varnish removers. solvents)
1990	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA
2005	0.59	0.22	0.56	0.41	0.07	1.21	0.28	0.09
2010	0.48	0.19	0.40	0.40	0.20	0.50	0.27	0.09
2015	0.49	0.55	0.43	0.40	0.16	1.36	0.27	0.09
2016	0.45	0.87	0.36	0.40	0.18	0.87	0.27	0.09

Year	NMVOC emissions by domestic solvent use categories. kt							
	Cosmetics and toiletries (all)	Household products (all)	Car care product (except antifreezes)	Car care products (antifreezes)	DIY/ buildings (adhesives)	DIY/ buildings (sealants. filling agents)	DIY/ buildings (paint thinner)	DIY/ buildings (paint and varnish removers. solvents)
2017	0.42	0.96	0.43	0.40	0.22	1.53	0.27	0.09
2018	0.71	0.25	0.43	0.40	0.36	1.26	0.27	0.09
2019	0.63	0.18	0.37	0.40	0.27	1.21	0.27	0.09
2020	0.28	0.34	0.41	0.40	0.14	1.28	0.27	0.09
2021	0.28	0.39	0.47	0.40	0.19	1.40	0.27	0.09
2022	0.35	0.15	0.55	0.40	0.13	1.20	0.27	0.09

Table 4.28 continues

Year	NMVOC emissions by domestic solvent use categories, kt		
	Pesticides	Pharmaceutical products	Total
1990	NA	NA	4.07
1995	NA	NA	3.75
2000	NA	NA	3.63
2005	0.17	0.07	3.68
2010	0.16	0.06	2.77
2015	0.34	0.06	4.15
2016	0.42	0.06	3.99
2017	0.31	0.06	4.69
2018	0.25	0.06	4.09
2019	0.34	0.06	3.82
2020	0.34	0.06	3.63
2021	0.44	0.06	3.99
2022	0.42	0.06	3.62

4.2.4.3. Source-Specific QA/QC and Verification

Normal statistical quality checks related to the assessment of magnitude and trends are carried out. Calculated emissions are compared to the previous years to detect calculation errors.

4.2.4.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.5. Coating Applications (NFR 2D3d)

4.2.5.1. Source Category Description

This chapter deals with the use of paints within the industrial and decorative (construction and buildings and domestic use) sectors. Traditionally, the term 'paint' has often been used to describe pigmented coating materials only, thus excluding clear coatings such as lacquers and varnishes. However, here, the term 'paint' is taken to include all materials applied as a continuous layer to a surface with the exception of glues and adhesives, which are covered by NFR source category 2D3i. Inks, which are coatings applied in a non-continuous manner to a surface to form an image, are excluded by the definition given above and are covered by NFR source category 2D3h.

Most paints contain organic solvents, which must be removed by evaporation after the paint has been applied to a surface for the paint to dry or 'cure'. Unless captured and either recovered or destroyed, these solvents can be considered emitted into the atmosphere. Some organic solvent may be added to coatings before application, which will also be emitted. Further solvent used for cleaning coating equipment is also emitted.

The proportion of organic solvent in paints can vary considerably. Traditional solvent-based paints contain approximately 50% organic solvents and 50% solids. In addition, more solvent may be added to further dilute the paint before application. High solids and water-based paints both contain less organic solvent, typically less than 30%, while powder coatings and solvent-free liquid coatings contain no solvent at all.

The most important pollutants released from painting activities are NMVOCs. Particulate matter can also be emitted where spraying is used as an application technique; however, many spraying operations are carried out in spray booths fitted with some type of particulate arrestment device.

Due to the wide range of paint applications and the even larger number of paint formulations available, there must be considerable scope for uncertainty in emission factors. Due to developments in paint formulation, the emission factors may only be valid for a short period. Therefore, improved emission factors are especially required for controlled processes.

Another aspect is the variation of paint types. This requires good activity data, which may not be present, particularly with the increasing use of alternatives to high-solvent paints.

Coating applications are divided into three major categories:

1) Decorative coating application;
2) Industrial coating application;
3) Other coating application.

Decorative coating application activity refers to two sub-categories of paint application:

- Paint application: construction and buildings (SNAP activity 060103)

This category refers to the use of paints for architectural application by construction enterprises and professional painters.

- Paint application: domestic use (SNAP activity 060104)

This category refers to the use of paints for architectural or furniture applications by private consumers. It is good practice not to include other domestic solvent use. However, it is sometimes difficult to distinguish between solvents used for thinning paints and solvents used for cleaning.

Industrial coating application describes the following sub-categories of paint application:

- manufacture of automobiles (SNAP activity 060101);
- car repairing (SNAP activity 060102);
- coil coating (SNAP activity 060105);
- boat building (SNAP activity 060106);
- wood (SNAP activity 060107) and
- other industrial paint application (SNAP activity 060108).

Most of the sub-categories are expected to be covered by environmental or IPPC permits. The only sector not expected to be fully covered by air pollution permits is car repairing.

Other coating application (SNAP activity 060109 – other non-industrial paint application) refers to the use of high-performance protective and/or anti-corrosive paints applied to structural steel, concrete, and other substrates together with any other non-industrial coatings not covered by any of the other SNAP codes described in the 'Coating applications' section. The sector includes coatings for offshore drilling rigs, production platforms, and similar structures as well as road-marking paints and non-decorative floor paints. Most paint is applied *in situ* by brushing, rolling, or spraying, although a significant proportion of new construction steelwork may be coated in store.

It is estimated that this sector is not very important and emissions are estimated with decorative coating application because it is very complicated to distribute paint use between decorative coating and other coating application activities.

By 2022, NMVOC emissions from this sector were increased by 212.6% compared to 1990. Compared to 2021, NMVOC emissions were increased by 6.9%. The increase in NMVOC emissions was mainly due to an increase in the consumption of decorative coatings (SNAP activities 060103 and 060104). In 2022, the consumption of decorative and industrial coatings increased by 3.9% compared to 2021. In recent years, construction and renovation of buildings has increased, which may be the reason for the increase in the use of decorative coating. Approximately 70% of the decorative coatings used were solvent-based. In 2022, 77.0% of coatings were used for decorative coating and 23% for industrial coating.

In 2022, an increase in the use of industrial coatings was also noticed. The consumption of industrial coatings had increased by 4.6%.

4.2.5.2. Methodological Issues and Activity Data

The quantity of paints and lacquers used in total in Estonia is estimated through the data that has been collected by Statistics Estonia (since 1995), and from the point sources database for point sources (since 2006). The amounts of coatings used are distinguished between solvent and water-based paints, which means that a Tier 2 methodology could be applied for diffuse sources and a Tier 3 methodology for point sources.

The production data is collected from Statistics Estonia using the following combined nomenclature (CN) codes: 3208 (solvent-based), 3209 (water-based), 3210.00.10 and 3210.00.90 (other paints and varnishes). The corresponding PRODCOM codes for import and export details are 20.30.12.00, 20.30.11.00, 20.30.22.13, and 20.30.22.15. Information related to imports and exports is not available for the years 1990–1994; therefore, these amounts were calculated using the change in current prices at that time in the industrial production of chemicals and chemical products.

The equation for calculating the amounts of coatings used is:

$$AR_{used} = AR_{import} - AR_{export} + AR_{production}$$

where:

AR_{used} = the amount of coatings used;

AR_{import} = the amount of imported coatings;

AR_{export} = the amount of exported coatings;

$AR_{production}$ = the amount of produced coatings.

As there is no information on stock data for the end of the year, it is assumed that all coatings have been used in the specific year.

When it comes to calculating emissions from diffuse sources, the activity data, which was reported by facilities into the point sources database, has been subtracted from the data collected by Statistics Estonia. Detailed activity data (involving class and type of chemical) for point sources in the point sources database has been available since 2006. The share of paint used in point sources in the total amount of paint used in Estonia was between 10% in 2006 up to 24% in 2022. This is due to the fact that, over time, more paint users were given permits and thanks to that, they have an annual reporting obligation. Emissions without activity data for the period of 1990–1999 were received from facilities via paper reports; emissions for the period of 2000–2005 were submitted into the CollectER database by an ESTEA air specialist, but they are also based on paper reports received from facilities.

Table 4.29 provides an overview of emission factors used in calculating NMVOC emissions from coating application activities.

Table 4.29 Emission factors used to calculate NMVOC emissions from coating applications (NFR 2D3d)

**PS - point sources*
**DS - diffuse sources*
**GB - guidebook*
**SB - solvent-based*
**WB - water-based*

SNAP	SNAP name	Chemical Type	Value	Unit	Tier	Source	Comment
060100	Paint application	All types	400	g/kg paint applied	1	GB2023, Chapter 2.D.3.d Coating applications; Table 3-2	PS: to reverse calculate the amounts of coatings used in the 1990-2005 period
060102	Paint application: car repairing	SB	720	g/kg paint applied	2/3	GB2023, Chapter 2.D.3.d Coating applications; Table 3-7	DS: for the years 1990-2006. For 2007 and onwards, annual IEFs from point sources are applied.
060102	Paint application: car repairing	WB	216	g/kg paint applied	2/3	GB2023, Chapter 2.D.3.d Coating applications; Table 3-7 in combination with Table 3-19; Abetment efficiency is taken for "Conventional primer; very high solid surfacer; improved topcoat(s); better cleaning agent(1)" (Efficiency 0.7)	DS: for the years 1990-2007. For 2008 and onwards, annual IEFs from point sources are applied.
060103	Paint application: construction and buildings	SB	230	g/kg paint applied	2	GB2023, Chapter 2.D.3.d Coating applications; Table 3-4	DS: for the whole time series

Return to the Table of Contents

SNAP	SNAP name	Chemical Type	Value	Unit	Tier	Source	Comment
060103	Paint application: construction and buildings	WB	69	g/kg paint applied	2	Chapter 2.D.3.d Coating applications; Table 3-4 (GB2023) in combination with Table 3-17 (GB2016); Abetment efficiency is taken for "Substitution with dispersion/emulsion, water-based and high solids paints" (Efficiency 70%)	DS: for the whole time series
060103	Paint application: construction and buildings	Other paints and varnishes (SB; WB)	149.5	g/kg paint applied	2	Average taken from the sum of 230 g/kg and 69 g/kg	DS: for the whole time series. Expert estimate; calculated as an average of SB and WB emissions factors.
060104	Paint application: domestic use (except 060107)	SB	230	g/kg paint applied	2	GB2023, Chapter 2.D.3.d Coating applications; Table 3-5	DS: for the whole time series
060104	Paint application: domestic use (except 060107)	WB	69	g/kg paint applied	2	Chapter 2.D.3.d Coating applications; Table 3-5 (GB2023) in combination with Table 3-17 (GB2023); Abetment efficiency is taken for "Substitution with dispersion/emulsion, water-based and high solids paints" (Efficiency 70%)	DS: for the whole time series
060104	Paint application: domestic use (except 060107)	Other paints and varnishes (SB; WB)	149.5	g/kg paint applied	2	Average taken from the sum of 230 g/kg and 69 g/kg	DS: for the whole time series. Expert estimate; calculated as an average of SB and WB emissions factors.

Decorative coating applications

Decorative coating applications (SNAP 060103 and 060104) only encompass NMVOC emissions from diffuse sources. The paint used for decorative coating applications is estimated in the following way:

Paint used for decorative coating applications = Total paint used – Paint used by all point sources – Paint used in car repairs (diffuse sources)

In order to divide paint between construction/building (SNAP 060103) and domestic use (SNAP 060104), paint production companies and construction stores were contacted. The main paint production companies, some of which have no direct sales department, were not able to answer this question.

In addition, interviews conducted in large construction stores revealed that:

1. sales divisions by company and private customer depends upon the marketing policy of the store,
2. a change in the division between 1995 and 2019 also depends upon the marketing policy, and
3. in the years 2004-2007, an increase in paint use was caused mainly by a rapid increase in developments and construction; the increased use of paint was caused mainly by professional painters and construction companies.

As a result of discussions, it is estimated that up to 60% of paint can be assigned to professional painters (SNAP 060103) and the remaining 40% to private customers (SNAP 060104).

The Tier 2 emission factors of the EMEP/EEA Guidebook 2023 (see Table 4.29) are used for NMVOC emission calculations. The general equation is:

$$E_{NMVOC} = AR_{used} \times EF_{NMVOC,technology}$$

where:

E_{NMVOC} = NMVOC emissions;
AR_{used} = the amount of coatings used in diffuse sources;
$EF_{NMVOC,technology}$ = the emissions factor for this technology and NMVOC.

Tier 2 emission factors for solvent-based paints are taken from the Tables 3-4 and 3-5 of the EMEP/EEA Guidebook 2023, from the chapter '2.D.3.d Coating applications'. Emission factors for water-based paints are calculated from the emission factors for solvent-based paints using the abatement efficiency default value of 70%, which is shown in Table 3-17 (EMEP/EEA Guidebook 2023) and which describes the rate of substitution for solvent-based paints with water-based paints, calculated as follows: *230 g/kg paint applied × (100% − 70%) = 69 g/kg paint applied*. The emission factor for other paints and varnishes, where it is impossible to distinguish between solvent and water-based products when it comes to the amount of paint used, has an average emission factor calculated as follows: *(230 g/kg paint applied + 69 g/kg paint applied) / 2 = 149.5 g/kg paint applied*. Emission factors are applied for the entire time series and, at the moment, they do not take into account the impact that EU Directive 2004/42/EC has had when it came into force on 1 January 2007. This is especially valid for the time period before 2007, when VOC content in decorative and vehicle refinishing paint products was not regulated and NMVOC emissions from the use of those products was probably higher.

Industrial coating applications

Industrial coating applications mostly cover pollutant emissions from point sources and, therefore, is considered a Tier 3 methodology. To a small degree, industrial coating applications also includes diffuse source emissions from car repairs. As there is no statistical information regarding the amount of paint used for car repairs, an expert opinion was sought from a representative of the 'repair unit' at the Association of Estonian Automobile Sales and Maintenance Companies (Autode Müügi- ja Teenindusettevõtete Eesti Liit).

The expert opinion in question was supplied by Benefit AS, which is the leading technology and materials supplier for car body and car paint shops in Estonia. The total amount of paint used for car repairs in Estonia is estimated to have risen from 0.1 kt in 1990 to 0.25 kt in 2020. As this is a rough estimate, the annual growth is estimated to be equal. The EMEP/EEA Guidebook 2023 Tier 2 emission factors are used for diffuse sources: 1) for solvent-based paints for the 1990–2006 period; 2) for water-based paints for the 1990–2007 period. For the subsequent period, annual implied emission factors calculated from point source data (see Table 4.30) are applied for emission calculations from diffuse sources.

Precisely how much paint has been used by all permitted companies between 1990 and 2005 is unknown. Therefore, a reverse calculation is carried out by applying the EMEP/EEA Guidebook 2023 Tier 1 NMVOC emission factor of 400 g/kg paint applied for industrial coating application.

Table 4.30 Implied emission factors from point sources for solvent and water-based refinishing products in car repair coating applications (g/kg paint applied)

Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
WB	-	181	255	234	76	110	113	114	133	151	143	174	172	151	124	90
SB	569	443	448	341	349	332	364	421	449	456	453	443	419	431	411	401

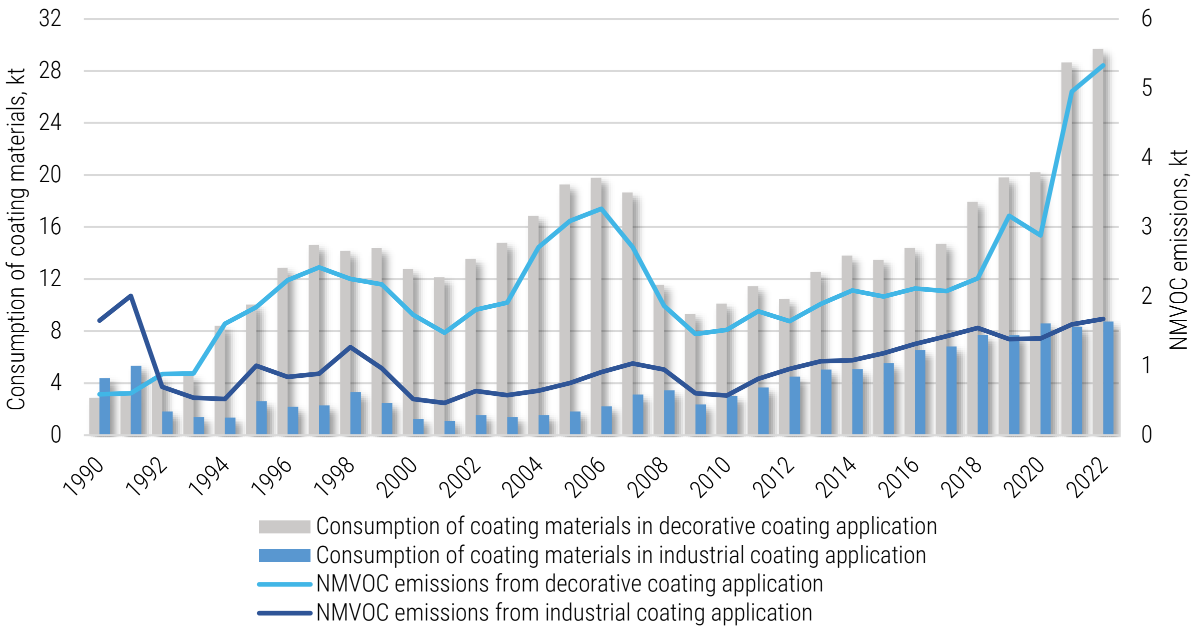


Figure 4.12 The consumption of coating materials and NMVOC emissions from decorative and industrial coating applications in the period of 1990-2022

Table 4.31 presents activity data and NMVOC emissions as the sum of water-based and solvent-based chemicals. However, emission calculations have been made separately for water-based and solvent-based chemicals.

Table 4.31 NMVOC emissions and the consumption of coating materials from decorative paint application by SNAP codes in the period of 1990-2022 (kt)

SNAP code	060103		060104	
Year	NMVOC	Activity data	NMVOC	Activity data
1990	0.35	1.73	0.24	1.16
1995	1.11	6.03	0.74	4.02
2000	1.04	7.67	0.69	5.12
2005	1.85	11.56	1.24	7.71
2010	0.91	6.07	0.61	4.04
2015	1.20	8.10	0.80	5.40
2016	1.27	8.64	0.85	5.76
2017	1.25	8.83	0.83	5.89
2018	1.36	10.77	0.91	7.18
2019	1.90	11.90	1.27	7.93
2020	1.73	12.13	1.15	8.08
2021	2.97	17.20	1.98	11.46
2022	3.20	17.82	2.13	11.88

Table 4.32 NMVOC emissions and consumption of coating materials from industrial paint application by SNAP codes in the period of 1990-2022 (kt)

SNAP code	060100		060101		060102		060105		060106		060107		060108	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	1.58	4.23	NA	NA	0.05	0.10	NA	NA	IE	IE	IE	IE	0.03	0.06
1995	0.80	2.14	NA	NA	0.06	0.12	NA	NA	IE	IE	0.05	0.12	0.09	0.24
2000	--	--	NA	NA	0.07	0.14	NA	NA	0.12	0.29	0.12	0.30	0.21	0.53
2005	--	--	0.002	0.004	0.09	0.17	NA	NA	0.13	0.33	0.18	0.46	0.35	0.87
2010	--	--	NA	NA	0.05	0.19	NA	NA	0.16	0.58	0.24	1.53	0.12	0.73
2015	--	--	NA	NA	0.08	0.34	0.01	0.06	0.09	0.26	0.66	3.54	0.34	1.35
2016	--	--	NA	NA	0.11	0.47	0.01	0.05	0.08	0.30	0.67	3.78	0.44	1.94

SNAP code	060100		060101		060102		060105		060106		060107		060108	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
2017	--	--	NA	NA	0.12	0.29	0.01	0.06	0.08	0.34	0.66	4.40	0.56	1.74
2018	--	--	NA	NA	0.12	0.29	0.01	0.05	0.09	0.32	0.69	4.73	0.63	2.31
2019	--	--	NA	NA	0.13	0.31	0.01	0.05	0.08	0.25	0.56	4.58	0.61	2.50
2020	--	--	NA	NA	0.12	0.31	0.01	0.05	0.11	0.44	0.58	4.89	0.57	2.91
2021	--	--	NA	NA	0.12	0.32	0.01	0.05	0.13	0.49	0.68	4.97	0.66	2.54
2022	--	--	NA	NA	0.12	0.32	0.01	0.05	0.15	0.58	0.69	5.28	0.71	2.51

NMVOC emissions presented in Table 4.32 are collected from point sources. Emissions for the period of 1990–1999 are received from facilities on paper reports; emissions for the period of 2000–2005 were submitted into the CollectER database by an ESTEA air specialist, but they were also based on the paper reports received from facilities. Since 2006, detailed emissions and activity data are reported electronically by facilities directly to the point sources database.

For some years, the coating application sector also includes particulate matter emissions, which are collected from the point sources database. Particulate matter emissions come mainly from the paint chambers.

When only PM$_{2.5}$ emissions are reported, it is assumed that PM$_{10}$ and TSP emissions are equal to the PM$_{2.5}$ emissions as larges size particle also include PM$_{2.5}$ size particles.

When only PM$_{10}$ emissions are reported, it is assumed that TSP emissions are equal to the PM$_{10}$ emissions. As the share of the PM$_{2.5}$ is not known, the notation key NA is used.

4.2.5.3. Source-Specific QA/QC and Verification

Normal statistical quality checks related to the assessment of magnitude and trends are carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The data reported and entered into the point sources database by operators are checked by specialists from ESTEA.

4.2.5.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.6. Degreasing (NFR 2D3e)

4.2.6.1. Source Category Description

The metalworking industries are the major users of solvent degreasing. Solvent degreasing is also used in industries such as printing and in the production of chemicals, plastics, rubber, textiles, glass, paper, and electric power. Also, repair stations for transportation vehicles use solvent cleaning on occasion. Therefore, a wide range of activities is covered.

Metal degreasing by using organic solvents takes place in either open top or closed tanks. The open top tanks, however, have been phased out in the European Union due to the Solvent Emissions Directive 1999/13/EC. Only small facilities which use no more than 1 or 2 tonnes of solvent per year (depending on the risk profile of the solvent) are still permitted to use open top tanks. Closed tanks offer much better opportunities for the recycling of solvents.

Return to the Table of Contents

In 2022, NMVOC emissions from this sector had decreased by 54.1% in comparison to the year 1990. Compared to 2021, NMVOC emissions in 2022 decreased by 0.7%.

Vapour Cleaning

The most common organic solvents for vapour cleaning are:

- methylene chloride (MC);
- tetrachloroethylene (PER);
- trichloroethylene (TRI);
- xylenes (XYL).

The use of chlorofluorocarbons (CFC) in the past is now displaced by HFCs or PFCs. The use of 1,1,1-trichloroethane (TCA) has been banned since the Montreal Protocol and replaced by TRI. Further details of the calculation of the emissions can be found in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The application of MC, PER and TRI normally requires a closed cleaning machine.

Cold Cleaning

The two basic types of cold cleaners are maintenance and manufacturing. Cold cleaners are batch loaded, non-boiling solvent degreasers, usually providing the simplest and least expensive method of metal cleaning. Maintenance cold cleaners are smaller, more numerous, and they generally use petroleum solvents as mineral spirits (petroleum distillates and Stoddard solvents).

Cold cleaner operations include spraying, brushing, flushing, and immersion. In a typical maintenance cleaner, dirty parts are cleaned manually by first spraying and then soaking in the tank. After cleaning, the parts are either suspended over the tank to drain or are placed on an external rack that directs the drained solvent back into the cleaner. The cover is intended to be closed whenever parts are not being handled in the cleaner. Typical manufacturing cold cleaners vary widely in design, but there are two basic tank designs: the simple spray sink and the dip tank. Of these, the dip tank provides more thorough cleaning through immersion, and often the cleaning efficiency is improved by agitation. Small cold cleaning operations may be numerous in urban areas.

4.2.6.2. Methodological Issues

The EMEP/EEA Guidebook 2023 Tier 2 emission factor 710 g/kg cleaning products for the open-top degreaser is used for NMVOC emission calculations taking into account the penetration of different technologies and replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology,abated} = (1 - \eta_{abated}) \times EF_{technology}$$

where,

$EF_{technology,abated}$ = emission factor for specific technology taking into account the abatement efficiency;
η_{abated} = abatement efficiency;
$EF_{technology}$ = emission factor for specific technology.

The general equation for emission calculations is:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

where

$E_{pollutant}$ = the emission of the specified pollutant;

$AR_{production}$ = the activity rate for the paint application (consumption of paint);
$EF_{pollutant}$ = the emission factor for this pollutant.

Five different process types (together called ‘technologies’) are taken into account which are:

- Open-top degreaser;
- Semi open-top degreaser;
- Semi open-top degreaser with activated carbon;
- Sealed chamber system using chlorinated solvents;
- Cold cleaner.

As there is no information on emission factors for all of those technologies, it is assumed that the emission factor for those technologies is the same as presented in the EMEP/EEA Guidebook 2023 for the open-top degreasers. The Table 4.33 below presents used emission factors and the reduction efficiencies for degreasing which are taken from the Table 3-4 presented in the Chapter ‘2.D.3.e Degreasing’ of the EMEP/EEA Guidebook 2023

Table 4.33 Tier 2 emission factors and abatement efficiencies for degreasing activities

Abatement technology	Pollutant	$EF_{technology}$, g/kg cleaning product	Efficiency, %	$EF_{technology,abated}$, g/kg cleaning product
Open-top degreaser	NMVOC	710	0	710
Semi open-top degreaser and good housekeeping	NMVOC	710	25	533
Semi open-top degreaser and good housekeeping with activated carbon	NMVOC	710	85	107
Sealed chamber system using chlorinated solvents	NMVOC	710	95	36
Cold cleaner	NMVOC	710	89	78

There is also no information available how different degreasing process types are stratified in Estonia, but an expert opinion has been formed in ESTEA how the penetration of different technologies within the degreasing industry could have been evolved (see Table 4.34). The expert opinion was formed in 2018. Forming the opinion, the development of technology was assessed, taking in to account the legislation, which obliged the replacement of hazardous solvents with less hazardous ones. The opinion was also based on information that, open-top vapour degreasers have been phased out in the EU following the Solvents Emissions Directive 1999/13/EC. It was assumed that sealed chamber system using chlorinates solvents were in use. Since chlorinated solvents are carcinogenic, mutagenic, reproductively toxic solvents, and the solvents directive recommended replacing them with safer ones as soon as possible, it was assumed that after Estonia joined the EU, their share began to gradually decrease. The opinion also assumed wider adoption of the best available technique and the need to reduce NMVOC emissions.The shares of different technologies within the pillar years have been interpolated (see Figure 4.13).

Table 4.34 The shares of different technologies within the degreasing industry (for the pillar years)

Technology	1990	1995	2000	2005	2010	2015	2020	2021	2022
Open-top degreaser	25%	20%	15%	5%	0%	0%	0%	0%	0%
Semi open-top degreaser and good housekeeping	5%	10%	10%	10%	10%	5%	0%	0%	0%
Semi open-top degreaser and good housekeeping with activated carbon	0%	0%	5%	10%	15%	20%	25%	26%	27%
Sealed chamber system using chlorinated solvents	10%	10%	10%	10%	5%	5%	0%	0%	0%
Cold cleaner	60%	60%	60%	65%	70%	70%	75%	74%	73%

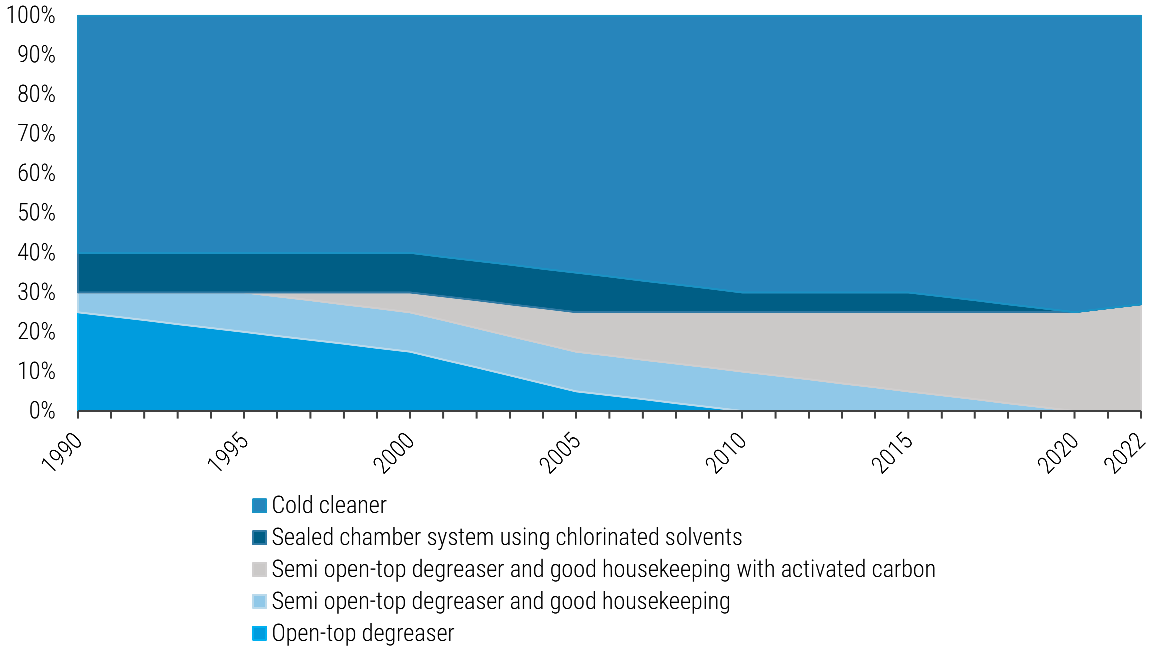


Figure 4.13 The shares of different technologies within the degreasing industry for the period of 1990-2022

For some years the degreasing sector also includes fine particulate matter, heavy metals and ammonia emissions which are collected from the point sources database.

Consumption of the most common organic solvents for vapour cleaning methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL) are used as a basis for emission calculations from degreasing.

As PER is also used for dry cleaning, this is not included as a degreaser.

The consumption of organic solvents is estimated by the import and export data from Statistics Estonia (by relevant CN codes) for the years 1995-2022. Data regarding import and export are not available for the years 1990-1994; therefore, these amounts were calculated by the change of percentage of the current prices in the industrial production of chemicals and chemical products in that period. There is no information available regarding production data for the years 1990-2005.

As there is no information on stock data for the end of the year, it is assumed that all solvents have been used in the specific year.

Part of the facilities report NMVOC emissions from degreasing operations as point sources. These are taken into account in the calculations of degreasing operations.

Between 2006 and 2022, the point sources database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2022, activity data for calculations were calculated as follows:

Solvent use in diffuse sources = Total solvent use – Solvent use in point sources

Some facilities reported emissions between 1995 and 2005, but without access to activity data. Emissions from point sources were subtracted from the total calculated NMVOC emission.

NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2022 are presented in the Table 4.35.

Table 4.35 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2022 (kt)

SNAP code	060200		060201		060203		060204	
Year	NMVOC (vapour and cold cleaning)	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	0.18	0.71	NA	NA	NA	NA	NA	NA
1995	0.08	0.31	NA	NA	NA	NA	NA	NA
2000	0.08	0.39	NA	NA	0.001	0.001	NA	NA
2005	0.05	0.32	0.0003	0.0005	0.003	0.004	0.001	0.001
2010	0.01	0.12	0.01	0.01	0.005	0.01	0.02	0.02
2015	0.01	0.06	0.01	0.01	0.004	0.01	0.04	0.06
2016	0.01	0.08	0.01	0.01	0.003	0.01	0.06	0.08
2017	0.01	0.14	0.01	0.01	0.01	0.02	0.06	0.08
2018	0.004	0.04	0.01	0.01	0.01	0.02	0.06	0.09
2019	0.00	0.00	0.01	0.01	0.01	0.02	0.05	0.08
2020	0.002	0.03	0.01	0.01	0.01	0.02	0.05	0.09
2021	0.003	0.04	0.01	0.01	0.01	0.02	0.07	0.11
2022	0.002	0.02	0.005	0.01	0.01	0.03	0.06	0.12

For the SNAP codes 060201, 060203 and 060204, emissions and solvent consumption are based only on the reported data from the point sources for the period 2000-2022.

4.2.6.3. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are checked by specialists from the ESTEA.

4.2.6.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.7. Dry Cleaning (NFR 2D3f)

4.2.7.1. Source Category Description

Dry Cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres, by using organic solvents.

Emissions arise from evaporative losses of solvent, primarily from the final drying of the clothes, known as deodorisation. Emissions may also arise from the disposal of wastes from the process.

The most widespread solvent used in dry cleaning, accounting for about 90% of total consumption, is tetrachloroethene (also called tetrachloroethylene or perchloroethylene (PER)). The most significant pollutants from dry cleaning are NMVOCs, including chlorinated solvents. Heavy metals and POPs emissions are unlikely to be significant.

NMVOC emissions from dry cleaning are insignificant, accounting for only 0.03% of the 2022 NMVOC emissions from the solvent sector. In 2022, NMVOC emissions from dry cleaning had decreased by 72.3% in comparison to the year 1990. Compared to 2021, NMVOC emissions in 2022 decreased by 23.1%.

4.2.7.2. Methodological Issues

In the Tier 1 approach, the emissions are estimated from solvent consumption data. Most of the solvent is recycled, but some is lost to the environment. This needs to be replaced and it can be assumed that the quantity of solvent used for replacement is equivalent to the quantity emitted plus the quantity taken away with the sludge.

Solvent emissions directly from the cleaning machine into the air represent about 80% of the solvent consumption (i.e. 80% of solvent used for the replacement of lost solvent) for open-circuit equipment and a little more than 40% for a closed-circuit machine. Open-circuit equipment, however, is no longer used within the EU following the European Solvents Directive coming into force. The remainder of the lost solvent is released into the environment in still residues or retained on cleaned clothes, but for the simpler methodology, it can be assumed that this eventually finds its way into the atmosphere (Passant, 1993[8]; UBA, 1989[9]). Also, a significant amount of the solvent goes back to the producers and to the recyclers, along with the sludge.

Solvent consumption data may be available from the industry and can be compared with a per capita emission factor. In addition, the proportion of solvent lost directly from the machine can also be estimated.

The Tier 1 default emission factors for NMVOC emissions from dry cleaning are a weighted average, calculated from the sum of all activity and emission data from the GAINS model (IIASA, 2008[10]) – 40 g/kg textile treated.

Situation in Estonia

In order to understand the market situation, a descriptive interview with the representative of the main dry cleaning service provider, SOL Estonia, was carried out in 2010.

Main findings for Estonia are:

- closed-circuit equipment is mainly used for dry cleaning;
- closed-circuit equipment was the main practice as far back as the 1990s;
- the main cleaning agent is PER (tetrachloroethylene / perchloroethylene);
- solvent waste (used solvent) is collected and given to hazardous waste companies;
- the quantity of cleaned textile is registered by cleaned items (for example, the number of cleaned coats or curtains), not by mass units.

In addition, four dry cleaning facilities were questioned by phone and e-mail. Questions and answers are presented in the Table 4.36.

Table 4.36 The results of the interviews with the dry cleaning operators

Question	Answers			
	Virumaa Puhastus	Euroclean	Pernau Pesumaja	Rea Pesumaja
Technology used?	Closed-circuit machines	Closed-circuit machines (automatic programs)	Closed-circuit machines with activated carbon	Closed-circuit machines
Cleaning agent used?	PER	PER	PER	PER

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[8] Passant N.R. (1993). Emissions of Volatile Organic Compounds from Stationary Sources in the United Kingdom: A Review of Emission Data by Process.

[9] UBA (1989). Luftreinhaltung '89 – Tendenzen – Probleme – Lösungen. Edited by the German Federal Protection Agency (Umweltbundesamt), Erich Schmidt Verlag GmbH, Berlin 1989.

[10] IIASA (2008). Greenhouse Gas and Air Pollution Integrations and Synergies (GAINS) model, www.iiasa.ac.at/rains/gains-online.html.

Return to the Table of Contents

Question	Answers			
	Virumaa Puhastus	Euroclean	Pernau Pesumaja	Rea Pesumaja
Quantity of cleaning agent?	30 kg per year	400 kg per year	165 kg per year	1,070 kg per year
Quantity of cleaned textiles?	ca 2,000 kg	Do not have statistics	Register by pieces (app. equal to 6.2 tonnes)	Register by pieces
Waste management?	Collected	Collected and given to hazardous waste company	Collected and given to hazardous waste company	Collected and given to hazardous waste company

Activity data

As the quantity of textile treated is very difficult to estimate because even dry cleaning shops do not have the relevant statistics, solvent consumption is taken as a basis for NMVOC calculations.

Solvent emissions direct from the cleaning machine into the air represent about 80% of solvent consumption (i.e. 80% of solvent used for the replacement of lost solvent) for open-circuit equipment and a little more than 40% for a closed-circuit machine.

All dry cleaning facilities questioned have closed-circuit equipment and use PER as a cleaning agent. Used solvent goes to hazardous waste companies.

The quantity of PER used in Estonia can be estimated by import and export data. Data regarding import and export are not available for the years 1990-1994; therefore, these amounts were calculated by the change in percentage of the current prices in industrial production of chemicals and chemical products in that period.

As there is no information on stock data for the end of the year, it is assumed that all PER has been used in the specific year.

According to point sources database, a portion of PER emissions is reported as emissions from point sources. This is also subtracted to determine the amount of PER emissions from diffuse sources.

Results

Perchloroethylene might also be used in the degreasing process. It is difficult to divide the consumption of PER between dry cleaning and degreasing, which is why all PER used in Estonia is deemed to be used for dry cleaning purposes.

The emission factor for degreasing is also 460 g/kg cleaning products, which is more or less about 40% of the used products. Because of that it is reasonable to use the emission factor 400 g/kg solvent use for dry cleaning activity.

Table 4.37 NMVOC emissions and the consumption of solvents from dry cleaning in the period of 1990-2022 (kt)

SNAP code	060202	
Year	NMVOC	Activity data
1990	0.01	0.04
1995	0.02	0.06
2000	0.05	0.13
2005	0.06	0.15
2010	0.01	0.03
2015	0.03	0.07
2016	0.01	0.00
2017	0.01	0.01
2018	0.01	0.01
2019	0.01	0.01
2020	0.01	0.01
2021	0.01	0.01

SNAP code	060202	
Year	NMVOC	Activity data
2022	0.004	0.01

For the dry cleaning sector in years 1990 to 2001, only statistical data is used, whereas for the period of 2002 to 2022, both statistical and reported data are used.

4.2.7.4. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends has been carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The data reported and entered into the point sources database by operators are checked by specialists from the ESTEA.

4.2.7.5. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.8. Chemical Products (NFR 2D3g)

4.2.8.1. Source Category Description

This chapter covers emissions from the use of chemical products. These include many activities such as paints, inks, glues and adhesives manufacturing, polyurethane and polystyrene foam processing, tyre production, fat, edible and non-edible oil extraction, and more. However, many of these activities are considered insignificant. For example, the total NMVOC emissions from these activities contributed just 0.6% to the total national NMVOC emissions in 2022 and only 1.3% to the whole solvent sector.

By 2022, NMVOC emissions from the chemical products sector had decreased by 66.7% compared to the year 1990. Compared to 2021, NMVOC emissions in 2022 decreased by 20.2%.

In Estonia, several companies have been issued activity licenses for the production of pharmaceutical products. The manufacture of pharmaceutical products includes preparation (including the production of blood components and medicinal gases), sterilization, packaging and re-packaging, labeling and re-labeling, quality control, and batch release of medicinal products, as well as related activities such as procurement, receipt, storage, and distribution of materials. Environmental permits have been issued to two companies for energy production. It can be assumed that either no pollutants were emitted from the production of medicines or if emitted, the emissions were insignificant, and thus the activity does not require an environmental permit.

The analysis of the annual ambient air reports for the years 2004-2022 revealed that facilities have not reported emissions with SNAP code 060311 (adhesive, magnetic tapes manufacturing).

4.2.8.2. Methodological Issues

This sector includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other chemical products manufacturing or processing activities under SNAP 060314. Polyester Resin Plastic Products Fabrication (polyester processing) is shown under SNAP 060314 (other). All emission estimates for the years 2006-2022 from the chemical products sector are based on emission data reported by facilities in the point source database;

hence they are divided by different SNAP codes. In Estonia, an environmental permit is mandatory if NMVOC emissions exceed 0.5 tons per year. Therefore, it is estimated that the facilities using chemical products have an environmental permit and are not subject to diffuse emissions.

At present, only the total NMVOC emissions for the years 1990-2005 are known to be without any activity data. Also, for some activities within NFR 2D3h, the activity data is unknown for the period of 2006-2022.

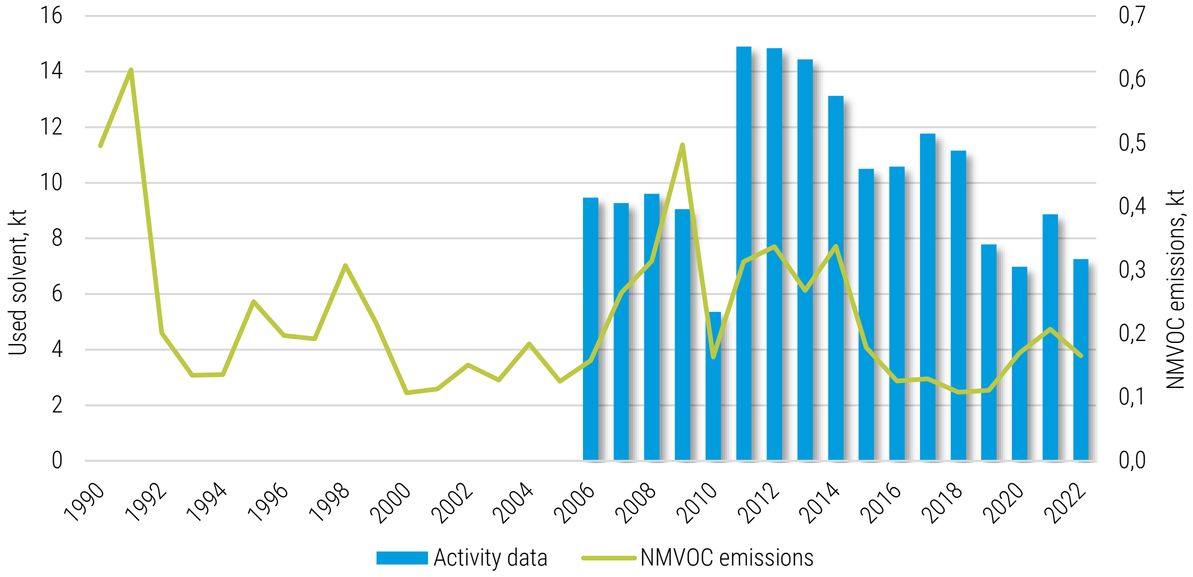

Figure 4.14 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 1990-2022

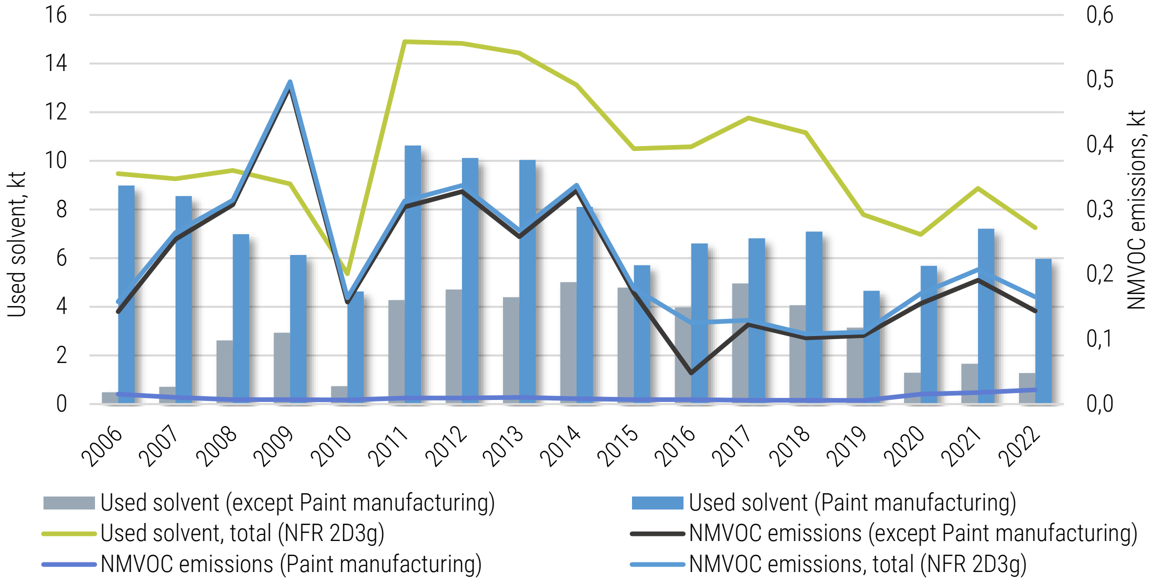

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 2006-2022

Figure 4.15 explains quite well why Figure 4.14 indicates that NMVOC emissions still grew from 2006 to 2009, although the amount of used solvent remained almost constant through that period. It is clear that the dynamics of emissions are dependent on the changes in used solvent within the sector, except the solvent used in paint manufacturing. It is because the emissions in paint manufacturing are marginal and do not affect the dynamics of the total NMVOC emissions in that sector.

NMVOC emissions for the period of 1990 to 2005 came only from point sources, but without the availability of the activity data for that period.

NMVOC emissions and the consumption of solvents from chemical production manufacturing or processing by SNAP codes in the period of 1990-2022 are presented in the Table 4.38.

Table 4.38 NMVOC emissions and the consumption of solvents from chemical products manufacturing or processing by SNAP codes in the period of 1990-2022 (kt)

SNAP code	060300		060303		060304		060305		060307	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	0.50	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	0.25	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0.11	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	0.13	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010	--	--	0.01	0.01	0.05	0.07	0.01	0.01	0.01	4.63
2015	--	--	0.01	3.02	0.06	0.10	0.02	0.01	0.01	5.71
2016	--	--	0.01	3.09	0.07	0.06	0.02	0.02	0.01	6.61
2017	--	--	0.01	3.60	0.08	0.04	0.01	0.01	0.01	6.81
2018	--	--	0.01	2.94	0.07	0.04	0.01	0.01	0.01	7.09
2019	--	--	0.01	2.09	0.07	0.01	0.004	0.20	0.01	4.65
2020	--	--	0.01	NA	0.07	0.08	0.004	0.01	0.02	5.68
2021	--	--	0.01	NA	0.07	0.002	0.004	0.004	0.02	7.21
2022	--	--	0.003	NA	0.08	0.002	0.004	0.004	0.022	5.97

Table 4.38 continues

SNAP code	060308		060309		060312		060313		060314	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010	0.0003	0.03	0.0004	0.001	0.000001	NA	0.0003	0.01	0.08	0.60
2015	NA	NA	NA	NA	0.0002	0.0001	0.0002	0.01	0.09	0.64
2016	NA	NA	NA	NA	0.001	0.39	0.0002	0.01	0.02	0.41
2017	NA	NA	NA	NA	0.001	0.69	0.0002	0.01	0.02	0.61
2018	NA	NA	NA	NA	0.001	0.69	0.0002	0.01	0.02	0.39
2019	NA	NA	NA	NA	0.002	0.45	0.0002	NA	0.03	0.39
2020	NA	NA	NA	NA	0.002	0.50	0.0001	0.01	0.07	0.71
2021	NA	NA	NA	NA	0.003	0.67	0.0001	0.01	0.10	0.98
2022	NA	NA	NA	NA	0.001	0.243	0.00005	0.004	0.06	1.03

For some years, the chemical products sector also includes particulate matter, ammonia, SO_x, CO and Cr emissions, which are collected from the point source database.

When only $PM_{2.5}$ emissions are reported, it is assumed that PM_{10} and TSP emissions are equal to the $PM_{2.5}$ emissions as larges size particle also include $PM_{2.5}$ size particles.

4.2.8.3. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are checked by from the ESTEA.

4.2.8.4. Source-Specific Planned Improvements

As some activities are not included in this inventory (by the SNAP codes 060302, 060311), it is necessary to research whether the emissions from these activities are important for this inventory or whether they exist in Estonia at all.

For the years 2006-2014, pollutant emissions from glue production have been reported in the annual air reports (SNAP oos 060309). It is necessary to analyze whether it is the production of resins in the chemical industry. If it is resin production, there may be a need to reallocate emissions under the correct SNAP code (e.g. under SNAP code 040527).

4.2.9. Printing (NFR 2D3h)

4.2.9.1. Source Category Description

Printing involves the use of inks, which may contain a proportion of organic solvents. These inks may then be subsequently diluted before use. Different inks have different proportions of organic solvents and require dilution to varying extents. Printing can also require the use of cleaning solvents and organic dampeners. Ink solvents, diluents, cleaners and dampeners may all make a significant contribution to emissions from industrial printing and involve the application of inks using presses.

In the EMEP/EEA guidebook, the following printing categories are identified:

- Heat set offset printing;
- Publication and packaging;
- Rotogravure and Flexography.

The emissions of NMVOCs from printing have been significantly reduced following the introduction of the Solvent Emissions Directive 1999/13/EC in March 1999, which was adopted in Estonia in 2004. Larger facilities are now required to control their emissions in such a way that the emission limit value in the residual gas does not exceed a maximum concentration. The threshold is 15 tonnes/year for the heat set offset and flexography/rotogravure in packaging and 25 tonnes/year for the publication gravure (for the latter installations below, the thresholds are not likely to exist).

In 2022, the NMVOC emissions of the printing sector accounted for only 1.3% of the national total NMVOC emissions and only 2.7% of the total NMVOC emissions of the solvent sector. NMVOC emissions from printing had increased by 324.1% compared to the year 1990. However, in 2022, NMVOC emissions from printing decreased by 25.5% compared to 2021. Printing ink consumption also decreased in 2022 compared to 2021.

4.2.9.2. Methodological Issues

The EMEP/EEA Guidebook 2023 Tier 1 emission factor 500 g/kg ink is used for the calculations of emissions from the printing sector for diffuse sources. The following equation is applied:

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

where

$E_{pollutant}$ = the emission of the specified pollutant;

$AR_{production}$ = the activity rate for the paint application (consumption of paint);
$EF_{pollutant}$ = the emission factor for this pollutant.

It involves either the use of solvent consumption data or combining ink consumption with emission factors for the industry. Unless solvent consumption data are used, the use of water based or low solvent inks as well as the extent of controls such as incineration are not considered.

An approach combining ink consumption with the emission factor is applied.

The emission factor has been estimated to be constant over the period. According to the revenues of the printing sector, the major part of printing is done for advertisements and the press. From Corinair[11], it can be concluded that the following techniques are applied (with relevant emission factors) for press and edition/ publication:

- cold set web offset – 54 kg/t (g/kg) ink consumed;
- heat set web offset – 82 kg/t (g/kg) ink consumed;
- rotogravure – 425 kg/t (g/kg) ink consumed.

As these stay below the current emission factor, it does not change over the period.

The quantity of ink (CN code 3215) used in Estonia can be estimated by the import and export data from Statistics Estonia (1995-2020). Data regarding import and export are not available for the years 1990-1994; therefore, these amounts were calculated by the change in percentage of the current prices in the industrial production of chemicals and chemical products in that period.

As there is no information on stock data for the end of the year, it is assumed that all ink has been used in the specific year.

A number of printing facilities are permitted.

Between 2006 and 2022, activity data regarding ink use in point sources were collected in the point source database. For these years activity data for calculations was calculated as follows:

Ink used in diffuse sources = Total ink used – Ink used in point sources

In 2005, according to CollectER, five companies reported as point sources. No activity data was available. Emissions from point sources were subtracted from the total calculated NMVOC emissions.

Table 4.39 NMVOC emissions and the consumption of solvents from the printing industry in the period of 1990-2022 (kt)

SNAP code	060403	
Year	NMVOC	Activity data
1990	0.08	0.16
1995	0.13	0.25
2000	0.25	0.50
2005	0.75	1.49
2010	0.35	1.73
2015	0.32	1.84
2016	0.31	1.91
2017	0.47	1.68
2018	0.34	1.79
2019	0.34	1.35
2020	0.33	1.37
2021	0.45	1.61
2022	0.34	1.41

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[11] Atmospheric Emission Inventory Guidebook. Second Edition. EEA 2000

4.2.9.3. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The data reported and entered into the point sources database by operators are first checked by specialists from the ESTEA.

4.2.9.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.10. Other Solvent Use (NFR 2D3i)

4.2.10.1. Source Category Description

This sector includes activities such as fat, edible and non-edible oil extraction, application of glues and adhesives, preservation of wood, underseal treatment and conservation of vehicles and vehicles dewaxing.

Fat, edible and non-edible oil extraction

This activity includes solvent extraction of edible oils from oilseeds and the drying of leftover seeds before resale as animal feed.

If the oil content of the seed is high, such as in olives, the majority of the oil is pressed out mechanically. Where the oil content is lower or the remaining oil is to be taken from material that has already been pressed, solvent extraction is used.

Hexane has become a preferred solvent for extraction. In extracting oil from seeds, the cleaned and prepared seeds are washed several times in warm solvent. The remaining seed residue is treated with steam to capture the solvent and oil that remain in it.

The oil is separated from the oil-enriched wash solvent and from the steamed-out solvent. The solvent is recovered and re-used. The oil is further refined.

Preservation of wood

This activity encompasses industrial processes for the impregnation with or immersion of timber in organic solvent based preservatives, creosote or water based preservatives. Wood preservatives may be supplied for both industrial and domestic use. This activity covers only industrial use and does not include the domestic use of wood preservatives, which is covered under the NFR source category 2D3a, Domestic solvent use. Most of the information currently available on emissions relates to the industrial use of wood preservatives. This section is not intended to cover the surface coating of timber with paints, varnishes or lacquer.

Vehicles dewaxing

Some new cars have a protective covering applied to their bodies after painting to provide protection during transport. For example, in the UK this is usually only done on cars destined for export. Removal of the coating is usually only done at import centres. In continental Europe, cars are transported long distances on land as well as imported from overseas, so the driving forces affecting the use of such coatings may be different.

Transport protection coverings are not applied to the whole car body, but only to regions of the body considered vulnerable to damage during transport. The pattern of application varies from one manufacturer to another. Some manufacturers do only the bumper, while others do only the driver's door; some do the horizontal surfaces while others do the sides as well.

There are various methods for applying coverings for protection during transport. Traditionally, a hydrocarbon wax was used, which had to be removed using a mixture of hot water, kerosene and detergent. Recently, two alternative methods have been introduced. The first of these is a water-soluble wax, which can be removed with hot water alone without the need for kerosene. The second is a self-adhesive polyethylene film called 'Wrap Guard'. This can be peeled off by hand and disposed of as ordinary commercial waste. Most European car manufacturers are currently either already using self-adhesive polyethylene film or are evaluating it. It is expected that within a few years all European manufacturers will be using self-adhesive polyethylene film as their only method of applying transportation protective coverings, as has been the case in the US for the past number of years.

Treatment of vehicles

This section addresses the application of protective coatings to the undersides of cars. It is only a very small source of emissions and can be considered negligible nowadays.

Before the early 1980s, car manufacturers did not apply any coating to the underside of their cars. If a car owner wanted to protect his car against rust and stone chip damage, he had to pay to have his car 'undersealed' at a garage or workshop. This involved the application of a bituminous coating. The market for this service is no longer very large in much of Western Europe. It may still occur in Eastern Europe, in countries that have cold climatic conditions, and in the restoration and maintenance of vintage cars, but this activity is likely to be insignificant.

Industrial application of adhesives

Sectors using adhesives are very diverse as are production processes and application techniques.

Relevant sectors include the production of adhesive tapes, composite foils, the transportation sector (passenger cars, commercial vehicles, mobile homes, rail vehicles and aircrafts), the manufacture of shoes and leather goods, the wood material and furniture industry (EGTEI, 2003[12]).

In the NFR source category 2D3i , the largest share was the use of adhesives (SNAP 060405) at 96.0%, followed by the use of other solvents (SNAP 060412) at 3.0%. Other activities are insignificant, as their share is less than 0.1%.

In 2022, NMVOC emissions from the NFR 2D3i sector had increas by 16.1% compared to the year 1990. In 2022, NMVOC emissions from the use of other solvents decreased by 21.6% compared to 2021. The main reason for this decrease was the reduced consumption of adhesives.

NMVOC emissions and corresponding activity data for the following activities are presented in the Table 4.41.

4.2.10.2. Methodological Issues

Glass and Mineral wool enduction (SNAP 060401, 060402)

The NMVOC emission estimates for these activities are based on the emission data reported by the facilities in the point source database.

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[12] EGTEI (2003). Final background documents on the sectors 'Industrial application of adhesives' and 'Fat, Edible and Non-Edible Oil Extraction'. Prepared in the framework of EGTEI by CITEPA, Paris.

Return to the Table of Contents

Fat, edible and non-edible oil extraction (SNAP 060404)

The major type of seed used for oil production in Estonia is rape. As solvents are not used in oil production in Estonia, the NMVOC emissions that have occurred in the process are of natural origin and are reported by operators who adhere to the environmental permit. Some smaller units also press oil out from other seeds, such as flax.

The main oil extracting company in Estonia is Scanola Baltic (former Werol Industries plc).

The company does not use solvents for oil extraction. From 2019, emissions from oil production are shown under SNAP 040609z.

Application of glues and adhesives (SNAP 060405)

The Tier 2 emission factor is used for calculations: 780 g/kg adhesive[13] for the period of 1990-2000, 522 g/kg adhesive[14] for the period of 2005 and onward. The emission factors for the period of 2001-2004 are interpolated.

Solvent borne adhesives have the CN code 3506 91 00 (adhesives based on polymers of heading 3901 to 3913 or on rubber (excl. products suitable for use as glues or adhesives put up for retail sale as glues or adhesives, with a net weight of ≤ 1 kg).

As this sector does not cover the domestic use of glues and adhesives, glues and adhesives for retail sale are not included.

The quantity of industrially used adhesives is estimated by import, export and production data (CN code 3506 91 00). Import, expor and productiont data are available from Statistics Estonia. At present, there is no information available regarding adhesive production between 1990 and 1999.

As there is no information on stock data for the end of the year, it is assumed that all adhesive has been used in the specific year.

Many facilities using adhesives have an environmental permit.

In the period from 2006 to 2022, activity data regarding adhesives use in point sources are collected in the point sources database (SNAP 060405).

For the years 2006-2022, activity data for calculations are calculated as follows:

Adhesives used in diffuse sources = Total adhesive used – Adhesive used in point sources

In 2000-2005, according to CollectER, some companies reported as point sources, but no activity data are available. Emissions from point sources are subtracted from the total calculated NMVOC emissions.

Preservation of wood (SNAP 060406)

Most of the preservation operations are carried out using waterborne preservatives. Before it was banned in 2004, chromated copper arsenate (CCA) was used. CCA is a waterborne preservative. Some creosote and shale oil were used in the past. Nowadays, creosote is not believed to be used; hence, wood treated with creosote is imported.

Solvent borne preservatives were used by some companies that produce windows, doors and log houses.

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[13] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[14] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023

In Estonia, an environmental permit is mandatory if NMVOC emissions exceed 0.5 tons per year. Therefore, it is estimated that these facilities are covered with environmental permits (point sources) and are not subject to diffuse emissions.

Underseal treatment and conservation of vehicles (SNAP 060407)

There is no statistical information regarding the treatment of vehicles. Therefore, in 2010 expert opinion was sought from a representative of the Association of Estonian Automobile Sales and Maintenance Companies "repair unit". Expert opinion was received from Benefit AS, which is the leading car body and car paint shops technology and materials supplier.

Between 1990 and 2000, treatment with bituminous materials was widespread, but there are no statistics available. Nowadays, treatment with bituminous coating is negligible, and treatment is done by special polymers, if needed.

So, NMVOC emissions from this activity are calculated for the years 1990 to 2004, and emissions from the treatment of vehicles are considered negligible since 2005.

The Tier 2 emission factor from the EMEP/EEA Guidebook 2023 is used for calculations: 0.2 kg/person/year.

As the number of cars in Estonia per inhabitant was lower than the number of cars per inhabitant in the European Union, a reduction coefficient for the emission factor is applied.

Table 4.40 Motorisation rate - cars per 1,000 inhabitants

Year	Number of vehicles per 1000 inhabitants		Coefficient, %
	Estonia	EU-15	
1990	153	386	40
1991	167	386	43
1992	182	401	45
1993	210	413	51
1994	229	420	55
1995	265	427	62
1996	285	435	66
1997	304	436	70
1998	324	451	72
1999	333	461	72
2000	338	472	72
2001	298	480	62
2002	294	485	61
2003	320	489	65
2004	349	490	71

It means that, for example, in 1995 the number of cars per inhabitant accounted for 62% of the average European Union country value and in 2000 for 72%. Information for 1990 was not found and it was considered equal with the year 1991.

The customised emission factors were calculated by the following example:

Year 1995: 0.2 x 62% = 0.124 kg/person/year;

Year 2000: 0.2 x 72% = 0.143 kg/person/year.

Considering that NMVOC emissions from vehicles treatment since 2005 are considered negligible, emission factors for the years 2001-2004 are not calculated using the previous method and are reduced 10% per year from the year 2000.

Vehicles dewaxing (SNAP 060409)

The Association of Estonian Automobile Sales and Maintenance Companies and Toyota Baltic plc were interviewed in 2010 regarding this activity.

It was found that no dewaxing operations have been carried out in at least the last five years. If required, paint protection is provided by using polyethylene film. Waxing is only used in very rare cases, such as special deliveries by sea transport from long distances.

In the period from 1995 to 2005, dewaxing was carried out in rare cases, i.e. special delivery directly from Japan. For these cases, it is not known if dewaxing was carried out in Finland or in Estonia as it is difficult to obtain relevant data. Most dewaxing operations of imported cars are conducted in a treatment centre located in the port of Hanko in Finland.

According to the information collected, NMVOC emissions from this source are considered to be approximately zero and historical emissions are considered negligible.

Other (SNAP 060412)

NMVOC emissions and activity data for the years 2000-2022 are gathered from point sources and CollectER databases and are reported by facilities.

Table 4.41 NMVOC emissions from other solvent use and the activity data by SNAP codes in the period of 1990-2022 (kt)

SNAP code	060400		060402		060404		060405		060406	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	0.82	NA	NA	NA	NA	NA	0.32	0.41	NA	NA
1995	0.41	NA	NA	NA	NA	NA	0.22	0.28	NA	NA
2000	--	--	NA	NA	NA	NA	0.91	1.16	0.001	NA
2005	--	--	NA	NA	0.002	NA	1.38	2.64	0.00001	NA
2010	--	--	NA	NA	0.001	NA	0.40	1.26	0.01	0.02
2015	--	--	NA	NA	0.002	NA	0.61	2.38	0.01	0.03
2016	--	--	NA	NA	0.002	NA	0.65	2.28	0.01	0.02
2017	--	--	NA	NA	0.002	NA	0.76	2.27	0.01	0.03
2018	--	--	NA	NA	0.002	NA	0.82	2.90	0.003	0.01
2019	--	--	NA	NA	NA	NA	1.00	3.04	0.00	0.02
2020	--	--	NA	NA	NA	NA	1.67	4.20	0.001	0.01
2021	--	--	0.0004	0.0004	NA	NA	1.82	4.48	0.001	0.01
2022	--	--	0.0003	0.0003	NA	NA	1.42	3.80	0.001	0.002

Table 4.41 continues

060407		060412	
NMVOC	Activity data. mln.inhab.	NMVOC	Activity data
0.12	1.57	NA	NA
0.18	1.45	NA	NA
0.20	1.40	0.01	NA
NO	--	0.00	NA
NO	--	0.01	0.07
NO	--	0.04	0.09
NO	--	0.04	0.08
NO	--	0.04	0.11
NO	--	0.03	0.21
NO	--	0.03	0.06
NO	--	0.04	0.10
NO	--	0.05	0.10
NO	--	0.05	0.10

Return to the Table of Contents

4.2.10.4. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are checked by specialists from the ESTEA.

4.2.10.5. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.11. Other Product Use (NFR 2G)

4.2.11.1. Source Category Description

This sector includes emissions from activities such as the use of fireworks, combustion (smoking) of tobacco, the use of shoes, and lubricant consumption in different vehicle types. The use of shoes is not currently included in the inventory, as it is not clear from the EMEP/EEA Guidebook 2023 to what kind of activity exactly the emission factor for the use of shoes applies. For this inventory it is assumed that all the NMVOC emission is emitted from the application of adhesives in the manufacture of shoes.

4.2.11.2. Methodological Issues

Use of fireworks (SNAP 060601)

The quantity of used fireworks in Estonia is estimated by the import and export data (CN code 3604) available from Statistics Estonia. Data regarding production of fireworks is not available.

Data regarding import and export are not available for the years 1990-1994. As a result, the amounts of used fireworks are calculated by multiplying each year the amount of used fireworks with 0.65 starting from 1995 back to 1990.

As there is no information on stock data for the end of the year, it is assumed that all fireworks has been used in the specific year.

The EMEP/EEA Guidebook 2023 Tier 2 emission factors were used for pollutant emissions calculations.

Table 4.42 Emission factors from the EMEP/EEA Guidebook 2023 for calculating pollutant emissions from the use of fireworks (g/t product)

Pollutant	Emission Factor	Unit
SO_2	3,020	g/t product
NO_x	260	g/t product
CO	7,150	g/t product
TSP	109,830	g/t product
PM_{10}	99,920	g/t product
$PM_{2.5}$	51,940	g/t product
As	1.33	g/t product
Cd	1.48	g/t product
Cr	15.6	g/t product
Cu	444	g/t product
Hg	0.057	g/t product
Ni	30	g/t product
Pb	784	g/t product
Zn	260	g/t product

Compared to 2021, the use of fireworks increased by 26.8% in 2022. The amounts of used fireworks and pollutant emissions are presented in the table below.

Table 4.43 The use of fireworks and pollutant emissions in the period of 1990-2022

Year	Product, kt	SO_2	CO	NO_x	TSP	PM_{10}	$PM_{2.5}$
		kt					
1990	0.003	0.00001	0.00002	0.000001	0.0003	0.0003	0.0001
1995	0.02	0.0001	0.0002	0.00001	0.002	0.002	0.001
2000	0.07	0.0002	0.0005	0.00002	0.01	0.01	0.004
2005	0.33	0.001	0.002	0.0001	0.04	0.03	0.02
2010	0.28	0.001	0.002	0.0001	0.03	0.03	0.01
2015	0.37	0.001	0.003	0.0001	0.04	0.04	0.02
2016	0.43	0.001	0.003	0.0001	0.05	0.04	0.02
2017	0.43	0.001	0.003	0.0001	0.05	0.04	0.02
2018	0.53	0.002	0.004	0.0001	0.06	0.05	0.03
2019	0.49	0.001	0.004	0.0001	0.05	0.05	0.03
2020	0.11	0.0003	0.001	0.0000	0.01	0.01	0.01
2021	0.39	0.001	0.003	0.0001	0.04	0.04	0.02
2022	0.49	0.001	0.004	0.0001	0.05	0.05	0.03

Table 4.43 continues

Year	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	t							
1990	0.000003	0.000004	0.00004	0.001	0.0000001	0.0001	0.002	0.001
1995	0.00003	0.00003	0.0003	0.01	0.000001	0.001	0.02	0.01
2000	0.0001	0.0001	0.001	0.03	0.000004	0.002	0.05	0.02
2005	0.0004	0.0005	0.01	0.15	0.00002	0.010	0.26	0.09
2010	0.0004	0.0004	0.004	0.12	0.00002	0.01	0.22	0.07
2015	0.0005	0.001	0.01	0.16	0.00002	0.01	0.29	0.10
2016	0.001	0.001	0.01	0.19	0.00002	0.01	0.33	0.11
2017	0.001	0.001	0.01	0.19	0.00002	0.01	0.34	0.11
2018	0.001	0.001	0.01	0.23	0.00003	0.02	0.41	0.14
2019	0.001	0.001	0.01	0.22	0.00003	0.01	0.38	0.13
2020	0.0001	0.0002	0.002	0.05	0.00001	0.00	0.08	0.03
2021	0.0005	0.0006	0.006	0.17	0.00002	0.01	0.30	0.10
2022	0.001	0.001	0.01	0.22	0.00003	0.01	0.38	0.13

Use of tobacco (SNAP 060602)

The quantity of tobacco combusted (smoked) in Estonia is estimated by the import and export data (CN code 2402) available from Statistics Estonia.

Data regarding import, export and production of tobacco products are not available for the years 1990-1994.

Tobacco products were produced in Estonia until 1996; as a result, the production and consumption amounts for the years 1990-1994 are considered equal.

As there is no information on stock data for the end of the year, it is assumed that all tobacco has been used in the specific year.

The EMEP/EEA Guidebook 2023 Tier 2 emission factors were used for pollutant emissions calculations.

Table 4.44 Emission factors from the EMEP/EEA Guidebook 2023 for calculating pollutant emissions from tobacco combustion

Pollutant	Emission Factor	Unit
NMVOC	4.84	kg/t tobacco
NO_x	1.80	kg/t tobacco
CO	55.1	kg/t tobacco
NH_3	4.15	kg/t tobacco
TSP	27.0	mg/cigarette
PM_{10}	27.0	mg/cigarette
$PM_{2.5}$	27.0	mg/cigarette
BC	0.45	% of $PM_{1.8}$
PCDD/F	0.1	µg I-TEQ/t tobacco
B(a)p	0.111	g/t tobacco
B(b)f	0.045	g/t tobacco
B(k)f	0.045	g/t tobacco
I(1,2,3-cd)p	0.045	g/t tobacco
Cd	5.4	µg/cigarette
Ni	2.7	µg/cigarette
Zn	2.7	µg/cigarette
Cu	5.4	µg/cigarette

Tobacco consumption is on a downward trend. Compared to 2021, the use of tobacco decreased by 7.4% in 2022. The amounts of used tobacco and pollutant emissions are presented in the table below.

Table 4.45 The use of tobacco and pollutant emissions from tobacco combustion in the period of 1990-2022

Year	Use of tobacco. kt	NMVOC	NO_x	CO	NH_3	TSP	PM_{10}	$PM_{2.5}$	BC
		kt							
1990	4.16	0.02	0.01	0.23	0.02	0.13	NR	NR	NR
1995	2.22	0.01	0.004	0.12	0.01	0.06	NR	NR	NR
2000	1.95	0.01	0.004	0.11	0.01	0.05	0.05	0.05	0.02
2005	2.60	0.01	0.005	0.14	0.01	0.07	0.07	0.07	0.03
2010	1.23	0.01	0.002	0.07	0.01	0.03	0.03	0.03	0.01
2015	1.88	0.01	0.003	0.10	0.01	0.05	0.05	0.05	0.02
2016	1.90	0.01	0.003	0.10	0.01	0.05	0.05	0.05	0.02
2017	1.82	0.01	0.003	0.10	0.01	0.05	0.05	0.05	0.02
2018	1.66	0.01	0.003	0.09	0.01	0.04	0.04	0.04	0.02
2019	1.65	0.01	0.003	0.09	0.01	0.04	0.04	0.04	0.02
2020	1.52	0.01	0.003	0.08	0.01	0.04	0.04	0.04	0.02
2021	1.50	0.01	0.003	0.08	0.01	0.04	0.04	0.04	0.02
2022	1.39	0.01	0.003	0.08	0.01	0.04	0.04	0.04	0.02

Table 4.45 continues

Year	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p	Cd	Ni	Zn	Cu	PCDD/F
	t								g I-Teq
1990	0.0005	0.0002	0.0002	0.0002	0.03	0.01	0.01	0.03	0.0004
1995	0.0002	0.0001	0.0001	0.0001	0.01	0.01	0.01	0.01	0.0002
2000	0.0002	0.0001	0.0001	0.0001	0.01	0.01	0.01	0.01	0.0002
2005	0.0003	0.0001	0.0001	0.0001	0.01	0.01	0.01	0.01	0.0003
2010	0.0001	0.0001	0.0001	0.0001	0.01	0.003	0.00	0.01	0.0001
2015	0.0002	0.0001	0.0001	0.0001	0.01	0.01	0.01	0.01	0.0002
2016	0.0002	0.0001	0.0001	0.0001	0.01	0.01	0.01	0.01	0.0002
2017	0.0002	0.0001	0.0001	0.0001	0.01	0.005	0.005	0.01	0.0002
2018	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0002
2019	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0002
2020	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0002
2021	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0002
2022	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0001

Use of lubricant (SNAP 060604)

The EMEP/EEA Guidebook 2023 Tier 2 emission factor was used for calculating NMVOC emissions from the use of lubricants (see Table 4.46).

Table 4.46 Emission factors from the EMEP/EEA Guidebook 2023 for calculating NMVOC emissions from the use of lubricant

Pollutant	Emission Factor	Unit
NMVOC	28,000	g/t product

Heavy metals emission calculations from lubricant use in transport are based on the Tier 3 method, whereby emissions are calculated by using a combination of reliable technical and detailed activity data. Tier 3 is implemented in the COPERT 5 program. A more detailed description of the methodology is presented in Chapter 3.3.3.2.

The amounts of used lubricants and pollutant emissions are presented in the table below.

Table 4.47 The use of lubricants and pollutant emissions in the period of 1990-2022

Year	Lubricant consumed kt	NMVOC	Pb	Cd	Cr	Cu	Ni	Se	Zn
		kt	t						
1990	1.19	0.03	0.00004	0.01	0.02	0.93	0.04	0.01	0.54
1995	0.77	0.02	0.00003	0.003	0.01	0.60	0.02	0.00	0.34
2000	0.81	0.02	0.00003	0.004	0.02	0.63	0.03	0.00	0.36
2005	1.12	0.03	0.00004	0.01	0.02	0.87	0.04	0.01	0.50
2010	1.19	0.03	0.00004	0.01	0.02	0.93	0.04	0.01	0.54
2015	1.35	0.04	0.00005	0.01	0.03	1.05	0.04	0.01	0.61
2016	1.41	0.04	0.00005	0.01	0.03	1.10	0.04	0.01	0.63
2017	1.46	0.04	0.00005	0.01	0.03	1.14	0.05	0.01	0.66
2018	1.54	0.04	0.00005	0.01	0.03	1.19	0.05	0.01	0.69
2019	1.55	0.04	0.00005	0.01	0.03	1.21	0.05	0.01	0.70
2020	1.49	0.04	0.00005	0.01	0.03	1.16	0.05	0.01	0.67
2021	1.53	0.04	0.00005	0.01	0.03	1.19	0.05	0.01	0.69
2022	1.57	0.04	0.00005	0.01	0.03	1.22	0.05	0.01	0.71

4.2.11.4. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions are compared to the previous years in order to detect calculation errors, errors in the reported data or in allocation. Reasons behind any fluctuation in the emission figures are studied.

4.2.11.5. Source-Specific Planned Improvements

It is planned to include NMVOC emissions from aeroplane de-icing agents into the inventory as soon as the activity data becomes available for the inventory team.

Photo by Marleen Valdmaa. brand.estonia.ee

5. AGRICULTURE (NFR 3)

5.1. Overview of the Sector

5.1.1. Source Category Description

The Estonian inventory of air pollutants from agriculture presently includes emissions from animal husbandry and the application of fertilizers, compost, and sewage sludge as listed in Table 5.1.

Table 5.1 Reporting activities for the agriculture sector

NFR	Source	Description	Emissions reported	Method
3B1a	Cattle dairy	Includes emissions from dairy cows	NH_3	Tier 3
			NO_x, NMVOC	Tier 2
			TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B1b	Cattle non-dairy	Includes emissions from young cattle, beef cattle and suckling cows	NH_3	Tier 3
			NO_x, NMVOC	Tier 2
			TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B2	Sheep	Includes emissions from sheep	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B3	Swine	Includes emissions from fattening pigs and sows	NH_3	Tier 3
			NO_x	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4a	Manure management - Buffalo	Regarding Statistics from Estonian Agricultural Registers and Information Board the number of heads of mules and asses in Estonia is less than 10	NO	
3B4d	Goats	Includes emissions from goats	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4e	Horses	Includes emissions from horses	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4gi	Laying hens	Includes emissions from laying hens	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4gii	Broilers	Includes emissions from broilers	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4giii	Turkeys	Emissions from this sector are allocated to NFR 3B4giv	IE	Tier 1
3B4giv	Other poultry	Includes emission from cocks, ducks, geese and turkeys	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4h	Manure management - Other animals	Includes emission from foxes, minks, racoons and chinchillas	NO_x, NH_3,	Tier 2
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3Da1	Synthetic N-fertilizers	Includes emissions from application of nitrogen fertilizers and field preparation	NH_3	Tier 2
			NO_x	Tier 1
3Da2a	Animal manure applied to soils	NH_3 emissions from this sector are allocated to NFR 3B1a, 3B1b, 3B2, 3B4gi and 3B4gii	NH_3	Tier 2
			NO_x	Tier 1
3Da2b	Sewage sludge applied to soils	Includes emission from sewage sludge applied into soils	NO_x, NH_3	Tier 1
3Da2c	Other organic fertilisers applied to soils (including compost)	Includes emission from compost applied to soils	NO_x, NH_3	Tier 1
3Da3	Urine and dung deposited by grazing animals	NH_3 emissions from this sector are allocated to NFR 3B1a, 3B1b and 3B2	NH_3	Tier 2
			NO_x	Tier 1
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Includes emissions from farm-level agricultural operations	TSP, PM_{10}, $PM_{2.5}$	Tier 2
3De	Cultivated crops	Includes emissions from cultivated crops	NMVOC	Tier 2
3Df	Use of pesticides	Emissions have not been estimated due to lack of activity data for the previous years	NE	
3F	Field burning of agricultural residues	The activity is not common practice in the region. Burning of cprop residues has been prohibited since 2004.	NO	

Return to the Table of Contents

The share of agricultural sources in total emissions in 2022 was as follows: NO_x – 11%, NH_3 – 93%, NMVOC – 18%, PM_{10} -16% and TSP – 11%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 45.7%, 50%, 55.3%, and 52% compared to 1990, and the trend of the emissions of these categories is given in Figure 5.1. The emissions from the agriculture sector are presented in Table 5.2. The decrease in air pollution is mainly a result of rapid economic changes and due to the low profitability of milk and meat production in the 1990s. The existing Soviet-era large-scale production were liquidated and after land and ownership reform the land was returned to former owners. Only half a hundred large-scale producer remain; the rest are all small-scale producers. The number of livestock on farms and the use of nitrogen fertilisers significantly decreased. Since the end of the nineties, the number of agricultural holdings has started to decline and the share of large-scale production has begun to increase.[15]

After Estonia joined the EU in 2004, livestock numbers and the consumption of mineral N-fertilisers increased compared to mid-nineties due the free market and EU support mechanisms. Over the past decade, the volume of emissions has also affected by changes in livestock housing and manure holding systems, as well as the adoption of various other emission abatement techniques.

In 2022, NO_x, NH_3, NMVOC and TSP emissions decresed by 7.3%, 3.9%, 1% and 21% respectively when compared to 2021. Emissions from the agriculture sector have decreased due to the decrease in fertilizer use and the decrease in the number of fattening pigs by 10% and 14%, respectively. The decrease in the number of swine is attributed to a simultaneous decrease in the market price of pork and an increase in the price of animal feed.

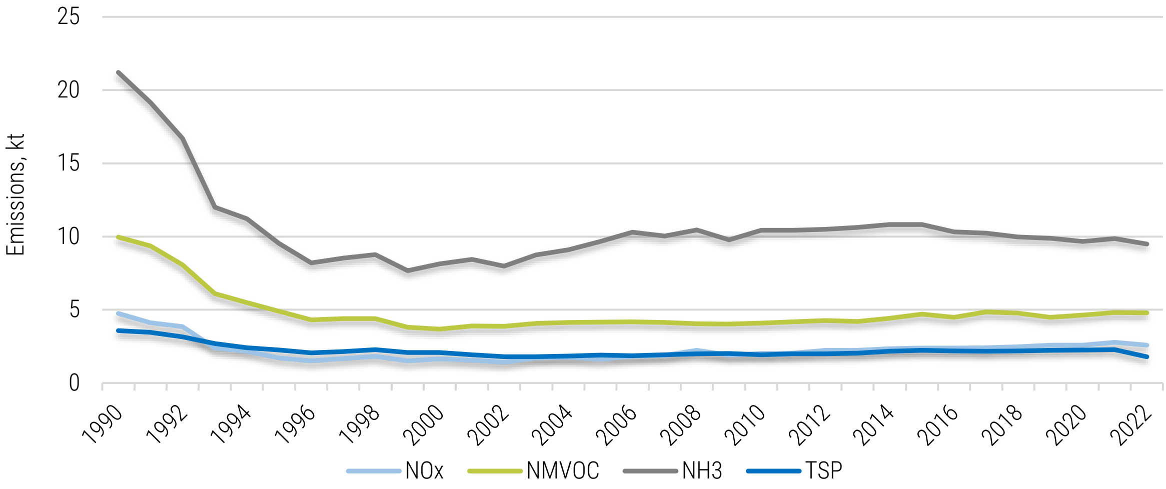

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector in the period of 1990-2022 (kt)

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[15] Estonian University of Life Sciences. (2011). Maaelu arengu aruanne.

Table 5.2 Total emissions from the agriculture sector in the period of 1990-2022 (kt)

Year	NO$_x$	NMVOC	NH$_3$	TSP	PM$_{2.5}$	PM$_{10}$
1990	4.75	9.96	21.21	3.58	NR	NR
1995	1.72	4.90	9.54	2.26	NR	NR
2000	1.63	3.68	8.13	2.08	0.19	1.65
2005	1.62	1.62	1.62	1.62	0.17	1.44
2010	2.01	2.01	2.01	2.01	2.01	2.01
2015	2.38	4.70	10.82	2.23	0.21	1.75
2016	2.38	4.49	10.33	2.19	0.19	1.77
2017	2.42	4.87	10.24	2.16	0.19	1.72
2018	2.48	4.76	9.98	2.20	0.19	1.79
2019	2.57	4.48	9.89	2.24	0.20	1.83
2020	2.58	4.63	9.66	2.25	0.20	1.84
2021	2.78	4.82	9.87	2.27	0.20	1.85
2022	2.58	4.78	9.49	1.79	0.20	1.41
Share in total 2022 emission, %	11.01	18.09	93.25	11.21	3.98	15.60
Change 2021-2022, %	**-7.26**	**-0.70**	**-3.88**	**-21.21**	**-0.82**	**-24.13**
Change 1990-2022, %	**-45.71**	**-51.97**	**-55.28**	**-49.95**	**3.55**	**-14.93**

More than half of NH$_3$ emissions come from the the manure management– 52% – and 48% originate from the agricultural soil sector, including animal manure application to soils and grazing (see Figure 5.2). The primary source of pollution of PM$_{10}$ is agricultural crop operations, accounting for 83% (see Figure 5.3).

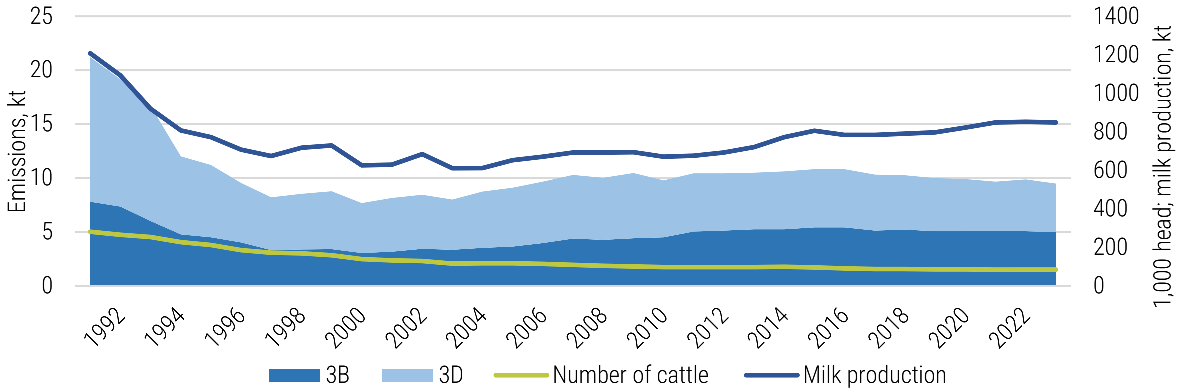

Figure 5.2 NH$_3$ emission distributions by the agriculture sector activities in the period of 1990-2022

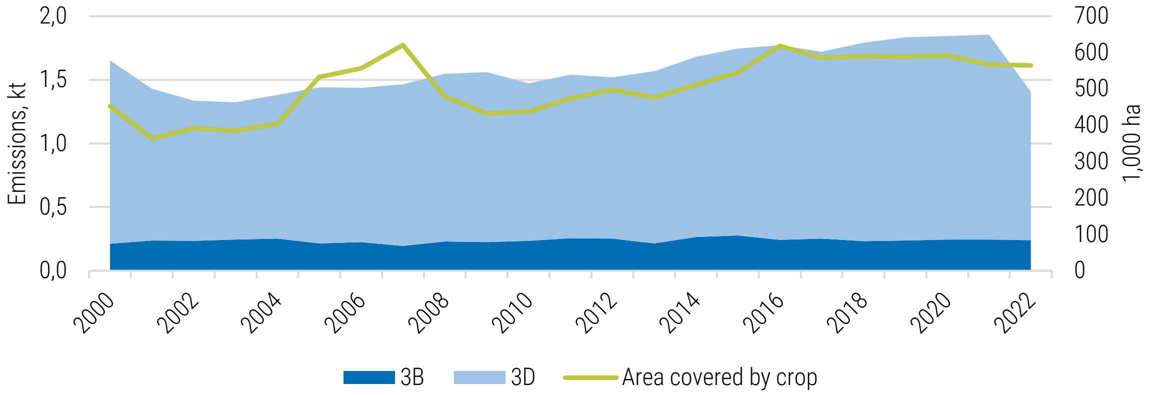

Figure 5.3 PM$_{10}$ emissions from livestock (3B) and agricultural soils (3D) in in the period of 2000-2022

Return to the Table of Contents

5.2. Manure Management (NFR 3b)

5.2.1. Source Category Description

Manure management is the primary source of NH_3 emissions in Estonia. Almost half of the total NH_3 emissionsin 2022 originated from manure management.The sector covers the management of manure from domestic livestock. Estonia reports emissions from the manure management of cattle, swine, horses, goats. sheep, poultry and fur animals. NH_3 and NO_x emissions from animal manure applied to soils are reported under NFR 3D2a, and emissions from grazing under NFR 3Da3.

The recalculations of emissions are primarily associated with the adjustment of the number of horses in the years 2020-2021, and for the first time, the technological distribution of manure storage facilities for poultry manure management has been taken into account, see Chapter 8.

In addition to NH_3, NO_x, NMVOC, TSP, PM_{10} and $PM_{2.5}$ are generated from manure management.

All the emission time series are presented in Tables 5.3-5.7.

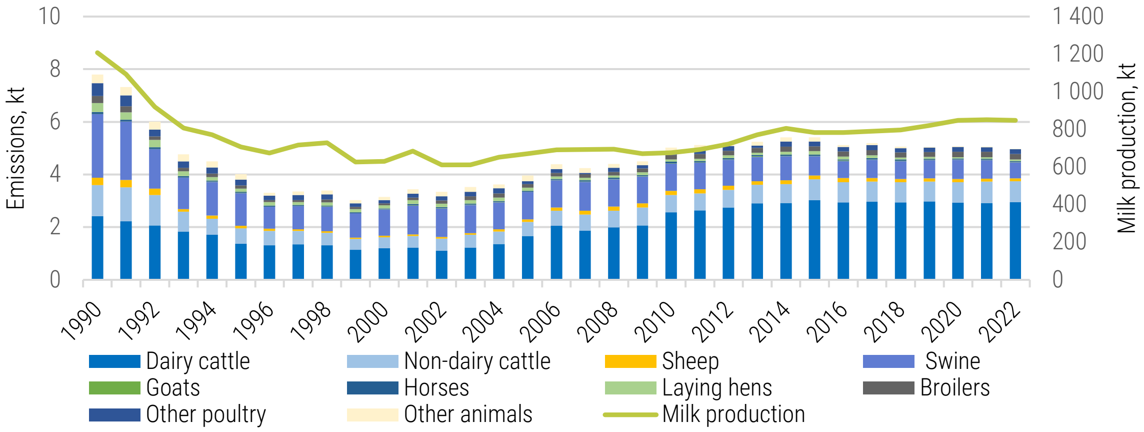

Figure 5.4 NH_3 emissions from manure management in the period of 1990-2022

During the period of 1990–2022, the emission of NH_3 decreased by 36% (see Figure 5.4). The reduction in air pollution was mainly due to the rapid economic changes in agriculture in the 1990s. Over the past decade, the volume of emissions was mainly affected by changes in livestock housing systems. Dairy cattle farmers adopted a loose-housing technology system instead of the older tie-stall housing technology and, due to this, liquid manure technology has been used in place of solid manure technology. In 2015, most bovine animals were already free-range, being held in insulated or partially-insulated lairages. There have also been changes in the way in which animals graze. The dairy farming industry has largely been abandoned. with farmers moving to year-round rearing in the lairages.

Due to changes in housing technology there have also been developments in manure storage. In 2015. the share of liquid manure in bovine animals was about 75%. Liquid manure storage technology has also changed significantly. In the 1990s, liquid manure was stored in lagoon-type reservoirs that remained uncovered and lacked any leakage capability. In 2015, liquid manure was mainly being stored in leak-proof ring tanks (for swine) or lagoons (for cattle), which were either covered with a natural crust (for cattle) or floating (for pigs).[16] Changes in manure-handling technology have decreased the levels of ammonia emissions because liquid manure generates less ammonia than does solid manure.

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[16] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf

At the same time the volumes of NH_3 and NO_x emissions in recent years have also been affected by improved animal productivity and nitrogen extraction. During the period of 1990-2022, the annual average nitrogen production per head of dairy cattle increased by 91%.

In 2022, ammonia emissions decreased by 1.5% in compared to 2021 figures, due to the decrease in the numbers of swine as a result of global pork prices.

Table 5.3 Total emissions of NO_x from manure management in the period of 1990-2022 (kt)

Year	Dairy cattle*	Non-dairy cattle*	Sheep*	Swine *	Goats*	Horses*	Laying hens*	Broilers*	Other poultry*	Other animals*
1990	0.06	0.03	0.01	0.01	0.0002	0.0015	0.015	0.007	0.004	0.008
1995	0.03	0.02	0.00	0.00	0.0001	0.0008	0.005	0.003	0.002	0.005
2000	0.03	0.01	0.00	0.00	0.0003	0.0008	0.005	0.002	0.001	0.003
2005	0.02	0.01	0.00	0.00	0.0003	0.0009	0.005	0.004	0.001	0.004
2010	0.02	0.01	0.00	0.00	0.0004	0.0012	0.004	0.004	0.001	0.004
2015	0.01	0.01	0.00	0.00	0.0004	0.0011	0.005	0.005	0.001	0.004
2016	0.01	0.02	0.00	0.00	0.0004	0.0010	0.005	0.005	0.001	0.002
2017	0.01	0.02	0.00	0.00	0.0004	0.0010	0.006	0.005	0.001	0.002
2018	0.01	0.02	0.00	0.00	0.0004	0.0010	0.004	0.005	0.001	0.002
2019	0.01	0.02	0.00	0.00	0.0003	0.0010	0.004	0.005	0.001	0.001
2020	0.00	0.02	0.00	0.00	0.0003	0.0010	0.003	0.005	0.006	0.001
2021	0.00	0.02	0.00	0.00	0.0003	0.0009	0.004	0.006	0.005	0.001
2022	0.00	0.02	0.00	0.00	0.0003	0.0009	0.004	0.006	0.005	0.001
Change 2021-2022, %	**-14.5**	**-2.2**	**-3.7**	**-11.9**	**-9.7**	**-3.2**	**3.6**	**1.1**	**-1.0**	**0.0**
Change 1990-2022, %	**-92.9**	**-35.5**	**-60.0**	**-82.1**	**86.7**	**-41.6**	**-72.7**	**-14.0**	**52.3**	**-93.5**

** NO_x emissions from animal manure applied to soils are reported under NFR 3D2a.*

Table 5.4 Total emissions of NMVOC from manure management in the period of 1990-2022 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1990	3.14	3.53	0.04	0.85	0.001	0.067	0.37	0.21	0.62	0.45
1995	1.86	1.44	0.02	0.44	0.001	0.036	0.14	0.09	0.27	0.26
2000	1.55	0.97	0.01	0.31	0.002	0.033	0.12	0.07	0.15	0.10
2005	1.66	1.09	0.02	0.36	0.002	0.037	0.12	0.11	0.14	0.25
2010	1.63	1.08	0.03	0.38	0.003	0.053	0.10	0.13	0.18	0.20
2015	2.13	1.11	0.02	0.31	0.003	0.049	0.14	0.15	0.23	0.23
2016	2.02	1.11	0.03	0.27	0.003	0.044	0.12	0.15	0.23	0.10
2017	2.34	1.12	0.02	0.33	0.003	0.044	0.14	0.16	0.24	0.10
2018	2.30	1.15	0.02	0.32	0.003	0.044	0.10	0.16	0.20	0.08
2019	2.18	1.17	0.02	0.19	0.003	0.043	0.09	0.16	0.22	0.01
2020	2.29	1.19	0.02	0.22	0.003	0.042	0.07	0.16	0.25	0.01
2021	2.47	1.23	0.02	0.21	0.003	0.040	0.09	0.18	0.23	0.00
2022	2.47	1.19	0.02	0.17	0.003	0.039	0.09	0.18	0.23	0.04
Change 2021-2022, %	**0.06**	**-3.04**	**-3.82**	**-18.77**	**-7.06**	**-3.40**	**3.64**	**1.12**	**-0.97**	**2,240.2**
Change 1990-2022, %	**-21.5**	**-66.4**	**-60.2**	**-100.0**	**90.8**	**-41.9**	**-75.0**	**-14.0**	**-62.4**	**-90.8**

Table 5.5 Total emissions of NH_3 from manure management in the period of 1990-2022 (kt)

Year	Dairy cattle*	Non-dairy cattle *	Sheep*	Swine*	Goats*	Horses*	Laying hens*	Broilers*	Other poultry*	Other* animals
1990	2.41	1.19	0.27	2.42	0.01	0.07	0.34	0.27	0.49	0.32
1995	1.37	0.58	0.10	1.25	0.01	0.04	0.13	0.12	0.22	0.21
2000	1.20	0.42	0.06	1.00	0.01	0.03	0.11	0.08	0.12	0.11
2005	1.66	0.54	0.10	1.04	0.01	0.04	0.11	0.14	0.11	0.21
2010	2.57	0.65	0.17	1.03	0.01	0.05	0.09	0.17	0.15	0.14
2015	3.03	0.79	0.15	0.73	0.01	0.05	0.13	0.19	0.18	0.15
2016	2.94	0.77	0.16	0.65	0.01	0.04	0.11	0.19	0.18	0.07
2017	2.97	0.76	0.14	0.69	0.01	0.04	0.11	0.19	0.19	0.08
2018	2.94	0.76	0.12	0.68	0.01	0.04	0.08	0.19	0.16	0.06
2019	2.98	0.76	0.12	0.69	0.01	0.04	0.07	0.19	0.17	0.03

Year	Dairy cattle*	Non-dairy cattle *	Sheep*	Swine*	Goats*	Horses*	Laying hens*	Broilers*	Other poultry*	Other* animals
2020	2.92	0.79	0.11	0.73	0.01	0.04	0.05	0.21	0.19	0.02
2021	2.91	0.82	0.11	0.70	0.01	0.04	0.06	0.21	0.18	0.02
2022	2.96	0.79	0.11	0.61	0.01	0.04	0.06	0.21	0.17	0.02
Change 2021-2022, %	**1.61**	**-3.78**	**-3.82**	**-12.86**	**-9.04**	**-3.40**	**3.64**	**1.43**	**-0.79**	**-0.64**
Change 1990-2022, %	**22.67**	**-34.00**	**-61.47**	**-74.66**	**85.52**	**-43.87**	**-82.42**	**-20.79**	**-64.28**	**-93.70**

** NH_3 emissions from animal manure applied to soils and grazing are reported under NFR 3D2a and 3Da3.*

Table 5.6 Total emissions of $PM_{2.5}$ from manure management in the period of 2000-2022 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
2000	0.04	0.01	0.001	0.002	0.0001	0.001	0.002	0.001	0.01	0.0004
2005	0.04	0.01	0.001	0.002	0.0001	0.001	0.002	0.002	0.01	0.0008
2010	0.04	0.02	0.002	0.002	0.0001	0.001	0.002	0.002	0.01	0.0005
2015	0.04	0.02	0.018	0.002	0.0001	0.001	0.002	0.003	0.01	0.0006
2016	0.03	0.02	0.002	0.001	0.0001	0.001	0.002	0.003	0.01	0.0003
2017	0.03	0.02	0.002	0.001	0.0001	0.001	0.002	0.003	0.01	0.0003
2018	0.03	0.02	0.001	0.001	0.0001	0.001	0.002	0.003	0.01	0.0003
2019	0.03	0.02	0.001	0.001	0.0001	0.001	0.002	0.003	0.01	0.0001
2020	0.03	0.02	0.001	0.002	0.0001	0.001	0.001	0.003	0.01	0.0001
2021	0.03	0.02	0.001	0.002	0.0001	0.001	0.002	0.003	0.01	0.0001
2022	0.03	0.02	0.001	0.001	0.0001	0.001	0.002	0.003	0.01	0.0008
Change 2021-2022, %	**0.00**	**-0.94**	**-3.79**	**-18.47**	**-11.11**	**-4.11**	**3.67**	**1.14**	**-0.97**	**850.00**
Change 1990-2022, %	**-23.8**	**58.7**	**89.6**	**-22.0**	**0.0**	**18.6**	**-23.2**	**172.4**	**51.1**	**72.7**

Table 5.7 Total emissions of PM_{10} from manure management in the period of 2000-2022 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
2000	0.07	0.02	0.002	0.04	0.0002	0.001	0.03	0.01	0.04	0.0009
2005	0.06	0.02	0.003	0.04	0.0002	0.001	0.03	0.02	0.04	0.0017
2010	0.06	0.03	0.006	0.04	0.0003	0.002	0.02	0.02	0.05	0.0011
2015	0.05	0.03	0.028	0.03	0.0003	0.001	0.03	0.03	0.07	0.0012
2016	0.05	0.03	0.005	0.03	0.0003	0.001	0.03	0.03	0.07	0.0006
2017	0.05	0.03	0.005	0.03	0.0003	0.001	0.03	0.03	0.07	0.0006
2018	0.05	0.03	0.004	0.03	0.0003	0.001	0.02	0.03	0.06	0.0005
2019	0.05	0.03	0.004	0.03	0.0003	0.001	0.02	0.03	0.06	0.0002
2020	0.05	0.03	0.004	0.04	0.0003	0.001	0.02	0.03	0.07	0.0002
2021	0.05	0.03	0.004	0.04	0.0003	0.001	0.02	0.03	0.07	0.0002
2022	0.05	0.03	0.004	0.03	0.0002	0.001	0.02	0.03	0.07	0.0012
Change 2021-2022, %	**0.00**	**-0.91**	**-3.81**	**-18.91**	**-7.69**	**-3.51**	**3.64**	**1.13**	**-0.97**	**643.75**
Change 1990-2022, %	**-23.80**	**57.61**	**89.50**	**-20.31**	**4.35**	**18.28**	**-23.22**	**172.28**	**51.13**	**35.23**

5.2.2. Methodological Issues

NH_3 and NO_x emission calculations from manure management based on the Tier 3 and Tier 2 (for both mass flow approach) methods from the EMEP/EEA Guidebook 2023 and stem from country-specific values with abatement measures data whenever possible.

For particles and NMVOC (mainly with silage use) except for dairy and non-dairy cattle, the Tier 1 methods from the EMEP/EEA Guidebook 2023 were used in calculations.

For particles the time spent in the pasture was excluded in the calculation of emissions.

The Tier 1 method uses readily available statistical data and default emission factors. The Tier 1 default emission factors also assume an average or typical process description.

The Tier 1 approach uses the following general equation:

Return to the Table of Contents

$$E = AAP_{animal} \times EF_{pollutant\_animal}$$

where

AAP_{animal} – the number of animals of a particular category present on average during the year; $EF_{pollutant\_animal}$ – the emission factor for this process and the technology.

Emissions from manure are calculated separately for each animal category; the separate calculation for a slurry or solid manure management system depends on the animal category (see Table 5.14). According to the EMEP/EEA Guidebook 2023, there are different emission factors for solid and slurry manure types (see Table 5.8). Information on which sectors include the condensable component of PM_{10} and $PM_{2.5}$ can be found in Appendix 1 'Summary Information on Condensable in PM'.

The Tier 2 methods from the EMEP/EEA Guidebook 2023 were used to calculate NMVOC emissions from the manure management of dairy and non dairy cattle.

The Tier 2 approach uses the following general equation:

$$E_{NMVOC\_i} = AAP_{animal\_i}\, x\, (E_{NMVOC,silage\_store\_i} + E_{NMVOC,silage\_feeding\_i} + E_{NMVOC,building\_i} + E_{NMVOC,store\_i} + E_{NMVOC,appl.\ \_i} + E_{NMVOC,graz\_i})$$

where

$MJ_{\_i}$ - is the gross feed intake in megajoules (MJ) per year;

AAP_{anima_i} - number of animals of a particular category present on average within the year; $E_{NMVOC,silage\_store\_i}$, $E_{NMVOC,silage\_feeding\_i}$, $E_{NMVOC,building\_i}$, $E_{NMVOC,store\_i}$, $E_{NMVOC,appl.\_i}$, $E_{NMVOC,graz\_i}$ - NMVOC emissions from silage store, silage feeding, building, store and grazing.

For the calculation method for gross feed intake by dairy cattle, use was made of the Estonian GHG National Inventory Report 2023[17] (see Table 5.10) and the emission factor from the EMEP/EEA Guidebook 2023 (see Table 5.9).

Table 5.8 NO_x, NH_3, NMVOC and PM emission factors for manure management, kg/capita

NFR	NMVOC	$PM_{2.5}$	PM_{10}	TSP
Sheep	0.279	0.020	0.060	0.140
Goats	0.624	0.017	0.056	0.139
Horses	7.781	0.140	0.220	0.480
Fur animals	1.941	0.004	0.008	0.018
Rabbits	0.059			
Dairy cows	17.937	0.410	0.630	1.380
Other cattle	8.902	0.180	0.270	0.590
Calves		0.100	0.160	0.340
Fattening pigs	0.551	0.060	0.340	0.750
Weaners		0.020	0.100	0.210
Sows	1.704	0.120	0.040	1.530
Laying hens	0.165	0.003	0.040	0.190
Broilers	0.108	0.002	0.020	0.040
Turkeys	0.489	0.020	0.110	0.110
Ducks	0.489	0.020	0.140	0.140
Geese	0.489	0.030	0.240	0.240

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[17] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

Table 5.9 NMVOC emission factors for manure management of dairy and non-dairy cattle

NFR	Frac silage	Frac silage_store	EF NMVOC, silage-feeding	EF NMVOC, building	EF NMVOC,graz
			kg NMVOC kg/MJ feed intake		
Dairy cattle	0.500	0.250	0.0002002	0.0000353	0.0000069
Non-dairy cattle	0.500	0.250	0.0002002	0.0000353	0.0000069

The Tier 3 methods from the EMEP/EEA Guidebook 2023/2019 were used to calculate NH_3 emissions from manure management, urine and dung deposited by grazing animals (NFR 3Da3), and from animal manure applied to soils (NFR 3D2a) by dairy cattle, non-dairy cattle and swine. The Tier 2 methods from the EMEP/EEA Guidebook 2023 were used to calculate NO and NH_3 emissions from manure management and NH_3 emissions from urine and dung deposited by grazing animals (NFR 3Da3), and from animal manure applied to soils (NFR 3D2a) by boilers. laying hens, other poultry, sheep, goats, horses and fur animals also for NO emissions from non-dairy cattle, swine and dairy-cattle.

For non-dairy cattle and swine, category emissions were calculated separately for sub-categories as presented in Tables 5.11-5.12.

NH_3 emission from cattle, swine, horses, goats, sheep, poultry and fur animals manure application to soils (NFR 3D2a) were calculated separately from sector 3B. In addition emissions from grazing of cattle (NFR 3D3) were calculated separately from sector 3B.

The Tier 2 and 3 methods use a mass flow approach which is based on the concept of the flow of Total Ammoniacal Nitrogen (TAN) through the manure management system. Calculations were carried out with the Excel spreadsheet which was provided in the previous EMEP/EEA Guidebook. Appendix B. Chapter 3B - Manure management. For the calculation method involving total annual nitrogen levels, use was made of the method that covers excretion by dairy cattle and non-dairy cattle as described in the Estonian GHG National Inventory Report 2023.[18]

The results for nitrogen excretion estimations are presented in Tables 5.11-5.12. For nitrogen excretion for the entire time series, the rates for swine (Regulation No 66 by the Minister of the Environment, 14.12.2016)[19] were used.

For cattle and swine, slurry-based and solid-manure-based housing types are distinguished. For each stage of manure management, use was made of the Tier 2 default NH_3-N EFs, and default data for the proportions of TAN excreta. The separate implied emissions factor for dairy cattle, non-dairy cattle, and swine sub-categories were calculated for each year using a share of various technologies and the corresponding emissions reduction measures. The additional project titled '*Loomakasvatusest eralduvate saasteainete heitkoguste inventuurimetoodikate täiendamine ja heite vähendamistehnoloogiate kaardistamine*' was carried out by the Estonian University and the Estonian Environmental Research Centre to refine the historical technological data which covers housing, grazing, manure storage and manure-spreading for the years 1990, 1995, 2000, 2005, 2010 and 2015.[20] For 2022, the data from the previous survey have been updated.[21] The updated data on housing and manure management technologies for cattle and swine are mostly sourced from point sources (PS) reported by operators. The values in-between were interpolated.

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[18] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

[19] Regulation No 66 by the Minister of the Environment

[20] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf

[21] https://www.klab.ee/wp-content/uploads/2021/09/Laudatehnoloogiad_final.pdf

Return to the Table of Contents

NH_3 emissions reductions in percentage terms were used from the United Nations Economic Commission for Europe's guidance document[22] on preventing and abating ammonia emissions from agricultural sources (see Table 5.14 and Table 5.15).

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock[23]

Year	Nitrogen excretion rate, kg N/head/yr	Gross energy intake, MJ/head/year
1990	74.3	89,436
1995	67.6	86,121
2000	78.1	97,793
2005	93.2	109,522
2010	117.4	113,150
2015	133.7	124,459
2016	137.5	128,892
2017	138.6	130,881
2018	139.2	131,507
2019	141.3	134,403
2020	140.1	134,130
2021	140.2	134,085
2022	142.0	134,080
Change 2021-2022, %	**1.3**	**0.00**
Change 1990-2022, %	**91.2**	**49.9**

Table 5.11 Nitrogen excretion rates of non-dairy cattle, kg N/head/year[24]

Year	Nitrogen excretion rate, kg N/head/yr				
	Mature females	Mature males	Bovine animals	Calves (6-12 month)	Calves (0-6 month)
1990	59.6	61.4	43.4	14.8	1.8
1995	60.3	62.2	43.8	14.8	1.8
2000	63.8	64.5	46.7	15.1	1.7
2005	66.3	66.9	51.4	16.9	2.1
2010	60.2	62.2	44.6	15.2	1.5
2015	72.8	72.8	50.9	15.5	2.3
2016	73.5	73.5	51.3	15.5	2.3
2017	73.1	73.2	51.2	15.5	2.3
2018	73.4	73.7	51.4	15.5	2.3
2019	72.8	73.1	51.1	15.5	2.3
2020	74.1	74.1	55.7	16.0	2.9
2021	75.4	75.5	56.5	16.0	2.9
2022	74.8	74.8	56.1	16.0	2.9
Change 2021-2022, %	**-0.8**	**-1.0**	**-0.7**	**0.0**	**0.0**
Change 1990-2022, %	**25.4**	**21.8**	**29.4**	**8.2**	**62.8**

Table 5.12 Average N excretion factors used in the estimates, kg N/head/year

Swine category	Nitrogen excretion rate, kg N/head/year
Piglets, live weight less than 20 kg	4.5
Young pigs, live weight 20–<50 kg	8.7
Fattening pigs	
…live weight 50–<80 kg	10.6
…live weight 80–<110 kg	10.6
…live weight 110 kg or more	10.6
Breeding pigs, live weight 50 kg or more	25.1

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[22] https://unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_120_ENG.pdf

[23] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

[24] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

Return to the Table of Contents

According to the EMEP/EEA Guidebook 2023, there are different emissions factors (GB default EF) for housing, manure storage, and grazing (see Table 5.16). The implied emission factors (IEF) have been calculated according to the following formula:

IEF = GB default EF * share of technology 1/100 * (100% - abatement techniques for technology 1) + GB default EF * share of technology 2/100 * (100% - abatement techniques for technology 2) +…". The implied emission factors for cattle and swine category are presented in Table 5.17.

In terms of separately assessing the proportions of different manure management types for different livestock categories, a country-specific manure management system (MMS) was used (involving liquid/slurry, solid storage, and pasture/range). A MMS which was used to store animal waste that had been generated by cattle and swine is presented in Table 5.13. For all other animal categories, the use of solid manure technology was accounted for in the calculations.

In the early years of the twenty-first century a loose-housing technology system started to replace tie-stall housing technology on dairy farms. Thanks to this, liquid manure technology has been used in place of solid manure technology. At the same time tie stall housing technology with its solid storage is still used for mature non-dairy cattle. Calves are kept in individual boxes. Liquid manure technology is mainly used for swine.

The share of the proportion of pasture was used to calculate the period in which cattle had been housed (in days). In order to be able to calculate the bedding mass being used, EMEP/EEA Guidebook standards were employed. Leaching from solid manure storage was taken into account also. According to an expert opinion by the Estonian University of Life Sciences, leakage may be presumed to have taken place for 70% of solid manure storage in the 1990s as most manure was kept in manure stacks. The leak-proof levels of manure storage facilities were studied in a 2010 survey which was conducted by Estonian, Latvian, & Lithuanian Environment Ltd[25]. For further insight regarding leakage and N-excretion estimations, see the Estonian GHG National Inventory Report 2023.

Table 5.13 Manure management system usage for swine and cattle[26]

Livestock category	Year	Fattening pig	Piglets	Shows	Young pig	Dairy cattle	Bowine animals	Calvess	Mature females	Mature males
Liquid/Slurry, %	1990	87.0	87.0	85.5	87.0	0.0	0.0	0.0	0.0	0.0
	1995	80.0	80.0	77.9	80.0	0.0	0.0	0.0	0.0	0.0
	2000	78.0	78.0	75.7	78.0	0.0	0.0	0.0	0.0	0.0
	2005	79.0	79.0	76.8	79.0	20.1	2.5	2.8	1.8	2.2
	2010	80.0	80.0	77.9	80.0	51.0	29.3	6.8	23.1	5.5
	2015	86.4	100.0	100.0	100.0	81.8	28.9	20.8	0.5	28.9
	2020	92.6	100.0	92.7	100.0	91.3	13.1	15.3	3.2	13.1
	2021	91.6	100.0	92.7	100.0	91.6	13.1	21.0	4.0	13.5
	2022	91.0	100.0	92.7	100.0	93.1	10.4	19.9	4.9	10.4
Solid Storage +deep litter, %	1990	13.0	13.0	14.5	13.0	82.7	67.8	85.7	51.3	67.1
	1995	20.0	20.0	22.1	21.2	80.5	67.8	85.7	51.3	67.1
	2000	22.0	22.0	24.3	23.3	82.7	62.4	85.7	44.4	67.1
	2005	21.0	21.0	23.2	22.3	63.0	46.3	82.8	37.4	66.3
	2010	20.0	20.0	22.1	21.2	45.0	42.0	83.7	55.2	73.4
	2015	13.6	0.0	0.0	0.0	13.5	42.0	65.3	55.2	42.0
	2020	7.4	0.0	7.3	0.0	7.3	66.7	72.4	51.7	66.7
	2021	8.4	0.0	7.3	0.0	7.2	66.7	68.3	53.3	65.8
	2022	9.0	0.0	7.3	0.0	5.6	66.5	70.4	51.7	66.5
Pasture/Range, %	1990	0.0	0.0	0.0	0.0	17.3	32.1	14.3	48.7	32.9
	1995	0.0	0.0	0.0	0.0	19.5	32.1	14.3	48.7	32.9

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[25] ELLE Manure management and storage inventory in nitrate vulnerable zone in farms with over 10 livestock units, 2010, pp. 56–58, http://www.envir.ee/sites/default/files/ntas6nnikukitlusearuanneelle230710.pdf

[26] https://www.klab.ee/wp-content/uploads/2021/06/Arendus2020_aruanne_180221.pdf

Livestock category	Year	Fattening pig	Piglets	Shows	Young pig	Dairy cattle	Bowine animals	Calvess	Mature females	Mature males
	2000	0.0	0.0	0.0	0.0	17.3	32.1	14.3	48.7	32.9
	2005	0.0	0.0	0.0	0.0	16.9	35.1	14.4	53.8	31.5
	2010	0.0	0.0	0.0	0.0	3.9	24.4	9.3	39.5	21.0
	2015	0.0	0.0	0.0	0.0	4.8	29.1	14.0	44.3	29.1
	2020	0.0	0.0	0.0	0.0	1.3	20.2	12.3	45.2	20.2
	2021	0.0	0.0	0.0	0.0	1.2	20.2	10.7	42.7	20.7
	2022	0.0	0.0	0.0	0.0	1.3	23.1	9.7	43.6	23.1

Table 5.14 Used NH_3 emission abetment techniques for manure storage

NH_3 abatement techniques		Replacement of lagoon with tall open tank, %	Tight lid roof, %	Low tech floating cover, %	Solid manure storage with tent, %
2005	Dairy cattle	0.0	0.0	0.0	0.0
	Bowine animals	0.0	0.0	0.0	0.0
	Calvess	0.0	0.0	0.0	0.0
	Mature females	0.0	0.0	0.0	0.0
	Mature males	0.0	0.0	0.0	0.0
	Fattening pig	21.0	0.0	0.0	0.0
	Shows	20.0	0.0	0.0	0.0
2010	Dairy cattle	10.0	0.0	0.0	0.0
	Bowine animals	0.0	0.0	0.0	0.0
	Calvess	10.0	0.0	0.0	0.0
	Mature females	10.0	0.0	0.0	0.0
	Mature males	0.0	0.0	0.0	0.0
	Fattening pig	34.4	0.0	45.9	0.0
	Shows	40.0	0.0	0.0	0.0
2015	Dairy cattle	35.8	0.8	0.0	0.0
	Bowine animals	31.9	1.0	0.0	0.0
	Calvess	40.0	0.8	0.0	0.0
	Mature females	32.0	0.0	0.0	0.0
	Mature males	31.9	0.9	0.0	0.0
	Fattening pig	82.3	0.0	0.0	0.0
	Shows	85.7	0.9	0.0	0.0
2020	Cattle	37.2	0.6	0.0	31
	Pigs	77.9	2.9	0.0	37
	Poultry	0.0	0.0	0.0	29
	Other *	0.0	0.0	0.0	18
2022	Cattle	35	0.9	0.0	32
	Pigs	77.8	2.9	0.0	37
	Poultry	0.0	0.0	0.0	30
	Other *	0.0	0.0	0.0	18
NH_3 emission reduction coefficient, %		45	80	40	50

** Sheep, goats, horses*

Table 5.15 NH_3 emission abetment techniques for manure application to land

NH_3 abatement techniques	2005			2010			2015			2021/2022			NH_3 emission reduction coefficient, %
	Cattle	Swine	Other*	Cattle	Swine	Other*	Cattle	Swine	Other*	Cattle	Swine	Other*	
Used abatement techniques for solid application to land, %													
Incorporation within 12 hours (solid)	0.0	0.0	0.0	100	100	100	100	100	100	0.0	0.0	0.0	50
Incorporation within 4 hours (solid)										100	100	100	65
Used abatement techniques for slurry application to land,%													
Incorporation of surface applied slurry within 12hours	0.0	0.0	0.0	79.2	78.6	0.0	5.4	0.0	0.0	2.1	0.0	0.0	50
Band spreading with trailing shoe within 12hours	0.0	0.0	0.0	21.8	21.4	0.0	81	97.1	0.0	3.5	59.4	0.0	45

NH_3 abatement techniques	2005			2010			2015			2021/2022			NH_3 emission reduction coefficient, %
	Cattle	Swine	Other*	Cattle	Swine	Other*	Cattle	Swine	Other*	Cattle	Swine	Other*	
Injecting slurry (open slot)	0.0	0.0	0.0	0.0	0.0	0.0	13.2	2.9	0.0	16.7	17.2	0.0	70
Injecting slurry (closed slot) (shallow slot 5-10cm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	4.9	0.0	80
Sod injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54	7.4	0.0	70
Closed slot injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	10.6	0.0	90

Table 5.16 NO and NH_3 emission factors for manure management

NFR	NH_3 house,slurry	NH_3 house,solid	NH_3 storage, slurry	NH_3 storage, solid	NO storage. slurry	NO storage, solid	NH_3 application, slurry	NH_3 application,solid	NH_3 grazing
Dairy cows	0.240	0.080	0.250	0.320	0.000	0.008	0.550	0.680	0.140
Other cattle	0.240	0.080	0.250	0.320	0.000	0.008	0.550	0.680	0.140
Calves									
Fattening pigs	0.270	0.230	0.110	0.290	0.000	0.008	0.400	0.450	0.000
Weaners									
Sows	0.350	0.240	0.110	0.290	0.000	0.008	0.290	0.450	0.000
Laying hens		0.410		0.140				0.690	
Broilers		0.210		0.300				0.380	
Turkeys		0.350		0.240				0.540	
Ducks		0.240		0.240				0.540	
Geese		0.570		0.160				0.450	
Sheep		0.220		0.320				0.900	0.090
Goats		0.220		0.280				0.900	0.090
Horses		0.220		0.350				0.900	0.350
Fur animals		0.270		0.090				NA	

Table 5.17 NH_3 implied emission factors for cattle and swine manure management

NFR	Year	NH_3 house, slurry	NH_3 house, solid	NH_3 storage, slurry	NH_3 storage, solid	NH_3 application, slurry	NH_3 application, solid
Dairy cows	2010	0.233	0.087	0.230	0.320	0.416	0.340
	2015	0.202	0.083	0.209	0.294	0.282	0.289
	2020	0.172	0.079	0.207	0.269	0.165	0.238
	2022	0.170	0.078	0.207	0.269	0.157	0.238
Other cattle	2010	0.233	0.080	0.250	0.320	0.416	0.340
	2015	0.202	0.080	0.212	0.320	0.282	0.289
	2020	0.172	0.080	0.207	0.269	0.165	0.238
	2022	0.167	0.080	0.207	0.269	0.157	0.238
Fattening pigs	2010	0.247	0.230	0.084	0.290	0.309	0.225
	2015	0.228	0.207	0.061	0.290	0.217	0.225
	2020	0.208	0.184	0.060	0.236	0.169	0.158
	2022	0.208	0.184	0.060	0.236	0.165	0.158
Sows	2010	0.320	0.240	0.084	0.290	0.224	0.225
	2015	0.290	0.240	0.062	0.290	0.157	0.225
	2020	0.282	0.240	0.060	0.236	0.122	0.158
	2022	0.282	0.240	0.060	0.236	0.120	0.158

Activity data

Information regarding the numbers of livestock in agriculture is available from Statistics Estonia (www.stat.ee) for the years 1990-2022. For dairy and swine, the annual livestock number was still used. For other livestock., the average annual population from livestock specific data (e.g. the production cycle, the proportion dying) was calculated.

Table 5.18 Number of livestock (1,000 head)

Year	Cattle dairy	Cattle non-dairy	Sheep	Goats	Horses	Fattening pigs	Sows	Laying hens	Broilers	Other poultry	Fur animals
1990	280.7	477.1	158.5	2.1	8.6	812.8	47.1	2 224.0	1 951.8	1,259.5	316.8
1995	185.4	185.0	55.4	2.0	4.6	425.4	23.4	828.3	862.2	561.0	206.8
2000	131.0	121.8	33.3	3.7	4.2	261.6	38.6	723.5	616.7	313.5	110.5
2005	112.8	136.7	55.4	3.1	4.8	312.2	34.3	725.7	1,033.8	279.8	209.5
2010	96.5	139.8	95.8	5.0	6.8	336.6	35.1	578.2	1,212.2	377.2	135.3
2015	90.6	165.6	85.9	5.0	6.3	279.4	25.1	825.0	1,376.9	475.6	147.1
2016	86.1	162.1	91.3	5.5	5.7	240.0	25.9	727.6	1,423.9	464.8	71.3
2017	86.4	164.5	80.8	5.1	5.7	262.6	26.5	819.4	1,452.8	491.0	74.4
2018	85.2	166.7	73.1	5.2	5.7	265.5	24.9	608.2	1,451.7	410.0	62.6
2019	85.0	169.0	70.8	4.7	5.5	275.5	26.1	562.8	1,453.5	458.2	24.9
2020	84.3	169.0	68.1	4.5	5.6	289.3	27.5	436.1	1,593.2	507.6	23.0
2021	83.7	167.1	65.6	4.3	5.4	282.0	26.0	536.0	1,660.4	478.4	20.3
2022	83.7	165.9	63.1	4.0	5.0	246.7	22.7	555.5	1,679.1	473.8	20.1
Change 2021-2022, %	**0.0**	**-0.7**	**-4.0**	**-7.5**	**-7.7**	**-14.3**	**-14.5**	**3.5**	**1.1**	**-1.0**	**-0.7**
Change 1990-2022, %	**-70.2**	**-65.2**	**-60.2**	**90.5**	**-41.9**	**-69.6**	**-51.8**	**-75.0**	**-14.0**	**-62.4**	**-93.6**

5.2.3. Uncertainty

An uncertainty analysis was carried out for the 2022 inventory. The uncertainty in the emission factors for all pollutants from agriculture sector is estimated to be 100% and in the activity data 2%. All uncertainty estimates for this source are given in Table 5.19.

Table 5.19 Uncertainties in agriculture sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	2.58	kt	11.01	7.77	1.11
NMVOC	4.78	kt	18.09	10.53	1.92
NH_3	9.49	kt	93.25	42.41	11.11
$PM_{2.5}$	0.20	kt	3.98	2.64	0.68
PM_{10}	1.41	kt	15.60	13.00	2.57
TSP	1.79	kt	11.21	7.50	0.41

5.2.4. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends was carried out.

5.2.5. Source-Specific Planned Improvements

Improve data quality to introduce other Tier 2 methods for emission estimation, which is based on detailed activities data and emission factors.

5.3. Agricultural Soils (NFR 3D)

5.3.1. Source Category Description

Direct NH_3 emissions from fertilisers are reported under NFR 3D1a. Particle emissions and NMVOC from grain fields are reported under NFR 3Dc and 3De respectively. NH_3 and NO_x emissions from animal manure applied to soils are reported under NFR 3Da2a and, emissions from grazing under NFR 3Da3.

NO_x and NH_3 emissions from animal manure applied to soils and urine and dung deposited by grazing animals are recalculated due to the minor corrections in the numbers for horses (for year 2019-2021). There were also other smaller recalculation, see Chapter 8.

The share of agricultural soils in the total NH_3 emissions in 2022 was at 47%.

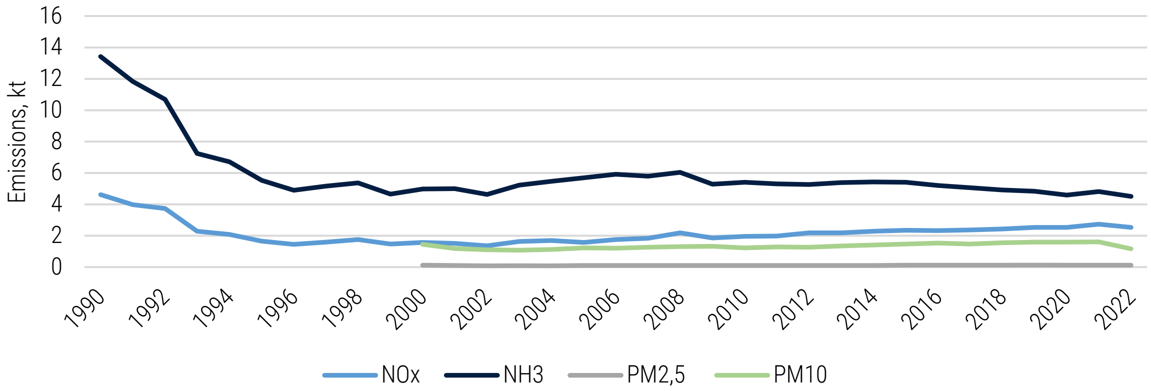

Figure 5.5 NO_x, NH_3 and PM_{10} emissions from agricultural soils in the period of 1990-2022

During the 1990-2022 period, emissions of NH_3 decreased to 33% (see Figure 5.5), mainly due to changes in Estonian agriculture. The reduction of NH_3 emissions in recent years is mainly related to the development of manure-spreading technologies. In the 1990s, the spreading method was in use. Nowadays the main method of spreading liquid manure is through band spreading, although there has been a shortening of the manure spreading period.[27]

All the emission time series are presented in Tables 5.20-5.22. In 2022, NH_3 emissions decreased by 6.4% compared to 2021. Emissions from the land use sector have decreased due to a 14% reduction in fertilizer use.

Table 5.20 NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions from agricultural soils in the period 1990-2022 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
1990	0.68	NR	NR	1.72
1995	0.35	NR	NR	1.36
2000	0.37	0.12	1.44	1.44
2005	0.37	0.10	1.22	1.22
2010	0.31	0.10	1.24	1.24
2015	0.34	0.12	1.47	1.47
2016	0.40	0.12	1.53	1.53
2017	0.37	0.12	1.47	1.47
2018	0.38	0.12	1.56	1.56
2019	0.38	0.13	1.60	1.60
2020	0.38	0.13	1.60	1.60

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[27] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
2021	0.35	0.12	1.61	1.61
2022	0.35	0.12	1.17	1.17
Change 2021-2022, %	**0.15**	**-1.39**	**-27.46**	**-27.46**
Change 1990-2022, %	**-47.71**	**3.70**	**-19.00**	**-32.17**

Table 5.21 NH_3 emissions from agricultural soils in the period 1990-2022 (kt)

Year	Inorganic N-fertilizers	Animal manure applied to soils	Sewage sludge applied to soils	Other organic fertilisers applied to soils	Urine and dung deposited by grazing animals
1990	5.19	7.20	0.01	0.00	1.01
1995	1.44	3.61	0.01	0.01	0.46
2000	1.64	2.99	0.01	0.01	0.34
2005	1.67	3.59	0.01	0.05	0.38
2010	2.01	3.06	0.01	0.11	0.22
2015	2.22	2.73	0.01	0.11	0.34
2016	2.23	2.49	0.01	0.16	0.33
2017	2.25	2.34	0.01	0.14	0.31
2018	2.33	2.14	0.01	0.14	0.30
2019	2.45	1.97	0.01	0.12	0.29
2020	2.38	1.81	0.01	0.11	0.28
2021	2.65	1.78	0.01	0.10	0.27
2022	2.39	1.73	0.01	0.10	0.28
Change 2021-2022, %	**-10.01**	**-2.74**	**0.13**	**0.42**	**2.82**
Change 1990-2022, %	**-54.07**	**-75.99**	**-15.76**	**2 497.12**	**-72.26**

Table 5.22 NO_x emissions from agricultural soils in the period 1990-2022 (kt)

Year	Inorganic N-fertilizers	Animal manure applied to soils	Sewage sludge applied to soils	Other organic fertilisers applied to soils	Urine and dung deposited by grazing animals
1990	2.87	1.32	0.003	0.00	0.42
1995	0.76	0.70	0.003	0.00	0.19
2000	0.90	0.53	0.003	0.01	0.14
2005	0.80	0.57	0.003	0.03	0.16
2010	1.15	0.65	0.003	0.06	0.10
2015	1.45	0.68	0.003	0.06	0.15
2016	1.46	0.66	0.003	0.08	0.14
2017	1.49	0.68	0.003	0.07	0.14
2018	1.55	0.67	0.003	0.07	0.13
2019	1.66	0.68	0.003	0.07	0.13
2020	1.66	0.69	0.003	0.05	0.12
2021	1.87	0.69	0.003	0.05	0.12
2022	1.68	0.68	0.003	0.05	0.12
Change 2021-2022, %	**-10.08**	**-2.03**	**0.11**	**0.00**	**1.71**
Change 1990-2022, %	**-41.35**	**-48.58**	**-15.21**	**2 423.30**	**-71.44**

5.3.2. Methodological Issues

Emission calculations from sewage sludge and other organic fertilisers on soils and NO_x emissions from grazing and animal manure application on soils are based on the Tier 1 method. For the first time, the emission calculations from the use of other organic fertilisers (3Da2c) on soils include accounting for the ammonia emissions from additional substrates generated during biogas production. The calculation for emissions from inputs, including feedstock, is addressed in section 6.3.2 of the waste chapter. Calculations affect emissions from 2014 to the present (see Chapter 8).

Emissions from the use of mineral fertilizers are based conditionally on the Tier 2 method. Statistics Estonia can only separately submit data covering the use of urea fertilizers (a detailed description is included in the activity data chapter). There are no statistics available for the entire data series on the distribution of other fertilizer types. With that in mind, two different emission factors were implemented to calculate NH3 emissions. For urea, EF 0.195 (kg kg-1 fertilizer-N applied) was used, and for others, EF 0.07 (kg kg-1 fertilizer-N applied) was used with an arithmetical mean of Tier 2 emission factors (except urea) as represented in Table 3.2 of the chapter on crop production and agricultural soils of the EMEP/EEA Guidebook 2023. Since the emission factors of the updated EMEP/EEA Guidebook 2023 differ from those of the previous EMEP/EEA Guidebook 2023, recalculations have been made for the entire time series (see Chapter 8). The calculations assumed that in 2015, according to experts, about 16% of the fertiliser plowed directly into the soil and this subsequently reduced emissions by 20%, this figure was 24.9% in 2022 with the values in-between being interpolated.

Following the question raised in the review and after consulting various authorities including Statistics Estonia, the Agricultural Board, and the Environmental Research Centre, the principle finding is that we need additional analyses for fertiliser data. A project about improving the Estonian National Inventory and the Estonian GHG National Inventory, including the agriculture sector, is currently underway, with an analysis of the fertiliser data being carried out in the previous year.[28] The study concludes that IFASTAT and Fertilizers Europe data are incomparable with national statistics, such as the quantities of urea fertilisers differing in some cases and without a reliable explanation the IFASTAT data will not be used. Various experts, including experts from IFASTAT, were consulted during the project. In addition, it was concluded that further research is needed.

Emissions from grazing and animal manure applied to soils (a detailed description is available in Chapter 5.2.2) are based on the Tier 2 method from the EMEP/EEA Guidebook 2023.

NMVOC emissions from grazing and animal applied to soil are reported under NFR 3B.

For calculating NMVOC emissions from the cultivated crops sector, the Tier 2 methodology and default values for NMVOC emission factor calculation were used (see Table 5.24). For crops for which no Tier 2 emission factor is presented in the EMEP/EEA Guidebook 2023, a Tier 1 emission factor was used (see Table 5.24). Due to the earlier incorrect interpretation of the EMEP/EEA Guidebook table, which was discovered during the review process, the entire time series has been recalculated (see Chapter 8).

The Tier 2 emission factor is calculated annually with the equation presented below.

$$\boldsymbol{EFi} = \sum(\mathbf{Ej}.\mathbf{NMVOC} * \mathbf{24} * \mathbf{365} * \boldsymbol{Fracemit.j}) * \boldsymbol{mdmj} * \boldsymbol{Fraci.j}$$

Where

i = Inventory year

j = Crops species

Ej,NMVOC = Hourly emission flux of NMVOC per species (kg/dm^3/h)

$Fracemit$ = Fraction of the year during which the species is emitting

mdm = Mean dry matter of crop (kg/ha/a)

$Fraci.j$ = Fraction of species j in relation to the total of cultivated areas and fallows for the year i.

Information on which sectors include the condensable component of PM_{10} and $PM_{2.5}$ can be found in Appendix 1 ‘Summary Information on Condensable in PM’.

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[28] https://www.klab.ee/wp-content/uploads/2021/06/Arendus2020_aruanne_180221.pdf

The Tier 1 method uses readily available statistical data (see Table 5.26) and default emission factors (see Table 5.23).

The Tier 1 approach uses the general equation:

$$E = AD \times EF_{pollutant}$$

Where

AD = activity data of a particular category present within the year;

$EF_{pollutant}$ = emission factor for this process and the technology.

For calculating particles emissions from the farm-level agricultural operations, the Tier 2 methodology and default valued for $PM_{2.5}$ and PM_{10} emission factor calculation for wet condition were used (see Table 5.25).

Table 5.23 NO_x, NH_3, NMVOC and PM emission factors for agricultural soils

NFR Code	Pollutant	Unit	Value
	NO_x	kg kg^{-1} fertilizer-N applied	0.040
3Da1	NH_3	kg NH_3 kg^{-1} urea-N applied	0.195
	NH3	kg NH_3 kg-1 fertilizer-N applied	0.07
3Da2a	NO_x	NO kg kg−1 fertiliser and manure N applied	0.040
3Da2b	NH_3	kg NH_3 capita^{-1}	0.0068
	NO_x	kg NO_2 capita^{-1}	0.002
3Da2c	NH_3	kg kg^{-1} waste-N applied	0.080
	NO_x	kg kg^{-1} waste-N applied	0.040
3Da3	NO_x	NO kg kg−1 fertiliser and manure N applied	0.040
3De	TSP	kg ha^{-1}	1.560

Table 5.24 Default values for NMVOC emission factor calculation

Crop	NMVOC, kg/ha
Wheat	0.32
Rye	1.03
Rape	1.34
Grass (15 C)	0.41
Grass (25 C)	1.85
Other	0.86

Table 5.25 Default values for PM_{10} and $PM_{2.5}$ emission factor calculation for wet conditions

Crop		Soil cultivation	Harvesting	Cleaning	Draying	Soil cultivation	Harvesting	Cleaning	Draying
		1	2	3	4	1	2	3	4
		kgha^{-1}PM_{10}				kgha^{-1}$PM_{2.5}$			
Wheat	1	0.25	2.7	0.19	0.56	0.015	0.02	0.09	0.168
Rye	2	0.25	2	0.16	0.37	0.015	0.15	0.008	0.111
Barley	3	0.25	2.3	0.16	0.43	0.015	0.16	0.008	0.129
Oat	4	0.25	3.4	0.25	0.66	0.015	0.025	0.125	0.198
Other arable	5	0.25	NC	NC	NC	0.015	NC	NC	NC
Grass	6	0.25	0.25	0	0	0.015	0.01	0	0

Due the lack of activity data for the previous years (1990–2011), HCB emissions are not estimated from the use of pesticides category (3Df). An additional analysis for finding an alternative source of activity data is ongoing. It has become evident that IFASTAT data are incomparable with national statistics (using indirect data). Various experts have been consulted, and it has been concluded that further research is needed.

Activity Data

Information regarding synthetic N-fertilizer use, the area covered by these crops and population is available from Statistics Estonia (www.stat.ee) for the years 1990-2022.

Return to the Table of Contents

In 2015 the Statistics Estonia stopped gathering mineral fertilizer data by their own and started to use data gathered by the Estonian Rural Economy Research in the framework of the Centre Farm Accounting Data Network (FADN).

Information regarding urea fertilizer is available also from Statistics Estonia. In 2014-2022 there was no production of urea fertilizers in Estonia therefore using urea fertilizer marketing data provided by the Estonian Agricultural Board was used.

In addition, information regarding compost application from Estonian Environment Agency were used.

Table 5.26 Active data for agricultural soil sector in the period of 1990-2022

Year	Synthetic N-fertilizers	Urea	Area covered by crop	Area covered by rye	Area covered by wheat	Area covered by rape	Area covered by grass	Compost applied on soils	Population
	tonnes	tonnes N	ha					tonnes	mln.inhab
1990	58,360	1 360.2	952,103	65,900	26,000	600,000	…	49,559	1.6
1995	18,905	873.0	415,952	32,000	38,600	600,000	…	65,102	1.6
2000	22,396	592.9	452,538	28,900	68,900	28,800	…	139,058	1.6
2005	20,083	1 919.7	532,319	7,400	85,400	46,600	143,400	684,523	1.5
2010	28,628	10.3	437,302	12,600	119,400	98,200	107,400	1426,440	1.5
2015	36,276	37.9	545,010	14,300	169,700	70,800	172,300	1412,791	1.4
2016	36,390	34.5	617,919	12,400	164,500	70,100	172,300	1913,635	1.4
2017	37,333	139.5	585,712	13,300	169,700	73,800	172,300	1702,609	1.4
2018	38,867	181.2	589,894	10,540	154,579	72,683	172,300	1792,866	1.4
2019	41,438	181.2	587,857	28,901	166,984	72,411	172,300	1629,830	1.4
2020	41,486	181.2	591,933	20,700	168,038	78,807	172,300	1331,283	1.3
2021	46,767	181.2	567,380	11,900	179,948	78,807	172,300	1250,920	1.3
2022	42,053	18.2	564,110	13,318	180,971	86,448	172,300	1250,920	1.3
Change 2021-2022, %	**-10.1**	**0.0**	**-0.6**	**11.9**	**0.6**	**9.7**	**0.0**	**0.0**	**0.1**
Change 1990-2022, %	**-27.9**	**-86.7**	**-40.8**	**-79.8**	**596.0**	**-85.6**	**0.0**	**2 424.1**	**-15.2**

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2022. The uncertainty in the emission factors for NO_x. NMVOC. NH_3. $PM_{2.5}$. PM_{10} and TSP from agricultural soils is estimated to be 100%, and in the activity data 2%. Uncertainty estimates for agricultural soils are described together with manure management sector in Table 5.19.

5.3.4. Source-Specific Planned Improvements

Improve data quality to introduce other Tier methods for emissions estimating which is based on detailed activities data and emission factors.

5.3.5. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends was carried out.

5.4. Field Burning of Agricultural Residues (NFR 3F)

In 2004, the burning of crop waste was prohibited by an Estonian legislative act (Regulation no. 5 of the Minister of Agriculture of 20 April 2004). The currently valid version is regulation no. 68 of the Minister of Agriculture of 21 December of 2022[29].

As no other official records of agricultural burning of crop waste exist in Estonia, an inquiry was made to the Estonian Ministry of Rural Affairs for the reporting period of 1990–2004, and according to their best knowledge, no widespread practice of burning agricultural waste took place during that time. In the 2024 submission, the notation key 'NO' was applied to the entire time series. During the review process, a question arose again, and therefore experts (including an expert from Life Science University) were consulted again. The conclusion remained the same.

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[29] Maa heas põllumajandus- ja keskkonnaseisundis hoidmise nõuded ning kohustuslikud majandamisnõuded–Riigi Teataja

Source: www.bioneer.ee

6. WASTE (NFR 5)

6.1. Overview of the Sector

Emissions from solid waste disposal on land (landfills), waste incineration, cremation, wastewater treatment, dry toilets, composting and other waste sources are included in this category. Emissions from the waste sector are based on point sources (facilities) and diffuse sources data are included for some sectors.

Emissions from point sources are taken from the point sources database and the emissions for diffuse sources are calculated based on data received from the Estonian Rescue Board and the waste data management system in ESTEA. For emission calculations are used the emission factors from EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 and from Review of emission factors for incident fires (Science report: SC060037/SR3, UK Environment Agency). In addition expert opinions are used in the additional emission calculations.

Used methods and reported emissions for the waste sector are presented in the Table 6.1.

Table 6.1 Used methods and reported emissions for the waste sector (NFR 5)

NFR	Source	Description	Method	Emissions reported
5A	Solid waste disposal on land	Includes emissions from solid waste disposal on land (including mineral waste handling)	Tier 1	NMVOC, PM$_{2.5}$, PM$_{10}$, TSP
5B1	Compost production	Includes emissions from the biological treatment of waste – composting	Tier 1 / Tier 2	NMVOC, NH$_3$
5B2	Anaerobic digestion at biogas facilities	Includes emissions from flaring and from pre-storage of feedstock at biogas facilities	Tier 2 / Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$, PM$_{2.5}$, PM$_{10}$, TSP, CO
5C1a	Municipal waste incineration	Includes point source emissions from municipal solid waste (MSW) incineration process with heat recovery	Tier 3	IE under NFR 1A1a Public electricity and heat production
5C1bi	Industrial waste incineration	Includes point sources emissions from afterburners in industry	Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$, PM$_{2.5}$, PM$_{10}$, TSP, BC, CO, Pb, As, Cr, Ni, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p,
5C1bii	Hazardous waste incineration	Includes point sources emissions from hazardous waste incineration	Tier 1 / Tier 3	NO$_x$, NMVOC, SO$_x$, PM$_{2.5}$, PM$_{10}$, TSP, BC, CO, Pb, Cd, , Hg, As, Cr, Cu, Ni, PCDD/F, PAHs Total, HCB
5C1biii	Clinical waste incineration	Includes point sources emissions from the incineration of clinical wastes	Tier 1 / Tier 2	NO$_x$, NMVOC, SO$_x$, PM$_{2.5}$, PM$_{10}$, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/F, PAHs Total, HCB, PCBs
5C1biv	Sewage sludge incineration	--	--	NA
5C1bv	Cremation	Includes emissions from the incineration of human bodies in a crematorium	Tier 1	NO$_x$, NMVOC, SO$_x$, PM$_{2.5}$, PM$_{10}$, TSP, 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, PAHs Total, HCB, PCBs
5C1bvi	Other waste incineration	--	--	NA
5C2	Open burning of waste	Includes diffuse sources emissions from the open burning of MSW	Tier 1	NO$_x$, NMVOC, SO$_x$, PM$_{2.5}$, PM$_{10}$, TSP, CO, PCDD/F, B(a)p, B(b)f, B(k)f, PAHs Total, HCB, PCBs
5D1	Domestic wastewater handling	Includes emissions from residential/commercial sectors wastewater handling and dry toilets	Tier 2 / Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$
5D2	Industrial wastewater handling	Includes point sources emissions from industrial wastewater handling	Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$
5D3	Other wastewater handling	--	--	NA
5E	Other waste handling	Includes point sources emissions from other waste and diffuse sources emissions from unwanted car and house fires	Tier 2 / Tier 3	NO$_x$, NMVOC, SO$_x$, NH$_3$, PM$_{2.5}$, PM$_{10}$, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total

The waste sector in the emission inventory is mostly insignificant except for PCBs, HCB and dioxins emissions. In 2022, PCBs emissions comprised about 39.3% of the national total PCBs emissions, dioxins emissions comprised about 28.8% of the national total dioxins emissions and HCB emissions comprised 23.1% of the national total HCB emissions.

The main sources of PCB and HCB emissions are the open burning of waste (NFR 5C2). In 2022, emissions of PCBs and HCB from the open burning of waste decreased by 78.2% compared to the 1990. The main reason for the reduction in PCB and HCB emissions is the decrease in the amount of open burned waste. The main source of dioxins emissions is car and house fires. In 2022, emissions of dioxins from car and house fires decreased slightly compared to 2021. The main reason for the reduction in dioxin emissions is the decrease in the number of car and house fires.

In 2022, NH$_3$ emissions from waste sector comprised about 2.0% of the national total NH$_3$ emissions. The main sources of NH$_3$ emissions are residential/commercial wastewater handling where the main source of NH$_3$ is the use of dry toilets (NFR 5D1).

Table 6.2 Pollutant emissions from the wate sector in the period of 1990–2022

Year	NOx	NMVOC	SOx	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO
	kt								
1990	0.02	0.15	0.004	0.370	NR	NR	0.07	NR	0.32
1995	0.03	0.22	0.01	0.310	NR	NR	0.09	NR	0.44
2000	0.04	0.26	0.01	0.277	0.29	0.29	0.30	0.000002	0.48
2005	0.02	0.17	0.01	0.25	0.21	0.21	0.21	0.000001	0.20
2010	0.03	0.17	0.01	0.23	0.12	0.13	0.13	0.000002	0.14
2015	0.02	0.11	0.03	0.22	0.19	0.19	0.20	0.000001	0.08
2016	0.03	0.13	0.04	0.23	0.17	0.17	0.17	0.000002	0.08
2017	0.03	0.13	0.004	0.22	0.13	0.14	0.14	0.000002	0.08
2018	0.02	0.12	0.07	0.22	0.14	0.15	0.15	0.000002	0.08
2019	0.03	0.12	0.08	0.21	0.13	0.13	0.14	0.000002	0.08
2020	0.04	0.13	0.01	0.21	0.12	0.12	0.13	0.00002	0.08
2021	0.02	0.12	0.01	0.21	0.12	0.12	0.13	0.000003	0.08
2022	0.02	0.11	0.01	0.21	0.12	0.12	0.13	0.000001	0.07
Change 1990-2022, %	**-16.2**	**-25.3**	**184.5**	**-43.6**			**98.5**		**-77.0**
Change 2021-2022, %	**-15.0**	**-8.1**	**-20.6**	**0.9**	**-0.7**	**-0.3**	**-1.7**	**-48.0**	**-2.4**

Table 6.2 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	0.0004	0.00004	0.001	0.000001	0.000005	0.0001	0.000004	NA	NA
1995	0.001	0.0001	0.002	0.00002	0.00002	0.0001	0.00004	0.00002	0.0001
2000	0.001	0.001	0.01	0.002	0.002	0.004	0.0001	0.0001	0.0005
2005	0.002	0.001	0.01	0.002	0.002	0.004	0.0001	0.0001	0.001
2010	0.001	0.001	0.01	0.001	0.001	0.01	0.0002	0.0001	0.001
2015	0.003	0.001	0.02	0.002	0.002	0.008	0.0004	0.0002	0.001
2016	0.003	0.001	0.02	0.002	0.001	0.003	0.0004	0.0002	0.001
2017	0.004	0.001	0.02	0.001	0.001	0.003	0.0005	0.0002	0.001
2018	0.002	0.001	0.02	0.001	0.001	0.003	0.0003	0.0002	0.001
2019	0.002	0.001	0.02	0.001	0.001	0.003	0.0003	0.0002	0.001
2020	0.003	0.001	0.03	0.001	0.002	0.003	0.003	0.0002	0.002
2021	0.003	0.001	0.04	0.001	0.001	0.002	0.0005	0.0002	0.002
2022	0.003	0.001	0.03	0.001	0.001	0.002	0.0005	0.0002	0.002
Change 1990-2022, %	**598.2**	**2325.3**	**4858.2**	**105026.9**	**23308.5**	**3147.5**	**12874.3**		
Change 2021-2022, %	**2.9**	**-0.3**	**-11.4**	**-2.7**	**-1.9**	**-1.0**	**-1.2**	**-7.0**	**-6.9**

Table 6.2 continues

Year	PCDD/ PCDF	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	PCB
	g I-TEQ	t				kg	
1990	1.06	0.01	0.01	0.01	0.01	0.31	0.96
1995	1.24	0.01	0.01	0.01	0.01	0.42	1.32
2000	3.17	0.02	0.01	0.01	0.01	0.46	1.44
2005	2.60	0.01	0.003	0.003	0.01	0.19	0.59
2010	1.22	0.004	0.002	0.002	0.004	0.13	0.37
2015	1.89	0.002	0.001	0.001	0.002	0.08	0.21
2016	1.66	0.002	0.001	0.001	0.002	0.09	0.21
2017	1.34	0.002	0.001	0.001	0.002	0.09	0.21
2018	1.44	0.002	0.001	0.001	0.002	0.09	0.22
2019	1.31	0.002	0.001	0.001	0.002	0.10	0.23
2020	1.21	0.002	0.001	0.001	0.002	0.13	0.23
2021	1.20	0.002	0.001	0.001	0.002	0.12	0.23
2022	1.19	0.002	0.001	0.001	0.002	0.11	0.22
Change 1990-2022, %	**12.2**	**-78.2**	**-78.2**	**-78.2**	**-78.2**	**-62.7**	**-76.9**
Change 2021-2022, %	**-0.7**	**-1.3**	**-1.3**	**-1.3**	**-1.3**	**-7.7**	**-2.1**

6.1.1. Uncertainty

An uncertainty analysis was carried out to the year 2022 inventory. The uncertainty in the emission factors for NO_x, NMVOC and particulates from waste sector use is estimated to be 100%, for SO_2 and CO 50%, for ammonia 50-100%; in the activity data in the range from 2% to 10%. Uncertainty estimates for waste sector are given in Table 6.3.

Table 6.3 Uncertainty estimation of the waste sector

Pollutant	Emission, 2022	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2022, %
NO_x	0.019	kt	0.1	0.05	0.01
NMVOC	0.109	kt	0.4	0.18	0.07
SO_x	0.011	kt	0.1	0.03	0.00
NH3	0.208	kt	2.0	0.84	0.09
$PM_{2.5}$	0.120	kt	2.4	2.16	0.32
PM_{10}	0.123	kt	1.4	1.18	0.16
TSP	0.131	kt	0.8	0.69	0.04
BC	0.000	kt	0.0001	0.00	0.00
CO	0.074	kt	0.1	0.03	0.01
Pb	0.003	t	0.1	0.03	0.00
Cd	0.001	t	0.2	0.14	0.01
Hg	0.032	t	16.3	5.65	0.91
PCDD	1.193	g I-TEQ	28.8	64.72	24.50
benzo(a) pyrene	0.002	t	0.2	0.44	0.12
benzo(b) fluoranthene	0.001	t	0.1	0.22	0.02
benzo(k) fluoranthene	0.001	t	0.2	0.33	0.11
Indeno	0.002	t	0.2	0.42	0.37
HCB	0.115	kg	23.1	34.64	97.52
PCB	0.223	kg	39.3	55.63	3.07

Return to the Table of Contents

6.2. Solid Waste Disposal on Land (NFR 5A)

6.2.1. Source Category Description

This chapter includes emissions from treatment and disposal of municipal, industrial and other solid waste at landfills. This sector, however, is only a minor source of air pollutant emissions. Small quantities of NMVOC had been emitted. Also, particulate emissions from waste handling are generated.

In 2022, Estonia had five functioning landfills (Tallinn Recycling Center, Uikala, Väätsa, Torma and Paikre) classified as managed SWD sites. These landfills conform fully to environmental and technical requirements and standards, and are capable of servicing more than one county or service area. When the landfills were originally established primarily for waste disposal, they have now become waste treatment centers where, in addition to waste disposal, various types of waste are processed (for example, certified compost is produced from biodegradable waste and different types of waste are sorted).

Due to the strict requirements established for waste landfilling, the number of landfills started decreasing, from 157 landfills in 2001 to five landfills in 2015. Landfills closed for waste depositing were conditioned in accordance with the requirements by the end of 2015.[30]

Also, in 2013 Eesti Energia finished building the modern and efficient waste-to-energy power unit at the Iru Power Plant to generate heat and electricity from mixed municipal solid waste (MSW), which also reduced depositing of mixed MSW in landfills.

In addition, there are industrial waste storage locations in Estonia for landfilling of natural mineral wastes from quarrying and mining, the wastes from the oil shale combustion and shale oil production industries.

The disposal of solid waste at landfills has decreased by 29.8% compared to the year 1990 due improved knowledge on recycling and waste reuse.

In 2022, NMVOC emissions from the disposal of solid waste at landfills has decreased compared to the 1990. Compared to 2021, emissions in 2022 decreased by 3.1%. In 2022, particulate matter emissions increased by 14% compared to the 2021. The increase is primarily due to the higher quantity of mineral waste being recovered.

Table 6.4 Emissions from solid waste disposal on land (including mineral waste recovery) in the period of 1990-2022

Year	Amount of deposited and recovered mineral waste, kt	Amount of deposited biodegradable SW in landfills, kt	NMVOC	$PM_{2.5}$	PM_{10}	TSP
			kt			
1990	10435.5	356.35	0.03	NR	NR	0.005
1995	10744.3	423.46	0.04	NR	NR	0.005
2000	9016.3	487.41	0.06	0.0003	0.002	0.004
2005	13247.3	279.94	0.06	0.0004	0.003	0.01
2010	15005.0	142.60	0.05	0.0005	0.003	0.01
2015	18593.0	19.91	0.03	0.0006	0.004	0.01
2016	18245.1	33.22	0.03	0.0006	0.004	0.01
2017	19722.3	54.06	0.03	0.0007	0.004	0.01
2018	19526.8	63.37	0.03	0.0006	0.004	0.01
2019	14038.1	41.17	0.03	0.0005	0.003	0.007
2020	13411.0	38.55	0.03	0.0004	0.003	0.006
2021	16661.8	37.82	0.03	0.0006	0.004	0.008
2022	19006.9	25.75	0.02	0.0006	0.004	0.009

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[30] „Greenhouse Gas Emissions in Estonia 1990-2021. National Inventory Report", Estonia 2023, p 362.

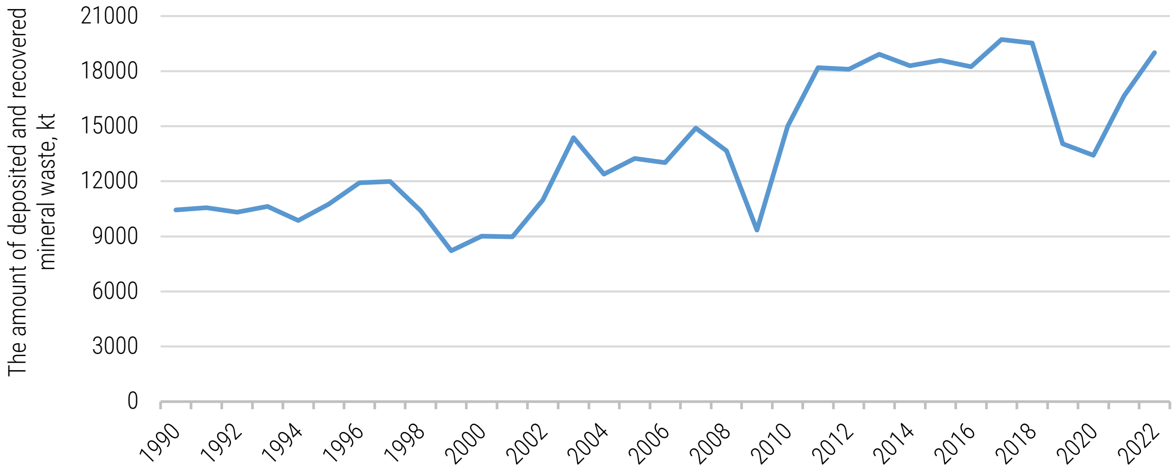

Figure 6.1 The amount of deposited and recovered mineral waste in the period of 1990-2022 (kt)

6.2.2. Methodological Issues

The EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 Tier 1 methodology was used for calculating particulate emissions:

TSP – 0.463 g/Mg;
PM_{10} – 0.219 g/Mg;
$PM_{2.5}$ – 0.033 g/Mg.

The following equation is applied:

$E_{pollutant} = AR_{production} \times EF_{pollutant}$

where

$E_{pollutant}$ = the emission of the specified pollutant;
$AR_{production}$ = the activity rate (mount of mineral waste deposited and recovered annually);
$EF_{pollutant}$ = the emission factor for this pollutant.

The amount of mineral waste deposited in the landfill and amount of mineral waste recovered were used to calculate particulate emissions. The annual amount of landfilled and recovered mineral waste were gathered from the waste management information system in ESTEA. Data on the amount of mineral waste deposited and recovered for the year 1990 weren't available. The amount of waste deposited and recovered in 1990 was obtained by extrapolation using the population and the amount of waste deposited and recovered in 1991-1993.

The EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 Tier 1 methodology were used for calculating NMVOC emissions:

NMVOC – 3.6 kg/Mg CH_4

NMVOC emissions were calculated using the amounts of biodegradable solid waste deposited in landfills and the amounts of CH_4 generated during the biodegradation process of these waste. NMVOC emission were calculated based on the amount of CH_4 emitted. The amount of CH_4 emitted into to the air was calculated by deducting the amount of recovered (incinerated) CH_4 from the total CH_4 emissions.

CH_4 emissions from solid waste disposal were calculated using the same method as in the Estonian GHG Inventory. These amounts were received from EERC, which compiles the Estonian GHG inventory (see Table 6.5).

Table 6.5 The amounts of deposited biodegradable solid waste deposited in landfills and the amounts of CH_4 and landfill gas emitted from it in the period of 1990-2022

Year	Amount of deposited biodegradable SW in landfills, kt	Total amount of CH_4 from SWDS, kt	Amount of CH_4 Recovered from SWDS, kt	CH_4 emission into air, kt
1990	356.35	8.55	NO	8.55
1995	423.46	11.88	1.73	10.15
2000	487.41	19.05	1.55	17.50
2005	279.94	18.58	3.04	15.54
2010	142.60	16.07	1.65	14.21
2015	19.91	11.95	2.43	8.66
2016	33.22	11.05	2.47	7.81
2017	54.06	10.34	1.90	7.68
2018	63.37	9.87	1.43	7.68
2019	41.17	9.51	1.04	7.70
2020	38.55	9.09	1.44	6.96
2021	37.82	8.69	0.96	7.03
2022	25.75	8.34	0.85	6.81

6.2.3. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

6.2.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

6.3. Biological Treatment of Waste (NFR 5B)

6.3.1. Source Category Description

This chapter covers the emissions from the biological treatment of waste – compost production (NFR source category 5B1, see Table 6.6) and anaerobic digestion at biogas facilities (NFR source category 5B2, see Table 6.7).

Composting related activities are mainly reflected in the environmental permits of wastewater treatment plants and landfills. In recent years, the most generated from biodegradable waste in Estonia has been sewage sludge. Sewage sludge is mainly treated by composting. In 2022, 51% of compostable biowaste was sewage sludge. In 2022, emissions from composting increased by 1.0% compared to the year 2021. The emissions increased because the amount of biodegradable waste composted increased.

Table 6.6 The amount of organic waste composted and emissions from compost production in the period of 1990-2022 (kt)

Year	Amount of biodegradable waste composted	NMVOC	NH_3
1990	6.78	0.001	0.002
1995	8.90	0.001	0.002
2000	19.01	0.003	0.005
2005	93.58	0.01	0.02
2010	195.00	0.03	0.05
2015	193.14	0.03	0.05
2016	261.60	0.04	0.06
2017	232.76	0.03	0.06
2018	245.09	0.04	0.06
2019	200.51	0.03	0.05
2020	181.99	0.03	0.04
2021	171.01	0.03	0.04
2022	172.79	0.03	0.04

There are five biogas plants in Estonia with agricultural inputs. Biogas is mainly produced from manure. Grass silage, green waste and a small amount of food industry waste are used as additional substrates.

In addition, there are four wastewater treatment plants and three industrial wastewater treatment plants where anaerobic digestion of sludge takes place during the treatment of sewage sludge. During the process, biogas is produced, which is used for energy production. The digested sludge is dewatered and composted. The emissions from wastewater treatment plants' sewage sludge handling are included under composting.

There are currently no biogas plants in Estonia that use only biowaste as a raw material.

Emissions from the biogas production are related to flaring in biogas and biomethane production facilities and to storages of additional substrates on the premises of the farm-scale biogas facility. To avoid double counting of emissions, emissions from storage of agricultural feedstock (manure) and handling of digestate are included under the agricultural sector.

In 2022, NH_3 emissions from biogas production increased by 13.2% compared to the year 2021. The emissions increased because the amount of biodegradable waste used in biogas production increased.

Table 6.7 Emissions from anaerobic digestion at biogas facilities in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
	kt							
1990	NA	NA	NA	NA	NR	NR	NA	NA
1995	NA	NA	NA	NA	NR	NR	NA	NA
2000	NE	NE	NE	NE	NE	NE	NE	NE
2005	NE	NE	NE	NE	NE	NE	NE	NE
2010	NE	NE	NE	NE	NE	NE	NE	NE
2015	0.008	0.001	0.005	0.00001	NE	NE	0.00002	0.008
2016	0.006	0.0005	0.0002	0.0001	NE	NE	0.00001	0.006
2017	0.007	0.001	0.0002	0.00004	NE	NE	0.00005	0.007
2018	0.001	0.0001	0.00002	0.0001	NE	NE	0.00004	0.001
2019	0.001	0.00004	0.002	0.0001	NE	NE	NE	0.0005
2020	0.001	0.0001	0.006	0.0001	0.000002	0.000002	0.000002	0.001
2021	0.002	0.0001	0.011	0.0001	0.00002	0.00002	0.00002	0.001
2022	0.002	0.0001	0.008	0.0001	0.00002	0.00002	0.00002	0.001

6.3.2. Methodological Issues

Data to calculate emission of NH_3 from composting (NFR 5B1) is obtained from the waste management information system in ESTEA. Waste handling companies are obligated to report the amount of waste biologically treated. Different waste codes for wood, sludge, paper and organic wastes are taken into account. The NH_3 emissions are calculated for the whole time series using the emission factor of 0.24 kg/Mg organic waste from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023.

There are no emission factors in the guidebook for the calculation of NMVOC emissions. As the waste handling companies provided data on NMVOC emissions in their annual air pollution reports, it was decided to include the NMVOC emissions in the inventory. In 2020, eight operators had air pollution permits where composting was indicated as the emission source. The amount of composted waste from these eight operators was about 60% of the total amount of composted waste. In 2019, seven operators had air pollution permits for composting and the amount of composted waste was about 40% of the total amount of composted waste. In the period 2005-2018 one to three operators had air pollution permits for composting and the amount of composted waste was an average of 3.5% of the total amount of composted waste. The implied emission factor was calculated based on the NMVOC emissions reported by the operators and the amount of composted waste and this emission factor was used over the whole time series. Data from 2019 and 2020, as the most representative, were used in the calculation. Data from 2005-2018 were not used because the share of composted waste in the companies that submitted NMVOC emissions in 2005-2018 was only 3.3% of the total amount of composted waste on average. The calculated implied emission factor is 0.00015 Mg/Mg.

Data to calculate emission of NH_3 from biogas productions (NFR 5B2) is obtained from the waste management information system in ESTEA. Waste handling companies are obligated to report the amount of waste biologically treated. The data of the waste management system does not allow to distinguish between the amounts of waste directed towards composting and biogas production, as both activities are reported in the companies waste reports with the same waste recovery code. Therefore, companies where biogas production is carried out were first identified on the basis of environmental permits. The waste reports of these companies were then analyzed, and the quantities of waste used for biogas production were determined.

Table 6.8 Anaerobically treated waste in 1990-2022 by subcategory, kt

Year	Green wastes	Animal waste of food preparation and products	Biodegradable sludges from treatment of other waste water	Other mixed and undifferentiated materials	Vegetal waste of food preparation and products	Mixed waste of food preparation and products	Sludges from industrial processes and effluent treatment
1990	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO	NO
2015	NO	NO	6.24	NO	NO	10.52	NO
2016	0.84	NO	10.45	18.05	NO	22.03	NO
2017	3.08	0.09	10.96	NO	NO	30.65	NO
2018	3.36	0.16	13.77	NO	0.27	41.14	NO
2019	0.14	NO	22.53	3.60	0.21	30.20	NO
2020	0.51	4.64	45.77	NO	2.37	28.40	0.68
2021	0.13	NO	46.70	1.34	4.31	47.72	0.58
2022	0.52	0.34	52.56	1.79	3.64	46.50	0.69

The NH_3 emissions are calculated for the whole time series using the emission calculation methods described in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. Calculation includes NH_3 emissions from the storage of feedstock on the premises of the biogas facility. Tier 2 approach is used. Emission factor of 0.0009 kg NH_3-N per kg N in feedstock is used for pre-storage of feedstock. There is no specific N amount available from national data. Therefore, N in feedstock was calculated by multiplying the total fresh weight of feedstock (tonnes) by the dry matter content of the feedstock (kg kg-1) and the concentration of N in the feedstock dry matter (kg N per kg DM). The N content of the feedstock was used, which is given in Table 3-4 of the EMEP/EEA Guidebook 2023. To avoid double counting of emissions, emissions from handling of digestate are included under the agricultural sector.

The emissions of pollutants from emergency gas flaring at biogas and biomethane production facilities are based on emission data reported by companies in the point source database.

6.3.3. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

6.3.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

6.4. Waste Incineration (NFR 5C)

6.4.1. Source Category Description

This sector includes the volume reduction, by combustion, of different kind of wastes. In Estonia, the following waste treatments take place: municipal, industrial, hazardous and clinical waste incineration, cremation, and open burning of waste. No incineration of sewage sludge is known to have taken place. No "other" waste incineration occurs in the country.

In 2013 Eesti Energia finished building the modern and efficient waste-to-energy power unit at the Iru Power Plant to generate heat and electricity from mixed municipal solid waste (MSW). With the completion of the Iru waste-to-energy unit, the large-scale depositing of mixed MSW in landfills decreased because for the first time the waste that previously went into landfills could be used as a fuel. The Iru waste-to-energy unit is a new solution for Estonia, for both energy production and waste handling. Because of mixed MSW is incinerated to generate heat and electricity, all the emissions that occur in the process are reported in the combustion sector (NFR source category 1A1a).

In Estonia, industrial waste was incinerated as fuel at Kunda Nordic Cement from 1999 in the production of clinker, which was terminated in 2020. Waste was incinerated with energy recovery and these emissions were reported under energy sector.

In Estonia, an environmental permit is required for incinerating industrial waste. Companies that incinerates industrial waste are obligated to report it in the annual waste report. Analysis of the annual waste reports revealed that the amounts of industrial waste incinerated without energy recovery are insignificant. For example, in 2020, the amount of industrial waste incinerated without energy recovery was 0.6 tonnes (wooden packaging, paper, and cardboard packaging), in 2021 it was 1.12 tonnes. In 2022, industrial waste was not incinerated without energy recovery.

In the inventory, incineration of industrial waste includes the exhaust gases from the afterburners of facilities. These are afterburners where gas or LPG is burned as additional fuel. If the residual heat from the afterburner is used, the activity is reported under the energy sector. For example, emissions from fuel combustion in an afterburner installed to reduce NMVOC emissions from the use of printing inks are reported under NFR 5C1bi. NMVOC emissions from solvent use are reported under NFR 2D3h (considering the efficiency of the afterburner). The emissions of pollutants from the afterburners are based on emission data reported by companies in the point source database.

Table 6.9 will give overview of emissions from industrial waste incineration in the period of 1990-2022.

Table 6. 9 Emissions from industrial waste incineration in the period of 1990-2022

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	NA	NA	NA	NE	NR	NR	NA	NR	NA
1995	NA	NA	NA	NE	NR	NR	NA	NR	NA
2000	NA	NA	NA	NE	NA	NA	NA	NA	NA
2005	NA	NA	NA	NE	NA	NA	NA	NA	NA
2010	0.01	0.005	0.01	0.0002	0.0001	0.0001	0.0001	0.000002	0.01
2015	0.0004	0.0002	0.02	0.0001	0.00002	0.00003	0.00005	0.000001	0.001
2016	0.0005	0.0003	0.04	0.0002	0.00003	0.00004	0.00006	0.000001	0.001
2017	0.00003	0.0002	NA	0.0001	0.00002	0.00004	0.00005	0.000001	0.001
2018	0.001	0.0003	0.07	0.0001	0.00002	0.00004	0.00005	0.000001	0.002
2019	0.003	0.0003	0.07	0.0001	0.00002	0.00004	0.00006	0.000001	0.002

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
2020	0.002	0.001	0.001	0.0004	0.0001	0.0001	0.0002	0.000003	0.001
2021	0.002	0.0001	0.00004	0.0001	0.00001	0.00002	0.00003	0.000001	0.001
2022	0.001	0.0001	0.00012	0.00002	0.00001	0.00001	0.00002	0.0000003	0.0004

Table 6.9 continues

Year	As	Cr
	t	
1990	NA	NE
1995	NA	NE
2000	NA	NE
2005	NA	NE
2010	NA	NE
2015	NA	NE
2016	NA	NE
2017	NA	NE
2018	0.00001	0.00003
2019	NA	NE
2020	NA	NE
2021	NA	NE
2022	NA	NE

In 1991, the hazardous waste incineration plant Epler & Lorenz began operations, the first activity being the collection and incineration of waste oils. In 1992, the nomenclature for waste to be collected was extended. Today, hazardous and clinical waste are incinerated in the Epler & Lorenz, though between 1990 and 2007, clinical waste was also incinerated at other facilities than Epler & Lorenz. Table 6.10 will provide an overview of emissions from hazardous waste incineration in the period of 1990-2022, and Table 6.11 will provide an overview of emissions from clinical waste incineration in the period of 1990-2022.

Table 6.10 Emissions from hazardous waste incineration in the period of 1990-2022

Year	Amount of incinerated hazardous waste, kt	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
		kt							
1990	NO	NO	NO	NO	NR	NR	NO	NO	NO
1995	0.14	0.0005	0.001	0.0004	NR	NR	0.00004	NR	0.0002
2000	0.33	0.001	0.002	0.001	0.00004	0.00007	0.0001	0.000001	0.0004
2005	0.34	0.001	0.01	0.002	0.00001	0.00002	0.00003	0.0000004	0.0003
2010	0.73	0.01	0.0003	0.001	0.00001	0.00002	0.00003	0.0000004	0.001
2015	1.82	0.004	0.0001	0.0003	0.00001	0.00002	0.00003	0.0000005	0.0004
2016	1.83	0.01	0.0002	0.001	0.00002	0.00004	0.00006	0.000001	0.001
2017	2.29	0.01	0.0004	0.001	0.00002	0.00004	0.00006	0.000001	0.001
2018	1.00	0.01	0.001	0.001	0.00003	0.00005	0.0001	0.000001	0.001
2019	1.31	0.01	0.001	0.001	0.00004	0.00007	0.0001	0.000001	0.002
2020	4.58	0.02	0.0003	0.01	0.0004	0.0006	0.001	0.000013	0.007
2021	1.73	0.003	0.004	0.001	0.00005	0.0001	0.0001	0.000002	0.001
2022	1.77	0.001	0.001	0.0003	0.00002	0.00004	0.0001	0.000001	0.001

Table 6.10 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni
	t						
1990	NO	NO	NO	NO	NO	NO	NO
1995	0.0002	0.00001	0.00001	0.000002	NE	NE	0.00002
2000	0.0004	0.00003	0.00002	0.00001	NE	NE	0.00005
2005	0.0004	0.00003	0.00002	0.00001	NE	NE	0.00005
2010	0.001	0.0001	0.00004	0.00001	NE	0.01	0.0001

Return to the Table of Contents

Year	Pb	Cd	Hg	As	Cr	Cu	Ni
	t						
2015	0.002	0.0002	0.0001	0.00003	NE	0.004	0.0003
2016	0.002	0.0002	0.0001	0.00003	NE	0.00001	0.0003
2017	0.003	0.0002	0.0001	0.00004	NE	0.00001	0.0003
2018	0.001	0.0001	0.0001	0.00002	NE	0.0001	0.0001
2019	0.001	0.0001	0.0001	0.00002	NE	0.000	0.0001
2020	0.003	0.0002	0.001	0.0002	0.001	0.001	0.003
2021	0.002	0.0002	0.0001	0.00003	0.000001	0.000001	0.0002
2022	0.002	0.0002	0.0001	0.00003	0.0000003	0.000001	0.0002

Table 6.10 continues

Year	PCDD/F	PAHs Total	HCB
	g I-TEQ	t	kg
1990	NO	NO	NO
1995	0.001	0.000003	0.0003
2000	0.003	0.00001	0.001
2005	0.003	0.00001	0.001
2010	0.001	0.00001	0.001
2015	0.001	0.00004	0.004
2016	0.001	0.00004	0.004
2017	0.002	0.00005	0.005
2018	0.001	0.00002	0.002
2019	0.001	0.00002	0.003
2020	0.002	0.00003	0.009
2021	0.001	0.00003	0.003
2022	0.001	0.00004	0.004

Table 6.11 Emissions from clinical waste incineration in the period of 1990-2022

Year	Amount of incinerated clinical waste, kt	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
		kt							
1990	0.01	0.00002	0.00001	0.00001	NR	NR	0.000027	NR	0.000018
1995	0.01	0.00002	0.00001	0.00001	NR	NR	0.000025	NR	0.000016
2000	0.02	0.00001	0.00001	0.000008	0.000007	0.00001	0.000016	0.0000004	0.00001
2005	0.02	0.00002	0.00001	0.00001	0.000013	0.00002	0.00003	0.000001	0.00002
2010	0.13	IE	IE	IE	IE	IE	IE	IE	IE
2015	0.16	IE	IE	IE	IE	IE	IE	IE	IE
2016	0.16	IE	IE	IE	IE	IE	IE	IE	IE
2017	0.21	IE	IE	IE	IE	IE	IE	IE	IE
2018	0.22	IE	IE	IE	IE	IE	IE	IE	IE
2019	0.22	IE	IE	IE	IE	IE	IE	IE	IE
2020	0.55	IE	IE	IE	IE	IE	IE	IE	IE
2021	0.51	IE	IE	IE	IE	IE	IE	IE	IE
2022	0.43	IE	IE	IE	IE	IE	IE	IE	IE

Table 6.11 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni
	t						
1990	0.0004	0.00004	0.001	0.000001	0.000005	0.00007	0.000004
1995	0.0004	0.00003	0.001	0.000001	0.000004	0.00007	0.000003
2000	0.0002	0.00002	0.001	0.000002	0.000003	0.00004	0.000002
2005	0.0005	0.00004	0.001	0.000003	0.00001	0.00008	0.000004
2010	0.00001	0.000004	0.004	0.00003	0.00001	IE	0.00001
2015	0.00001	0.000005	0.01	0.00003	0.00001	IE	0.00001
2016	0.00001	0.000005	0.01	0.00003	0.00001	IE	0.00001
2017	0.00002	0.00001	0.01	0.00004	0.00001	IE	0.00001
2018	0.00002	0.00001	0.01	0.00004	0.00001	IE	0.00001

Return to the Table of Contents

Year	Pb	Cd	Hg	As	Cr	Cu	Ni
				t			
2019	0.00002	0.00001	0.01	0.00004	0.00001	IE	0.00001
2020	0.00005	0.00002	0.02	0.0001	0.00003	IE	0.00002
2021	0.00005	0.00002	0.02	0.0001	0.00003	IE	0.00002
2022	0.00004	0.00001	0.01	0.0001	0.00002	IE	0.00002

Table 6.11 continues

Year	PCDD/F	PAHs Total	HCB	PCB
	g I-TEQ	t	kg	
1990	0.48	0.000000001	0.001	0.0002
1995	0.43	0.0000000004	0.001	0.0002
2000	0.28	0.000000001	0.002	0.0003
2005	0.53	0.000000001	0.002	0.0005
2010	0.0001	0.00000001	0.01	0.003
2015	0.0002	0.00000001	0.02	0.003
2016	0.0002	0.00000001	0.02	0.003
2017	0.0002	0.00000001	0.02	0.004
2018	0.0002	0.00000001	0.02	0.004
2019	0.0002	0.00000001	0.02	0.004
2020	0.001	0.00000002	0.06	0.01
2021	0.001	0.00000002	0.05	0.01
2022	0.0004	0.00000002	0.04	0.01

The first crematorium was established in Estonia in 1993. By the year 2022 there were already 9 crematoriums. As in 1993 there were only 39 cremations then in 2022 the number of cremations was over 11,400 which is about 66% of deceased people in that year. Calculated emissions from cremation are presented in the following Table 6.12.

Table 6.12 Pollutants emissions from cremation in the period of 1990-2022

Year	Number of cremations	NO_x	NMVOC	SO_x	$PM_{2.5}$	PM_{10}	TSP	CO
					kt			
1990	NA	NA	NA	NA	NR	NR	NA	NA
1995	876	0.001	0.00001	0.0001	NR	NR	0.00003	0.0001
2000	3063	0.003	0.00004	0.0003	0.0001	0.0001	0.0001	0.0004
2005	4768	0.004	0.0001	0.001	0.0002	0.0002	0.0002	0.001
2010	6211	0.01	0.0001	0.001	0.0002	0.0002	0.0002	0.001
2015	7824	0.01	0.0001	0.001	0.0003	0.0003	0.0003	0.001
2016	7861	0.01	0.0001	0.001	0.0003	0.0003	0.0003	0.001
2017	8065	0.01	0.0001	0.001	0.0003	0.0003	0.0003	0.001
2018	9032	0.01	0.0001	0.001	0.0003	0.0003	0.0003	0.001
2019	9050	0.01	0.0001	0.001	0.0003	0.0003	0.0003	0.001
2020	10034	0.01	0.0001	0.001	0.0003	0.0003	0.0004	0.001
2021	12263	0.01	0.0002	0.001	0.0004	0.0004	0.0005	0.002
2022	11424	0.01	0.0001	0.001	0.0004	0.0004	0.0004	0.002

Table 6.12 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	0.00003	0.000004	0.001	0.00001	0.00001	0.00001	0.00002	0.00002	0.0001
2000	0.0001	0.00002	0.005	0.00004	0.00004	0.00004	0.0001	0.0001	0.0005
2005	0.0001	0.00002	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.001
2010	0.0002	0.00003	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.001
2015	0.0002	0.00004	0.01	0.0001	0.0001	0.0001	0.0001	0.0002	0.001
2016	0.0002	0.00004	0.01	0.0001	0.0001	0.0001	0.0001	0.0002	0.001
2017	0.0002	0.00004	0.01	0.0001	0.0001	0.0001	0.0001	0.0002	0.001
2018	0.0003	0.00005	0.01	0.0001	0.0001	0.0001	0.0002	0.0002	0.001

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
2019	0.0003	0.00005	0.01	0.0001	0.0001	0.0001	0.0002	0.0002	0.001
2020	0.0003	0.0001	0.01	0.0001	0.0001	0.0001	0.0002	0.0002	0.002
2021	0.0004	0.0001	0.02	0.0002	0.0002	0.0002	0.0002	0.0002	0.002
2022	0.0003	0.0001	0.02	0.0002	0.0002	0.0001	0.0002	0.0002	0.002

Table 6.12 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	PCBs
	g I-TEQ	t				kg	
1990	NA	NA	NA	NA	NA	NA	NA
1995	0.00002	0.00000001	0.00000001	0.00000001	0.00000001	0.0001	0.0004
2000	0.0001	0.00000004	0.00000002	0.00000002	0.00000002	0.0005	0.001
2005	0.0001	0.0000001	0.00000003	0.00000003	0.00000003	0.001	0.002
2010	0.0002	0.0000001	0.00000005	0.00000004	0.00000004	0.001	0.003
2015	0.0002	0.0000001	0.0000001	0.00000005	0.0000001	0.001	0.003
2016	0.0002	0.0000001	0.0000001	0.00000005	0.0000001	0.001	0.003
2017	0.0002	0.0000001	0.0000001	0.00000005	0.0000001	0.001	0.003
2018	0.0002	0.0000001	0.0000001	0.0000001	0.0000001	0.001	0.004
2019	0.0002	0.0000001	0.0000001	0.0000001	0.0000001	0.001	0.004
2020	0.0003	0.0000001	0.0000001	0.0000001	0.0000001	0.002	0.004
2021	0.0003	0.0000002	0.0000001	0.0000001	0.0000001	0.002	0.005
2022	0.0003	0.0000002	0.0000001	0.0000001	0.0000001	0.002	0.005

This chapter also covers emissions from open waste burning in households. This is a poorly quantified sector. In Estonia, open burning of waste is not a common practice for eliminating waste, as it is considered an illegal activity and is forbidden. Can be assumed to be burning waste in piles, barrels or domestic fires are not burning waste for the purpose of disposal but rather it could be considered a habitual behaviour. The reduction in the amount of open burning waste is related to the development of an organised waste collection system and raising people's awareness. Environmental supervision has also been improved.

Open burning of agricultural waste (plant residues, straw, etc.) is prohibited in Estonia. This is a result of requirements imposed on farmers who are in receipt of payments under the common agricultural policy and national agri-environmental schemes.Various experts have been consulted (e.g., Estonian University of Life Sciences), and according to their best knowledge, the practice of open burning agricultural waste has not taken place in Estonia. Agricultural plastic (silage bale film, silage cover film, cover net, plastic rope, etc) is a product of concern, and the system of producer responsibility applies to producers. The producers must arrange the collection and further handling of agricultural plastic waste. Open burning of agricultural plastic is prohibited.

The Table 6.13 will give overview of emissions from domestic waste burning in the period of 1990-2022.

Table 6.13 Pollutants emissions from domestic waste burning in the period of 1990-2022

Year	NO$_x$	NMVOC	SO$_2$	PM$_{2.5}$	PM$_{10}$	TSP	CO
				kt			
1990	0.02	0.11	0.00	NR	NR	0.06	0.32
1995	0.03	0.16	0.01	NR	NR	0.08	0.44
2000	0.03	0.17	0.01	0.09	0.09	0.09	0.48
2005	0.01	0.07	0.002	0.037	0.037	0.04	0.20
2010	0.01	0.04	0.001	0.023	0.023	0.02	0.12
2015	0.005	0.02	0.001	0.013	0.013	0.01	0.07
2016	0.005	0.02	0.001	0.013	0.013	0.01	0.07
2017	0.005	0.02	0.001	0.013	0.013	0.01	0.07
2018	0.01	0.03	0.001	0.014	0.014	0.01	0.07
2019	0.01	0.03	0.001	0.014	0.014	0.01	0.07
2020	0.01	0.03	0.001	0.014	0.014	0.01	0.07
2021	0.01	0.03	0.001	0.013	0.013	0.01	0.07
2022	0.00	0.02	0.001	0.013	0.013	0.01	0.07

Table 6.13 continues

Year	PCDD/ F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	PCB
	g I-TEQ			t		kg	
1990	0.59	0.01	0.01	0.01	0.01	0.31	0.96
1995	0.80	0.01	0.01	0.01	0.01	0.42	1.32
2000	0.88	0.02	0.01	0.01	0.01	0.46	1.44
2005	0.36	0.01	0.003	0.003	0.01	0.19	0.59
2010	0.22	0.004	0.002	0.002	0.004	0.12	0.36
2015	0.12	0.002	0.001	0.001	0.002	0.06	0.20
2016	0.12	0.002	0.001	0.001	0.002	0.06	0.20
2017	0.13	0.002	0.001	0.001	0.002	0.07	0.21
2018	0.13	0.002	0.001	0.001	0.002	0.07	0.22
2019	0.13	0.002	0.001	0.001	0.002	0.07	0.22
2020	0.13	0.002	0.001	0.001	0.002	0.07	0.21
2021	0.13	0.002	0.001	0.001	0.002	0.07	0.21
2022	0.13	0.002	0.001	0.001	0.002	0.07	0.21

6.4.2. Methodological Issues

Emissions from industrial waste incineration are based on data from facilities and includes the exhaust gases from the afterburners.

NO$_x$, CO, NMVOC, SO$_2$, TSP, Cu and Cr emissions from hazardous waste incineration are based on data from facilities. Emissions are calculated by operators on the basis of measurements, and the combined method (measurements plus calculations) is also used. Emissions of PM$_{10}$, PM$_{2.5}$, BC, Pb, Cd, Hg, As, Ni, and Total 4 PAH's were calculated based on the emission factors of EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. Emission factors are presented in Table 6.14. Data on incinerated hazardous waste from the waste management information system were used in these calculations. Data on the amount of hazardous waste incinerated for the period 1990-1995 weren't available, the amount of incinerated waste were calculated on the basis of population data and the amount of waste per capita in 1996.

Table 6.14 Emission factors for hazardous waste incineration

Pollutant	Unit	Value
NOx	-	facility data
CO	-	facility data
NMVOC	-	facility data
SO2	-	facility data
TSP	-	facility data
PM$_{10}$	% of TSP	70

Return to the Table of Contents

Pollutant	Unit	Value
$PM_{2.5}$	% of TSP	40
BC	% of $PM_{2.5}$	3.5
Pb	g/Mg waste	1.3
Cd	g/Mg waste	0.1
Hg	g/Mg waste	0.056
As	g/Mg waste	0.016
Ni	g/Mg waste	0.14
Total 4 PAH	g/Mg waste	0.02
HCB	g/Mg waste	0.002
Cu	-	facility data

Hazardous and clinical waste are incinerated together in Epler & Lorenz. Between 1990 and 2007, clinical waste was incinerated at facilities other than Epler & Lorenz.

No data are available on emissions from other clinical incineration plants. Therefore, the emissions of other clinical incineration plants were calculated based on the emission factors of EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. Since the technology used for the incineration of clinical waste in other facilities is not known, Tier 2 emission factors were used for emissions calculations based on the EMEP Guidebook 2023 recommendation.

NO_x, CO, NMVOC, SO_2, TSP and Cu emissions from Epler & Lorenz are reported under sector NFR 5Cbii. Emissions of Pb, Cd, Hg, As, Cr, Ni, Total 4 PAH's, PCB and HCB from clinical waste incineration were calculated based on the emission factors of EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. At the Epler & Lorenz waste incineration plant, rotary kiln is used. The entire combustion process is controlled and optimized. The plant is equipped with a multi-stage exhaust gas cleaning system, therefore Tier 1 emission factors were used for emissions calculations. Emission factors are presented in Table 6.15.

Emission factors are presented in Table 6.15.

Table 6.15 Emission factors for hazardous waste incineration

Pollutant	Unit	Value Tier 2 (Other)	Value Tier 1 (Epler & Lorenz)
NO_x	kg/Mg waste	1.8	facility data under 5Cbii
CO	kg/Mg waste	1.5	facility data under 5Cbii
NMVOC	kg/Mg waste	0.7	facility data under 5Cbii
SO_2	kg/Mg waste	1.1	facility data under 5Cbii
TSP	kg/Mg waste	2.3	facility data under 5Cbii
PM2.5	% of TSP	43	facility data under 5Cbii
PM10	% of TSP	65	facility data under 5Cbii
BC	% of TSP	2.3	facility data under 5Cbii
Pb	g/Mg waste	36	0.09
Cd	g/Mg waste	3	0.03
Hg	g/Mg waste	54	33
As	g/Mg waste	0.1	0.2
Cr	g/Mg waste	0.4	0.05
Cu	g/Mg waste	6	facility data under 5Cbii
Ni	g/Mg waste	0.3	0.04
PCDD/F	mg I-TEQ/t	40	0.525/0.001
Total 4 PAH	mg/Mg waste	0.04	0.04
PCB	g/Mg waste	0.02	0.02
HCB	g/Mg waste	0.1	0.1

UNEP Standardized Toolkit emission factors were used in the calculation of dioxins emissions from clinical and hazardous waste incineration. In 2006, the incinerator at hazardous waste incineration facility Epler & Lorenz was modernised and classified as class 4 according to the UNEP classification.

Return to the Table of Contents

- Hazardous waste (Epler & Lorenz):
  - 1991-2006 - 10 µg/Mg waste;
  - 2007-2022 – 0.75 µg/Mg waste.
- Clinical waste (Epler & Lorenz)
  - 1991-2006 - 525 µg/Mg waste;
  - 2007-2022 - 1 µg/Mg waste.

Data on incinerated clinical waste from the waste management information system were used in these calculations. Data on the amount of clinical waste incinerated for the period 1990-1995 weren't available, the amount of incinerated waste were calculated on the basis of population data and the amount of waste per capita in 1996.

The pollutant emissions from open domestic waste burning are calculated based on an expert judgement about the amount of burned waste. An Ministry of Environment expert judgement indicates that in 1990–2003, 2% of MSW was open burned, in 2004-2014 1% of MSW was open burned and starting from 2015, the amount of open burned waste decreased to 0.5%. The change in the open burning percentage is connected to the development of an organised waste collection system.

Table 6.16 Amount of domestic waste burned in the period of 1990- 2022 (kt)

Year	Total MSW	Open burned MSW
1990	382.15	7.64
1995	522.10	10.44
2000	570.58	11.41
2005	465.44	4.65
2010	289.42	2.89
2015	317.43	1.59
2016	324.85	1.62
2017	327.63	1.64
2018	344.22	1.72
2019	348.72	1.74
2020	337.91	1.69
2021	336.86	1.68
2022	332.49	1.66

Unfortunately, there is no emission factor applicable for this category in the Guidebook. Therefore emission factors from the document Review of emission factors for incident fires were used for calculation (Science report: SC060037/SR3, UK Environment Agency) (recommended by the review team). The recommended document does not contain emission factors for PM_{10} and $PM_{2.5}$. During the review in 2023, the TERT recommended calculating the $PM_{2.5}$ and PM_{10} emissions as 100% fractions of TSP. Emission factors are presented in Table 6.17.

Table 6.17 Emission factors for open burning of waste incineration

Pollutant	Unit	Value
NO_X	kg/Mg waste	3
NMVOC	kg/Mg waste	15
SO_2	kg/Mg waste	0.5
CO	kg/Mg waste	42
TSP	kg/Mg waste	8
PM2.5	kg/Mg waste	8
PM10	kg/Mg waste	8
PCDD/F	µg/Mg waste	76.8
B(a)p	mg/Mg waste	1,4
B(b)f	mg/Mg waste	670
B(k)f	mg/Mg waste	670

Return to the Table of Contents

Pollutant	Unit	Value
I(1,2,3-cd)p	mg/Mg waste	1,27
HCB	g/Mg waste	0,04
PCB	mg/Mg waste	126

Emissions from cremation are calculated for the whole time series using the Tier 1 emission factors from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023. Data about burned bodies provided by operators of crematorium.

6.4.3. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

6.4.4. Source-Specific Planned Improvements

It is planned to analyze the possibility of reporting emissions from the combustion of afterburner fuel under the industrial combustion sector or the industrial sector. In addition, we will analyze whether there may be double counting and the emissions of fuel combustion have already been calculated under the energy sector, which has been compiled based on the energy balance.

6.5. Waste Water Handling (NFR 5D)

6.5.1. Source Category Description

This chapter covers emissions from domestic and industrial wastewater handling and dry toilets. No “other” wastewater handling occurs in the country. In general, emissions of NO_x, NMVOC, SO_x, NH_3 and CO occur from waste water treatment plants, but are largely insignificant in terms of total national emissions.

By 2022, NMVOC emissions from residential/commercial wastewater handling had decreased by 22.1% compared to 2005. Compared to 2021, NMVOC emissions had increased by 18.1%.

The most common wastewater treatment method in Estonia is centralised aerobic wastewater treatment. Septic systems are also emptied into centralized aerobic wastewater systems in accordance with local government regulations.

Dry toilets are mainly used at in sparsely populated rural areas. The use of dry toilets had decreased over time. Dry toilets are the main source of NH_3 in the residential/commercial wastewater handling sector. By 2022, NH_3 emissions from residential/commercial wastewater handling had decreased by 55.2% compared to 1990. However, compared to 2021, NH_3 emissions were slightly increased by 0.4%.

Table 6.18 Emissions from domestic wastewater handling in the period of 1990-2022

Year	Wastewater handled	Number of dry toilet user	NO_x	NMVOC	SO_x	NH_3
	thousand m³	thousand user	kt			
1990	NE	230	NA	NE	NA	0.37
1995	1 848 984	193	NA	0.03	NA	0.31
2000	1 495 188	170	NA	0.02	NA	0.27
2005	1 619 735	142	NA	0.02	NA	0.23
2010	1 899 355	115	0.0001	0.03	0.00007	0.18
2015	1 641 669	107	0.0001	0.02	0.00007	0.17
2016	1 820 069	106	0.0001	0.03	0.00007	0.17
2017	1 870 585	104	0.0001	0.03	0.00007	0.17
2018	1 658 809	102	0.0001	0.02	0.00007	0.16
2019	1 065 559	101	0.0002	0.02	0.00007	0.16

Return to the Table of Contents

Year	Wastewater handled	Number of dry toilet user	NO_x	NMVOC	SO_x	NH_3
	thousand m^3	thousand user	kt			
2020	923 137	100	0.0001	0.01	0.00007	0.16
2021	1 067 579	100	0.0001	0.02	0.00007	0.16
2022	1 261 337	98	NA	0.02	NA	0.16

Emissions from industrial wastewater treatment are reported by companies in their annual ambient air reports. In 2022, 6 industrial companies reported pollutant emissions from processes related to wastewater treatment.

Table 6.19 Emissions from industrial wastewater handling in the period of 1990-2022 (kt)

Year	NO_x	NMVOC	SO_x	NH_3
1990	NA	NE	NA	NE
1995	NA	IE	NA	NE
2000	NA	IE	NA	NE
2005	NA	IE	NA	NE
2010	0.0004	0.01	0.0001	0.0004
2015	0.0003	0.001	0.0001	0.001
2016	0.001	0.005	0.002	0.001
2017	0.001	0.01	0.001	0.001
2018	0.001	0.001	0.0003	0.001
2019	0.0003	0.001	0.0001	0.001
2020	0.0003	0.008	0.0001	0.001
2021	0.0003	0.001	0.0001	0.001
2022	NA	0.004	NA	0.002

6.5.2. Methodological Issues

NMVOC emissions from residential/commercial wastewater treatment were calculated using the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 Tier 2 method. Emissions were calculated using a default emission factor (15 mg/m^3 wastewater handled). In this calculation, data from Statistics Estonia and an overview of water use prepared by the Environmental Agency were used. The overview of water use has been compiled based on the annual water use reports submitted by the facilities. The total amount of wastewater was used in the calculations. Data is available from the year 1994 and those NMVOC emissions are reported under NFR source category 5D1.

NO_x, SO_x and NH_3 emissions from residential/commercial wastewater handling are based on data from facilities.

NH_3 emissions from dry toilets was calculated using the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 Tier 2 method. Emissions were calculated using a default emission factor (1.6 kg/person/year). In Estonia, there is no exact numbers of persons who use dry toilets. Therefore, the number of persons using dry toilets is an estimate. The Estimate is based on the national inventory of wastewater treatment types in low-population settlements, which is used in the GHG inventory[31].

Table 6.20 Dry toilets in settlements, %

Year	Dry toiletsin in low population settlements %	Dry toilets in high population settlements %
1990	25.7	9.9
1991	25.4	9.6
1992	25.1	9.3

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[31] Greenhouse Gas Emissions in Estonia 1990-2021. National Inventory Report", Estonia 2023, p 362.

Year	Dry toiletsin in low population settlements %	Dry toilets in high population settlements %
1993	24.9	9.1
1994	24.6	8.8
1995	24.4	8.6
1996	24.1	8.1
1997	23.9	7.9
1998	23.7	7.6
1999	23.5	7.6
2000	23.1	7.4
2001	22.7	7.3
2002	22.3	6.7
2003	21.7	6.5
2004	21.7	6.3
2005	21.4	5.7
2006	21.1	5.7
2007	20.8	5.6
2008	20.5	4.2
2009	20.3	4.2
2010	20.1	3.7
2011	20.0	3.7
2012	19.8	3.7
2013	19.7	3.7
2014	19.7	3.7
2015	19.4	3.4
2016	19.0	3.3
2017	18.7	3.3
2018	18.3	3.2
2019	18.0	3.2
2020	17.8	3.1
2021	17.5	3.2
2022	17.2	3.2

Approximately 70% of the population lives in high-population settlements, and 30% in low-population settlements. The estimate is based on data from the Estonian population census.

Emissions from industrial wastewater treatment are reported by companies in their annual ambient air reports. It is assumed that diffuse sources NMVOC emissions from industrial wastewater handling for the years 1994 to 2007 are included in the domestic wastewater handling NMVOC emissions for the same period.

6.5.3. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

6.5.4. Source-Specific Planned Improvements

The calculation of NMVOC emissions is currently based on the total amount of wastewater. There are plans to analyze the feasibility of basing the calculation on the amount of treated wastewater. Additionally, using annual water use reports, there is an intention to differentiate more clearly between the quantities of treated residential/commercial wastewater and industrial wastewater to avoid possible double-counting of NMVOC emissions.

6.6. Other Waste (NFR 5E)

6.6.1. Source Category Description

This chapter covers emissions from the other waste sector, which includes data from facilities (6 operators in 2022). Emissions from venting pipes of oil waste tanks and from cleaning soil contaminated with oil products are reported under this sector. All emission estimates are based on emission data reported by facilities in the point source database.

The other waste sector also includes data from car fires, detached and undetached house fires, apartment and industrial building fires.

Emissions of all pollutants in this sector have decreased compared to 2021. The decrease in NMVOC and SO_2 emissions was primarily due to the decrease in bilge water and other oil mixed waste treatment plant emissions in 2022.

Pollutants emissions are presented in the following Table 6.21.

Table 6.21 Emissions from other waste in the period of 1990-2022

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO
	kt							
1990	NE	NE	NE	NE	NR	NR	NE	NE
1995	NE	NE	NE	NE	NR	NR	NE	NE
2000	NE	NE	NE	NE	0.20	0.20	0.20	NE
2005	NE	NE	NE	NE	0.17	0.17	0.17	NE
2010	0.0005	0.01	NE	NE	0.10	0.10	0.10	0.00
2015	0.0004	0.003	NE	0.0002	0.18	0.18	0.18	NE
2016	0.0001	0.01	NE	0.00001	0.15	0.15	0.15	0.00
2017	NE	0.003	NE	NE	0.12	0.12	0.12	NE
2018	NE	0.01	NE	NE	0.13	0.13	0.13	NE
2019	NE	0.01	NE	0.0002	0.12	0.12	0.12	NE
2020	NE	0.03	0.00003	0.0003	0.11	0.11	0.11	NE
2021	NE	0.02	0.00003	0.0003	0.11	0.11	0.11	NE
2022	NE	0.01	0.00001	0.0003	0.11	0.11	0.11	NE

Table 6.21 continues

Year	Pb	Cd	Hg	As	Cr	Cu
	t					
1990	NE	NE	NE	NE	NE	NE
1995	NE	NE	NE	NE	NE	NE
2000	0.001	0.001	0.001	0.002	0.002	0.004
2005	0.0005	0.001	0.001	0.002	0.002	0.004
2010	0.0003	0.001	0.001	0.001	0.001	0.002
2015	0.0005	0.001	0.001	0.002	0.002	0.004
2016	0.0004	0.001	0.001	0.001	0.001	0.003
2017	0.0003	0.001	0.001	0.001	0.001	0.002
2018	0.0004	0.001	0.001	0.001	0.001	0.003
2019	0.0003	0.001	0.001	0.001	0.001	0.002
2020	0.0003	0.001	0.001	0.001	0.001	0.002
2021	0.0003	0.001	0.001	0.001	0.001	0.002
2022	0.0003	0.001	0.001	0.001	0.001	0.002

Return to the Table of Contents

Table 6.21 continues

Year	PCDD/F
	g I-TEQ
1990	NE
1995	NE
2000	2.01
2005	1.71
2010	1.00
2015	1.77
2016	1.53
2017	1.21
2018	1.30
2019	1.17
2020	1.08
2021	1.07
2022	1.06

6.6.2. Methodological Issues

Emissions from the other waste sector are based on data from facilities. The emissions from other sources related to waste management were obtained from the point source database, where facilities with an environmental permit submit the data of the annual ambient air reports. The emissions in the annual ambient air reports are calculated based on the methodologies used in the environmental permit application. The Environmental Board, as the permit issuer, has approved the use of these methodologies.

In addition to the facility data, emissions of particulate matter, heavy metals and dioxins of unwanted fires are calculated according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023 Tier 2 method default emission factors (see Table 6.22). In these calculations, data from the Estonian Rescue Board were used. Since 2015, the fire statistics provided by the Rescue Board to the ESTEA are more accurate and contain more precise data by building type. Which allows building fires to be more accurately grouped into the correct categories. Since 2015, the building fire statistics include all building fires.

Table 6.22 Emission factors for unwanted fires in cars and various types of houses

Category	$PM_{2.5}$	PM_{10}	TSP	Pb	Cd	Hg	As	Cr	Cu	PCDD/F
	kg/fire			mg/fire						µg/fire
Car fire	2.3	2.3	2.3							48
Detached house fire	143.82	143.82	143.82	420	850	850	1.350	1.290	2.990	1.440
Undetached house fire	61.62	61.62	61.62	180	360	360	580	550	1.280	620
Apartment building fire	43.78	43.78	43.78	130	260	260	410	390	910	440
Industrial building fire	27.23	27.23	27.23	80	160	160	250	240	570	270

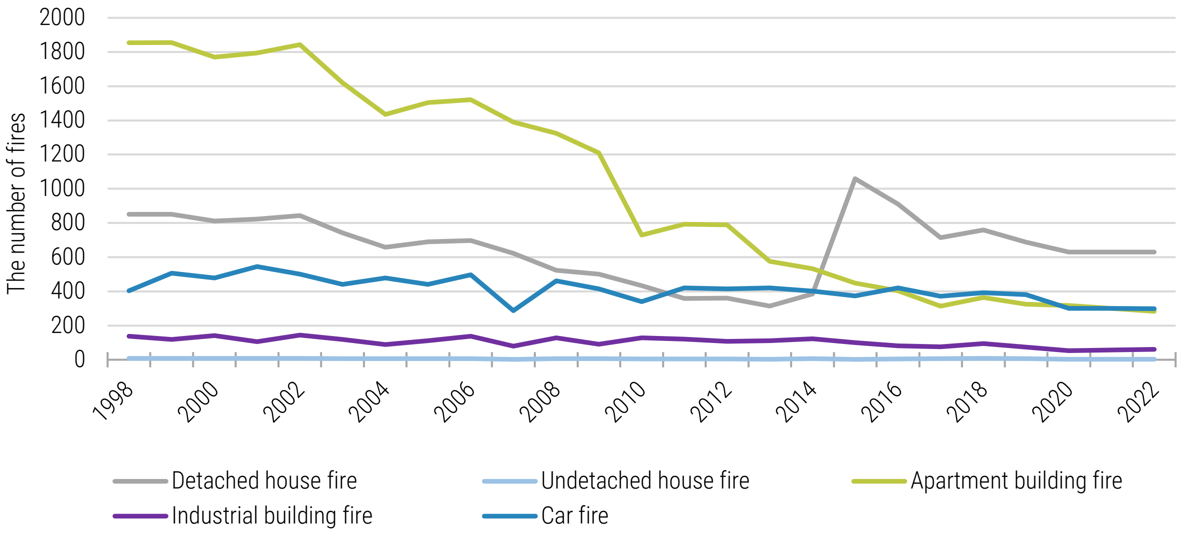

Figure 6.2 The number of fires according to the Estonian Rescue Board in the period of 1998-2022

6.6.3. Source-Specific QA/QC and Verification

Common statistical quality checking related to the assessment of trends has been carried out.

6.6.4. Source-Specific Planned Improvements

It is necessary to analyze the statistics of building fires before 2015 and, if necessary, adjust the categorization of building fires.

Golden Spring Morning (Photo by Sven Začek)

Nature Year Photo 2011

7. NATURAL EMISSIONS (NFR 11)

Return to the Table of Contents

7.1. Overview of the Sector

7.1.1. Source Category Description

The Estonian inventory of air pollutants from natural sources includes emissions from forest fires and NMVOC emission from non-managed deciduous/coniferous forests and managed deciduous/coniferous forests, as well as emissions of grassland and other low vegetation including crops.

These emissions are reported as memo items and are not included in the national total amount of pollutant emissions.

Table 7.1 Natural sources

NFR	Source	Description	Emissions reported
11	B. Forest fires	Includes emissions from naturally or man-induced burning of managed and non-managed forests	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO
	C. Other natutral emissions (please specify in the IIR)	Includes all types of foliar forest emissions: managed and non-managed, deciduous and coniferous.	NMVOC

7.2. Forest Fires (NFR 11B)

7.2.1. Source Category Description

A forest fire is an uncontrolled fire occurring in nature. Many forest fires are due to human activity.

The number of forest fires varies from year to year, and quite a long time may elapse between forest fires that are considered to be large. Climatic conditions are the factor that has greatest impact on the extent of forest fires. The forest is most vulnerable in spring and summer seasons when there are long dry spells. Weather conditions such as precipitation and wind, as well as the layout of the terrain, are important factors in determining the size of the forest fire (see Figure 7.1). The figures it is clear there is a tendency of forest fires depending on weather conditions - in the years with the highest temperature the greatest number of fires.

Table 7.2 Pollutant emissions from forest fires in the period of 1990–2022

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.019	0.058	0.004	0.004	0.244	0.298	0.460	NR	0.582
1995	0.019	0.056	0.004	0.004	0.239	0.292	0.451	NR	0.558
2000	0.068	0.205	0.014	0.014	0.871	1.064	1.645	0.871	2.051
2005	0.009	0.026	0.002	0.002	0.111	0.135	0.209	0.111	0.260
2010	0.002	0.007	0.000	0.000	0.034	0.042	0.064	0.034	0.074
2015	0.008	0.025	0.002	0.002	0.119	0.145	0.224	0.119	0.249
2016	0.012	0.037	0.002	0.002	0.175	0.214	0.331	0.175	0.369
2017	0.003	0.010	0.001	0.001	0.047	0.057	0.089	0.047	0.099
2018	0.034	0.101	0.007	0.007	0.476	0.582	0.899	0.476	1.015
2019	0.005	0.015	0.001	0.001	0.070	0.085	0.132	0.070	0.150
2020	0.012	0.036	0.002	0.002	0.164	0.201	0.310	0.164	0.357
2021	0.003	0.010	0.001	0.001	0.044	0.054	0.083	0.044	0.098
2022	0.002	0.005	0.000	0.000	0.024	0.029	0.045	0.024	0.053
Trend 1990-2022, %	-90.92	-90.92	-90.93	-90.93	-90.19	-90.19	-90.19		-90.92
Change 2021-2022, %	-45.78	-45.78	-45.85	-45.85	-45.77	-45.77	-45.77	-45.77	-45.78

Return to the Table of Contents

Table 7.2 continues

Year	PCDD/F, g	PCB, kg
1990	0.027	0.003
1995	0.026	0.003
2000	0.096	0.010
2005	0.012	0.001
2010	0.004	0.000
2015	0.013	0.001
2016	0.019	0.002
2017	0.005	0.001
2018	0.052	0.005
2019	0.008	0.001
2020	0.018	0.0018
2021	0.005	0.0005
2022	0.005	0.0005

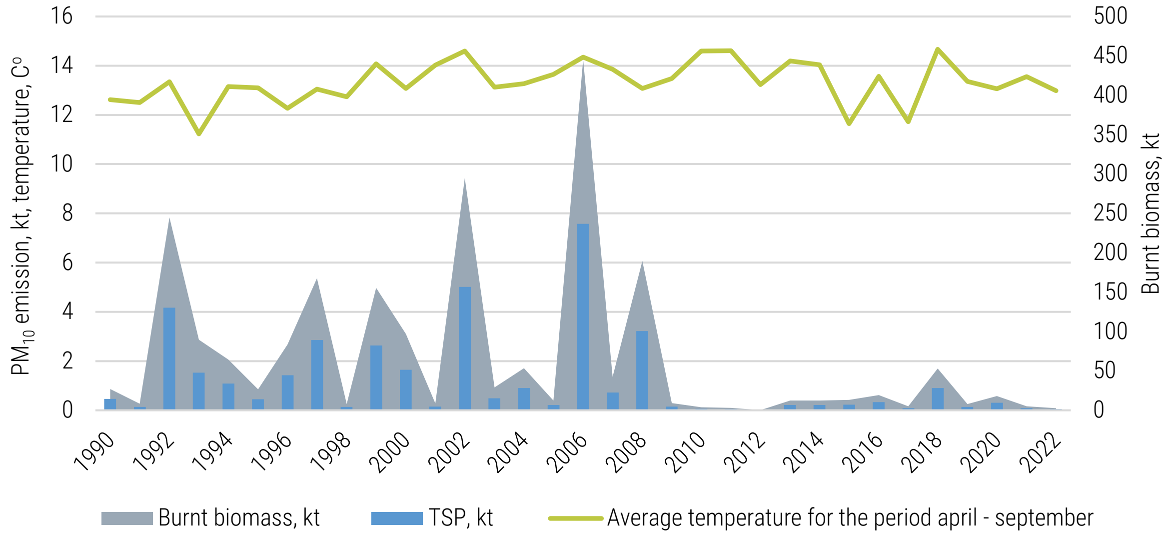

Figure 7.1 Burnt biomass, particulates emission and average temperature in the period 1990-2022

This year submission the data from the Forest Department on the area of the burned forest were used. Based on the statistics of forest fires for the period 1999–2022, it can be said that on average 1.3% of forest fires were caused by natural factors (thunder) and the rest of the forest fires were more or less caused by human activities. During the observed period, a significant part of the causes of forest fires are careless and careless forest visitors (vacationers, berries, children, etc.), who account for about 37% of forest fires. In 2021, the largest number of fires caused by forest visitors was in Harju, Pärnu and Lääne-Viru counties. When considering the causes of forest fires, it must be taken into account that this is an assessment by the employees of the Rescue Board about the cause of the fire, not a thorough investigation.[32]

7.2.2. Methodological Issues

The forest fires category isn't key category therefore for calculation the Tier 1 method was used for calculation of emissions.

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[32] Yearbook Forest 2019, Estonian Environment Agency, 2020, file://sise.envir.ee/Kasutajad$/KAUR/45306140363/Downloads/mets2019_0%20(3).pdf

Compared to 2021, the area of burned forest decreased in 2022 by about 2 times, which accordingly led to an decrease in pollutants emissions.

The emissions of NO_x, NMVOC, SO_x, NH_3 and CO are calculated using EMEP/EEA Guidebook 2023 Tier 1 emission factors (see Table 7.3) and burnt forest area (1990–2020) received from the Yearbook Forest 2019 (see Table 7.4). Data for 2021-2022 the forest burning area are obtained from the Forest Department of Estonian Environment Agency.

The emissions of particulates are calculated on the base of EMEP/EEA Guidebook 2023 Tier 1 emission factors and biomass burnt. Data about biomass amount are available in statistical database only for the years 1990-2021. Since data on forest area and, accordingly, biomass for 2022 were not published, data for 2021 were used for calculations. Data will be updated next year.

It should be noted that in 2023, statistics changed data on biomass for the entire period from 1990 to 2020 and on forest areas for 1999-2021, which in turn affected the calculation of emissions.

In this reporting year, dioxin and PCB emissions were additionally calculated based on the UNEP „Toolkit for Identification and Quantification of Realeases of Dioxins, Furans and Other Unintentional POPs", 2013 emission factor (Table 7.3).

Table 7.3 Tier 1 emission factors for category 11B Forest fires

Pollutant	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Unit	kg/ha area burned	kg/ha area burned	kg/ha area burned	kg/ha area burned	g/kg wood burned	g/kg wood burned	g/kg wood burned	g/kg wood burned	kg/ha area burned
Value	100.000	300.000	20.000	20.000	9.000	11.000	17.000	0.81	3000.000

Activity Data

Table 7.4 Forest burnt area and burnt biomass in the period 1990-2022

Year	Forest burnt area ha	Burnt biomass t
1990	194.0	27,076.7
1995	185.9	26,509.7
2000	683.8	96,747.7
2005	86.5	12,292.8
2010	24.8	3,792.7
2015	83.1	13,183.7
2016	122.9	19,493.7
2017	33.0	5,213.4
2018	338.3	52,875.9
2019	49.8	7,754.6
2020	119.1	18,252.4
2021	32.5	4,897.1
2022	17.62	2,655.7

7.2.3. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends has been carried out.

7.2.4. Source-Specific Planned Improvements

Not planned.

7.3. Other Natural Sources (NFR 11C)

7.3.1. Source Category Description

The Estonian inventory of air pollutants from natural emissions includes NMVOC emission from non-managed deciduous/coniferous forests and managed deciduous/coniferous forests, as well as emissions of grassland and other low vegetation including crops. The emissions natural sources sector are presented in Table 7.5. Due to changes in the Statistics Estonia data, emissions for the period 2012-2021 have been recalculated (See Chapter 8).

Table 7.5 NMVOC emission from other natural sources in the period of 1990–2022 (kt)

Year	NMVOC
1990	35.438
1995	34.730
2000	39.621
2005	38.348
2010	37.313
2015	39.859
2016	40.611
2017	41.176
2018	41.223
2019	41.043
2020	41.185
2021	40.730
2022	40.522
Change 2020-2021, %	-0.5
Trend 1990-2022, %	14.3

7.3.2. Methodological Issues

All methodologies for calculating biogenic emissions essentially involve multiplying an emissions factor for a type of vegetation by a statistic providing for the amount of vegetation in the country or grid square. Two major alternatives for this are:

- to perform these calculations at a general or preferably species-specific level (applied to forests in this report), or
- to perform the calculations for different ecosystem types (applied to grassland and crops).

Based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, in conclusion, total VOC emissions per year from these activities can be calculated based on the following equation:

$$\text{Emission of VOC per vegetation type} = F \times A$$

$$= (\varepsilon \times D \times \Gamma) \times A$$

$$= D.A.[\Gamma - iso \times \varepsilon_{iso} + \Gamma - mts/ovoc \times (\varepsilon_{mts} + \varepsilon_{ovoc})]$$

where

A (m^2) – area used per vegetation type;

D (g/m^2) – foliar biomass density per vegetation type;

Γ – the integrated value of a unitless environmental correction factor over the growing season of the vegetation concerned;

ε-iso (µg/g.h) – isoprenes standard emission potential[33] per vegetation type;

ε-mts (µg/g.h) – monoterpenes standard emission potential per vegetation type;

ε-ovoc (µg/g.h) – other VOC standard emission potential per vegetation type.

Average data on Γ, D, and ε for European trees and other vegetation are given in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023.

By using meteorological data from the EMEP MSC-W models, the integrated values, Γ-iso and Γ-mts, have been calculated for both six monthly (May–October) and 12 monthly growing seasons, as averages over Estonia:

- Γ-mts = Γ-ovoc – 565 hours (6-month) and 669 hours (12-month);
- Γ-iso – 422 hours (6-month) and 491 hours (12-month).

Table 7.6 gives an overview of the input parameters for trees and ecosystem types used to calculate emission factors. There are also emission factors for Estonia included in the table.

Table 7.6 The input parameters for trees and ecosystem types used to calculate emission factors

Common name	Latin name	Type*	Biomass density D, g/m²	Isoprenes ε-iso, µg/g.h	Monoterpenes ε-mts, µg/g.h	o-VOC ε-ovoc, µg/g.h	Emission factor, t/km²
Pine	*Pinus sylvestris*	E	700	0	1.5	1.5	1.41
Spruce	*Picea abies*	E	1,400	1	1.5	1.5	3.50
Birch	*Betula*	D	320	0	0.2	1.5	0.31
Asp	*Populus*		320	60	0.0	1.5	8.37
Common Alder	*Alnus*	D	320	0	1.5	1.5	0.54
Ash	*Fraxinus*	D	320	0	0.0	1.5	0.27
Oak	*Quercus robur*	D	320	60	0.2	1.5	8.41
Grassland (meadows/ pastures)	-	-	400	0	0.1	1.5	0.36
Grass related crops	-	-	800	0.002	0.1	1.5	0.72

**D=deciduous; E=evergreen*

Activity Data

The area used per vegetation type can be obtained from Statistics Estonia. For the years 1990 and 1995, information on forest land is not available, therefore the information from the Yearbook Forests 2008 was used. From this reference, the available information about the closest years – 1988 and 1994 – was applied accordingly for the years 1990 and 1995. The distribution of forest land area by dominant tree species in counties is performed by using information from the forest register (Centre of Forest Protection and Silviculture).

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[33] Emission potential at 30 °C and PAR (photosynthetically active radiation) = 1,000 $\mu mol.m^{-2}.s^{-1}$

Statistics on agricultural lands obtained from Statistics Estonia contain information on crop fields and cereal field area for the years 1990-2022. These data were used for calculating the total emission. Information on permanent grasslands is available for the years 2005-2022. There is no information in the statistical database for the years 1990-2000.

Table 7.7 Activity data used for NMVOC emission calculation in 1990-2022, thousand ha

Year	Pine-woods	Spruce-woods	Birch-woods	Aspen-woods	Alder-woods	Grey alder-woods	Other stands
1990	749.6	454.2	540.4	30.1	28.9	90.1	23.1
1995	731.7	457.6	585.3	31.5	28.2	82.9	20.6
2000	713,4	363,5	643,2	113,9	60	170	31,9
2005	692,3	360,8	649,9	110,9	64,6	193,5	35,3
2010	711,4	332,1	646	112	65	179	36
2015	702,4	364,5	654,1	120,3	72,3	197,7	35
2016	697,9	371,6	642,2	124	75,1	196,2	35,5
2017	693	377,7	648,9	129	78,3	194	36,6
2018	688,4	378,7	641,8	128,6	79,4	196,5	35,4
2019	683,1	380,3	636,2	131	81,6	195,8	34,1
2020	668,5	376,2	629,5	133,5	84,4	195,7	32,7
2021	665,8	367,1	630,8	131,8	85,3	204,4	32,8
2022	658,3	361,5	627,9	132,8	86	211,6	33,1

Table 7.8 Activity data used for NMVOC emission calculation in 1990-2022, thousand ha

Year	Area of cereals	Area of permanent grasslands
1990	397.000	278.900
1995	304.300	257.900
2000	329.300	257.900
2005	282.100	23. 000
2010	275.295	187.262
2015	282.10	231.00
2020	350.38	192.30
2021	350.38	192.30
2022	350.38	192.30

7.3.3. Source-Specific QA/QC and Verification

Common statistical quality control related to the assessment of trends has been carried out.

Source: www.drivelayer.com

8. RECALCULATIONS AND IMPROVEMENTS

The latest recalculations in the emission inventory were done for the time period from 1990 to 2021. The reason for the recalculations is specified in the Summary.

The main objective of recalculation is to improve the emissions inventory and the quality of reports.

The following changes have been carried out in comparison with the last year's report.

8.1. Energy Sector (NFR 1)

8.1.1. Stationary Combustion in Energy Sector

Overviews of recalculations are given below by NFR 1A1a, 1A1c, 1A2, 1A4ai, 1A4bi and 1A4ci subsectors. The comparison between the submissions for 2023 and 2024 are made by using exact calculation numbers.

If last year's recalculations was based on adjusted data on the distribution of boilers by capacity for the entire period from 1990 to 2021, as well as on refined emission factors, then this year the recalculations were primarily based on corrected fuel usage data (mainly natural gas). Therefore, changes in emissions of main substances and heavy metals were very insignificant. At the same time, the emission factors of POPs when burning gas and ammonia for boilers with a capacity of less than 1 MW when burning biofuels have been updated (according to the new edition of the Guidebook, they are equal to zero).

Changes in emissions for sectors 1A1c and 1A4bi are due to changes in emission factors.

The emission factors specified in Section 3.2.2.2.

The differences in emissions from the stationary combustion sector as well as in the amount of fuel consumed between the submissions for 2022 and 2023 are presented in Tables 8.1– 8.7.

1A1a Public electricity and heat production

All emissions from public electricity and heat production have been recalculated for the period between 1990-2021.

One of the reasons for the recalculation is that there were minor changes in the amount of gas consumed over the entire period, so this had a minor impact on the change in emissions (approximately 0.01-0.0009%). Therefore, these changes are not discussed in this chapter, but the corresponding changes have been given in the NFR tables. Changes in fuel quantity are shown in Table 8.

The change in emission factors of POPs for natural gas and ammonia for small boilers when burning wood in the new edition Guidebook 2023 had a greater impact on the change in POPs and ammonia emission factors and is equal to 0.

This sector contains data on 21 large point sources, as well as smaller diffuse sources. Large point sources, in accordance with national legislation or the requirements specified in the pollution permit, are obliged to carry out continuous or periodic monitoring of emissions. Therefore, the inventory includes data on substances for which measurements were carried out, based on data from enterprises. For other substances, as heavy metals and POPs, emissions are calculated using national emission factors or Guidebook 2023 EF. For example, emissions of heavy metals from oil shale power plants are calculated based on measurements carried out by Tallinn University of Technology for different technologies, which made it possible to refine emissions for the entire period from 1990 to 2021, improve data quality and reduce uncertainty results. When making calculations, the time of introduction of new technologies or more modern treatment equipment was taken into account.

The energy balance data for the Transformation sector category were used for calculations. First of all, fuel consumed by large sources was excluded from each fuel. Then, the remaining part is divided, using the data of the analysis, into fuel used by boiler houses up to and equal to 1 MWh and from 1 to 50 MWh. For boiler with a capacity of less than 1 MWh, the Tier 2 emission factors of GB 2019 from the small combustion chapter were used. Then, also using the results of the analysis, the quantities of fuels for installations with and without control (for solid fuels and biomass) were determined. Liquid fuels were splited into heavy fuel oil, light fuel oil and shale oil because these fuels have different sulphur content, which also changed over the entire period, taking into account legislation and fuel quality requirements.

For the calculation of ammonia emissions from biomass, peat, liquid fuels and natural gas combustion in boilers with a capacity of 1 to 50 MWh, national emission factors obtained from measurements were used (see chapter 3.2.2.2, Table 3.10 -3.13).

The differences in emissions from the sector 1A1a as well as in the amount of fuel consumed between the submissions for 2022 and 2023 are presented in Tables 8.1 and 8.2

Table 8.1 The differences in the sector NFR 1A1a POPs and NH_3 emissions for 1990-2021 between 2023 and 2024 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			NH_3, kt		
	2023	2024	%	2023	2024	%	2023	2024	%
1990	2.15	2.14	-0.76	0.75	0.75	-0.013	0.017	0.017	0.00
1991	2.08	2.07	-0.77	0.72	0.72	-0.014	0.018	0.018	0.00
1992	1.80	1.79	-0.48	0.56	0.56	-0.010	0.017	0.009	-47.3
1993	1.51	1.50	-0.22	0.41	0.41	-0.005	0.011	0.005	-52.0
1994	1.75	1.74	-0.29	0.51	0.51	-0.006	0.027	0.006	-76.6
1995	1.22	1.22	-0.49	0.24	0.24	-0.015	0.016	0.004	-77.0
1996	1.21	1.21	-0.58	0.26	0.26	-0.017	0.017	0.004	-77.1
1997	1.28	1.27	-0.52	0.30	0.30	-0.014	0.020	0.005	-76.3
1998	0.90	0.90	-0.64	0.26	0.26	-0.013	0.021	0.004	-79.6
1999	1.00	0.99	-0.63	0.26	0.26	-0.015	0.020	0.004	-79.3
2000	1.01	1.00	-0.80	0.21	0.21	-0.024	0.017	0.003	-80.2
2001	1.20	1.19	-0.68	0.23	0.23	-0.022	0.022	0.004	-82.9
2002	1.22	1.21	-0.67	0.29	0.29	-0.018	0.022	0.006	-73.8
2003	0.93	0.92	-0.78	0.22	0.22	-0.020	0.019	0.004	-77.4
2004	1.05	1.05	-0.80	0.26	0.26	-0.020	0.022	0.005	-77.0
2005	1.09	1.08	-0.81	0.27	0.27	-0.020	0.024	0.005	-78.6
2006	1.01	1.00	-0.87	0.24	0.24	-0.023	0.020	0.005	-76.7
2007	0.95	0.94	-0.93	0.24	0.24	-0.023	0.016	0.005	-67.2
2008	2.39	2.38	-0.37	0.22	0.22	-0.025	0.014	0.005	-62.9
2009	2.32	2.31	-0.30	0.19	0.19	-0.022	0.011	0.004	-60.2
2010	2.39	2.38	-0.31	0.21	0.21	-0.022	0.010	0.004	-58.6
2011	3.44	3.44	-0.18	0.15	0.15	-0.025	0.008	0.003	-57.1
2012	2.08	2.08	-0.32	0.16	0.16	-0.026	0.008	0.003	-57.3
2013	1.32	1.32	-0.38	0.30	0.30	-0.011	0.017	0.007	-57.3
2014	1.48	1.47	-0.31	0.25	0.25	-0.011	0.014	0.005	-59.7
2015	1.54	1.54	-0.24	0.29	0.29	-0.008	0.016	0.006	-62.7
2016	2.04	2.04	-0.19	0.46	0.46	-0.005	0.026	0.008	-68.1
2017	2.15	2.15	-0.17	0.54	0.54	-0.001	0.022	0.008	-62.5
2018	2.21	2.20	-0.16	0.57	0.57	-0.004	0.020	0.009	-57.1
2019	2.16	2.16	-0.14	0.53	0.53	-0.003	0.020	0.009	-55.4
2020	2.34	2.34	-0.10	0.58	0.58	-0.003	0.018	0.007	-61.9
2021	2.08	2.15	3.13	0.39	0.43	11.992	0.012	0.004	-65.3

Table 8.2 The differences of activity data (TJ) in the sector NFR 1A Stationary combustion for 1990-2021 between 2023 and 2024 submissions

Year	Gaseous Fuels		
	2023	2024	%
1990	32 733.00	32 733.0	0.000
1991	32 139.00	32 139.0	0.000
1992	17 366.00	17 365.5	-0.003
1993	6 763.00	6 762.6	-0.006
1994	10 156.00	10 155.6	-0.004
1995	11 902.00	11 901.6	-0.003
1996	14 037.00	14 037.3	0.002
1997	13 321.00	13 320.9	-0.001
1998	11 406.00	11 405.7	-0.003
1999	12 561.00	12 560.4	-0.005
2000	16 135.00	16 135.2	0.001
2001	16 298.00	16 298.1	0.001
2002	16 193.00	16 193.7	0.004
2003	14 401.00	14 400.9	-0.001
2004	16 822.00	16 821.9	-0.001
2005	17 551.00	17 550.9	-0.001
2006	17 489.00	17 488.8	-0.001
2007	17 482.00	17 481.6	-0.002
2008	17 649.00	17 649.0	0.000
2009	13 741.00	13 741.2	0.001
2010	14 882.00	14 881.5	-0.003
2011	12 551.00	12 551.4	0.003
2012	13 259.00	13 258.8	-0.002
2013	9 891.00	9 891.0	0.000
2014	8 864.00	8 864.1	0.001
2015	7 036.00	7 035.3	-0.010
2016	7 363.00	7 362.0	-0.014
2017	7 128.00	7 128.0	0.000
2018	6 781.00	6 779.0	-0.029
2019	5 830.00	5 713.0	-2.007
2020	4 307.00	4 303.00	-0.093
2021	5 680.7	5 681.0	0.005

1A1c Manufacture of solid fuels and other energy industries

This year the data of NMVOC and CO for the period 1990-2021 has been revised. The reason for that – is a new permit and a change in the methodology for calculating emissions from shale oil production at the Enefit 140 installation (Enefit Power AS). For other enterprises and technological installations for the production of shale oil, the emissions calculation methodologies have not changed.

Table 8.3 NMVOC and CO emission factors for Enefit 140, t/TJ oil shale used

	NMVOOC	CO
EF, t/TJ	0.12011	2.16843

The differences in the emissions from the manufacture of solid fuels and other energy industries between the 2023 and 2024 submissions are presented in Table 8.4.

Table 8.4 The differences in the sector NFR 1A1c NMVOC and CO emissions (kt) for 1990-2021 between 2023 and 2024 submissions

Year	NMVOC			CO		
	2023	2024	%	2023	2024	%
1990	0.86	1.09	26.4	6.49	7.11	9.5
1991	0.81	0.93	15.3	4.02	3.91	-2.9
1992	0.80	0.97	20.6	4.57	5.65	23.9
1993	0.65	0.91	40.0	5.93	9.14	54.2
1994	0.53	0.84	57.5	8.56	10.33	20.8
1995	0.55	0.83	52.7	8.52	9.36	9.9
1996	0.66	0.95	44.2	8.89	9.97	12.2
1997	0.61	0.94	53.0	6.99	11.19	60.2
1998	0.52	0.80	54.2	6.55	9.45	44.3
1999	0.38	0.66	71.7	5.63	8.99	59.7
2000	0.36	0.78	114.5	8.20	12.82	56.4
2001	0.47	0.90	93.4	8.71	13.60	56.2
2002	0.60	1.07	78.1	10.90	14.66	34.4
2003	0.66	1.19	80.7	12.32	16.65	35.2
2004	0.70	1.25	78.6	11.60	17.68	52.4
2005	0.73	1.31	79.5	12.42	19.29	55.3
2006	0.50	1.05	109.2	9.47	18.24	92.6
2007	0.50	1.02	102.8	12.67	17.38	37.1
2008	0.58	1.31	123.7	16.02	23.55	46.9
2009	0.65	1.59	143.3	19.36	28.67	48.1
2010	0.71	1.77	149.9	20.34	32.23	58.5
2011	0.71	1.63	130.9	16.57	29.96	80.8
2012	0.79	1.83	130.5	26.70	34.83	30.4
2013	0.81	1.89	133.4	26.12	35.68	36.6
2014	0.82	1.85	125.7	25.88	34.11	31.8
2015	0.74	1.74	133.3	26.87	32.15	19.6
2016	0.60	1.61	166.1	28.10	31.16	10.9
2017	0.63	1.81	186.0	31.17	43.17	38.5
2018	0.42	1.89	347.9	32.17	43.23	34.4
2019	0.48	1.74	263.1	35.16	44.45	26.4
2020	0.53	1.87	250.4	39.08	47.37	21.2
2021	0.38	1.77	359.7	32.15	41.95	30.5

1A2 Stationary combustion in manufacturing industries and construction

Compared with the previous submission, emissions from NFR 1A2 have been recalculated for the period between 1990–2021 due to the correction of natural gas consumption for all period and biomass for 2021 year. The tables 8.5 show the summary data of sector 1A2. The increase in biomass amount was the reason of pollutants emission. Table 8.6 shows the amount of fuel used.

Since the change in the amount of gas used was small, it had a negligible impact on the amount of emissions. Therefore, these changes are not discussed in this chapter, but the corresponding changes have been given in the NFR tables.

The change in emission factors of POPs for natural gas and ammonia for small boilers when burning wood in the new edition Guidebook 2023 had a greater impact on the change in POPs and ammonia emission factors and is equal to 0.

Return to the Table of Contents

Table 8.5 The differences in the sector NFR 1A2 pollutants emissions for 1990-2021 between 2023 and 2024 submissions (main pollutants in kt)

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			PAHs total, t		
	2023	2024	%	2023	2024	%	2023	2024	%
1990	1.178	1.174	-0.34	0.352	0.352	-0.01	0.009	0.007	-17.9
1991	1.144	1.140	-0.39	0.350	0.350	-0.01	0.008	0.007	-18.5
1992	0.553	0.550	-0.57	0.200	0.200	-0.01	0.009	0.008	-17.0
1993	0.444	0.441	-0.45	0.152	0.152	-0.04	0.015	0.014	-9.8
1994	0.461	0.459	-0.39	0.130	0.130	-0.01	0.017	0.013	-23.1
1995	0.800	0.797	-0.35	0.320	0.320	-0.02	0.040	0.022	-43.8
1996	0.952	0.949	-0.32	0.370	0.370	-0.02	0.054	0.025	-54.3
1997	0.448	0.445	-0.66	0.205	0.205	0.01	0.046	0.029	-37.7
1998	0.384	0.381	-0.84	0.183	0.183	-0.04	0.019	0.004	-81.0
1999	0.439	0.436	-0.54	0.193	0.193	-0.01	0.022	0.003	-86.2
2000	0.421	0.418	-0.63	0.198	0.198	-0.04	0.022	0.003	-86.3
2001	0.524	0.520	-0.60	0.257	0.257	-0.02	0.025	0.004	-83.3
2002	0.581	0.579	-0.40	0.249	0.249	0.01	0.027	0.003	-87.5
2003	0.610	0.606	-0.60	0.270	0.270	-0.03	0.028	0.004	-85.8
2004	0.639	0.636	-0.53	0.293	0.293	-0.01	0.028	0.004	-84.8
2005	0.675	0.672	-0.51	0.295	0.295	0.00	0.030	0.004	-86.1
2006	0.479	0.475	-0.75	0.237	0.237	-0.01	0.019	0.004	-81.6
2007	0.490	0.486	-0.73	0.270	0.270	0.01	0.019	0.004	-81.2
2008	0.543	0.540	-0.56	0.328	0.328	-0.01	0.020	0.003	-82.8
2009	0.388	0.386	-0.52	0.258	0.258	0.01	0.012	0.002	-80.7
2010	0.479	0.477	-0.48	0.231	0.231	0.03	0.013	0.003	-79.3
2011	0.502	0.499	-0.44	0.199	0.199	0.06	0.013	0.003	-79.9
2012	0.358	0.356	-0.67	0.178	0.178	0.03	0.009	0.002	-72.9
2013	0.394	0.391	-0.76	0.158	0.158	0.01	0.012	0.003	-77.8
2014	0.404	0.402	-0.50	0.190	0.190	0.01	0.008	0.002	-72.0
2015	0.462	0.460	-0.44	0.187	0.187	-0.01	0.009	0.002	-73.9
2016	0.065	0.063	-3.53	0.065	0.065	-0.04	0.004	0.002	-56.1
2017	0.228	0.226	-0.93	0.040	0.040	-0.08	0.003	0.001	-56.7
2018	0.200	0.198	-1.18	0.037	0.037	-0.04	0.003	0.002	-55.6
2019	0.209	0.206	-1.00	0.045	0.045	-0.03	0.004	0.001	-60.9
2020	0.096	0.094	-2.09	0.095	0.095	-0.01	0.004	0.001	-59.6
2021	0.060	0.080	32.97	0.032	0.039	24.07	0.003	0.001	-54.8

Table 8.5 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2021	0.02	0.03	32.9	0.02	0.03	34.8	0.004	0.005	24.6	0.03	0.04	33.5

Table 8.5 continues

Year	NO_x			NMVOC			CO		
	2023	2024	%	2023	2024	%	2023	2024	%
2021	0.35	0.38	6.4	0.04	0.06	26.0	0.10	0.12	20.2

Table 8.6 The differences of activity data (TJ) in the sector NFR 1A2 Stationary combustion for 1990-2021 between 2023 and 2024 submissions

Year	Gasoues Fuels			Biomass		
	2023	2024	%	2023	2024	%
1990	8 004.00	8 003.7	-0.004	264.00	264.0	0.0
1991	8 820.00	8 820.0	0.000	264.00	264.0	0.0
1992	6 309.00	6 309.0	0.000	264.00	264.0	0.0
1993	3 870.00	3 868.2	-0.047	264.00	264.0	0.0
1994	3 595.00	3 593.7	-0.036	722.00	722.0	0.0
1995	5 408.00	5 408.1	0.002	3 161.00	3 161.0	0.0
1996	5 976.00	5 974.2	-0.030	5 037.00	5 037.0	0.0
1997	6 062.00	6 062.4	0.007	2 996.00	2 996.0	0.0

Return to the Table of Contents

Year	Gasoues Fuels			Biomass		
	2023	2024	%	2023	2024	%
1998	6 248.00	6 246.9	-0.018	2 647.00	2 647.0	0.0
1999	4 673.00	4 671.0	-0.043	3 459.00	3 459.0	0.0
2000	5 101.00	5 099.4	-0.031	3 318.00	3 318.0	0.0
2001	6 171.00	6 169.5	-0.024	3 768.00	3 768.0	0.0
2002	4 745.00	4 743.5	-0.032	4 769.00	4 769.0	0.0
2003	7 104.00	7 101.9	-0.030	5 003.00	5 003.0	0.0
2004	6 754.00	6 754.5	0.007	5 015.00	5 015.0	0.0
2005	6 934.00	6 933.6	-0.006	5 464.00	5 464.0	0.0
2006	7 179.00	7 179.3	0.004	3 536.00	3 536.0	0.0
2007	7 282.00	7 281.9	-0.001	3 650.00	3 650.0	0.0
2008	6 004.00	6 003.9	-0.002	4 955.00	4 955.0	0.0
2009	4 121.00	4 121.1	0.002	3 599.00	3 599.0	0.0
2010	4 782.00	4 782.2	0.004	4 370.00	4 370.0	0.0
2011	4 758.00	4 756.5	-0.032	4 582.00	4 582.0	0.0
2012	4 991.00	4 988.7	-0.046	3 200.00	3 200.0	0.0
2013	6 127.00	6 126.3	-0.011	3 529.00	3 529.0	0.0
2014	4 094.00	4 094.1	0.002	3 735.00	3 735.0	0.0
2015	3 949.00	3 948.3	-0.018	4 350.00	4 350.0	0.0
2016	4 460.00	4 458.6	-0.031	466.00	466.0	0.0
2017	4 115.00	4 113.9	-0.027	581.00	581.0	0.0
2018	4 566.00	4 565.0	-0.022	748.00	748.0	0.0
2019	4 166.00	4 166.0	0.000	501.00	501.4	0.1
2020	3 965.00	3 964.00	-0.025	762.80	762.50	0.0
2021	4 129.97	4 129.00	-0.023	471.04	691.23	46.7

1A4ai Commercial/institutional: Stationary

Compared with the previous submission, emissions from NFR 1A2 have been recalculated for the period between 1990–2021 mainly due to the correction of coal (1997-2014), peat (1997-2006; 2012-2016) and liquid fuel (2019-2021) consumption; also natural gas consumption for some years and biomass for 2021. The tables 8.7 show difference in pollutants emission. Table 8.8 shows the amount of fuel used.

The change in emission factors of POPs for natural gas and ammonia for small boilers when burning wood in the new edition Guidebook 2023 had a greater impact on the change in POPs and ammonia emission factors and is equal to 0. The change in PCB emissions resulted from changes in coal and peat consumption.

Table 8.7 The differences in the sector NFR 1A4ai all pollutants emissions for 1990-2021 between 2023 and 2024 submissions (main pollutants in kt)

Year	NO$_x$			NMVOC			SO$_x$			NH$_3$		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.47	0.47	-0.004	0.21	0.21	0.000	1.25	1.25	0.000	0.030	0.001	-96.62
1991	0.45	0.45	0.002	0.20	0.20	0.000	1.05	1.05	0.000	0.029	0.001	-96.81
1992	0.35	0.35	0.000	0.16	0.16	0.000	0.76	0.76	0.000	0.023	0.001	-97.23
1993	0.29	0.29	-0.004	0.13	0.13	-0.001	0.80	0.80	0.000	0.020	0.001	-97.29
1994	0.36	0.36	-0.003	0.21	0.21	0.000	0.66	0.66	0.000	0.031	0.001	-97.46
1995	0.17	0.17	0.009	0.02	0.02	0.005	0.69	0.69	0.000	0.002	0.000	-82.44
1996	0.19	0.19	-0.006	0.02	0.02	0.000	0.78	0.78	0.000	0.001	0.000	-78.05
1997	0.28	0.28	0.012	0.06	0.06	0.016	0.96	0.96	0.012	0.006	0.000	-92.60
1998	0.29	0.29	0.036	0.06	0.06	0.078	1.12	1.12	0.035	0.004	0.000	-89.61
1999	0.29	0.29	0.019	0.07	0.07	0.045	0.97	0.97	0.026	0.006	0.000	-91.57
2000	0.36	0.36	-0.005	0.07	0.07	-0.018	1.12	1.12	-0.009	0.005	0.001	-88.04
2001	0.45	0.45	0.006	0.09	0.09	0.030	1.21	1.21	0.015	0.007	0.001	-89.07
2002	0.33	0.33	0.029	0.08	0.08	0.079	0.54	0.54	0.072	0.007	0.001	-89.66
2003	0.37	0.37	0.034	0.09	0.09	0.082	0.43	0.43	0.088	0.008	0.001	-85.38
2004	0.44	0.44	0.021	0.13	0.13	0.056	0.52	0.52	0.080	0.014	0.001	-91.35
2005	0.36	0.36	-0.043	0.11	0.11	-0.097	0.35	0.35	-0.159	0.009	0.001	-89.36
2006	0.32	0.32	0.001	0.11	0.11	0.006	0.21	0.21	0.023	0.011	0.001	-91.16

Year	NO_x			NMVOC			SO_x			NH_3		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2007	0.31	0.31	0.002	0.11	0.11	0.010	0.18	0.18	0.015	0.011	0.001	-92.17
2008	0.30	0.30	-0.020	0.11	0.11	-0.049	0.19	0.19	-0.060	0.011	0.001	-92.38
2009	0.25	0.25	0.036	0.08	0.08	0.089	0.16	0.16	0.091	0.008	0.001	-91.00
2010	0.25	0.25	0.025	0.09	0.09	0.087	0.14	0.14	0.101	0.009	0.001	-92.05
2011	0.29	0.29	0.024	0.09	0.09	0.086	0.12	0.12	0.122	0.009	0.001	-91.69
2012	0.27	0.27	0.050	0.07	0.07	0.196	0.14	0.15	0.265	0.006	0.001	-87.07
2013	0.28	0.28	-0.009	0.07	0.07	-0.020	0.14	0.14	0.076	0.006	0.001	-84.70
2014	0.27	0.28	0.043	0.06	0.06	0.186	0.12	0.12	0.266	0.005	0.001	-79.74
2015	0.28	0.28	0.029	0.05	0.05	0.106	0.13	0.13	0.183	0.006	0.001	-80.00
2016	0.28	0.28	0.044	0.05	0.05	0.202	0.11	0.11	0.397	0.005	0.001	-75.91
2017	0.27	0.27	-0.008	0.05	0.05	-0.002	0.07	0.07	-0.001	0.005	0.001	-79.95
2018	0.27	0.27	-0.015	0.05	0.05	-0.004	0.11	0.11	-0.002	0.005	0.001	-77.55
2019	0.27	0.25	-5.222	0.06	0.06	-3.451	0.11	0.10	-8.200	0.006	0.001	-80.68
2020	0.27	0.26	-4.509	0.07	0.06	-2.605	0.07	0.07	-10.708	0.006	0.001	-82.54
2021	0.25	0.26	7.037	0.05	0.06	30.754	0.07	0.07	-2.673	0.004	0.001	-69.41

Table 8.7 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.28	0.28	0.00
1991	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.27	0.27	0.00
1992	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.21	0.21	0.00
1993	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.18	0.18	0.00
1994	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.27	0.27	0.00
1995	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.02	0.02	0.00
1996	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.02	0.02	0.00
1997	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.09	0.09	0.03
1998	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.08	0.08	0.10
1999	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.09	0.09	0.07
2000	0.07	0.07	-0.03	0.07	0.07	-0.03	0.009	0.009	-0.01	0.08	0.08	-0.03
2001	0.09	0.09	0.04	0.09	0.10	0.04	0.012	0.012	0.03	0.11	0.11	0.04
2002	0.08	0.08	0.11	0.09	0.09	0.11	0.011	0.011	0.05	0.10	0.10	0.10
2003	0.08	0.08	0.12	0.09	0.09	0.11	0.012	0.012	0.05	0.10	0.10	0.11
2004	0.12	0.12	0.08	0.13	0.13	0.07	0.019	0.019	0.03	0.15	0.15	0.07
2005	0.10	0.10	-0.13	0.11	0.11	-0.13	0.014	0.014	-0.06	0.12	0.12	-0.13
2006	0.09	0.09	0.01	0.10	0.10	0.01	0.015	0.015	0.01	0.11	0.11	0.01
2007	0.09	0.09	0.01	0.11	0.11	0.01	0.015	0.015	0.01	0.11	0.11	0.01
2008	0.08	0.08	-0.07	0.10	0.10	-0.06	0.015	0.015	-0.02	0.10	0.10	-0.06
2009	0.06	0.06	0.12	0.07	0.07	0.12	0.010	0.010	0.04	0.07	0.07	0.11
2010	0.07	0.07	0.11	0.07	0.07	0.11	0.012	0.012	0.04	0.08	0.08	0.11
2011	0.06	0.06	0.12	0.07	0.07	0.11	0.012	0.012	0.04	0.08	0.08	0.11
2012	0.05	0.05	0.26	0.05	0.05	0.25	0.008	0.008	0.08	0.06	0.06	0.25
2013	0.05	0.05	-0.04	0.06	0.06	-0.04	0.008	0.008	-0.02	0.06	0.06	-0.04
2014	0.04	0.04	0.24	0.04	0.04	0.23	0.007	0.007	0.08	0.05	0.05	0.23
2015	0.03	0.03	0.13	0.04	0.04	0.12	0.006	0.006	0.05	0.04	0.04	0.13
2016	0.03	0.03	0.24	0.03	0.03	0.23	0.006	0.006	0.09	0.04	0.04	0.24
2017	0.03	0.03	0.00	0.03	0.03	0.00	0.006	0.006	0.00	0.03	0.03	0.00
2018	0.03	0.03	0.00	0.04	0.04	0.00	0.006	0.006	0.00	0.04	0.04	0.00
2019	0.03	0.03	-1.21	0.04	0.04	-1.04	0.006	0.006	-3.46	0.04	0.04	-1.05
2020	0.04	0.04	-0.88	0.05	0.05	-0.74	0.007	0.007	-2.54	0.05	0.05	-0.75
2021	0.03	0.04	40.96	0.03	0.04	42.73	0.005	0.006	42.31	0.03	0.05	42.65

Table 8.7 continues

Year	CO			Pb, t			Cd			Hg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.46	0.46	0.000	0.080	0.080	0.00	0.032	0.032	0.00	0.002	0.002	0.00
1991	0.42	0.42	0.000	0.075	0.075	0.00	0.032	0.032	0.00	0.002	0.002	0.00
1992	0.29	0.29	0.000	0.055	0.055	0.00	0.024	0.024	0.00	0.001	0.001	0.00
1993	0.25	0.25	0.000	0.045	0.045	0.00	0.018	0.018	0.00	0.001	0.001	0.00
1994	0.42	0.42	0.000	0.065	0.065	0.00	0.027	0.027	0.00	0.002	0.002	0.00
1995	0.08	0.08	0.001	0.019	0.019	0.00	0.005	0.005	0.00	0.000	0.000	0.00
1996	0.05	0.05	-0.004	0.019	0.019	0.00	0.006	0.006	0.00	0.000	0.000	0.00
1997	0.49	0.49	0.064	0.060	0.060	0.04	0.010	0.010	0.00	0.003	0.003	0.07
1998	0.48	0.48	0.175	0.061	0.061	0.13	0.009	0.009	0.01	0.003	0.003	0.14
1999	0.47	0.47	0.127	0.061	0.061	0.09	0.012	0.012	0.01	0.003	0.003	0.15
2000	0.43	0.43	-0.062	0.062	0.062	-0.04	0.013	0.013	0.00	0.002	0.002	-0.08
2001	0.55	0.55	0.071	0.078	0.078	0.05	0.017	0.017	0.00	0.003	0.003	0.03
2002	0.49	0.49	0.191	0.063	0.063	0.14	0.014	0.014	0.01	0.003	0.003	0.19
2003	0.54	0.54	0.199	0.065	0.065	0.15	0.016	0.016	0.01	0.003	0.003	0.18
2004	0.61	0.61	0.166	0.074	0.074	0.13	0.018	0.018	0.01	0.003	0.003	0.16
2005	0.64	0.64	-0.224	0.078	0.078	-0.17	0.024	0.024	0.00	0.003	0.003	-0.22
2006	0.47	0.47	0.014	0.058	0.058	0.01	0.019	0.019	0.00	0.002	0.002	0.00
2007	0.52	0.52	0.029	0.060	0.060	0.02	0.019	0.019	0.00	0.002	0.002	0.04
2008	0.41	0.41	-0.160	0.054	0.054	-0.12	0.022	0.022	0.00	0.002	0.002	-0.16
2009	0.32	0.32	0.267	0.044	0.044	0.18	0.019	0.019	0.01	0.001	0.001	0.28
2010	0.31	0.31	0.276	0.042	0.042	0.20	0.018	0.018	0.01	0.001	0.001	0.22
2011	0.28	0.28	0.314	0.045	0.045	0.19	0.025	0.025	0.01	0.001	0.001	0.25
2012	0.26	0.26	0.558	0.042	0.042	0.34	0.023	0.023	0.01	0.001	0.001	0.52
2013	0.36	0.36	-0.051	0.050	0.050	-0.03	0.022	0.022	0.00	0.002	0.002	0.06
2014	0.25	0.25	0.466	0.034	0.035	0.33	0.016	0.016	0.01	0.001	0.001	0.42
2015	0.15	0.15	0.382	0.027	0.027	0.21	0.017	0.017	0.01	0.001	0.001	0.35
2016	0.17	0.17	0.636	0.026	0.026	0.43	0.015	0.015	0.01	0.001	0.001	0.58
2017	0.11	0.11	-0.003	0.021	0.021	0.00	0.018	0.018	0.00	0.001	0.001	0.00
2018	0.18	0.18	-0.004	0.028	0.028	0.00	0.015	0.015	0.00	0.001	0.001	-0.11
2019	0.18	0.18	-2.843	0.028	0.025	-9.92	0.015	0.012	-17.97	0.001	0.001	-1.40
2020	0.20	0.19	-2.270	0.029	0.026	-8.02	0.016	0.014	-13.65	0.001	0.001	-1.29
2021	0.16	0.18	12.604	0.024	0.026	5.70	0.014	0.014	1.98	0.001	0.001	12.61

Table 8.7 continues

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.248	0.248	-0.07	0.100	0.100	0.00	0.011	0.011	0.00	0.011	0.011	0.0
1991	0.241	0.240	-0.08	0.097	0.097	0.00	0.011	0.011	0.00	0.005	0.005	0.0
1992	0.187	0.187	-0.04	0.073	0.073	0.00	0.009	0.009	0.00	0.000	0.000	0.0
1993	0.159	0.159	-0.03	0.059	0.059	0.00	0.008	0.008	0.00	0.000	0.000	0.0
1994	0.245	0.245	-0.02	0.092	0.092	0.00	0.012	0.012	0.00	0.005	0.005	0.0
1995	0.028	0.028	-0.20	0.019	0.019	0.00	0.001	0.001	0.00	0.005	0.005	0.0
1996	0.025	0.025	-0.61	0.018	0.018	-0.01	0.000	0.000	0.00	0.003	0.003	0.0
1997	0.105	0.105	-0.10	0.061	0.061	0.03	0.002	0.002	0.00	0.049	0.049	0.1
1998	0.101	0.101	-0.02	0.063	0.063	0.12	0.002	0.002	0.00	0.049	0.049	0.2
1999	0.108	0.108	-0.09	0.066	0.066	0.08	0.002	0.002	0.00	0.044	0.044	0.2
2000	0.104	0.104	-0.25	0.067	0.067	-0.04	0.002	0.002	0.00	0.039	0.039	-0.1
2001	0.137	0.137	-0.30	0.087	0.087	0.05	0.003	0.003	0.00	0.049	0.049	0.1
2002	0.122	0.122	-0.35	0.076	0.076	0.13	0.003	0.003	0.00	0.043	0.043	0.2
2003	0.130	0.129	-0.90	0.083	0.083	0.14	0.003	0.003	0.00	0.045	0.045	0.3
2004	0.183	0.182	-0.58	0.101	0.101	0.11	0.005	0.005	0.02	0.044	0.044	0.3
2005	0.160	0.159	-0.76	0.106	0.106	-0.17	0.004	0.004	0.00	0.052	0.052	-0.3
2006	0.144	0.143	-0.72	0.084	0.084	0.00	0.004	0.004	0.00	0.032	0.032	0.0
2007	0.154	0.153	-0.60	0.091	0.091	0.01	0.005	0.005	0.00	0.035	0.035	0.0
2008	0.141	0.140	-0.60	0.083	0.083	-0.11	0.005	0.005	0.00	0.024	0.024	-0.3
2009	0.104	0.104	-0.42	0.067	0.068	0.16	0.003	0.003	0.00	0.019	0.019	0.4
2010	0.113	0.112	-0.43	0.067	0.067	0.17	0.004	0.004	0.00	0.017	0.017	0.5

Return to the Table of Contents

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2011	0.113	0.113	-0.45	0.071	0.072	0.17	0.004	0.004	0.03	0.012	0.012	0.7
2012	0.087	0.086	-0.53	0.064	0.064	0.33	0.002	0.002	0.04	0.014	0.014	1.1
2013	0.101	0.100	-0.96	0.077	0.077	-0.04	0.002	0.002	0.00	0.024	0.024	0.0
2014	0.075	0.074	-1.61	0.054	0.054	0.31	0.002	0.002	0.05	0.014	0.014	0.8
2015	0.060	0.058	-2.33	0.041	0.041	0.19	0.002	0.002	0.00	0.005	0.005	1.3
2016	0.061	0.059	-2.58	0.041	0.041	0.39	0.002	0.002	0.00	0.009	0.009	1.6
2017	0.052	0.050	-3.07	0.035	0.035	-0.03	0.002	0.002	0.00	0.000	0.000	0.0
2018	0.065	0.063	-2.54	0.045	0.045	-0.02	0.002	0.002	0.00	0.007	0.007	0.0
2019	0.071	0.068	-4.20	0.047	0.043	-7.51	0.002	0.002	0.00	0.007	0.007	0.0
2020	0.082	0.079	-3.41	0.051	0.048	-5.80	0.003	0.003	0.00	0.007	0.007	0.0
2021	0.056	0.074	31.97	0.040	0.046	14.89	0.002	0.003	63.5	0.007	0.007	0.0

Table 8.8 The differences of activity data (TJ) in the sector NFR 1A4ai Stationary combustion for 1990-2021 between 2023 and 2024 submissions

Year	Liquid Fuels			Solid Fuels			Gaseous Fuels			Biomass		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	1 524.350	1 524.350	0.0	64.0	64.0	0.0	338.0	337.5	-0.1	2 204.0	2 204.0	0.0
1991	1 475.400	1 475.400	0.0	32.0	32.0	0.0	375.0	375.3	0.1	2 194.0	2 194.0	0.0
1992	1 124.200	1 124.200	0.0	NA	NA	NA	135.0	135.0	0.0	1 759.0	1 759.0	0.0
1993	916.250	916.250	0.0	NA	NA	NA	102.0	101.7	-0.3	1 500.0	1 500.0	0.0
1994	784.750	784.750	0.0	32.0	32.0	0.0	120.0	119.7	-0.3	2 307.0	2 307.0	0.0
1995	1 029.250	1 029.250	0.0	32.0	32.0	0.0	113.0	113.4	0.4	109.0	109.0	0.0
1996	1 163.900	1 163.900	0.0	16.0	16.0	0.0	300.0	299.7	-0.1	93.0	93.0	0.0
1997	1 203.600	1 203.600	0.0	288.0	288.2	0.1	273.0	272.7	-0.1	410.0	410.0	0.0
1998	1 350.0	1 350.000	0.0	290.0	290.6	0.2	269.0	269.1	0.0	316.0	316.0	0.0
1999	1 368.050	1 368.050	0.0	260.0	260.4	0.2	355.0	354.6	-0.1	428.0	428.0	0.0
2000	1 847.600	1 847.600	0.0	232.0	231.8	-0.1	446.0	446.4	0.1	366.0	366.0	0.0
2001	2 223.600	2 223.600	0.0	288.0	288.3	0.1	939.0	938.7	0.0	528.0	528.0	0.0
2002	1 383.600	1 383.600	0.0	250.0	250.6	0.2	1 152.0	1 152.0	0.0	517.0	517.0	0.0
2003	1 203.800	1 203.800	0.0	266.0	266.7	0.3	2 688.0	2 688.3	0.0	545.0	545.0	0.0
2004	1 334.650	1 334.650	0.0	260.0	260.7	0.3	2 451.0	2 450.7	0.0	1 046.0	1 046.0	0.0
2005	1 289.050	1 289.050	0.0	307.0	306.1	-0.3	1 936.0	1 935.9	0.0	711.0	711.0	0.0
2006	919.800	919.800	0.0	188.0	188.1	0.0	2 062.0	2 061.9	0.0	866.0	866.0	0.0
2007	813.100	813.100	0.0	206.0	206.1	0.0	1 838.0	1 837.8	0.0	927.0	927.0	0.0
2008	1 017.250	1 017.250	0.0	141.0	140.6	-0.3	1 421.0	1 421.1	0.0	927.0	927.0	0.0
2009	950.250	950.250	0.0	113.0	113.5	0.4	1 141.0	1 141.2	0.0	642.0	642.0	0.0
2010	839.400	839.400	0.0	97.0	97.5	0.5	1 245.0	1 244.7	0.0	767.0	767.0	0.0
2011	1 184.020	1 184.020	0.0	70.0	70.5	0.7	1 298.0	1 297.8	0.0	824.0	824.0	0.0
2012	1 196.940	1 196.940	0.0	84.0	84.9	1.1	1 460.0	1 459.8	0.0	499.0	499.0	0.0
2013	1 102.470	1 102.470	0.0	139.0	139.0	0.0	1 814.0	1 813.5	0.0	516.0	516.0	0.0
2014	839.440	839.440	0.0	84.0	84.7	0.8	2 798.0	2 798.1	0.0	444.0	444.0	0.0
2015	933.260	933.260	0.0	30.0	30.4	1.3	2 930.0	2 930.4	0.0	484.0	484.0	0.0
2016	746.640	746.640	0.0	50.0	50.8	1.6	3 321.0	3 321.0	0.0	631.0	631.0	0.0
2017	843.918	843.918	0.0	NA	NA	NA	3 056.0	3 055.5	0.0	554.0	554.0	0.0
2018	796.110	796.110	0.0	44.0	44.0	0.0	3 191.0	3 190.0	0.0	489.0	489.0	0.0
2019	766.487	625.437	-18.4	40.0	40.0	0.0	3 073.0	3 073.0	0.0	553.800	565.0	2.0
2020	711.709	593.409	-16.6	43.0	43.000	0.0	3 150.0	3 147.0	-0.1	643.100	643.0	0.0
2021	634.060	593.110	-6.5	42.400	42.400	0.0	3 331.730	3 332.0	0.0	360.150	583.0	61.9

1A4bi Residential: Stationary

Compared with the previous submission, emissions from NFR 1A4bi have been recalculated for the period between 1990–2021 mainly due to the correction of emission factor.

Emissions of major substances from the combustion of biomass in the residential sector have been calculated based on new measurement data which were carried out within the framework of the "Greenhouse gases and ambient air pollutants reporting development" project (https://klab.ee/wp-content/uploads/2024/03/Arendus2023_aruanne_final.pdf). It should be noted that the particulate emissions factor also includes the condensable component. Measurements were conducted for various types of combustion installations, allowing for a more precise calculation of pollutant emissions with less uncertainty. Emission factors are shown in Table 3.29 of IIR.

The calculation of POPs emissions for the residential stationary combustion sector was achieved by the use of national factors for wood burning defined within the project "The Geneva Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants Protocol compliance". Within the project, measurements for various types of burning installations (stoves, single household boilers, open fireplaces) were carried out and average values were defined. Measurements were also made for conventional and advanced stoves and boilers. Emission factors are shown in Table 3.29 of IIR. For the calculation of heavy metals emissions from wood combustion were used as emission factors for the new EMEP/EEA Guidebook 2023 and these are presented in the Table 3.28 of IIR.

Calculations of emissions of POPs from the burning of waste in stoves were made in addition. Emission factors were also defined within the project *"Tööstuslikest allikatest ja koduahjudest eralduvate välisõhu saasteainete heitkoguste inventuuri metoodikate täiendamine"* (see Table 3.30). Data on the amount of the burned waste were obtained on the basis of the Statistics Estonia questionnaire (see Table 3.34 of IIR). Emissions are included in sector 1A4bi.

The calculations of heavy metals emissions from the burning of waste in stoves were made on the base of Guidebook 2023 emission factors of, Chapter 5.C.1.a Municipal waste incineration, table 3-2 (see Table 3.30 of IIR).

The tables 8.9 show difference in pollutants emission. Table 8.10 shows the amount of fuel used.

Table 8.9 The differences in the sector NFR 1A4bi all pollutants emissions for 1990-2021 between 2023 and 2024 submissions (main pollutants in kt)

Year	NO_x			NMVOC			SO_x			NH_3		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	4.381	4.417	0.8	5.797	5.988	3.3	5.369	6.138	14.3	0.025	0.031	26.9
1991	4.346	4.389	1.0	5.785	5.983	3.4	5.283	6.111	15.7	0.025	0.031	26.7
1992	4.101	4.113	0.3	4.363	4.591	5.2	2.748	3.211	16.8	0.025	0.033	30.8
1993	4.051	4.050	0.0	3.892	4.126	6.0	1.955	2.278	16.5	0.025	0.034	32.0
1994	5.438	5.410	-0.5	4.481	4.809	7.3	1.263	1.427	13.0	0.035	0.047	34.1
1995	9.906	9.846	-0.6	8.082	8.691	7.5	1.948	2.162	11.0	0.065	0.087	35.0
1996	11.279	11.220	-0.5	9.318	10.040	7.7	2.481	2.763	11.4	0.074	0.101	35.0
1997	11.357	11.294	-0.6	8.998	9.735	8.2	1.841	1.988	8.0	0.076	0.103	35.5
1998	8.638	8.592	-0.5	6.679	7.242	8.4	1.211	1.268	4.7	0.059	0.079	35.5
1999	8.144	8.107	-0.4	6.367	6.906	8.5	1.365	1.433	5.0	0.056	0.075	35.4
2000	7.991	7.958	-0.4	6.131	6.670	8.8	1.163	1.192	2.5	0.055	0.075	35.6
2001	7.528	7.504	-0.3	5.656	6.171	9.1	0.947	0.924	-2.4	0.053	0.072	35.9
2002	6.832	6.823	-0.1	5.216	5.697	9.2	1.018	1.030	1.2	0.049	0.067	35.8
2003	7.199	7.198	0.0	5.345	5.866	9.7	0.782	0.749	-4.3	0.053	0.072	36.1
2004	6.784	6.799	0.2	5.134	5.632	9.7	0.962	0.963	0.1	0.051	0.069	36.1
2005	5.701	5.724	0.4	4.298	4.728	10.0	0.860	0.863	0.4	0.043	0.059	36.0
2006	5.432	5.457	0.5	4.031	4.442	10.2	0.718	0.695	-3.3	0.042	0.057	36.0
2007	6.817	6.854	0.6	4.901	5.433	10.9	0.545	0.473	-13.2	0.054	0.074	36.6
2008	6.793	6.837	0.6	4.888	5.431	11.1	0.577	0.513	-11.1	0.054	0.074	36.5
2009	6.934	6.989	0.8	4.935	5.485	11.2	0.455	0.357	-21.6	0.057	0.077	36.5
2010	6.903	6.966	0.9	4.934	5.489	11.3	0.491	0.404	-17.8	0.057	0.078	36.1
2011	5.686	5.748	1.1	4.084	4.555	11.5	0.518	0.458	-11.6	0.048	0.066	35.7
2012	5.862	5.942	1.4	4.129	4.638	12.3	0.504	0.429	-14.9	0.051	0.069	37.0
2013	5.382	5.471	1.7	3.778	4.262	12.8	0.485	0.417	-14.1	0.048	0.066	37.2
2014	5.161	5.239	1.5	3.601	4.057	12.7	0.438	0.365	-16.8	0.047	0.064	36.5
2015	4.891	4.958	1.4	3.364	3.787	12.6	0.352	0.263	-25.2	0.045	0.061	36.4

Year	NO$_x$			NMVOC			SO$_x$			NH$_3$		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2016	5.030	5.105	1.5	3.408	3.832	12.4	0.273	0.152	-44.3	0.047	0.064	36.2
2017	4.954	5.032	1.6	3.359	3.779	12.5	0.274	0.155	-43.5	0.047	0.064	36.0
2018	4.865	4.946	1.7	3.281	3.698	12.7	0.247	0.125	-49.5	0.047	0.064	36.0
2019	4.576	4.655	1.7	3.071	3.465	12.8	0.242	0.124	-48.7	0.045	0.061	35.8
2020	4.600	4.685	1.9	3.076	3.477	13.0	0.244	0.122	-50.2	0.046	0.062	35.7
2021	4.467	4.467	0.0	2.985	3.302	10.6	0.225	0.108	-52.0	0.045	0.060	34.3

Table 8.9 continues

Year	PM$_{2.5}$			PM$_{10}$			BC			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	NR	NR	NR	NR	NR	NR	NR	NR	NR	4.420	4.206	-4.8
1991	NR	NR	NR	NR	NR	NR	NR	NR	NR	4.446	4.246	-4.5
1992	NR	NR	NR	NR	NR	NR	NR	NR	NR	3.345	2.948	-11.9
1993	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.993	2.532	-15.4
1994	NR	NR	NR	NR	NR	NR	NR	NR	NR	3.291	2.530	-23.1
1995	NR	NR	NR	NR	NR	NR	NR	NR	NR	5.563	4.097	-26.4
1996	NR	NR	NR	NR	NR	NR	NR	NR	NR	6.365	4.747	-25.4
1997	NR	NR	NR	NR	NR	NR	NR	NR	NR	6.096	4.428	-27.4
1998	NR	NR	NR	NR	NR	NR	NR	NR	NR	4.628	3.372	-27.1
1999	NR	NR	NR	NR	NR	NR	NR	NR	NR	4.456	3.317	-25.6
2000	3.835	2.843	-25.9	3.978	2.966	-25.4	1.486	0.972	-34.6	4.304	3.194	-25.8
2001	3.529	2.609	-26.1	3.661	2.725	-25.6	1.389	0.918	-33.9	3.961	2.930	-26.0
2002	3.277	2.482	-24.3	3.400	2.592	-23.8	1.257	0.845	-32.8	3.679	2.789	-24.2
2003	3.284	2.459	-25.1	3.408	2.570	-24.6	1.313	0.891	-32.1	3.686	2.758	-25.2
2004	3.172	2.439	-23.1	3.291	2.549	-22.6	1.230	0.850	-30.9	3.562	2.737	-23.1
2005	2.687	2.112	-21.4	2.789	2.207	-20.9	1.020	0.719	-29.5	3.019	2.371	-21.5
2006	2.531	1.993	-21.2	2.628	2.085	-20.7	0.966	0.687	-28.9	2.846	2.238	-21.4
2007	2.965	2.285	-22.9	3.077	2.391	-22.3	1.209	0.864	-28.6	3.329	2.557	-23.2
2008	2.949	2.303	-21.9	3.061	2.409	-21.3	1.196	0.864	-27.8	3.312	2.577	-22.2
2009	2.937	2.285	-22.2	3.047	2.393	-21.5	1.213	0.884	-27.1	3.297	2.555	-22.5
2010	2.902	2.288	-21.1	3.011	2.395	-20.4	1.193	0.881	-26.1	3.258	2.558	-21.5
2011	2.514	2.060	-18.0	2.611	2.157	-17.4	0.995	0.759	-23.7	2.828	2.309	-18.4
2012	2.575	2.138	-17.0	2.673	2.239	-16.2	1.027	0.800	-22.1	2.896	2.393	-17.4
2013	2.331	1.975	-15.3	2.420	2.068	-14.5	0.909	0.721	-20.7	2.622	2.209	-15.8
2014	2.332	1.950	-16.4	2.423	2.042	-15.7	0.917	0.742	-19.0	2.628	2.183	-16.9
2015	2.226	1.812	-18.6	2.312	1.898	-17.9	0.880	0.718	-18.4	2.509	2.026	-19.3
2016	2.281	1.854	-18.7	2.369	1.943	-18.0	0.920	0.763	-17.1	2.572	2.073	-19.4
2017	2.301	1.888	-17.9	2.390	1.979	-17.2	0.929	0.783	-15.7	2.597	2.112	-18.7
2018	2.259	1.859	-17.7	2.347	1.949	-17.0	0.913	0.779	-14.7	2.551	2.079	-18.5
2019	2.105	1.730	-17.8	2.187	1.814	-17.1	0.838	0.721	-13.9	2.377	1.933	-18.7
2020	2.265	1.898	-16.2	2.355	1.990	-15.5	0.915	0.807	-11.8	2.562	2.126	-17.0
2021	2.292	1.906	-16.9	2.385	1.999	-16.2	0.929	0.816	-12.2	2.596	2.139	-17.6

Table 8.9 continues

Year	CO			Pb			Cd			Hg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	74.687	71.532	-4.2	2.706	2.708	0.1	0.132	0.133	0.9	0.080	0.085	5.9
1991	74.464	71.394	-4.1	2.873	2.876	0.1	0.137	0.138	0.9	0.085	0.090	5.7
1992	61.675	58.421	-5.3	2.641	2.645	0.1	0.143	0.143	0.5	0.075	0.077	3.5
1993	57.401	54.069	-5.8	2.620	2.623	0.1	0.146	0.147	0.3	0.073	0.075	2.5
1994	71.016	66.200	-6.8	2.673	2.674	0.04	0.179	0.180	0.2	0.073	0.074	1.5
1995	129.931	120.727	-7.1	3.072	3.072	-0.01	0.276	0.276	0.1	0.083	0.085	1.9
1996	149.593	139.098	-7.0	3.243	3.244	0.05	0.311	0.311	0.2	0.088	0.090	2.3
1997	147.915	136.968	-7.4	3.185	3.186	0.03	0.320	0.321	0.1	0.086	0.087	1.6
1998	111.186	102.715	-7.6	3.014	3.015	0.02	0.267	0.268	0.1	0.081	0.082	1.0
1999	105.704	97.660	-7.6	3.057	3.058	0.02	0.262	0.262	0.1	0.082	0.083	1.1
2000	103.169	95.082	-7.8	3.127	3.128	0.02	0.267	0.267	0.1	0.084	0.084	0.9
2001	96.717	88.803	-8.2	2.969	2.969	0.02	0.260	0.260	0.1	0.079	0.080	0.7

Year	CO			Pb			Cd			Hg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2002	89.150	81.792	-8.3	2.854	2.855	0.02	0.247	0.247	0.1	0.076	0.077	0.8
2003	93.632	85.521	-8.7	2.749	2.750	0.01	0.262	0.262	0.0	0.073	0.073	0.5
2004	89.664	81.758	-8.8	2.673	2.673	0.02	0.255	0.255	0.1	0.071	0.072	0.7
2005	75.669	68.875	-9.0	2.509	2.510	0.02	0.229	0.229	0.0	0.067	0.068	0.6
2006	71.929	65.306	-9.2	2.558	2.559	0.02	0.228	0.228	0.0	0.068	0.069	0.5
2007	89.822	81.153	-9.7	2.668	2.668	0.01	0.278	0.278	0.0	0.070	0.070	0.3
2008	90.084	81.367	-9.7	2.703	2.704	0.01	0.284	0.284	0.0	0.071	0.071	0.3
2009	92.293	83.046	-10.0	2.697	2.697	0.01	0.296	0.296	0.0	0.070	0.071	0.2
2010	92.793	83.503	-10.0	2.676	2.676	0.01	0.301	0.301	0.0	0.070	0.070	0.2
2011	77.236	69.468	-10.1	2.649	2.649	0.01	0.270	0.270	0.0	0.070	0.070	0.2
2012	79.389	70.844	-10.8	2.703	2.703	0.01	0.285	0.285	0.0	0.071	0.071	0.2
2013	73.640	65.456	-11.1	2.709	2.709	0.01	0.277	0.277	0.0	0.071	0.071	0.2
2014	70.909	62.790	-11.5	2.691	2.361	-12.3	0.276	0.265	-3.9	0.071	0.062	-12.5
2015	67.165	59.027	-12.1	2.660	1.996	-24.9	0.270	0.248	-8.0	0.070	0.052	-25.6
2016	69.115	60.425	-12.6	2.673	1.942	-27.3	0.282	0.258	-8.5	0.070	0.050	-28.2
2017	68.662	59.913	-12.7	2.681	1.887	-29.6	0.285	0.260	-9.1	0.070	0.049	-30.5
2018	67.797	58.970	-13.0	2.685	1.823	-32.1	0.288	0.259	-9.8	0.070	0.047	-33.2
2019	64.008	55.494	-13.3	2.678	1.744	-34.9	0.279	0.249	-10.9	0.070	0.045	-36.0
2020	64.818	56.022	-13.6	2.704	1.700	-37.1	0.289	0.257	-11.3	0.070	0.043	-38.4
2021	62.922	53.534	-14.9	2.697	1.644	-39.0	0.285	0.250	-12.1	0.070	0.042	-40.4

Table 8.9 continues

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	5.292	5.936	12.2	7.214	8.423	16.759	0.092	0.088	-3.6	1.142	1.140	-0.2
1991	5.298	5.956	12.4	7.201	8.422	17.0	0.092	0.089	-3.4	1.147	1.146	0.0
1992	3.139	3.212	2.3	5.180	5.890	13.7	0.097	0.093	-3.3	0.604	0.606	0.3
1993	2.435	2.314	-4.9	4.509	5.049	12.0	0.098	0.095	-3.2	0.427	0.428	0.3
1994	2.052	1.529	-25.5	4.990	5.411	8.5	0.133	0.128	-3.3	0.262	0.262	0.1
1995	3.452	2.377	-31.1	8.988	9.677	7.7	0.237	0.229	-3.3	0.397	0.395	-0.5
1996	4.121	2.988	-27.5	10.396	11.275	8.5	0.270	0.263	-2.6	0.507	0.507	0.01
1997	3.550	2.246	-36.7	9.884	10.648	7.7	0.276	0.271	-1.9	0.361	0.361	0.02
1998	2.495	1.462	-41.4	7.248	7.801	7.6	0.215	0.213	-1.1	0.226	0.226	0.03
1999	2.505	1.593	-36.4	6.924	7.507	8.4	0.204	0.204	-0.3	0.259	0.259	0.03
2000	2.285	1.360	-40.5	6.596	7.156	8.5	0.204	0.205	0.6	0.212	0.212	0.04
2001	1.987	1.087	-45.3	6.007	6.528	8.7	0.195	0.198	1.7	0.160	0.160	0.1
2002	1.946	1.185	-39.1	5.547	6.086	9.7	0.180	0.185	2.9	0.188	0.188	0.1
2003	1.785	0.942	-47.2	5.549	6.106	10.0	0.192	0.200	4.2	0.130	0.130	0.1
2004	1.885	1.151	-38.9	5.369	5.965	11.1	0.184	0.194	5.5	0.184	0.185	0.1
2005	1.603	1.021	-36.3	4.454	4.998	12.2	0.157	0.168	6.9	0.167	0.167	0.1
2006	1.418	0.849	-40.1	4.100	4.614	12.5	0.152	0.164	7.6	0.131	0.131	0.1
2007	1.470	0.706	-52.0	4.856	5.485	13.0	0.193	0.209	8.5	0.077	0.077	0.3
2008	1.475	0.746	-49.4	4.799	5.463	13.8	0.194	0.212	9.3	0.083	0.083	0.3
2009	1.381	0.613	-55.6	4.735	5.408	14.2	0.201	0.221	10.1	0.052	0.052	0.5
2010	1.392	0.663	-52.4	4.661	5.366	15.1	0.201	0.223	10.9	0.062	0.062	0.5
2011	1.213	0.666	-45.1	3.813	4.451	16.7	0.170	0.191	12.1	0.077	0.077	0.3
2012	1.219	0.665	-45.4	3.880	4.596	18.5	0.179	0.204	13.9	0.071	0.071	0.4
2013	1.123	0.647	-42.4	3.497	4.212	20.4	0.169	0.196	15.5	0.070	0.071	0.4
2014	1.035	0.589	-43.1	3.265	3.963	21.4	0.164	0.189	14.7	0.059	0.059	0.5
2015	0.915	0.487	-46.8	3.003	3.676	22.4	0.159	0.181	14.1	0.037	0.037	0.7
2016	0.852	0.392	-53.9	2.954	3.639	23.2	0.164	0.189	14.7	0.014	0.015	2.1
2017	0.835	0.398	-52.3	2.866	3.564	24.3	0.164	0.189	15.1	0.015	0.016	2.0
2018	0.789	0.372	-52.9	2.750	3.460	25.8	0.164	0.189	15.6	0.008	0.008	4.1
2019	0.738	0.361	-51.1	2.534	3.226	27.3	0.156	0.181	15.9	0.009	0.009	3.8
2020	0.729	0.365	-49.9	2.503	3.226	28.9	0.159	0.185	16.5	0.007	0.008	4.6
2021	0.696	0.343	-50.7	2.403	3.026	25.9	0.155	0.179	15.5	0.005	0.005	7.0

Return to the Table of Contents

Table 8.10The differences of activity data (TJ) in the sector NFR 1A4bi Stationary combustion for 2014-2021 between 2023 and 2024 submissions

Year	Other fuels		
	2023	2024	%
2014	403.52	343.73	-14.8
2015	402.74	282.60	-29.8
2016	403.56	271.23	-32.8
2017	403.46	259.85	-35.6
2018	404.54	248.48	-38.6
2019	406.30	237.10	-41.6
2020	407.53	225.73	-44.6
2021	408.42	217.78	-46.7

1A4ci Agriculture/Forestry/Fishing: Stationary

Compared with the previous submission, emissions from NFR 1A2 have been recalculated for the period between 1990–2021 mainly due to the correction of coal (1990-2000, 2002-2003, 2005, 2007, 2020-2021), peat (1994; 1996-1999) and liquid fuel (2021) consumption; also natural gas consumption for some years and biomass for 2021. The tables 8.11 show difference in pollutants emission. Table 8.12 shows the amount of fuel used.

Since the change in the amount of fuels used was small (excepted biomass), it had a negligible impact on the amount of emissions. Therefore, these changes are not discussed in this chapter, but the corresponding changes have been given in the NFR tables.

The change in emission factors of POPs for natural gas and ammonia for small boilers when burning wood in the new edition Guidebook 2023 had a greater impact on the change in POPs and ammonia emission factors and is equal to 0. The change in PCB emissions resulted from changes in coal and peat consumption.

Table 8.11 The differences in the sector NFR 1A4ci all pollutants emissions for 1990-2021 between 2023 and 2024 submissions (main pollutants in kt)

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			PCB, kg			NH_3		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.154	0.154	-0.2	0.125	0.124	-0.13	0.041828	0.041743	-0.20	0.011	0.0005	-95.42
1991	0.153	0.153	-0.2	0.124	0.124	-0.13	0.041828	0.041743	-0.20	0.010	0.0005	-95.52
1992	0.089	0.089	-0.1	0.076	0.076	0.00	0.020066	0.020066	0.00	0.008	0.0004	-94.83
1993	0.054	0.054	-0.5	0.046	0.046	-0.35	0.007145	0.007060	-1.19	0.007	0.0004	-94.72
1994	0.044	0.044	-0.1	0.037	0.037	-0.05	0.008673	0.008663	-0.12	0.004	0.0003	-93.68
1995	0.027	0.027	-0.1	0.025	0.025	-0.05	0.004252	0.004246	-0.14	0.003	0.0002	-94.77
1996	0.086	0.085	-0.2	0.073	0.073	-0.09	0.028732	0.028696	-0.13	0.002	0.0003	-87.42
1997	0.073	0.072	-0.4	0.054	0.054	-0.31	0.018026	0.017938	-0.49	0.007	0.0003	-96.38
1998	0.062	0.062	-0.2	0.045	0.045	-0.03	0.013776	0.013769	-0.05	0.007	0.0003	-96.11
1999	0.046	0.046	-0.5	0.027	0.027	-0.53	0.005957	0.005881	-1.28	0.009	0.0001	-98.57
2000	0.035	0.035	-0.5	0.023	0.023	-0.45	0.004595	0.004541	-1.18	0.006	0.0001	-98.54
2001	0.038	0.038	-0.2	0.027	0.027	0.00	0.000008	0.000008	0.00	0.009	0.0002	-98.03
2002	0.049	0.049	-0.1	0.037	0.037	0.13	0.004598	0.004623	0.54	0.009	0.0002	-97.88
2003	0.037	0.037	-0.3	0.032	0.032	0.05	0.004595	0.004603	0.17	0.006	0.0002	-96.59
2004	0.026	0.025	-0.5	0.025	0.025	0.00	0.002723	0.002723	0.00	0.004	0.0002	-94.39
2005	0.038	0.038	-0.2	0.030	0.030	0.17	0.004595	0.004622	0.59	0.006	0.0002	-96.86
2006	0.048	0.047	-0.3	0.027	0.027	0.00	0.000010	0.000010	0.00	0.012	0.0002	-98.26
2007	0.028	0.028	-0.3	0.026	0.026	0.19	0.004593	0.004620	0.59	0.003	0.0002	-94.45
2008	0.022	0.022	-0.6	0.021	0.021	0.00	0.000004	0.000004	0.00	0.004	0.0002	-95.34
2009	0.026	0.026	-0.6	0.021	0.021	0.00	0.000005	0.000005	0.00	0.005	0.0002	-96.21
2010	0.024	0.024	-0.7	0.020	0.020	0.00	0.000004	0.000004	0.00	0.005	0.0002	-95.79
2011	0.024	0.024	-0.6	0.023	0.023	0.00	0.000004	0.000004	0.00	0.004	0.0002	-95.00
2012	0.013	0.012	-1.4	0.019	0.019	-0.01	0.000001	0.000001	0.00	0.001	0.0002	-84.94
2013	0.025	0.025	-0.6	0.023	0.023	0.00	0.000004	0.000004	0.00	0.005	0.0002	-95.13

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			PCB, kg			NH_3		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2014	0.027	0.027	-0.5	0.027	0.027	0.00	0.000004	0.000004	0.00	0.005	0.0003	-94.57
2015	0.028	0.028	-0.5	0.029	0.029	0.00	0.000004	0.000004	0.00	0.004	0.0003	-93.85
2016	0.073	0.073	-0.2	0.067	0.067	-0.01	0.021932	0.021929	-0.01	0.003	0.0003	-90.16
2017	0.043	0.042	-0.3	0.041	0.041	0.00	0.007483	0.007483	0.00	0.004	0.0003	-93.20
2018	0.033	0.033	-0.4	0.032	0.032	0.00	0.003743	0.003743	0.00	0.004	0.0002	-93.28
2019	0.030	0.030	-0.3	0.030	0.030	0.00	0.002043	0.002043	0.00	0.004	0.0002	-94.16
2020	0.031	0.031	-0.2	0.028	0.028	0.00	0.001024	0.001024	0.00	0.005	0.0002	-95.32
2021	0.022	0.035	56.2	0.022	0.026	19.42	0.002122	0.002125	0.14	0.002	0.0002	-92.74

Table 8.11 continues

Year	NO_x			NMVOC			SO_x			CO		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2021	0.09	0.10	13.63	0.02	0.04	60.41	0.08	0.08	-0.84	0.080	0.120	49.1

Table 8.11 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2021	0.01	0.02	78.4	0.01	0.02	78.6	0.00	0.01	46.0	0.01	0.02	76.6

Table 8.12 The differences of activity data (TJ) in the sector NFR 1A4ci Stationary combustion for 1990-2021 between 2023 and 2024 submissions

Year	Liquid Fuels			Solid Fuels			Gaseous Fuels			Biomass		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	2 509.500	2 509.500	0.0	246.000	245.5	-0.2	67.000	66.6	-0.6	304.000	304.0	0.0
1991	2 404.700	2 404.700	0.0	246.000	245.5	-0.2	65.000	64.8	-0.3	303.000	303.0	0.0
1992	1 864.600	1 864.600	0.0	118.000	118.0	0.0	217.000	216.9	-0.05	234.000	234.0	0.0
1993	1 700.600	1 700.600	0.0	42.000	41.5	-1.2	113.000	112.5	-0.4	200.000	200.0	0.0
1994	1 140.800	1 140.800	0.0	51.000	50.9	-0.1	60.000	60.3	0.5	123.000	123.0	0.0
1995	843.400	843.400	0.0	25.000	25.0	-0.2	11.000	10.8	-1.8	87.000	87.0	0.0
1996	1 092.700	1 092.700	0.0	169.000	168.8	-0.1	132.000	132.3	0.2	70.000	70.0	0.0
1997	670.300	670.300	0.0	106.000	105.5	-0.5	130.000	129.6	-0.3	234.000	234.0	0.0
1998	647.600	647.600	0.0	81.000	81.0	0.0	200.000	199.8	-0.1	232.000	232.0	0.0
1999	342.300	342.300	0.0	35.000	34.6	-1.3	109.000	108.9	-0.1	288.000	288.0	0.0
2000	299.400	299.400	0.0	27.000	26.7	-1.2	107.000	107.1	0.1	216.000	216.0	0.0
2001	700.200	700.200	0.0	NA	NA	NA	151.000	151.2	0.1	312.000	312.0	0.0
2002	736.700	736.700	0.0	27.000	27.2	0.6	170.000	170.1	0.1	312.000	312.0	0.0
2003	676.800	676.800	0.0	27.000	27.1	0.2	230.000	229.5	-0.2	190.000	190.0	0.0
2004	623.500	623.500	0.0	16.000	16.0	0.0	254.000	253.8	-0.1	128.000	128.0	0.0
2005	583.800	583.800	0.0	27.000	27.2	0.6	270.000	270.0	0.0	210.000	210.0	0.0
2006	507.600	507.600	0.0	NA	NA	NA	298.000	297.9	0.0	424.000	424.0	0.0
2007	562.000	562.000	0.0	27.000	27.2	0.6	293.000	293.4	0.1	116.000	116.0	0.0
2008	658.400	658.400	0.0	NA	NA	NA	268.000	268.2	0.1	152.000	152.0	0.0
2009	593.300	593.300	0.0	NA	NA	NA	322.000	322.2	0.1	200.000	200.0	0.0
2010	572.700	572.700	0.0	NA	NA	NA	342.000	342.0	0.0	182.000	182.0	0.0
2011	729.840	729.840	0.0	NA	NA	NA	292.000	291.6	-0.1	163.000	163.0	0.0
2012	745.020	745.020	0.0	NA	NA	NA	346.000	345.6	-0.1	50.000	50.0	0.0
2013	736.620	736.620	0.0	NA	NA	NA	304.000	304.2	0.1	179.000	179.0	0.0
2014	905.820	905.820	0.0	NA	NA	NA	228.000	227.7	-0.1	247.000	247.0	0.0
2015	1 060.080	1 060.080	0.0	NA	NA	NA	253.000	252.9	-0.04	170.000	170.0	0.0
2016	970.060	970.060	0.0	129.000	129.0	0.0	194.000	193.5	-0.3	219.000	219.0	0.0
2017	987.060	987.060	0.0	44.000	44.0	0.0	184.000	183.6	-0.2	222.000	222.0	0.0
2018	919.640	919.640	0.0	22.000	22.0	0.0	180.000	180.0	0.0	218.000	218.0	0.0
2019	920.089	920.089	0.0	12.000	12.0	0.0	171.000	171.0	0.0	171.000	160.0	-6.4
2020	920.089	876.760	-4.7	12.000	6.000	-50.0	171.000	150.000	-12.3	200.000	201.000	0.5
2021	876.760	651.600	-25.7	6.000	12.470	107.8	150.000	124.000	-17.3	200.500	230.000	14.7

Return to the Table of Contents

8.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2023 and 2024 are made by using exact calculation numbers.

1A3b Road transport

All emissions from road transport have been recalculated for the period between 1990-2021. Recalculations entailed the adopting of a new and improved edition (version 5.7.2) of the COPERT 5 programme for emissions calculations.

The differences in road transport emissions between the submissions for 2023 and 2024 are presented in Table 8.13.

Table 8.13 The differences in road transport emissions between the 2023 and 2024 submissions (main pollutants in kt)

Year	NOx			NMVOC			NH_3			$PM_{2.5}$		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	25.526	25.526	0.0	17.410	17.410	0.0	0.016	0.016	-0.002	NR	NR	
1991	23.148	23.148	0.0	16.756	16.756	0.0	0.015	0.015	0.003	NR	NR	
1992	11.447	11.447	0.0	8.592	8.592	0.0	0.007	0.007	-0.010	NR	NR	
1993	12.709	12.709	0.0	9.035	9.032	0.0	0.011	0.011	0.001	NR	NR	
1994	15.994	15.994	0.0	11.714	11.705	-0.1	0.021	0.021	0.000	NR	NR	
1995	15.728	15.727	0.0	10.936	10.923	-0.1	0.026	0.026	0.000	NR	NR	
1996	16.474	16.474	0.0	11.698	11.674	-0.2	0.034	0.034	0.002	NR	NR	
1997	17.282	17.281	0.0	12.349	12.323	-0.2	0.044	0.044	0.000	NR	NR	
1998	17.900	17.900	0.0	11.471	11.448	-0.2	0.045	0.045	-0.001	NR	NR	
1999	15.588	15.588	0.0	10.556	10.527	-0.3	0.055	0.055	0.000	NR	NR	
2000	14.242	14.242	0.0	8.915	8.875	-0.5	0.098	0.098	0.000	0.777	0.777	0.0
2001	16.765	16.765	0.0	9.474	9.407	-0.7	0.123	0.123	0.000	0.938	0.938	0.0
2002	16.114	16.114	0.0	8.077	8.004	-0.9	0.128	0.128	0.000	1.009	1.009	0.0
2003	13.873	13.872	0.0	6.486	6.409	-1.2	0.141	0.141	0.000	0.958	0.958	0.0
2004	13.412	13.412	0.0	5.564	5.487	-1.4	0.214	0.214	0.000	1.058	1.058	0.0
2005	13.276	13.276	0.0	5.390	5.312	-1.4	0.203	0.203	0.000	1.060	1.060	0.0
2006	13.231	13.231	0.0	5.184	5.096	-1.7	0.231	0.231	0.000	1.080	1.080	0.0
2007	12.847	12.847	0.0	4.818	4.731	-1.8	0.245	0.245	0.000	1.103	1.103	0.0
2008	11.671	11.671	0.0	4.032	3.960	-1.8	0.245	0.245	0.000	1.028	1.028	0.0
2009	9.529	9.529	0.0	3.505	3.417	-2.5	0.220	0.220	0.000	0.908	0.908	0.0
2010	9.717	9.717	0.0	3.179	3.072	-3.4	0.206	0.206	0.000	0.904	0.904	0.0
2011	9.816	9.815	0.0	2.640	2.563	-2.9	0.194	0.194	0.000	0.906	0.906	0.0
2012	9.508	9.506	0.0	2.565	2.479	-3.3	0.182	0.182	0.000	0.912	0.912	0.0
2013	8.941	8.938	0.0	2.263	2.182	-3.5	0.159	0.159	0.000	0.888	0.888	0.0
2014	8.401	8.397	0.0	1.745	1.688	-3.3	0.149	0.149	0.000	0.876	0.876	0.0
2015	8.314	8.302	-0.1	1.726	1.628	-5.7	0.151	0.151	0.000	0.901	0.901	0.0
2016	7.934	7.913	-0.3	1.776	1.571	-11.5	0.149	0.149	0.000	0.923	0.923	0.0
2017	7.549	7.515	-0.4	1.656	1.358	-18.0	0.145	0.145	0.004	0.933	0.933	0.0
2018	7.250	7.213	-0.5	1.692	1.265	-25.2	0.139	0.139	0.011	0.958	0.958	0.0
2019	6.946	6.913	-0.5	1.674	1.224	-26.9	0.139	0.139	0.018	0.962	0.962	0.0
2020	6.503	6.424	-1.2	1.371	0.976	-28.8	0.111	0.111	0.058	0.919	0.919	0.0
2021	6.297	6.312	0.2	1.440	0.858	-40.4	0.095	0.095	0.037	0.911	0.911	0.0

Return to the Table of Contents

Table 8.13 continues

Year	PM_{10}			TSP			BC			CO		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	NR	NR		2.346	2.346	0.0	NR	NR		117.695	117.695	0.0
1991	NR	NR		2.300	2.300	0.0	NR	NR		117.774	117.774	0.0
1992	NR	NR		1.055	1.055	0.0	NR	NR		46.199	46.199	0.0
1993	NR	NR		1.245	1.245	0.0	NR	NR		52.750	52.750	0.0
1994	NR	NR		1.752	1.752	0.0	NR	NR		72.763	72.764	0.0
1995	NR	NR		1.725	1.725	0.0	NR	NR		62.802	62.804	0.0
1996	NR	NR		1.760	1.760	0.0	NR	NR		75.150	75.153	0.0
1997	NR	NR		1.874	1.874	0.0	NR	NR		78.170	78.174	0.0
1998	NR	NR		1.793	1.793	0.0	NR	NR		81.373	81.377	0.0
1999	NR	NR		1.722	1.722	0.0	NR	NR		72.934	72.939	0.0
2000	1.101	1.101	0.0	1.690	1.690	0.0	0.237	0.237	0.0	57.308	57.315	0.0
2001	1.356	1.356	0.0	2.121	2.121	0.0	0.282	0.282	0.0	72.004	72.010	0.0
2002	1.431	1.431	0.0	2.203	2.203	0.0	0.327	0.327	0.0	60.402	60.409	0.0
2003	1.377	1.377	0.0	2.147	2.147	0.0	0.306	0.306	0.0	49.685	49.693	0.0
2004	1.499	1.499	0.0	2.312	2.312	0.0	0.351	0.351	0.0	42.378	42.387	0.0
2005	1.525	1.525	0.0	2.385	2.385	0.0	0.343	0.343	0.0	40.396	40.408	0.0
2006	1.589	1.589	0.0	2.530	2.530	0.0	0.336	0.336	0.0	38.472	38.487	0.0
2007	1.649	1.649	0.0	2.659	2.659	0.0	0.334	0.334	0.0	35.425	35.438	0.0
2008	1.564	1.564	0.0	2.555	2.555	0.0	0.296	0.296	0.0	29.884	29.902	0.1
2009	1.404	1.404	0.0	2.325	2.325	0.0	0.254	0.254	0.0	26.287	26.307	0.1
2010	1.397	1.397	0.0	2.308	2.308	0.0	0.260	0.260	0.0	23.934	23.952	0.1
2011	1.407	1.407	0.0	2.330	2.330	0.0	0.259	0.259	0.0	19.641	19.660	0.1
2012	1.425	1.425	0.0	2.370	2.370	0.0	0.261	0.261	0.0	18.215	18.234	0.1
2013	1.402	1.402	0.0	2.352	2.352	0.0	0.245	0.245	0.0	15.475	15.500	0.2
2014	1.406	1.406	0.0	2.387	2.387	0.0	0.225	0.225	0.0	12.870	12.893	0.2
2015	1.459	1.459	0.0	2.495	2.495	0.0	0.222	0.222	0.0	12.856	12.765	-0.7
2016	1.512	1.512	0.0	2.607	2.607	0.0	0.214	0.214	0.0	13.024	12.715	-2.4
2017	1.547	1.547	0.0	2.692	2.692	0.0	0.201	0.201	0.0	11.853	11.312	-4.6
2018	1.606	1.606	0.0	2.815	2.815	0.0	0.193	0.193	0.0	11.307	10.491	-7.2
2019	1.619	1.619	0.0	2.846	2.846	0.0	0.188	0.188	0.0	10.933	10.027	-8.3
2020	1.551	1.551	0.0	2.731	2.731	0.0	0.179	0.179	0.0	8.420	7.549	-10.3
2021	1.554	1.554	0.0	2.751	2.751	0.0	0.163	0.163	0.0	7.909	6.684	-15.5

Table 8.13 continues

Year	Pb			Cd			As			Cr		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	73.863	73.863	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.333	0.333	0.0
1991	66.240	66.240	0.0	0.003	0.003	0.0	0.009	0.009	0.0	0.300	0.300	0.0
1992	31.001	31.001	0.0	0.002	0.002	0.0	0.005	0.005	0.0	0.150	0.150	0.0
1993	33.624	33.624	0.0	0.002	0.002	0.0	0.005	0.005	0.0	0.168	0.168	0.0
1994	42.605	42.605	0.0	0.002	0.002	0.0	0.006	0.006	0.0	0.212	0.212	0.0
1995	24.126	24.126	0.0	0.002	0.002	0.0	0.006	0.006	0.0	0.200	0.200	0.0
1996	21.322	21.322	0.0	0.002	0.002	0.0	0.006	0.006	0.0	0.209	0.209	0.0
1997	9.237	9.237	0.0	0.003	0.003	0.0	0.007	0.007	0.0	0.226	0.226	0.0
1998	7.045	7.045	0.0	0.003	0.003	0.0	0.007	0.007	0.0	0.227	0.227	0.0
1999	7.070	7.070	0.0	0.002	0.002	0.0	0.006	0.006	0.0	0.211	0.211	0.0
2000	5.305	5.305	0.0	0.003	0.003	0.0	0.007	0.007	0.0	0.216	0.216	0.0
2001	6.389	6.389	0.0	0.003	0.003	0.0	0.008	0.008	0.0	0.270	0.270	0.0
2002	5.944	5.944	0.0	0.003	0.003	0.0	0.008	0.008	0.0	0.277	0.277	0.0
2003	2.626	2.626	0.0	0.003	0.003	0.0	0.008	0.008	0.0	0.268	0.268	0.0
2004	2.588	2.588	0.0	0.003	0.003	0.0	0.009	0.009	0.0	0.280	0.280	0.0
2005	2.656	2.656	0.0	0.003	0.003	0.0	0.009	0.009	0.0	0.290	0.290	0.0
2006	2.036	2.036	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.313	0.313	0.0
2007	2.145	2.145	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.333	0.333	0.0
2008	2.139	2.139	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.330	0.330	0.0
2009	1.933	1.933	0.0	0.003	0.003	0.0	0.009	0.009	0.0	0.297	0.297	0.0
2010	0.841	0.841	0.0	0.004	0.004	0.0	0.009	0.009	0.0	0.306	0.306	0.0

Return to the Table of Contents

Year	Pb			Cd			As			Cr		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2011	0.861	0.861	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.314	0.314	0.0
2012	0.874	0.874	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.320	0.320	0.0
2013	0.862	0.862	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.316	0.316	0.0
2014	0.849	0.849	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.323	0.323	0.0
2015	0.881	0.881	0.0	0.004	0.004	0.0	0.010	0.010	0.0	0.335	0.335	0.0
2016	0.916	0.916	0.0	0.004	0.004	0.0	0.011	0.011	0.0	0.348	0.348	0.0
2017	0.949	0.949	0.0	0.004	0.004	0.0	0.011	0.011	0.0	0.360	0.360	0.0
2018	0.993	0.993	0.0	0.004	0.004	0.0	0.011	0.011	0.0	0.377	0.377	0.0
2019	0.999	0.999	0.0	0.004	0.004	0.0	0.012	0.012	0.0	0.379	0.379	0.0
2020	0.954	0.954	0.0	0.004	0.004	0.0	0.011	0.011	0.0	0.362	0.362	0.0
2021	1.002	1.002	0.0	0.004	0.004	0.0	0.012	0.012	0.0	0.380	0.380	0.0

Table 8.13 continues

Year	Cu			Ni			Se			Zn		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	7.207	7.207	0.0	0.051	0.051	0.0	0.006	0.006	0.0	2.206	2.206	0.0
1991	6.497	6.497	0.0	0.046	0.046	0.0	0.005	0.005	0.0	2.001	2.001	0.0
1992	3.254	3.254	0.0	0.023	0.023	0.0	0.002	0.002	0.0	0.995	0.995	0.0
1993	3.628	3.628	0.0	0.026	0.026	0.0	0.003	0.003	0.0	1.110	1.110	0.0
1994	4.598	4.598	0.0	0.033	0.033	0.0	0.004	0.004	0.0	1.417	1.417	0.0
1995	4.330	4.330	0.0	0.031	0.031	0.0	0.003	0.003	0.0	1.348	1.348	0.0
1996	4.518	4.518	0.0	0.032	0.032	0.0	0.004	0.004	0.0	1.408	1.408	0.0
1997	4.896	4.896	0.0	0.035	0.035	0.0	0.004	0.004	0.0	1.524	1.524	0.0
1998	4.914	4.914	0.0	0.035	0.035	0.0	0.004	0.004	0.0	1.532	1.532	0.0
1999	4.572	4.572	0.0	0.032	0.032	0.0	0.004	0.004	0.0	1.426	1.426	0.0
2000	4.675	4.675	0.0	0.033	0.033	0.0	0.004	0.004	0.0	1.454	1.454	0.0
2001	5.843	5.843	0.0	0.041	0.041	0.0	0.005	0.005	0.0	1.826	1.826	0.0
2002	5.982	5.982	0.0	0.042	0.042	0.0	0.005	0.005	0.0	1.879	1.879	0.0
2003	5.791	5.791	0.0	0.041	0.041	0.0	0.005	0.005	0.0	1.824	1.824	0.0
2004	6.056	6.056	0.0	0.043	0.043	0.0	0.005	0.005	0.0	1.907	1.907	0.0
2005	6.267	6.267	0.0	0.044	0.044	0.0	0.005	0.005	0.0	1.984	1.984	0.0
2006	6.774	6.774	0.0	0.048	0.048	0.0	0.005	0.005	0.0	2.144	2.144	0.0
2007	7.192	7.192	0.0	0.051	0.051	0.0	0.006	0.006	0.0	2.274	2.274	0.0
2008	7.138	7.138	0.0	0.050	0.050	0.0	0.006	0.006	0.0	2.229	2.229	0.0
2009	6.428	6.428	0.0	0.045	0.045	0.0	0.005	0.005	0.0	2.008	2.008	0.0
2010	6.606	6.606	0.0	0.047	0.047	0.0	0.005	0.005	0.0	2.064	2.064	0.0
2011	6.790	6.790	0.0	0.048	0.048	0.0	0.005	0.005	0.0	2.122	2.122	0.0
2012	6.912	6.912	0.0	0.049	0.049	0.0	0.005	0.005	0.0	2.162	2.162	0.0
2013	6.834	6.834	0.0	0.048	0.048	0.0	0.005	0.005	0.0	2.137	2.137	0.0
2014	6.975	6.975	0.0	0.049	0.049	0.0	0.005	0.005	0.0	2.182	2.182	0.0
2015	7.238	7.238	0.0	0.051	0.051	0.0	0.006	0.006	0.0	2.261	2.261	0.0
2016	7.524	7.524	0.0	0.053	0.053	0.0	0.006	0.006	0.0	2.355	2.355	0.0
2017	7.795	7.795	0.0	0.055	0.055	0.0	0.006	0.006	0.0	2.443	2.443	0.0
2018	8.152	8.152	0.0	0.057	0.057	0.0	0.006	0.006	0.0	2.556	2.556	0.0
2019	8.199	8.199	0.0	0.058	0.058	0.0	0.006	0.006	0.0	2.572	2.572	0.0
2020	7.837	7.837	0.0	0.055	0.055	0.0	0.006	0.006	0.0	2.457	2.457	0.0
2021	8.227	8.227	0.0	0.058	0.058	0.0	0.006	0.006	0.0	2.587	2.587	0.0

Table 8.13 continues

Year	PCDD/PCDF, g			B(a)p, t			B(b)f, t			B(k)f, t		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.281	0.281	0.0004	0.006	0.006	0.0	0.015	0.015	0.0	0.013	0.013	0.0
1991	0.253	0.253	0.0001	0.006	0.006	0.0	0.013	0.013	0.0	0.010	0.010	0.0
1992	0.123	0.123	0.0000	0.003	0.003	0.0	0.007	0.007	0.0	0.006	0.006	0.0
1993	0.135	0.135	-0.0003	0.003	0.003	0.0	0.008	0.008	0.0	0.007	0.007	0.0
1994	0.174	0.174	-0.0005	0.004	0.004	0.0	0.009	0.009	0.0	0.008	0.008	0.0
1995	0.166	0.166	0.0001	0.004	0.004	0.0	0.009	0.009	0.0	0.007	0.007	0.0
1996	0.182	0.182	0.0001	0.004	0.004	0.0	0.009	0.009	0.0	0.007	0.007	0.0

Return to the Table of Contents

Year	PCDD/PCDF, g			B(a)p, t			B(b)f, t			B(k)f, t		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1997	0.198	0.198	-0.0003	0.004	0.004	0.0	0.010	0.010	0.0	0.008	0.008	0.0
1998	0.202	0.202	0.0006	0.004	0.004	0.0	0.010	0.010	0.0	0.009	0.009	0.0
1999	0.186	0.186	-0.0002	0.004	0.004	0.0	0.009	0.009	0.0	0.008	0.008	0.0
2000	0.197	0.197	0.0007	0.004	0.004	0.0	0.009	0.009	0.0	0.008	0.008	0.0
2001	0.253	0.253	0.0000	0.005	0.005	0.0	0.011	0.011	0.0	0.009	0.009	0.0
2002	0.258	0.258	-0.0001	0.006	0.006	0.0	0.012	0.012	0.0	0.010	0.010	0.0
2003	0.257	0.257	0.0005	0.006	0.006	0.0	0.011	0.011	0.0	0.010	0.010	0.0
2004	0.257	0.257	0.0002	0.007	0.007	0.0	0.012	0.012	0.0	0.010	0.010	0.0
2005	0.272	0.272	0.0003	0.007	0.007	0.0	0.012	0.012	0.0	0.010	0.010	0.0
2006	0.313	0.313	-0.0001	0.008	0.008	0.0	0.013	0.013	0.0	0.011	0.011	0.0
2007	0.339	0.339	-0.0001	0.009	0.009	0.0	0.014	0.014	0.0	0.012	0.012	0.0
2008	0.328	0.328	0.0001	0.008	0.008	0.0	0.013	0.013	0.0	0.012	0.012	0.0
2009	0.303	0.303	0.0002	0.008	0.008	0.0	0.012	0.012	0.0	0.011	0.011	0.0
2010	0.312	0.312	0.0000	0.008	0.008	0.0	0.013	0.013	0.0	0.012	0.012	0.0
2011	0.321	0.321	-0.0002	0.009	0.009	0.0	0.014	0.014	0.0	0.013	0.013	0.0
2012	0.320	0.320	0.0001	0.009	0.009	0.0	0.014	0.014	0.0	0.013	0.013	0.0
2013	0.307	0.307	-0.0002	0.010	0.010	0.0	0.014	0.014	0.0	0.013	0.013	0.0
2014	0.293	0.293	-0.0002	0.010	0.010	0.0	0.015	0.015	0.0	0.013	0.013	0.0
2015	0.307	0.307	0.0004	0.011	0.011	0.0	0.015	0.015	0.0	0.014	0.014	0.0
2016	0.289	0.289	-0.0002	0.011	0.011	0.0	0.016	0.016	0.0	0.014	0.014	0.0
2017	0.277	0.277	0.0013	0.011	0.011	0.0	0.016	0.016	0.0	0.014	0.014	0.0
2018	0.267	0.267	0.0034	0.012	0.012	0.0	0.016	0.016	0.0	0.014	0.014	0.0
2019	0.261	0.261	0.0057	0.012	0.012	0.0	0.016	0.016	0.0	0.014	0.014	0.0
2020	0.253	0.253	0.0164	0.012	0.012	0.0	0.016	0.016	0.0	0.014	0.014	0.1
2021	0.217	0.217	0.0100	0.012	0.012	0.0	0.017	0.017	0.0	0.015	0.015	0.0

Table 8.13 continues

Year	I(1,2,3-cd)p, t			Total PAHs, t		
	2023	2024	%	2023	2024	%
1990	0.010	0.010	0.0	0.044	0.044	0.0
1991	0.009	0.009	0.0	0.038	0.038	0.0
1992	0.004	0.004	0.0	0.021	0.021	0.0
1993	0.005	0.005	0.0	0.023	0.023	0.0
1994	0.007	0.007	0.0	0.028	0.028	0.0
1995	0.006	0.006	0.0	0.027	0.027	0.0
1996	0.006	0.006	0.0	0.027	0.027	0.0
1997	0.007	0.007	0.0	0.029	0.029	0.0
1998	0.007	0.007	0.0	0.030	0.030	0.0
1999	0.006	0.006	0.0	0.027	0.027	0.0
2000	0.006	0.006	0.0	0.027	0.027	0.0
2001	0.007	0.007	0.0	0.033	0.033	0.0
2002	0.008	0.008	0.0	0.035	0.035	0.0
2003	0.007	0.007	0.0	0.034	0.034	0.0
2004	0.008	0.008	0.0	0.036	0.036	0.0
2005	0.008	0.008	0.0	0.038	0.038	0.0
2006	0.009	0.009	0.0	0.041	0.041	0.0
2007	0.010	0.010	0.0	0.044	0.044	0.0
2008	0.009	0.009	0.0	0.043	0.043	0.0
2009	0.008	0.008	0.0	0.039	0.039	0.0
2010	0.009	0.009	0.0	0.041	0.041	0.0
2011	0.009	0.009	0.0	0.044	0.044	0.0
2012	0.010	0.010	0.0	0.046	0.046	0.0
2013	0.010	0.010	0.0	0.047	0.047	0.0
2014	0.010	0.010	0.0	0.047	0.047	0.0
2015	0.011	0.011	0.0	0.050	0.050	0.0
2016	0.011	0.011	0.0	0.052	0.052	0.0
2017	0.011	0.011	0.0	0.053	0.053	0.0
2018	0.012	0.012	0.0	0.054	0.054	0.0
2019	0.012	0.012	0.0	0.054	0.054	0.0

Return to the Table of Contents

Year	I(1,2,3-cd)p, t			Total PAHs, t		
	2023	2024	%	2023	2024	%
2020	0.012	0.012	0.0	0.054	0.054	0.0
2021	0.013	0.013	0.0	0.057	0.057	0.0

8.1.3. Fugitive emissions

1B1c Other fugitive emissions from solid fuels

Compared with the previous submission, emissions from NFR 1B1c have been recalculated for the period between 1990–2021 mainly due to the correction of emission factors.

This year a new recalculation was done, since one enterprise (Estonia Kaevandus, Enefit Power) provided data using a new methodology and the results were higher for the main substances, with the exception of ammonia, which is now not taken into account from blasting operations.

Thus, emissions from the Estonia Kaevandus are recalculated based on the emission factors and the amount of oil shale produced for this enterprise. Emission factors are presented in the tables 3.85-3.86 of the IIR and activity data in the table 3.87. From the remaining amount of oil shale mined, emissions are calculated based on emission factors from Viru Keemia Grupp.

The differences in the emissions in the Other fugitive emissions from solid fuels sector between the 2023 and 2024 submissions are presented in Table 8.14.

Table 8.14 The differences in the sector NFR 1B1c pollutants emissions for 1990-2021 between 2023 and 2024 submissions (main pollutants in kt)

Year	NO$_x$			NMVOC			SO$_x$			NH$_3$		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.037	0.107	190.0	0.00006	0.000	-100.0	0.038	0.043	11.4	0.222	0.033	-85.1
1991	0.032	0.090	180.6	0.00005	0.000	-100.0	0.033	0.037	11.3	0.194	0.029	-84.9
1992	0.028	0.080	187.0	0.00004	0.000	-100.0	0.029	0.032	11.4	0.168	0.025	-85.0
1993	0.023	0.071	205.1	0.00004	0.000	-100.0	0.024	0.027	11.6	0.141	0.021	-85.4
1994	0.023	0.069	201.8	0.00004	0.000	-100.0	0.024	0.027	11.5	0.138	0.020	-85.4
1995	0.020	0.062	210.7	0.00003	0.000	-100.0	0.021	0.023	11.6	0.119	0.017	-85.5
1996	0.021	0.067	214.2	0.00003	0.000	-100.0	0.022	0.025	11.7	0.129	0.019	-85.6
1997	0.021	0.068	224.3	0.00003	0.000	-100.0	0.022	0.024	11.8	0.127	0.018	-85.8
1998	0.018	0.059	229.0	0.00003	0.000	-100.0	0.019	0.021	11.8	0.108	0.015	-85.9
1999	0.016	0.053	233.9	0.00002	0.000	-100.0	0.016	0.018	11.9	0.095	0.013	-86.0
2000	0.016	0.065	300.1	0.00003	0.000	-100.0	0.017	0.019	12.6	0.098	0.012	-87.5
2001	0.016	0.066	308.5	0.00003	0.000	-100.0	0.017	0.019	12.7	0.098	0.012	-87.6
2002	0.017	0.080	363.2	0.00003	0.000	-100.0	0.018	0.020	13.3	0.104	0.012	-88.8
2003	0.021	0.095	360.1	0.00003	0.000	-100.0	0.021	0.024	13.2	0.124	0.014	-88.7
2004	0.019	0.087	351.1	0.00003	0.000	-100.0	0.020	0.023	13.1	0.116	0.013	-88.6
2005	0.020	0.088	332.0	0.00003	0.000	-100.0	0.021	0.024	12.9	0.122	0.014	-88.1
2006	0.020	0.090	359.9	0.00003	0.000	-100.0	0.020	0.023	13.2	0.118	0.013	-88.7
2007	0.023	0.095	311.8	0.00004	0.000	-100.0	0.024	0.027	12.7	0.138	0.017	-87.7
2008	0.017	0.100	479.4	0.00003	0.000	-100.0	0.023	0.026	13.0	0.102	0.016	-84.6
2009	0.034	0.095	176.1	0.00004	0.000	-100.0	0.014	0.024	79.4	0.089	0.014	-84.3
2010	0.035	0.114	230.1	0.00005	0.000	-100.0	0.017	0.029	75.7	0.115	0.017	-85.4
2011	0.027	0.129	384.1	0.00003	0.000	-100.0	0.021	0.031	49.0	0.175	0.016	-90.6
2012	0.015	0.126	735.2	0.00004	0.000	-100.0	0.021	0.029	38.6	0.211	0.015	-93.0
2013	0.020	0.140	583.0	0.00004	0.000	-100.0	0.026	0.029	14.4	0.191	0.013	-93.1
2014	0.023	0.147	527.5	0.00004	0.000	-100.0	0.028	0.029	3.3	0.191	0.012	-93.6
2015	0.023	0.147	528.5	0.00004	0.000	-100.0	0.028	0.029	2.2	0.196	0.012	-93.8
2016	0.019	0.141	623.4	0.00003	0.000	-100.0	0.023	0.025	6.3	0.142	0.008	-94.1
2017	0.024	0.168	601.1	0.00004	0.000	-100.0	0.029	0.031	6.9	0.168	0.011	-93.5
2018	0.024	0.168	593.7	0.00004	0.000	-100.0	0.029	0.031	8.0	0.157	0.012	-92.6

Return to the Table of Contents

Year	NO_x			NMVOC			SO_x			NH_3		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2019	0.020	0.116	472.2	0.00003	0.000	-100.0	0.024	0.024	0.1	0.097	0.010	-89.4
2020	0.015	0.069	360.1	0.00002	0.000	-100.0	0.017	0.018	2.8	0.075	0.010	-86.2
2021	0.051	0.070	38.0	0.00002	0.000	-100.0	0.022	0.018	-20.8	0.040	0.010	-74.8

Table 8.14 continues

Year	$PM_{2.5}$			PM_{10}			TSP			CO		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
1990	NR	NR	NR	NR	NR	NR	0.258	0.817	217.0	0.343	0.494	44.2
1991	NR	NR	NR	NR	NR	NR	0.225	0.677	201.5	0.299	0.419	40.1
1992	NR	NR	NR	NR	NR	NR	0.195	0.609	212.0	0.260	0.371	42.9
1993	NR	NR	NR	NR	NR	NR	0.163	0.558	241.7	0.217	0.328	50.8
1994	NR	NR	NR	NR	NR	NR	0.161	0.540	236.3	0.214	0.319	49.4
1995	NR	NR	NR	NR	NR	NR	0.139	0.487	250.9	0.185	0.283	53.3
1996	NR	NR	NR	NR	NR	NR	0.150	0.534	256.7	0.199	0.309	54.9
1997	NR	NR	NR	NR	NR	NR	0.147	0.550	273.3	0.196	0.312	59.3
1998	NR	NR	NR	NR	NR	NR	0.125	0.476	280.9	0.166	0.269	61.4
1999	NR	NR	NR	NR	NR	NR	0.110	0.428	289.1	0.146	0.239	63.5
2000	0.006	0.289	5 151.0	0.054	0.298	453.1	0.110	0.569	417.1	0.200	0.293	46.5
2001	0.007	0.295	4 432.7	0.064	0.304	377.3	0.130	0.580	346.3	0.180	0.296	64.6
2002	0.008	0.369	4 506.4	0.078	0.380	384.6	0.160	0.725	353.0	0.270	0.354	30.9
2003	0.010	0.438	4 326.2	0.097	0.452	365.6	0.198	0.862	335.3	0.350	0.421	20.4
2004	0.007	0.398	5 580.7	0.069	0.410	497.7	0.140	0.782	458.8	0.260	0.385	48.1
2005	0.009	0.396	4 297.1	0.088	0.408	362.8	0.180	0.779	332.7	0.170	0.389	129.1
2006	0.011	0.416	3 682.0	0.108	0.429	297.9	0.220	0.818	272.0	0.190	0.400	110.6
2007	0.009	0.421	4 579.2	0.088	0.435	392.7	0.180	0.829	360.7	0.220	0.422	91.9
2008	0.009	0.453	4 780.9	0.091	0.467	413.6	0.186	0.891	380.2	0.260	0.442	70.2
2009	0.009	0.437	4 556.4	0.092	0.451	389.9	0.188	0.860	358.0	0.152	0.421	176.4
2010	0.011	0.525	4 592.2	0.117	0.542	361.4	0.224	1.033	361.5	0.181	0.505	179.6
2011	0.012	0.604	4 948.4	0.118	0.622	428.9	0.239	1.187	396.2	0.179	0.567	215.8
2012	0.009	0.597	6 884.7	0.084	0.615	634.0	0.171	1.172	586.4	0.151	0.553	267.5
2013	0.007	0.678	9 716.6	0.068	0.698	931.1	0.138	1.331	863.9	0.155	0.611	293.8
2014	0.007	0.717	9 979.4	0.070	0.738	958.5	0.142	1.408	889.5	0.168	0.638	279.3
2015	0.007	0.722	9 998.1	0.070	0.743	960.5	0.143	1.417	891.3	0.170	0.640	276.7
2016	0.005	0.704	13 899.1	0.049	0.724	1 369.3	0.101	1.382	1 273.4	0.137	0.607	344.7
2017	0.006	0.836	13 756.7	0.059	0.860	1 354.5	0.121	1.641	1 259.6	0.166	0.726	337.2
2018	0.006	0.834	14 937.9	0.054	0.858	1 478.8	0.111	1.637	1 375.8	0.165	0.728	340.0
2019	0.003	0.566	16 978.3	0.032	0.583	1 693.8	0.066	1.112	1 576.8	0.130	0.506	290.4
2020	0.003	0.316	11 534.4	0.027	0.325	1 124.0	0.054	0.621	1 044.3	0.095	0.305	219.4
2021	0.003	0.323	9 594.8	0.033	0.333	920.0	0.067	0.634	853.6	0.241	0.309	28.6

1B2b Fugitive emissions from natural gas

Compared with the previous submission, emissions from NFR 1B2b have been recalculated for the years 2018-2021 due to the correction of activity data

The differences in the emissions and activity data in the Fugitive emissions from natural gas sector between the 2023 and 2024 submissions are presented in Tables 8.15 and 8.16 respectively.

Table 8.15 The differences in the sector NFR 1B2b NMVOC emission between 2023 and 2024 submissions, in kt

Year	NMVOC		
	2023	2024	%
2018	0.014039	0.014148	0.78
2019	0.012878	0.013050	1.33
2020	0.011778	0.012039	2.22
2021	0.013176	0.013590	3.14

Table 8.16 The differences of activity data (TJ) in the sector NFR 1B2b for 2018-2021 between 2023 and 2024 submissions

Year	Natural gas		
	2023	2024	%
2018	504.00	507.96	0.8
2019	461.00	467.24	1.4
2020	420.80	430.27	2.25
2021	477.40	492.40	3.14

8.2. Industry Sector (NFR 2)

8.2.1. Industrial Processes

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2024 and 2023 are made by using exact calculation numbers.

2A5b Construction and demolition

All emissions from Construction and demolition sector have been recalculated for the period between 1990-2021.

This year emissions of particulate matter additionally calculated from road construction.

Emission calculations from construction and demolition (2A5b) sectors are based on the Tier 1 method from the EMEP/EEA Guidebook 2023. The Tier 1 method uses readily available statistical data and default emission factors (see Table 4.6).

It should be noted that in the previous submission, calculations of emissions from the construction of buildings were incorrect, since they did not take into account correction factors such as duration of construction, efficiency of emission control measures, precipitation-evaporation index and soil silt content, which take into account national characteristics and which affect the calculation results. The methodology and source data used are described in chapter 4.1.2.1. Changes in particulate emissions are shown in Table 8.17.

Table 8.17 The differences of particulate emissions (kt) in the sector NFR 2H1 for 2013-2021 between 2023 and 2024 submissions

Year	$PM_{2.5}$			PM_{10}			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%
1990	NR	NR	NR	NR	NR	NR	11.325	7.077	-37.5
1991	NR	NR	NR	NR	NR	NR	7.951	4.051	-49.0
1992	NR	NR	NR	NR	NR	NR	5.761	1.706	-70.4
1993	NR	NR	NR	NR	NR	NR	2.303	1.072	-53.4
1994	NR	NR	NR	NR	NR	NR	2.388	0.941	-60.6
1995	NR	NR	NR	NR	NR	NR	1.481	1.599	8.0
1996	NR	NR	NR	NR	NR	NR	2.078	2.290	10.2
1997	NR	NR	NR	NR	NR	NR	2.147	2.024	-5.7
1998	NR	NR	NR	NR	NR	NR	3.970	2.557	-35.6
1999	NR	NR	NR	NR	NR	NR	2.948	2.638	-10.5
2000	0.098	0.085	-13.0	0.976	0.851	-12.8	3.221	2.840	-11.8
2001	0.097	0.051	-46.9	0.968	0.515	-46.8	3.196	1.718	-46.3
2002	0.133	0.129	-3.1	1.326	1.288	-2.9	4.379	4.302	-1.8
2003	0.181	0.087	-51.6	1.807	0.879	-51.3	5.965	2.930	-50.9
2004	0.285	0.157	-45.1	2.854	1.581	-44.6	9.423	5.269	-44.1
2005	0.290	0.182	-37.3	2.903	1.833	-36.9	9.584	6.113	-36.2
2006	0.289	0.188	-35.1	2.892	1.892	-34.6	9.549	6.312	-33.9

Return to the Table of Contents

Year	$PM_{2.5}$			PM_{10}			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%
2007	0.347	0.195	-43.9	3.473	1.969	-43.3	11.467	6.565	-42.7
2008	0.404	0.183	-54.7	4.038	1.847	-54.3	13.333	6.152	-53.9
2009	0.291	0.210	-27.9	2.915	2.113	-27.5	9.624	7.051	-26.7
2010	0.240	0.190	-20.8	2.402	1.909	-20.5	7.931	6.372	-19.7
2011	0.284	0.185	-35.0	2.842	1.858	-34.6	9.381	6.199	-33.9
2012	0.390	0.160	-59.0	3.904	1.613	-58.7	12.889	5.368	-58.4
2013	0.353	0.199	-43.6	3.529	2.006	-43.1	11.650	6.688	-42.6
2014	0.287	0.146	-49.3	2.871	1.487	-48.2	9.484	4.953	-47.8
2015	0.334	0.213	-36.2	3.336	2.165	-35.1	11.019	7.221	-34.5
2016	0.288	0.179	-38.0	2.884	1.829	-36.6	9.530	6.099	-36.0
2017	0.321	0.168	-47.6	3.210	1.726	-46.2	10.608	5.754	-45.8
2018	0.389	0.194	-50.1	3.888	1.988	-48.9	12.847	6.625	-48.4
2019	0.354	0.163	-53.8	3.538	1.691	-52.2	11.693	5.633	-51.8
2020	0.472	0.242	-48.7	4.717	2.477	-47.5	15.586	8.254	-47.0
2021	0.466	0.253	-45.7	4.660	2.598	-44.2	15.399	8.661	-43.8

2H1 Pulp and paper production

Emissions of NMVOC and CO for the period 2013-2020 for NFR 2H1 have been updated due to adjustments to operators activities. For the recalculation, the reported data from operators and Guidebook 2023 emission factors were used. Updated emissions of NMVOC and CO have been relocated to NFR 2I.

Emission differences between 2023 and 2024 data in sector 2H1 are presented in Table 8.18.

Table 8.18 The differences of NMVOC and CO emissions (kt) in the sector NFR 2H1 for 2013-2021 between 2023 and 2024 submissions

Year	NMVOC			CO		
	2023	2024	%	2023	2024	%
2013	0.01927	0.01846	-4.2	0.01902	0.01724	-9.4
2014	0.06527	0.06446	-1.2	0.00235	0.00235	0.0
2015	0.05110	0.05014	-1.9	0.00517	0.00323	-37.6
2016	0.00237	0.00160	-32.7	0.00199	0.00044	-78.2
2017	0.01366	0.01292	-5.5	0.00175	0.00025	-86.0
2018	0.02062	0.01691	-18.0	0.00446	NA	-100.0
2019	0.03566	0.03510	-1.6	0.00165	NA	-100.0
2020	0.04756	0.04462	-6.2	0.00180	NA	-100.0
2021	0.04198	0.04125	-1.7	0.00062	NA	-100.0

2H2 Food and drink production

Compared to the previous submission, update NH_3 emissions from NFR 5A have been reallocated under the NFR 2H2 for the period 2007-2021. NH_3 emissions from the storage of biowaste for the period 2007-2021 were reported by only one meat industry operator, where a slaughterhouse was a part of the production process. NH_3 emission from the biowaste storage were reported in the annual air report under SNAP code 090403 (Biological treatment of waste - Solid waste disposal on land – other). During the 2023 review the TERT recommended that this source be reallocated to NFR 2H2 as a part of the production process.

Compared to the previous submission, update NH_3 emissions from NFR 5C1bv have been reallocated under the NFR 2H2 for the period 2007-2021. Annual air reports of facilities reporting NH_3 emissions under the NFR 5C1bv were analysed. The analysis revealed that no animal carcasses were incinerated in the facilities. The animal by-products were processed at the facility. For example, meat and bone meal unsuitable for human and animal consumption were produced. Therefore, the NH_3 emissions from this source were reallocated to NFR 2H2 as a part of the production process.

After analyzing operator reports for the period 2004-2021, the inventory team came to the conclusion that the previously unreported emissions of NMVOCs from the processing of animal by-products should be included in the inventory under NFR 2H2. In previous years, these emissions were not included in any sector in the inventory and now they are added to the NFR 2H2.

Emission differences between 2023 and 2024 data in sector 2H2 are presented in Table 8.19.

Table 8.19 The differences of NH_3 emission (kt) for 2007-2021 and NMVOC emission (kt) for 2004-2021 in the sector NFR 2H2 between 2023 and 2024 submissions

Year	NH_3			NMVOC		
	2023	2024	%	2023	2024	%
2004	NA	NA	NA	0.76809	0.79113	3.0
2005	NA	NA	NA	0.72411	0.74851	3.4
2006	NA	NA	NA	0.77860	0.80322	3.2
2007	NA	0.00004	100	0.80846	0.82924	2.6
2008	NA	0.00004	100	0.79923	0.82003	2.6
2009	NA	0.00158	100	0.74667	0.75617	1.3
2010	NA	0.00164	100	0.72000	0.72996	1.4
2011	NA	0.00170	100	0.76620	0.77652	1.3
2012	NA	0.00003	100	0.74000	0.74064	0.1
2013	NA	0.00003	100	0.72000	0.72038	0.1
2014	NA	0.00003	100	0.65250	0.65292	0.1
2015	NA	0.00004	100	0.65501	0.65575	0.1
2016	NA	0.00003	100	0.67085	0.67160	0.1
2017	NA	0.00001	100	0.69401	0.69446	0.1
2018	NA	0.00001	100	0.70918	0.70962	0.1
2019	NA	0.00009	100	0.72473	0.72537	0.1
2020	NA	0.00009	100	0.70197	0.70291	0.1
2021	NA	0.00004	100	0.72526	0.72596	0.1

2I Wood processing

Emissions of $PM_{2.5}$, PM_{10} and TSP have been clarified due to operator data adjustments for the period 2019-2021. For the recalculation, the reported data from operators and Guidebook 2023 emission factors were used.

Emission differences between 2023 and 2024 data in sector 2I are presented in Table 8.20.

Table 8.20 The differences of $PM_{2.5}$, PM_{10} and TSP emissions (kt) in the sector NFR 2I for 2019-2021 between 2023 and 2024 submissions

Year	$PM_{2,5}$			PM_{10}			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%
2019	0,05325	0,05462	2,6	0,15873	0,16283	2,6	0,48410	0,49654	2,6
2020	0,05354	0,05601	4,6	0,15888	0,16630	4,7	0,48691	0,50940	4,6
2021	0,05556	0,05652	1,7	0,16581	0,16882	1,8	0,50551	0,51781	2,4

Emissions of NMVOC and CO for 2013-2021 for NFR 2I have been updated due to adjustments to the operators activities. For the recalculation reported data from operators were used. Updated NMVOC and CO emissions data have been relocated to NFR 2I from NFR 2H1.

Emission differences between 2023 and 2024 data in sector 2I are presented in Table 8.21.

Table 8.21 The differences of NMVOC and CO emissions (kt) in the sector NFR 2I for 2013-2021 between 2023 and 2024 submissions

Year	NMVOC			CO		
	2023	2024	%	2023	2024	%
2013	0.00910	0.00974	7.0	NA	0.00178	100.0
2014	0.00106	0.00187	76.6	NA	0.00227	100.0
2015	0.00189	0.00286	51.0	NA	0.00194	100.0
2016	0.00079	0.00156	98.2	NA	0.00156	100.0
2017	0.00180	0.00255	41.4	0.00010	0.00160	1578.9
2018	0.00432	0.00802	85.8	0.00033	0.00479	1368.7
2019	0.02935	0.04714	60.6	0.00131	0.00380	191.5
2020	0.02597	0.05662	118.0	0.00372	0.00664	78.6
2021	0.09365	0.09438	0.8	0.00310	0.00649	109.7

8.2.2. Solvent and Other Product Use

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2024 and 2023 are made by using exact calculation numbers.

2D3a Domestic solvent use including fungicides

NMVOC emission for the years 2004-2021 was recalculated due to the correction of statistical activity data. Since 2014, in the product category “Glaziers' putty, grafting putty, resin cements, caulking compounds and other mastics” (CN-code 32141010), as initially reported by Statistics Estonia, exported quantities have consistently exceeded the sum of imported and produced quantities, resulting in negative consumed quantities in Estonia. Therefore, emission estimations in this category were based on a population-based approach. For an explanation, Statistics Estonia was asked what the reason was for the reported exported quantities of product category with CN-code 32141010 being bigger than the sum of imported and produced quantities. The Statistics Estonia explained that starting from 2013 a large quantity of these products was produced by subcontractors of foreign producers (from raw material imported by the foreign producer) and thus, reported to Statistics Estonia as providing a service, not production. Adding the subcontract-produced quantities to the calculations, resulted in positive quantities of used product. Then the population-based approach was replaced with product-based approach. The reporting method for sealants and filling agents does not distinguish between domestic and industrial use, thus a large part of emissions reported there originate from construction sector.

Since 2019, the use of antifreeze (CN code 38200000) has increased significantly. Antifreeze production increased, although there was no significant increase in exports. Statistics Estonia was asked an explanation, what was the reason for the increase in the reported production quantities of the product. The answer from Statistics Estonia revealed that the increase in production was caused by the addition of a new company producing antifreeze. It turned out that the CN-code 38200000 also includes antifreezes containing methanol. In addition, it was discovered that it is not possible to distinguish the amount of antifreeze based on use. Antifreezes with the same CN-code can be used for car care and as a heat carrier in heating systems. Therefore, the product-based approach was replaced with population-based approach, as there are no accurate statistical data on how much antifreeze is used in car care.

Return to the Table of Contents

Table 8.22 The differences of NMVOC emissions (kt) in the sector NFR 2D3a between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2004	2.14	3.07	43.44
2005	2.17	3.68	69.50
2006	2.26	4.46	97.17
2007	2.36	3.54	49.63
2008	2.37	3.58	51.17
2009	2.11	2.74	29.93
2010	2.03	2.77	36.10
2011	2.15	2.95	36.93
2012	2.62	3.20	22.40
2013	2.37	5.50	131.61
2014	2.70	4.43	64.26
2015	2.71	4.15	53.00
2016	2.81	3.99	41.75
2017	3.22	4.69	45.55
2018	2.88	4.09	41.78
2019	3.11	3.82	23.00
2020	4.22	3.63	-14.00
2021	4.70	3.99	-14.99

2D3d Coating applications

NMVOC emission for the year 2018-2021 was recalculated due to the correction of statistical data for international trade and production. In addition, the annual air reports of facilities related to coil coating (SNAP code 060105) were analyzed. The analysis revealed that 2018-2021, emissions from coil coating were mistakenly reported under SNAP code 060108. As a result of the analysis, errors in the classification of chemicals were also identified. As a results of the correction, the NMVOC emissions changed slightly.

Table 8.23 The differences of NMVOC emissions (kt) in the sector NFR 2D3d between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2018	3.82	3.81	-0.18
2019	4.56	4.55	-0.17
2020	4.28	4.27	-0.06
2021	6.56	6.55	-0.09

2D3g Chemical products

The annual air reports of facilities were analyzed. The analysis revealed that the facilitye's 2021 annual air report had mistakenly overestimated NMVOC emissions. As a results of the correction, the NMVOC emissions changed slightly.

Table 8.24 The differences of NMVOC emissions (kt) in the sector NFR 2D3g between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2021	0.209	0.207	-0.73

2D3h Printing

NMVOC emission for the year 2021 was recalculated due to the correction of statistical data for international trade and production.

Table 8.25 The differences of NMVOC emissions (kt) in the sector NFR 2D3h between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2021	0.4537	0.4538	0.02

2D3i Other product us

It was a correction of an expert's calculation mistake.

Table 8.26 The differences of NMVOC emissions (kt) in the sector NFR 2D3i between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2021	1.8710	1.8713	0.01

8.3. Agriculture Sector (NFR 4)

8.3.1. Manure Management

Overview of recalculations are given below by each subsector. The comparison between the submissions for 2024 and 2023 are made using exact calculation numbers. In comparison with the previous submission, NO_x and NH_3 emissions from manure management of horses and poltry are primarily associated with the adjustment of the number of horses in the years 2020-2021, and for the first time, the technological distribution of manure storage facilities for poultry manure management has been taken into account.

3B4e Manure management - horses

Table 8.27 The differences in horses manure management NO_x, NMVOC and NH_3 emissions (kt) for the years 2020-2021 between 2023 and 2024 submissions

Year	NOx			NH_3			NMVOC		
	2023	2024	%	2023	2024	%	2023	2024	%
2020	0.001	0.001	-4.0	0.041	0.040	-3.9	0.04	0.04	-3.9
2021	0.001	0.001	-4.1	0.040	0.039	-3.9	0.04	0.04	-3.9

Table 8.28 The differences in horses manure management $PM_{2.5}$, PM_{10} and TSP emissions (kt) for the years 2020-2021 between 2023 and 2024 submissions

Year	$PM_{2.5}$			PM_{10}			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%
2020	0.001	0.001	-3.8	0.001	0.001	-4.1	0.003	0.003	-4.1
2021	0.001	0.001	-3.9	0.001	0.001	-4.2	0.003	0.002	-3.9

3B4gi Manure management – Laying hens

Table 8.29 The differences in laying hens manure management NH_3 emissions (kt) for the years 2016- 2021 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2016	0.106	0.106	-0.3
2017	0.113	0.112	-0.7
2018	0.078	0.077	-1.2
2019	0.068	0.066	-1.7
2022	0.049	0.047	-2.4
2021	0.060	0.058	-2.2

3B4gii Manure management – Broilers

Table 8.30 The differences in broilers manure management NH_3 emissions (kt) for the year 2021 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2021	0.216	0.208	-3.6

Return to the Table of Contents

3B4giv Manure management – Other poultry

Table 8.31 The differences in otherpoultry manure management management NH_3 emissions (kt) for the year 2019-2021 between 2022 and 2023 submissions

Year	NH_3		
	2023	2024	%
2019	0.177	0.168	-5.2
2020	0.197	0.186	-5.2
2021	0.185	0.176	-5.2

8.3.2. Agricultural Soils

In comparison with the previous submission, NO_x and NH_3 emissions from animal manure applied to soils and urine and dung deposited by grazing animals are recalculated due to the correction in the numbers for horses (for year 2019-2020) and also the use of technological distribution of manure storage facilities for poultry manure management has been affecting emissions slightly. Since the emission factors of the updated EMEP/EEA Guidebook 2023 differ from those of the previous EMEP/EEA Guidebook 2019, recalculations have been made for the entire time series.

For the first time, the NH_3 emission calculations from the use of other organic fertilisers (3Da2c) on soils include accounting for the ammonia emissions from additional substrates generated during biogas production. The calculation for emissions from inputs, including feedstock, is addressed in section 6.3.2 of the waste chapter. Calculations affect emissions from 2014 to the present. In addition to the above, there was also an emission input error in 2019, which has now been corrected.

NMVOC emissions from the cultivated crops sector have been recalculated due the the earlier incorrect interpretation of the EMEP/EEA Guidebook table, which was discovered during the review process.

3Da1 Inorganic N-fertilizers (includes also urea application)

Table 8.32 The differences in inorganic N-fertilizers use NH_3 emissions (kt) for the years 1990–2021 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
1990	3.64	5.19	42.6
1991	2.97	4.25	42.9
1992	2.95	4.17	41.5
1993	1.51	2.13	41.2
1994	1.34	1.94	44.7
1995	0.98	1.44	46.4
1996	0.86	1.27	46.8
1997	1.05	1.52	44.4
1998	1.27	1.81	42.7
1999	1.02	1.47	44.3
2000	1.14	1.64	43.6
2001	1.01	1.45	44.3
2002	0.85	1.22	43.1
2003	1.18	1.70	43.1
2004	1.28	1.85	44.9
2005	1.08	1.67	54.1
2006	1.17	1.72	46.4
2007	1.34	2.04	52.3
2008	1.78	2.51	40.9
2009	1.38	1.95	41.5
2010	1.43	2.01	40.0
2011	1.49	2.09	40.1

Year	NH_3		
	2023	2024	%
2012	1.44	2.02	40.1
2013	1.49	2.11	42.0
2014	1.56	2.19	40.1
2015	1.58	2.22	40.1
2016	1.59	2.23	40.1
2017	1.61	2.25	40.0
2018	1.65	2.33	40.9
2019	1.73	2.45	41.3
2020	1.72	2.38	38.5
2021	1.90	2.66	39.7

3Da2a Animal manure applied to soills

Table 8.33 The differences in animal manure applied to soils NO_x and NH_3 emissions (kt) for the years 2019–2021 between 2023 and 2024 submissions

Year	NO_x			NH_3		
	2023	2024	%	2023	2024	%
2019	0.68	0.68	0.0	1.97	1.97	0.1
2020	0.70	0.69	-0.4	1.81	1.81	0.0
2021	0.69	0.69	0.0	1.78	1.78	0.1

3Da2c Other organic fertilisers applied to soils

Table 8.34 The differences in other orcanic fertilisers applied to soils NH_3 emissions (kt) for the years 2014- 2021 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2014	0.106	0.106	0.35
2015	0.113	0.113	0.29
2016	0.153	0.155	1.62
2017	0.136	0.137	0.95
2018	0.143	0.145	1.33
2019	0.130	0.119	-8.38
2022	0.106	0.109	2.97
2021	0.099	0.103	3.14

3Da3 Urine and dung deposited by grazing animals

Table 8.35 The differences in animal grazing NO_x and NH_3 emissions (kt) for the years 2020-2021 between 2023 and 2024 submissions

Year	NH_3			NO_x		
	2023	2024	%	2023	2024	%
2020	0.28	0.28	-0.16	0.12	0.12	-0.22
2021	0.27	0.27	-0.30	0.12	0.12	-0.21

3De Cultivated crops

Table 8.36 The differences in cultivated crops NMVOC emissions (kt) for the years 1990-2021 between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
1990	0.606	0.676	12
1991	0.583	0.646	11
1992	0.736	0.807	10
1993	0.381	0.453	19

Return to the Table of Contents

Year	NMVOC		
	2023	2024	%
1994	0.400	0.432	8
1995	0.298	0.345	16
1996	0.240	0.291	21
1997	0.292	0.346	18
1998	0.317	0.390	23
1999	0.275	0.342	24
2000	0.293	0.371	26
2001	0.231	0.297	29
2002	0.250	0.321	28
2003	0.235	0.320	36
2004	0.117	0.320	172
2005	0.245	0.371	51
2006	0.254	0.399	57
2007	0.281	0.452	61
2008	0.162	0.338	108
2009	0.120	0.296	148
2010	0.123	0.313	154
2011	0.151	0.333	120
2012	0.136	0.334	145
2013	0.101	0.301	199
2014	0.121	0.319	163
2015	0.147	0.336	128
2016	0.216	0.401	86
2017	0.181	0.372	106
2018	0.199	0.383	92
2019	0.174	0.378	117
2020	0.179	0.382	114
2021	0.156	0.353	127

8.4. Waste Sector (NFR 5)

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2024 and 2023 are made by using exact calculation numbers.

5A Solid waste disposal on land

Compared to the previous submission, particulate and NMVOC emissions from NFR 5A have been recalculated for the period between 1990–2021 ($PM_{2.5}$, PM_{10} emissions for the period 2000-2021) due to the change in the EMEP/EEA Air Pollutant Emission Inventory Guidebook.

Based on the EMEP Guidebook 2023, the amount of recovered and deposited mineral waste was used as the activity data for calculating particle emissions. NMVOC emissions were calculated using the amounts of biodegradable solid waste deposited in landfills and the amounts of CH_4 generated during the biodegradation process of these waste. NMVOC emission were calculated based on the amount of CH_4 emitted. The amount of CH_4 emitted into to the air was calculated by deducting the amount of recovered (incinerated) CH_4 from the total CH_4 emissions.

Table 8.37 The differences of $PM_{2.5}$ and PM_{10} emissions (kt) in the sector NFR 5A between 2023 and 2024 submissions

Year	$PM_{2.5}$			PM_{10}		
	2023	2024	%	2023	2024	%
2000	0.0003	0.0003	-4.5	0.0021	0.0020	-4.6
2001	0.0003	0.0003	-5.7	0.0021	0.0020	-5.7
2002	0.0003	0.0004	4.9	0.0023	0.0024	5.1
2003	0.0004	0.0005	20.3	0.0026	0.0031	20.3
2004	0.0004	0.0004	7.3	0.0025	0.0027	7.4
2005	0.0004	0.0004	15.6	0.0025	0.0029	15.8
2006	0.0004	0.0004	18.5	0.0024	0.0028	18.6
2007	0.0004	0.0005	22.7	0.0027	0.0033	22.5
2008	0.0004	0.0005	17.1	0.0026	0.0030	17.0
2009	0.0003	0.0003	9.6	0.0019	0.0020	9.5
2010	0.0004	0.0005	28.6	0.0026	0.0033	28.7
2011	0.0003	0.0006	95.4	0.0020	0.0040	95.6
2012	0.0003	0.0006	121.9	0.0018	0.0040	121.6
2013	0.0004	0.0006	76.8	0.0023	0.0041	76.8
2014	0.0004	0.0006	34.5	0.0030	0.0040	34.4
2015	0.0004	0.0006	52.4	0.0027	0.0041	52.1
2016	0.0004	0.0006	42.0	0.0028	0.0040	41.9
2017	0.0004	0.0007	49.0	0.0029	0.0043	49.0
2018	0.0004	0.0006	47.7	0.0029	0.0043	47.7
2019	0.0002	0.0005	86.7	0.0016	0.0031	87.0
2020	0.0002	0.0004	123.7	0.0013	0.0029	123.9
2021	0.0002	0.0006	155.8	0.0014	0.0036	155.7

Table 8.38 The differences of TSP and NMVOC emissions (kt) in the sector NFR 5A between 2023 and 2024 submissions

Year	TSP			NMVOC		
	2023	2024	%	2023	2024	%
1990	0.005	0.005	-1.0	0.13	0.03	-77.2
1991	0.005	0.005	-3.8	0.14	0.03	-77.2
1992	0.006	0.005	-20.3	0.15	0.03	-77.2
1993	0.006	0.005	-13.9	0.17	0.04	-77.2
1994	0.005	0.005	-16.1	0.17	0.04	-77.2
1995	0.005	0.005	-5.4	0.16	0.04	-77.5
1996	0.006	0.006	-11.5	0.19	0.04	-77.4
1997	0.006	0.006	-10.9	0.23	0.05	-77.3
1998	0.005	0.005	-3.1	0.25	0.06	-77.3

Year	TSP			NMVOC		
	2023	2024	%	2023	2024	%
1999	0.004	0.004	-14.6	0.25	0.06	-77.4
2000	0.004	0.004	-4.6	0.28	0.06	-77.3
2001	0.004	0.004	-5.7	0.28	0.06	-77.3
2002	0.005	0.005	5.1	0.28	0.06	-77.4
2003	0.006	0.007	20.3	0.27	0.06	-77.4
2004	0.005	0.006	7.4	0.27	0.06	-77.4
2005	0.005	0.006	15.8	0.25	0.06	-77.6
2006	0.005	0.006	18.6	0.24	0.05	-77.6
2007	0.006	0.007	22.5	0.23	0.05	-77.7
2008	0.005	0.006	17.0	0.22	0.05	-77.6
2009	0.004	0.004	9.5	0.23	0.05	-77.4
2010	0.005	0.007	28.7	0.23	0.05	-77.7
2011	0.004	0.008	95.6	0.22	0.05	-78.2
2012	0.004	0.008	121.7	0.20	0.04	-78.6
2013	0.005	0.009	76.8	0.18	0.04	-79.0
2014	0.006	0.008	34.4	0.16	0.03	-79.5
2015	0.006	0.009	52.1	0.15	0.03	-79.7
2016	0.006	0.008	41.9	0.14	0.03	-79.7
2017	0.006	0.009	49.0	0.14	0.03	-79.6
2018	0.006	0.009	47.7	0.13	0.03	-78.5
2019	0.003	0.007	87.0	0.13	0.03	-78.4
2020	0.003	0.006	123.8	0.12	0.03	-79.6
2021	0.003	0.008	155.7	0.12	0.03	-79.4

Compared to the previous submission, NH_3 emissions from NFR 5A have been reallocated under the NFR 2H2. NH_3 emissions from the storage of biowaste for the period 2007-2021 were reported by one meat industry, where a slaughterhouse was a part of the production process. NH_3 emission from the biowaste storage were reported in the annual air report under SNAP code 090403 (Biological treatment of waste - Solid waste disposal on land – other). During the 2023 review the TERT recommended that this source should be reallocated to NFR 2H2 as a part of the production process.

Table 8.39 The differences of NH_3 emissions (kt) in the sector NFR 5A between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2007	0.00004	NE	100.0
2008	0.00004	NE	100.0
2009	0.00004	NE	100.0
2010	0.00003	NE	100.0
2011	0.00003	NE	100.0
2012	0.00003	NE	100.0
2013	0.00003	NE	100.0
2014	0.00003	NE	100.0
2015	0.00003	NE	100.0
2016	0.00003	NE	100.0
2017	0.00001	NE	100.0
2018	0.00001	NE	100.0
2019	0.00003	NE	100.0
2020	0.00003	NE	100.0
2021	0.00001	NE	100.0

Return to the Table of Contents

5B2 Biological treatment of waste - Anaerobic digestion at biogas facilities

NH_3 emissions from NFR 5B2 have been recalculated for the period between 2011–2021 due to the change in the calculations of NH_3 emission from biogas production.

In the previous submission, NH_3 emissions for 2011-2016 were reported by one biogas production facility. This biogas production facility worked with agricultural feedstock. The facility reported every year the maximum allowed emission according to their air pollution permit. Therefore, those emissions did not represented the real emissions and because of that were probably overestimated. Unfortunately, it is now not possible to obtain further information from this facility, as it was closed down in 2017. This biogas production plant used agricultural feedstock. Emissions from the storage and handling of agricultural feedstock (manure) were included under the agricultural sector.

Since 2014, biogas production plants working on agricultural feedstock have also received waste from the food industry as additional feedstock.

In 2024 submission, NFR 5B2 includes NH_3 emissions from the storage of additional substrates at farm-scale biogas production plants. Emissions from the storage of agricultural feedstock (manure) and handling of digestate are included under the agricultural sector.

In 2020, the EERC started a project to develop a methodology to estimate GHG and NH_3 emissions from the production of biomethane using agricultural (and waste) feedstock and to develop country specific emission factors for biomethane production. The project concluded at the end of 2023. The final report of the project was not yet available at the time the inventory was compiled. Therefore, emissions were calculated based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023.

A more detailed description of the activity data and methodology is presented in Chapter 6.3.2.

Table 8.40 The differences of NH_3 emissions (kt) in the sector NFR 5B2 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2011	0.0003	NE	100.0
2012	0.0003	NE	100.0
2013	0.0003	NE	100.0
2014	0.0003	0.00001	-96.2
2015	0.0003	0.00001	-96.8
2016	0.0003	0.00008	-75.6
2017	NE	0.00004	100.0
2018	NE	0.00006	100.0
2019	NE	0.00007	100.0
2020	NE	0.00011	100.0
2021	NE	0.00011	100.0

5C1bii Hazardous waste incineration

Pb, Cd, Hg, As,Ni, PCDD/PCDF, PAH total and HBC emissions were recalculated due to the correction of activity data. The amount of incinerated hazardous waste was checked in the ESTEA waste management information system. The amount of incinerated hazardous waste in 2020 was corrected. In 2020, the amount of incinerated hazardous waste increased slightly.

Table 8.41 The differences of Pb, Cd, Hg and As emissions (t) in the sector NFR 5C1bii between 2023 and 2024 submissions

Year	Pb			Cd			Hg			As		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2020	0.0027	0.0028	0.5	0.0002	0.0002	0.6	0.0011	0.0011	0.1	0.0002	0.0002	0.1

Return to the Table of Contents

Table 8.42 The differences of Ni, PCDD/PCDF, PAH total and HCB emissions in the sector NFR 5C1bii between 2023 and 2024 submissions

Year	Ni, t			PCDD/PCDF, g I-Teq			PAH total, t			HCB, kg		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2020	0.0027	0.0027	0.1	0.0016	0.0016	0.5	0.00003	0.00003	0.7	0.0091	0.0092	0.2

5C1biii Clinical waste incineration

Compared to the previous submission, NO$_x$, SO$_x$, PM$_{2.5}$, PM$_{10}$, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni and PAH total emissions from NFR 5Cbiii have been recalculated due to the changes in the EMEP/EEA Air Pollutant Emission Inventory Guidebook. A more detailed description of the activity data and methodology is presented in Chapter 6.4.2.

The amount of incinerated clinical waste was checked as well in the ESTEA waste management information system. The amount of incinerated clinical waste in 2021 was corrected. Therefore, PCDD/PCDF, HCB and PCB emissions were also recalculated.

Table 8.43 The differences of NO$_x$, SO$_x$ and TSP emissions (kt) in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	NO$_x$			SO$_x$			TSP		
	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.000027	0.000021	-22.2	0.000006	0.000013	116.7	0.000202	0.000027	-86.6
1991	0.000027	0.000021	-22.2	0.000006	0.000013	116.7	0.000199	0.000027	-86.4
1992	0.000027	0.000021	-22.2	0.000006	0.000013	116.7	0.000198	0.000027	-86.4
1993	0.000026	0.000020	-23.1	0.000006	0.000012	100.0	0.000192	0.000026	-86.5
1994	0.000025	0.000020	-20.0	0.000006	0.000012	100.0	0.000188	0.000025	-86.7
1995	0.000025	0.000019	-24.0	0.000006	0.000012	100.0	0.000184	0.000025	-86.4
1996	0.000025	0.000019	-24.0	0.000006	0.000012	100.0	0.000181	0.000025	-86.2
1997	0.000036	0.000028	-22.2	0.000008	0.000017	112.5	0.000265	0.000036	-86.4
1998	0.000032	0.000025	-21.9	0.000008	0.000015	87.5	0.000237	0.000032	-86.5
1999	0.000017	0.000013	-23.5	0.000004	0.000008	100.0	0.000123	0.000017	-86.2
2000	0.000016	0.000012	-25.0	0.000004	0.000008	100.0	0.000117	0.000016	-86.3
2001	0.000013	0.000010	-23.1	0.000003	0.000006	100.0	0.000093	0.000013	-86.0
2002	0.000031	0.000024	-22.6	0.000007	0.000015	114.3	0.000231	0.000031	-86.6
2003	0.000028	0.000022	-21.4	0.000006	0.000013	116.7	0.000204	0.000028	-86.3
2004	0.000028	0.000022	-21.4	0.000007	0.000014	100.0	0.000210	0.000028	-86.7
2005	0.000030	0.000023	-23.3	0.000007	0.000014	100.0	0.000221	0.000030	-86.4
2006	0.000002	0.000002	0.0	0.0000005	0.000001	103.7	0.000015	0.000002	-86.7
2007	0.000002	0.000001	-50.0	0.0000004	0.000001	103.5	0.000014	0.000002	-85.7

Table 8.44 The differences of CO emissions (kt) in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	CO		
	2023	2024	%
1990	0.000002	0.000018	800.0
1991	0.000002	0.000018	800.0
1992	0.000002	0.000017	750.0
1993	0.000002	0.000017	750.0
1994	0.000002	0.000017	750.0
1995	0.000002	0.000016	700.0
1996	0.000002	0.000016	700.0
1997	0.000003	0.000023	666.7
1998	0.000003	0.000021	600.0
1999	0.000001	0.000011	1000.0
2000	0.000001	0.000010	900.0
2001	0.000001	0.000008	700.0
2002	0.000003	0.000020	566.7
2003	0.000002	0.000018	800.0
2004	0.000002	0.000019	850.0
2005	0.000002	0.000020	900.0

Return to the Table of Contents

Year	CO		
	2023	2024	%
2006	0.000000	0.000001	100.0
2007	0.000000	0.000001	100.0

Table 8.45 The differences of $PM_{2.5}$, PM_{10} and BC emissions (kt) in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	$PM_{2.5}$			PM_{10}			BC		
	2023	2024	%	2023	2024	%	2023	2024	%
2000	NE	0.00001	100.0	NE	0.00001	100.0	0.000003	0.0000004	-87.7
2001	NE	0.00001	100.0	NE	0.00001	100.0	0.000002	0.0000003	-85.1
2002	NE	0.00001	100.0	NE	0.00002	100.0	0.00001	0.0000007	-85.7
2003	NE	0.00001	100.0	NE	0.00002	100.0	0.00001	0.0000006	-87.1
2004	NE	0.00001	100.0	NE	0.00002	100.0	0.00001	0.0000006	-87.1
2005	NE	0.00001	100.0	NE	0.00002	100.0	0.00001	0.0000007	-86.2
2006	NE	0.000001	100.0	NE	0.000001	100.0	0.00000	0.00000005	100.0
2007	NE	0.000001	100.0	NE	0.000001	100.0	0.00000	0.00000005	100.0

Table 8.46 The differences of Pb, Cd and Hg emissions (t) in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	Pb			Cd			Hg		
	2023	2024	%	2023	2024	%	2023	2024	%
1990	0.000738	0.000429	-41.9	0.000095	0.000036	-62.5	0.000512	0.000643	25.6
1991	0.000727	0.000422	-41.9	0.000094	0.000035	-62.5	0.000505	0.000638	26.5
1992	0.000721	0.000419	-41.9	0.000093	0.000035	-62.5	0.000500	0.000633	26.5
1993	0.000701	0.000407	-41.9	0.000090	0.000034	-62.5	0.000486	0.000615	26.5
1994	0.000685	0.000398	-41.9	0.000088	0.000033	-62.5	0.000475	0.000601	26.5
1995	0.000672	0.000390	-41.9	0.000087	0.000033	-62.5	0.000466	0.000590	26.5
1996	0.000661	0.000384	-41.9	0.000085	0.000032	-62.5	0.000459	0.000580	26.5
1997	0.000968	0.000562	-41.9	0.000125	0.000047	-62.5	0.000672	0.000864	28.5
1998	0.000863	0.000501	-41.9	0.000112	0.000042	-62.5	0.000602	0.000821	36.4
1999	0.000450	0.000262	-41.9	0.000059	0.000022	-62.6	0.000318	0.000508	59.7
2000	0.000427	0.000249	-41.7	0.000056	0.000021	-62.7	0.000310	0.000664	114.0
2001	0.000339	0.000197	-41.7	0.000045	0.000017	-62.7	0.000247	0.000532	115.8
2002	0.000843	0.000490	-41.9	0.000109	0.000041	-62.5	0.000587	0.000784	33.6
2003	0.000743	0.000432	-41.8	0.000097	0.000036	-62.6	0.000527	0.000888	68.5
2004	0.000766	0.000445	-41.9	0.000100	0.000037	-62.6	0.000541	0.000875	61.6
2005	0.000806	0.000469	-41.8	0.000105	0.000039	-62.6	0.000575	0.001022	77.8
2006	0.000056	0.000033	-41.6	0.000007	0.000003	-62.9	0.000042	0.000111	165.6
2007	0.000050	0.000030	-40.2	0.000008	0.000003	-64.4	0.000050	0.000366	628.0
2008	0.000000	0.000004	100.0	0.000006	0.000001	-75.0	0.000079	0.001613	1937.0
2009	0.000000	0.000013	100.0	0.000017	0.000004	-75.0	0.000230	0.004681	1937.0
2010	0.000000	0.000011	100.0	0.000015	0.000004	-75.0	0.000204	0.004153	1937.0
2011	0.000000	0.000011	100.0	0.000015	0.000004	-75.0	0.000204	0.004153	1937.0
2012	0.000000	0.000012	100.0	0.000016	0.000004	-75.0	0.000210	0.004276	1937.0
2013	0.000000	0.000003	100.0	0.000004	0.000001	-75.0	0.000054	0.001094	1937.0
2014	0.000000	0.000013	100.0	0.000017	0.000004	-75.0	0.000227	0.004614	1937.0
2015	0.000000	0.000015	100.0	0.000019	0.000005	-75.0	0.000262	0.005329	1937.0
2016	0.000000	0.000015	100.0	0.000020	0.000005	-75.0	0.000267	0.005436	1937.0
2017	0.000000	0.000019	100.0	0.000025	0.000006	-75.0	0.000338	0.006880	1937.0
2018	0.000000	0.000020	100.0	0.000026	0.000007	-75.0	0.000353	0.007182	1937.0
2019	0.000000	0.000020	100.0	0.000026	0.000007	-75.0	0.000354	0.007202	1937.0
2020	0.000000	0.000050	100.0	0.000066	0.000017	-75.0	0.000891	0.018157	1937.0
2021	0.000000	0.000046	100.0	0.000062	0.000015	-75.0	0.000834	0.016981	1936.0

Table 8.47 The differences of As emissions in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	As		
	2023	2024	%
1990	0.0000024	0.000001	-50.0
1991	0.0000023	0.000001	-48.7
1992	0.0000023	0.000001	-48.7
1993	0.0000023	0.000001	-48.7
1994	0.0000022	0.000001	-48.7
1995	0.0000022	0.000001	-48.7
1996	0.0000021	0.000001	-48.7
1997	0.0000031	0.000002	-45.9
1998	0.0000028	0.000002	-35.0
1999	0.0000015	0.000001	-2.1
2000	0.0000014	0.000002	77.6
2001	0.0000011	0.000002	80.2
2002	0.0000027	0.000002	-38.9
2003	0.0000024	0.000003	10.7
2004	0.0000025	0.000002	0.7
2005	0.0000026	0.000003	24.1
2006	0.0000002	0.0000005	157.1
2007	0.0000002	0.000002	1098.2
2008	0.0000000	0.000010	19851.0
2009	0.0000001	0.000028	19880.3
2010	0.0000001	0.000025	19877.8
2011	0.0000001	0.000025	19876.2
2012	0.0000001	0.000026	19833.8
2013	0.0000000	0.000007	20000.0
2014	0.0000001	0.000028	19874.3
2015	0.0000002	0.000032	19962.1
2016	0.0000002	0.000033	19868.5
2017	0.0000002	0.000042	19947.1
2018	0.0000002	0.000044	19867.0
2019	0.0000002	0.000044	19922.9
2020	0.0000006	0.000110	19908.0
2021	0.0000005	0.000103	19883.9

Table 8.48 The differences of Ni and PAHs Total emissions (t) in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	Ni			PAH total		
	2023	2024	%	2023	2024	%
1990	0.000024	0.000004	-85.0	0.00000000	0.000000001	100.0
1991	0.000024	0.000004	-85.0	0.00000000	0.000000001	100.0
1992	0.000023	0.000003	-85.0	0.00000000	0.000000001	100.0
1993	0.000023	0.000003	-85.0	0.00000000	0.000000001	100.0
1994	0.000022	0.000003	-85.0	0.00000000	0.0000000004	100.0
1995	0.000022	0.000003	-85.0	0.00000000	0.0000000004	100.0
1996	0.000021	0.000003	-85.0	0.00000000	0.0000000004	100.0
1997	0.000031	0.000005	-85.0	0.00000000	0.000000001	-40.0
1998	0.000028	0.000004	-85.0	0.00000000	0.000000001	-30.0
1999	0.000016	0.000002	-85.1	0.00000000	0.000000000	100.0
2000	0.000016	0.000002	-85.3	0.00000000	0.000000001	-30.0
2001	0.000013	0.000002	-85.3	0.00000000	0.000000001	-50.0
2002	0.000028	0.000004	-85.0	0.00000000	0.000000001	-40.0
2003	0.000026	0.000004	-85.1	0.00000000	0.000000001	-20.0
2004	0.000027	0.000004	-85.1	0.00000000	0.000000001	-20.0
2005	0.000029	0.000004	-85.2	0.00000000	0.000000001	-10.0
2006	0.000002	0.000000	-85.4	0.00000000	0.0000000001	100.0
2007	0.000005	0.000001	-86.1	0.00000000	0.0000000004	100.0
2008	0.000015	0.000002	-86.7	0.00000000	0.000000002	0.0
2009	0.000043	0.000006	-86.7	0.00000001	0.000000006	-5.0

Return to the Table of Contents

Year	Ni			PAH total		
	2023	2024	%	2023	2024	%
2010	0.000038	0.000005	-86.7	0.00000001	0.000000005	0.0
2011	0.000038	0.000005	-86.7	0.00000001	0.000000005	0.0
2012	0.000039	0.000005	-86.7	0.00000001	0.000000005	4.0
2013	0.000010	0.000001	-86.7	0.00000000	0.000000001	30.0
2014	0.000042	0.000006	-86.7	0.00000001	0.000000006	-6.7
2015	0.000048	0.000006	-86.7	0.00000001	0.000000007	8.3
2016	0.000049	0.000007	-86.7	0.00000001	0.000000007	-5.7
2017	0.000063	0.000008	-86.7	0.00000001	0.000000008	3.7
2018	0.000065	0.000009	-86.7	0.00000001	0.000000009	-3.3
2019	0.000065	0.000009	-86.7	0.00000001	0.000000009	-3.3
2020	0.000165	0.000022	-86.7	0.00000002	0.000000022	0.0
2021	0.000154	0.000021	-86.7	0.00000002	0.000000021	-1.9

Table 8.49 The differences of PCDD/PCDF, HCB and PCB emissions in the sector NFR 5C1biii between 2023 and 2024 submissions

Year	PCDD/PCDF, g I-Teq			HCB, kg			PCB, kg		
	2023	2024	%	2023	2024	%	2023	2024	%
2021	0.0005	0.0005	-0.1	0.0515	0.0515	-0.1	0.0103	0.0103	-0.1

5C1bv Creamtion

Compared to the previous submission, NH_3 emissions from NFR 5C1bv have been reallocated under the NFR 2H2. Annual air reports of facilities reporting NH_3 emissions under the NFR 5C1bv were analysed. The analysis revealed that no animal carcasses were incinerated in the facilities. Instead, the animal by-products were processed. For example, meat and bone meal unsuitable for human and animal consumption were produced. Therefore, the NH_3 emissions from this source were reallocated to NFR 2H2 as a part of the production process.

Table 8.50 The differences of NH_3 emissions (kt) in the sector NFR 5C1bv between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
2009	0.00154	NA	100.0
2010	0.00162	NA	100.0
2011	0.00168	NA	100.0
2012	0.00000	NA	100.0
2013	0.00001	NA	100.0
2014	0.00001	NA	100.0
2015	0.00001	NA	100.0
2016	0.00001	NA	100.0
2017	0.00001	NA	100.0
2018	0.00001	NA	100.0
2019	0.00006	NA	100.0
2020	0.00006	NA	100.0
2021	0.00004	NA	100.0

5C2 Open burning of waste

Compared to the previous submission, $PM_{2.5}$ and PM_{10} emissions were additionally calculated. Open burning of MSW is forbidden in Estonia. However, since it is known that MSW has been burned in piles, barrels, and bonfires, this activity is included in the inventory. There is no applicable emission factor for this activity in the EMEP/EEA Guidebook. During the review in 2021, the TERT recommended using emission factors from the document 'Review of Emission Factors for Incident Fires' (Science report: SC060037/SR3, UK Environment Agency). The recommended document does not contain emission factors for PM_{10} and $PM_{2.5}$.

Therefore, $PM_{2.5}$ and PM_{10} emissions from open burning of MSW were not calculated. During the review in 2023, the TERT recommended calculating the $PM_{2.5}$ and PM_{10} emissions as 100% fractions of TSP.

Table 8.51 The differences of PM2.5 and PM10 emissions (kt) in the sector NFR 5C2 between 2023 and 2024 submissions

Year	$PM_{2.5}$			PM_{10}		
	2023	2024	%	2023	2024	%
2000	NE	0.09	100.0	NE	0.09	100.0
2001	NE	0.06	100.0	NE	0.06	100.0
2002	NE	0.07	100.0	NE	0.07	100.0
2003	NE	0.07	100.0	NE	0.07	100.0
2004	NE	0.04	100.0	NE	0.04	100.0
2005	NE	0.04	100.0	NE	0.04	100.0
2006	NE	0.04	100.0	NE	0.04	100.0
2007	NE	0.03	100.0	NE	0.03	100.0
2008	NE	0.03	100.0	NE	0.03	100.0
2009	NE	0.02	100.0	NE	0.02	100.0
2010	NE	0.02	100.0	NE	0.02	100.0
2011	NE	0.02	100.0	NE	0.02	100.0
2012	NE	0.02	100.0	NE	0.02	100.0
2013	NE	0.02	100.0	NE	0.02	100.0
2014	NE	0.02	100.0	NE	0.02	100.0
2015	NE	0.01	100.0	NE	0.01	100.0
2016	NE	0.01	100.0	NE	0.01	100.0
2017	NE	0.01	100.0	NE	0.01	100.0
2018	NE	0.01	100.0	NE	0.01	100.0
2019	NE	0.01	100.0	NE	0.01	100.0
2020	NE	0.01	100.0	NE	0.01	100.0
2021	NE	0.01	100.0	NE	0.01	100.0

5D1 Domestic wastewater handling

Compared to the previous submission, NH_3 emissions were additionally calculated. NH_3 emissions from dry toilets were calculated. A more detailed description of the activity data and methodology is presented in Chapter 6.5.2.

Table 8.52 The differences of NH_3 emissions (kt) in the sector NFR 5D1 between 2023 and 2024 submissions

Year	NH_3		
	2023	2024	%
1990	NE	0.3680	100.0
1991	NE	0.3598	100.0
1992	NE	0.3497	100.0
1993	NE	0.3338	100.0
1994	NE	0.3199	100.0
1995	NE	0.3082	100.0
1996	NE	0.2950	100.0
1997	NE	0.2861	100.0
1998	NE	0.2777	100.0
1999	NE	0.2727	100.0
2000	NE	0.2720	100.0
2001	NE	0.2657	100.0
2002	NE	0.2524	100.0
2003	NE	0.2432	100.0
2004	NE	0.2382	100.0
2005	NE	0.2268	100.0
2006	NE	0.2223	100.0
2007	NE	0.2181	100.0
2008	NE	0.1956	100.0
2009	0.00010	0.1929	200839.6

Year	NH_3		
	2023	2024	%
2010	0.00008	0.1848	239911.7
2011	0.00001	0.1829	1306142.9
2012	0.00001	0.1810	1292557.1
2013	0.00017	0.1792	103498.3
2014	0.00003	0.1785	557690.6
2015	0.00004	0.1720	409478.6
2016	0.00019	0.1694	88592.7
2017	0.00010	0.1662	162827.5
2018	0.00023	0.1637	70457.3
2019	0.00020	0.1618	82042.6
2020	0.00118	0.1608	13489.4
2021	0.00438	0.1642	3650.8

5E Other waste

NOx, CO, $PM_{2.5}$, PM_{10}, TSP, Pb, Hg, Ni, Zn, b(a)p, b(b), b(k), indeno and PAHs total emissions were recalculated due to the correction of data from the point sources database. Emission for 2012-2013 were reported undert the incorrect SNAP code. Emissions were from the incineration of diesel fuel, which had already been taken into account under the energy sector.

TSP emissions for the year 2011, Pb and Hg emissions for the year 2014, and Cd emissions for the years 2013-2014 were recalculated due to a mistake made by the expert.

$PM_{2.5}$, PM10, TSP, Pb, Hg, Cd, As, Cr, Cu and PCDD/PCDF emissions for 2015-2021 were recalculated due to correction of building fire statistics. Since 2015, the fire statistics provided by the Rescue Board to the ESTEA are more accurate and contain more precise data by building type. Which allows building fires to be more accurately grouped into the correct categories. Since 2015, the building fire statistics include all building fires.

Table 8.53 The differences of NO_x and CO emissions (kt) in the sector NFR 5E between 2023 and 2024

Year	NOx			CO		
	2023	2024	%	2023	2024	%
2012	0.00353	0.00352	-0.5	0.00373	0.00371	-0.5
2013	0.00180	0.00179	-0.6	0.00025	0.00024	-4.5

Table 8.54 The differences of $PM_{2.5}$ and PM_{10} emissions (kt) in the sector NFR 5E between 2023 and 2024

Year	$PM_{2.5}$			PM_{10}		
	2023	2024	%	2023	2024	%
2012	0.09065	0.09064	-0.01	0.09065	0.09064	-0.02
2013	0.07451	0.07451	-0.01	0.07452	0.07451	-0.01
2015	0.06512	0.17567	169.8	0.06512	0.17567	169.8
2016	0.06723	0.15205	126.2	0.06723	0.15205	126.2
2017	0.05553	0.11986	115.8	0.05553	0.11986	115.8
2018	0.06143	0.12905	110.1	0.06143	0.12905	110.1
2019	0.05484	0.11625	112.0	0.05484	0.11625	112.0
2020	0.04716	0.10685	126.5	0.04716	0.10685	126.5
2021	0.04523	0.10607	134.5	0.04523	0.10607	134.5

Table 8.55 The differences of TSP emissions (kt) in the sector NFR 5E between 2023 and 2024

Year	TSP		
	2023	2024	%
2011	0.0908	0.0908	-0.002
2012	0.0907	0.0906	-0.028
2013	0.0745	0.0745	-0.015
2015	0.0651	0.1757	169.8
2016	0.0672	0.1520	126.2
2017	0.0555	0.1199	115.8
2018	0.0614	0.1290	110.1
2019	0.0548	0.1163	112.0
2020	0.0472	0.1069	126.3
2021	0.0505	0.1114	120.4

Table 8.56 The differences of Pb and Hg emissions (t) in the sector NFR 5E between 2023 and 2024

Year	Pb			Hg		
	2023	2024	%	2023	2024	%
2012	0.0009	0.0003	-69.48	0.0007	0.0005	-23.04
2013	0.0009	0.0002	-76.16	0.0006	0.0004	-25.13
2014	0.0002	0.0002	11.1	0.0004	0.0005	10.7
2015	0.0002	0.0005	170.9	0.0004	0.0010	172.1
2016	0.0002	0.0004	157.0	0.0003	0.0009	157.3
2017	0.0002	0.0003	117.5	0.0003	0.0007	118.0
2018	0.0002	0.0004	110.7	0.0004	0.0008	111.7
2019	0.0002	0.0003	113.9	0.0003	0.0007	113.8
2020	0.0001	0.0003	128.7	0.0003	0.0006	128.4
2021	0.0001	0.0003	135.1	0.0003	0.0006	136.0

Table 8.57 The differences of Cd emissions (t) in the sector NFR 5E between 2023 and 2024

Year	Cd		
	2023	2024	%
2013	0.0005	0.0004	-12.47
2014	0.0004	0.0005	10.71
2015	0.0004	0.0010	172.1
2016	0.0003	0.0009	157.3
2017	0.0003	0.0007	118.0
2018	0.0004	0.0008	111.7
2019	0.0003	0.0007	113.8
2020	0.0003	0.0006	128.4
2021	0.0003	0.0006	136.0

Table 8.58 The differences of AS, Cr, Cu and PCDD/PCDF emissions in the sector NFR 5E between 2023 and 2024

Year	As, t			Cr, t			Cu, t			PCDD/PCDF, g I-Teq		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2015	0.0006	0.0016	172.43	0.0006	0.0016	172.35	0.001	0.004	172.08	0.66	1.77	167.21
2016	0.0006	0.0014	157.17	0.0005	0.0014	157.41	0.001	0.003	157.25	0.61	1.53	151.95
2017	0.0005	0.0011	118.0	0.0005	0.0011	118.0	0.001	0.002	117.6	0.57	1.21	113.88
2018	0.0006	0.0012	112.0	0.0005	0.0011	112.2	0.001	0.003	111.6	0.63	1.30	108.25
2019	0.0005	0.0011	113.8	0.0005	0.0010	114.1	0.001	0.002	113.8	0.56	1.17	109.97
2020	0.0004	0.0010	128.4	0.0004	0.0010	128.6	0.001	0.002	128.5	0.48	1.08	124.45
2021	0.0004	0.0010	136.6	0.0004	0.0009	137.2	0.001	0.002	136.6	0.46	1.07	132.21

Table 8.59 The differences of Ni, Zn and PAHs Total emissions (t) in the sector NFR 5E between 2023 and 2024

Year	Ni			Zn			PAHs Total		
	2023	2024	%	2023	2024	%	2023	2024	%
2012	0.0000007	NE	100.0	0.0000010	NE	100.0	0.000004	NE	100.0
2013	0.0000004	NE	100.0	0.0000006	NE	100.0	0.000002	NE	100.0

Return to the Table of Contents

Table 8.60 The differences of b(a)p, b(b)b, b(k)f and I(1,2,3-cd)p emissions (t) in the sector NFR 5E between 2023 and 2024

Year	b(a)p			b(b)f			b(k)f			I(1.2.3-cd)p		
	2023	2024	%	2023	2024	%	2023	2024	%	2023	2024	%
2012	0.000001	NE	100.0	0.000001	NE	100.0	0.0000009	NE	100.0	0.0000005	NE	100.0
2013	0.000001	NE	100.0	0.000001	NE	100.0	0.0000004	NE	100.0	0.0000002	NE	100.0

8.5. Natural emissions (NFR 11)

11c Other natural emissions

Table 8.61 The differences in other natural NMVOC emissions (kt) for the years 2012-2021 between 2023 and 2024 submissions

Year	NMVOC		
	2023	2024	%
2012	37.89	37.920	0.1
2013	38.54	38.279	-0.7
2014	39.31	39.329	0.0
2015	39.84	39.859	0.0
2016	40.62	40.611	0.0
2017	40.62	41.176	1.4
2018	40.98	41.223	0.6
2019	41.13	41.043	-0.2
2020	41.13	41.185	0.1
2021	41.13	40.730	-1.0

Source: http://lofciam.pl

9.PROJECTIONS

9.1. Description of general methods, data sources and assumptions

Ministry of Climate has appointed the Estonian Environmental Research Centre (EERC) to be the institution to have the overall responsibility of maintaining the national systems for GHG reporting, including reporting on GHG policies, measures, and projections under the Regulation (EU) 2018/1999[34], on behalf of the MoC. With having a system in place for reporting GHG PaMs and projections, EERC is also responsible for the compilation of air pollutant projections reported in this chapter. Atmospheric pollutant emissions' projections are updated every two years.

Estonia's national system for the projection compilation is set up to ensure the transparency, accuracy, consistency, comparability, and completeness of the information reported on policies and measures and projections of anthropogenic atmospheric pollutant emissions.

'With Existing Measures' (WEM) scenario evaluates future AP trends under current policies and measures. In case there are additional measures planned and their impact can be taken into consideration, then 'With Additional Measures' (WAM) scenario is created. Two projections scenarios of air pollutant (AP) emissions have been calculated for energy, transport and agriculture sector for the period 2021–2050. WEM=WAM scenario is created tor Industrial processes and solvent use and waste sector. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020).

Estonia's emission projections described in the Chapter 9.2 and included in Annex IV have been calculated based on national strategy documents, legislation, and sector-specific studies (incl. economic and population forecasts) and input from the ministries. Where possible, long-term action plans of relevant companies have been taken into account in the projection compiling process.

9.2. Sectoral methods and projections

9.2.1. Energy

9.2.1.1. Electricity supply

The Electricity Market Act (2005) governs the generation, transmission, sale, export, import and transit of electricity and the economic and technical management of the power system. This Act prescribes the principles of the operation of the electricity market, based on the need to ensure an effective supply of electricity which is provided at a reasonable price and which meets environmental requirements and the needs of consumers, and the utilisation of energy sources in a balanced manner, in an environmentally clean way and with a long-term perspective. It states that electricity undertakings shall always facilitate activities performed by consumers for the purpose of conserving electricity

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[34] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council [www] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018R1999&from=EN (26.02.21)

Return to the Table of Contents

Table 9.1 Support for renewable and efficient CHP based electricity production(Electricity Market Act §59)

Level of subsidy	Conditions for receiving the subsidy
	Subsidies are paid for electricity that is produced:
0.0537 €/kWh	Electricity generated from a renewable energy source except biomass if the net capacity of the production machinery does not exceed 125 MW
0.0537 €/kWh	From biomass in CHP mode. From 1 July 2010, producers who have started generating electricity from biomass can only get the subsidy for electricity generated in efficient CHP mode
0.032 €/kWh	In efficient CHP mode from waste as defined in the Waste Act, peat or oil shale retort gas
0.032 €/kWh	In efficient CHP mode using generating equipment with a capacity of not more than 10 MW

Electricity supply WEM scenario measures include:

1. **Renewable energy support through underbidding auctions (technology neutral)** – The aim of this measure is to increase energy production from renewable energy sources. Support for renewable energy production is regulated by the Electricity Market Act (technology neutral auction).
2. **Support for renewable and efficient CHP-based electricity production** – The aim of this measure is to increase energy production from renewable energy sources and promote cogeneration (Table 9.1).
3. **Investment support for wind parks** – The aim of this measure is to increase electricity production from renewable energy sources.
4. **Increasing the share of solar energy in electricity generation** – The aim of this measure is to increase electricity production by increasing the proportion of solar energy.
5. **Introduction of renewable energy in maritime surveillance radar stations on small islands** – Increase energy production from renewable energy sources. Many small islands in Estonia do not have a permanent connection to the electricity grid. However, small islands have various state-owned facilities or buildings and permanent residents.
6. **Renewable energy support through underbidding auctions (technology specific)** – Support for renewable energy production through technology-specific auction. Increase energy production from renewable energy sources.

In addition to the planned measures, there are additional electricity-supply-related measures that have either a direct effect on AP emissions or support the implementation of WEM/WAM measures. The following additional measures are under discussion and therefore not part of the projection scenarios.

1. **Energy storage pilot programme** – supports measures to increase the deployment of renewable energy by enabling the deployment of heat storage devices to reduce the demand for fossil fuels during peak loads.
2. **The acquisition of air surveillance radars for the development of wind farms** – Supporting the development of wind energy through the construction of radars and other compensation measures in order to promote the development of renewable energy in Estonia, freeing the areas of onshore and offshore wind farms from height and national defence restrictions, which enables the construction of wind farms.
3. **Encouraging the introduction of biomethane** –
4. **Promoting the deployment of complete hydrogen technologies** –

Electricity grid reinforcement programme to increase renewable energy production capacity and adaptation to climate change – Implementation of this measure would increase the capacity of the Estonian electricity system while introducing renewable energy increases and new renewable energy production capacities are added to the electricity system.

9.2.1.2. Heat supply

The District Heating Act (2003) governs activities related to the production, distribution and sale of heat by way of district heating networks and connection to district heating networks.

Due to the large share of buildings in the total energy use, the improvement of energy efficiency in the residential and tertiary sectors also has an important role from the emissions reduction aspect. Here, the impact of EU Directive 2002/91/EC and its recast 2010/31/EU on the energy performance of buildings (EPBD) should be highlighted. In Estonia, the implementation of the EPBD is the responsibility of the MoC. The provisions of the EPBD have been transposed into the Building Code. Several detailed requirements were enforced using secondary legislation. The most important secondary-level act is the regulation (No 55 of 3 June 2015) for Minimum requirements for energy performance regulation that establishes **minimum requirements for the energy performance of buildings**, including low energy buildings and nearly zero-energy buildings. The regulation applies to new as well as existing ones undergoing major renovations.

Heat supply WEM scenario measures include:

1. **Construction of local heating solutions instead of district heating solution** – The aim of the measure is to reduce the final consumption of energy. As part of the measure, inefficient district heating will be replaced with local heating, provided that the district heating company continues to provide the service through the local heating solution.
2. **Renovation of depreciated and inefficient heat pipelines** – Renovation of depreciated and inefficient heat pipelines and/or construction of new heat pipelines.
3. **Renovation of district heating boilers and fuel change** – Renovation and/or construction of district heating boilers and fuel exchange.
4. **Oil boiler replacement programme** – The aim of the measure is to replace local inefficient fossil fuel heating systems with efficient modern systems.

Heat supply WAM scenario measures include:

1. **Additional renovation of depreciated and inefficient heat pipelines** – Additional renovation of depreciated and inefficient heat pipelines and/or construction of new heat pipelines.
2. **Additional renovation of district heating boilers and fuel change** – Additional renovation and/or construction of district heating boilers and fuel exchange.

Additional construction of local heating solutions instead of district heating solution – Additional replacement of inefficient district heating with local heating, provided that the district heating company continues to provide the service through the local heating solution.

9.2.1.3. Energy consumption — Manufacturing industries and construction

WEM scenario measures in energy consumption in manufacturing industries include:

1. **Support for energy- and resource audits in industries** – Raising awareness in energy and resource usage efficiency in the manufacturing industries.
2. **Energy and resource efficiency in industries** – Supporting investment in energy and resource usage efficiency in the manufacturing industries.

9.2.1.4. Energy consumption — Other sectors (Commercial/institutional and residential sectors)

The Product Conformity Act (2010) sets out the competence of authorities participating in market surveillance and stipulates that the Technical Surveillance Authority must exercise state surveillance over compliance of household appliances, heating appliances and devices with energy efficiency, ener gy performance labels and ecological design requirements,

Energy Sector Organisation Act (2017) provides the measures for achieving the national target of energy efficiency, the principles for promoting renewable energy and the requirements for improving energy efficiency and the parties on whom obligations are imposed in the public as well as in the private sector.

WEM scenario measures in energy consumption in other sectors include:

1. **Support for making the processing of fishery and aquaculture products more energy and resource efficient** – The aim of the measure is to increase the energy saving and resource productivity of companies through the introduction of more sustainable technologies and solutions, while reducing the impact on the environment. The implementation of an energyor resource-saving solution based on an energy or resource audit is supported.
2. **Energy efficiency in local government buildings** – The purpose of the measure is to increase the energy efficiency of local government buildings, reduce greenhouse gas emissions, support the use of renewable energy and reduce general heating costs.
3. **Energy efficiency in central government buildings** – The purpose of the measure is to increase the energy efficiency of central government buildings, reduce greenhouse gas emissions, support the use of renewable energy and reduce general heating costs.
4. **Arrangement of the basic school network** – The aim of the measure is to support the construction of new schools to replace old ones or the complete renovation of old school buildings.
5. **Arrangement of the gymnasium network** – The aim of the measure is to support the construction of new gymnasiums to replace old ones or the complete renovation of old gymnasium buildings.
6. **Reorganisation of special care institutions** – The aim of the measure is to support the construction of new care institutions to replace old ones or the complete renovation of old care institution buildings.
7. **Institutional development programme for R&D institutions and higher education institutions** – The measure supports the construction and reconstruction of new buildings for research and development institutions and schools.
8. **Modernisation of health centres** – The aim of the measure is to support the construction of new health centres to replace old ones or the complete renovation of old health centres.
9. **New childcare and pre-primary education infrastructure** – The aim of the measure is to support the renovation of childcare and pre-primary school buildings.
10. **Kindergarten renovation** – The aim of the measure is to support the renovation of kindergarten buildings.
11. **Supporting the reconstruction of apartment buildings** – The aim of the measure is to increase the energy efficiency of apartment buildings and improve the indoor climate. Across all investments, the goal is to reconstruct an estimated net area of 3.2 million m^2 of apartment buildings.
12. **Supporting the reconstruction of private houses** – The aim is to support the complete reconstruction of small houses and to reduce the energy consumption of small houses. The goal is to reconstruct 80 small houses. The investment in small houses will support the energy efficiency and reconstruction of an estimated 13,000 m^2 of net space.
13. **Street lighting reconstruction programme investments** – The purpose of the programme is to improve the use of electricity in street lighting through the renovation of the street lighting infrastructure.

WAM scenario measures in energy consumption in other sectors include:

1. **Supporting the reconstruction of non-residential buildings in the private sector** – The aim is to support the complete reconstruction of the non-residential buildings by 2050.
2. **Reconstruction of municipal buildings** – The aim is to support the complete reconstruction of the municipal buildings by 2050.
3. **Reconstruction of central government buildings** – The aim is to support the complete reconstruction of the central government buildings by 2050.
4. **Additional reconstruction of apartment buildings** – The aim is additional support for the complete reconstruction of the apartment buildings by 2050.
5. **Additional reconstruction of private houses** – The aim is additional support for the complete reconstruction of the small houses by 2050.
6. **Investments into energy saving of greenhouses and vegetable warehouses and dissemination of renewable energy** – Supporting investment in energy and resource usage efficiency in agriculture.

In addition to the planned measures, there are additional measures that have either a direct effect on AP emissions or support the implementation of WEM/WAM measures. The following additional measures are under discussion and therefore not part of the projection scenarios.

1. **Support for making the processing of fishery and aquaculture products more energy and resource efficient** – The aim of the measure is to increase the energy saving and resource productivity of companies through the introduction of more sustainable technologies and solutions, while reducing the impact on the environment. Resource productivity is an indicator of the efficiency of the use of materials, which characterizes how much added value is created by using a unit of material. Therefore, the purpose of the support is to increase energy savings as well as the use of resources or materials (water, raw materials, heating, waste, etc.). The implementation of an energy or resource saving solution based on an energy or resource audit is supported.
2. **Residential Investment Fund** – In order to ensure adequate and sustainable reconstruction financing, a national reconstruction fund is being developed. In the long term, the fund ensures the financial independence of measures related to reconstruction from the state budget and external funds. The housing investment fund allows to ensure consistent financing (loans, loan guarantees) in regions where the real estate value is low and the residents opportunities to carry out reconstruction under market conditions are limited.

There are two agriculture and energy sector cross cutting measures in WEM scenario:

1. **Investments into improved performance of agricultural holdings** – The objective is to support the reconstruction or construction of new livestock facilities and provide investments into renewable energy through investments in bioenergy and promote its production.
2. **Material and intangible investments by farmers** – The objective is to promote resource efficiency in agricultural production, to prevent the generation of waste and emissions, to reduce the environmental impact of production and greenhouse gas emissions, and to improve biosecurity through tangible investments which may also lead to intangible investments.

9.2.1.5. Methodology

Two projections scenarios of air pollutant emissions have been calculated for the period 2021–2050. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020). The 'With Existing Measures' (WEM) scenario evaluates future AP trends under current policies and measures. In the second scenario a number of additional measures and their impact are taken into consideration, forming the basis of the 'With Additional Measures' (WAM) scenario.

The scenarios projecting AP emissions in the Energy sector are mainly based on the measures of the Ministry of Climate (MoC), which are funded through the Recovery and Resilience Facility (RRF), Environmental Investment Centre (EIC) and the State Shared Service Center (SSSC). In addition, the scenarios were updated based on the input received from the MoC and input from the meeting points of the Government´s Climate and Energy Committee (2020).

The Balmorel[35] model was used for the electricity generation projections in the Electricity generation category. It is a model for analysing the Electricity and Combined heat and power sectors from an international perspective while minimising the total costs of the system. The Balmorel model combines the approach of bottom-up modelling in a classic technical modelling tradition with top-down economic analysis, projections and forecasts. Some of the key strengths of the Balmorel model include the flexible handling of the time and space dimensions and the combination of operation and investment optimisation. The existing functionality and structural suitability for extensions make it a useful tool for assessing challenges in the ongoing energy transitions. However, the downsides of the Balmorel model are complex user interface, the speed of the model and adding additional sectors to make the energy model more complete. The Balmorel model can differentiate, for example, the fuel consumption between the electricity and heat production, which is useful on order to avoid double counting. Furthermore, the Balmorel model makes estimated projections for both heat and power, to what extent it is reasonable to use a type of fuel (like biomass) to meet energy demand.

The main assumption for the projection was that step-by-step, the use of oil shale shall decrease for the production of electricity and increase for the production of shale oil. The retort gas that occurs as a side product during the production of shale oil is used for electricity production. The projected usage of fuel based on the model was applied while using the EMEP/EEA 2019 Guidelines[36].

The projections for heat generation in the Public heat and electricity generation sector are primarily based on the reconstruction rate of the Shared Service Center, Analysis of the opportunities to increase climate ambition in Estonia measures[37] and Long-term for building reconstruction scenarios[38]. The projections in the heat production are based on measures funded through the EIC and measures highlighted in the Analysis of the opportunities to increase the climate ambitions in Estonia.

The projections of the AP emissions of shale oil production in the Manufacturing of solid fuels and other energy industries were calculated based on input from the industry. The amounts of oil shale used and the construction of a new shale oil production plant were used for the AP projections.

The AP projections in the Manufacturing industries and construction sector and in Other sectors are also based on historical trends, long term real GDP growth rate[39] (the Ministry of Finance), Shared Service Center measures and Long-term strategy for building reconstruction scenarios. The emissions are calculated based on the methoology of EMEP/EEA 2019 Guidebook.

9.2.1.6. AP emissions projections

The Energy sector includes AP emissions from the consumption and production of fuels and energy (electricity and heat). The main sub-sectors in this sector are: Energy industries; Manufacturing industries

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[35] Balmorel model. [www] http://www.balmorel.com/ (01.03.23)

[36] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (01.03.23)

[37] SEI. (2019). Analysis of the opportunities to increase climate ambition in Estonia. [www] https://envir.ee/media/1412/ download (7.12.2022).

[38] Tallinna University of Technology. (2020) Long-term for building reconstruction scenarios. [www] https://www.mkm.ee/media/155/download (01.03.2023)

[39] Ministry of Finance. (09.09.22) Ministry of Finance´s long term projections until 2070. [www] https://www.fin.ee/riigi-rahandus-ja-maksud/fiskaalpoliitika-ja-majandus/rahandusministeeriumi-majandusprognoos (01.03.23)

and construction (including non-road transport); Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms sub-sectors, including non-road transport) and Fugitive emissions from natural gas distribution.

The Energy sector's projected emissions in the WEM scenario are presented in Figure 9.1. In the WEM scenario, the NO_x emissions are projected to decrease by 40.0%, SO_2 by 89.5%, NMVOC by 33.9%, $PM_{2.5}$ by 75.1% and NH_3 by 70.7% from 2020 to 2050.

The main electricity producer in Estonia is Enefit Power AS incl. the Eesti Power Plant and the Balti Power Plant. Both of these plants mainly use oil shale for electricity production. Air pollutant emissions are projected to decrease in the Energy industries sector due to the phasing out of oil shale pulverized combustion in these plants, reduction of direct combustion of oil shale, increasing the use of shale oil production plants instead and deployment of renewable energy on a larger scale.

Air pollutant emissions in the Manufacturing and construction sector (divided into iron and steel; non-ferrous metals; chemicals; pulp, paper and print; food processing, beverages and tobacco; non-metallic minerals; and other industries) are projected to increase. In this sector, only one scenario (WEM=WAM) is projected, as there are no additional planned policies or measures.

The emissions in Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms) are expected to decrease, due to reconstruction and heat economy measures.

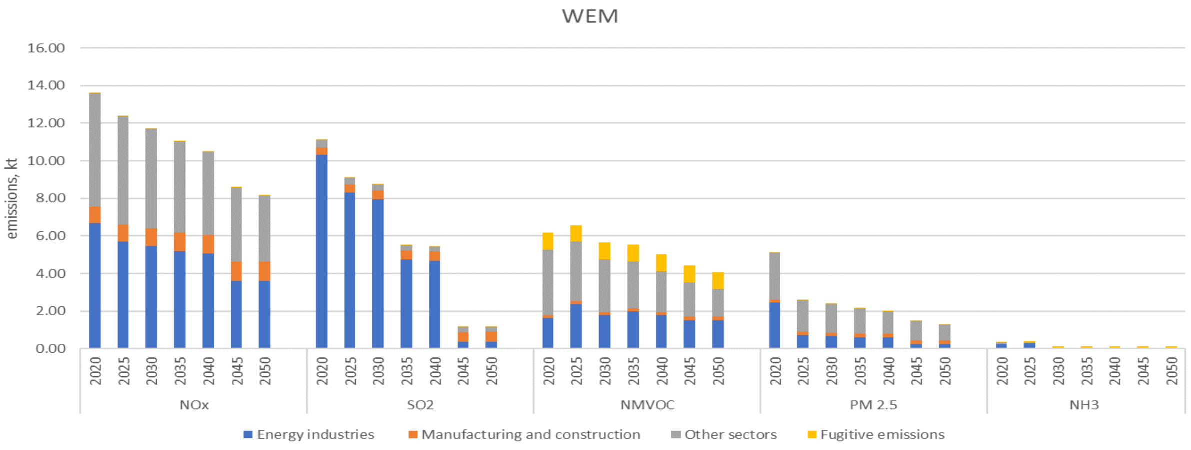

Figure 9.1 Total projected WEM scenario air pollutant emissions from Energy sector, kt

The projected emissions of the Energy sector in the WAM scenario are presented Figure 9.2. In the WAM scenario, the NO_x emissions are projected to decrease by 49.2%, SO_2 by 90.6%, NMVOC by 42.1%, $PM_{2.5}$ by 79.1% and NH_3 by 72.7% from 2020 to 2050.

The increased reduction of air pollutant emissions in the WAM scenario results from higher energy efficiency requirements for buildings (entails additional funding for renovation purposes) and heat supply, which help to decrease energy consumption for heat production.

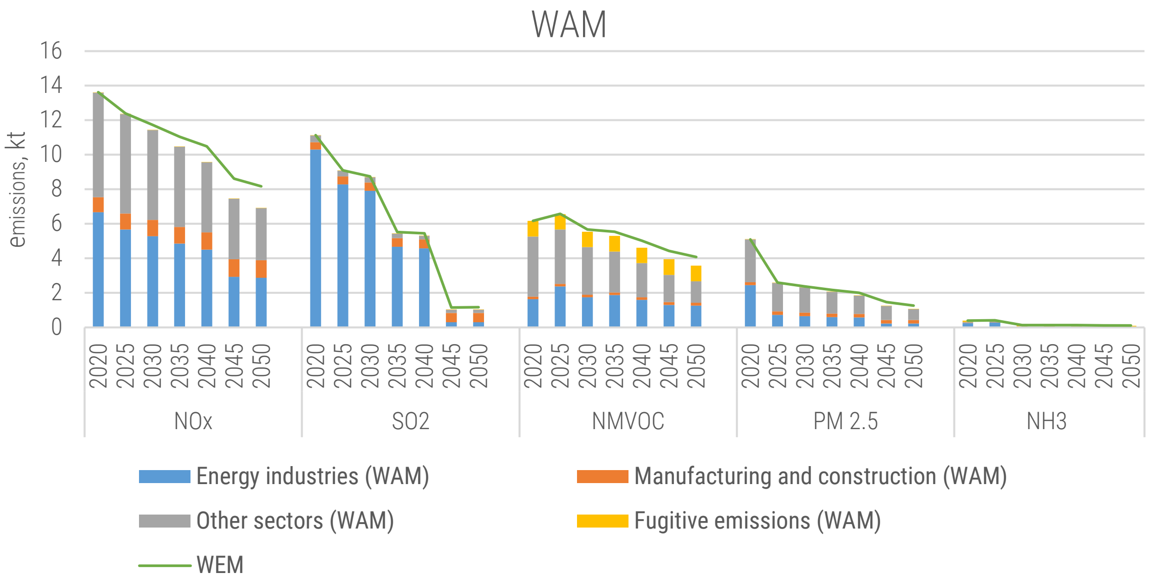

Figure 9.2 Total projected WAM scenario air pollutant emissions from Energy sector, kt

9.2.2. Transport

9.2.2.1. Methodology

The Liquid Fuel Act (2003) provides the bases and procedure for handling liquid fuel, the liability for violations of this Act and the arrangements for exercising state supervision, with a view to ensuring the payment of taxes and guaranteeing the quality of the more widely used motor fuels.

The main focus of the **Transport and Mobility Development Plan 2021–2035** (**MoC, 2021)** is to reduce the environmental footprint of the transport means and system to contribute to the achievement of climate goals by 2050. In order to manage people's behavioural changes in the future, emphasis is placed on the 'polluter pays' principle and, among other things, to taxation of fuels according to their emission factors and energy content. Also, according to the development plan, it is necessary to introduce low-carbon fuels in all modes of transport.

For this development plan, the Ministry of Economic Affairs and Communications also commissioned a report from the International Transport Forum (ITF) The Future of Passenger Mobility and Goods (ITF, 2020), the goal of which was to assess Estonia´s transport sector and give recommendations for future improvements from an external observer's perspective.

In the transport sector, the WEM measures having an effect on AP emissions that are already in place include:

1. **Increasing the share of biofuels in transport** – The total energy content of the petrol, diesel and biofuel released for consumption, as well as of the electricity supplied for use in road transport, must include a total energy content of biofuels, or of biomethane or electricity supplied for final consumption, at the value, as a weighted average for the calendar year, of at least 7.5% by the end of that year.
2. **Promoting the use of electricity in passenger cars** – The aim of the measure is to develop a support system for expanding infrastructure that is needed for switching to electric cars.
3. **Promoting the use of biomethane in buses** – The aim of the measure is to increase the supply of biomethane in the market, creating demand for fuels produced from renewable energy sources

and supporting the construction of filling stations.

4. **Promoting the use of electricity in buses** – This measure includes the development of a support system for the infrastructure to switch to electric buses (including the use of trolleybuses).
5. **Promoting the use of biomethane in heavy-duty vehicles** – The aim of the support is to offer the market an alternative fuel source (biomethane or bio-LNG) to replace diesel-fuelled heavy-duty trucks.
6. **Promotion of economical driving** – This measure includes promoting eco-driving, which helps to save fuel, and reduce noise level, emissions, accidents and vehicle repair costs.
7. **Reduction of forced movement by passenger car**– Implementing the measure helps to plan land use to reduce urbanisation and car dependency (forced mobility). It includes the development of telecommunications and also the development of a short-term rental car network. The measure requires stronger spatial planning at the regional level, because the activities of the measure go beyond the borders of one municipality. The aim of the measure is also to ease the transport burden during peak hours.
8. **Reorganisation of city streets** – The measure includes updating parking policies in cities, planning land use to reduce the use of private cars, restructuring city streets, etc. The measure also requires stronger spatial planning at the regional level, because the activities of the measure go beyond the borders of one municipality. The aim of the measure is also to ease the transport burden during peak hours.
9. **Development of convenient and modern public transport** – This measure includes improving the availability of public transport, along with the development of ticket systems and new services. The measure also requires stronger spatial planning at the regional level, because the activities of the measure go beyond the borders of one municipality.
10. **Road usage fees for heavy-duty vehicles based on time** – This measure includes the establishment of road user charges based on time, location, environmental aspects, etc. for vehicles with a gross weight greater than 3,500 kg (heavy trucks).
11. **Electric car purchase support** – The purchase subsidy for electric cars is aimed at companies and individuals with high transport needs. The condition for receiving the subsidy is that the vehicle is driven 80,000 kilometres within four years from the payment of the subsidy. This means that an average of 20,000 km is covered per year. At least 80% of this, or 16,000 km, must be travelled in Estonia.
12. **Promotion of clean and energy-efficient road transport vehicles in public procurement** – The government must implement the system provided in the Clean Vehicles Directive within 24 months, i.e., from August 2021. The aim is to promote the procurement of clean and energy-efficient vehicles in the public sector.
13. **The railroad electrification**– Electrification of existing railway and extension of its use.
14. **Acquisition of additional passenger trains** – Additional acquisition of comfortable new passenger trains.
15. **Developing the railroad infrastructure (includes the building of Rail Baltic)** – This measure includes building Rail Baltic, additional stops and raising speed limits. In addition to transport, the measure also concerns emissions from the Industry and solvent sector (IPPU). The impact of Rail Baltic on the fuel consumption of heavy trucks is evaluated, which in turn means reducing the consumption of AdBlue (exhaust gas catalyst liquid) and the CO2 released from it.
16. **Pilot project for hydrogen** – A project covering the entire hydrogen use chain, i.e., from production, transport, storage to consumption in public transport (hydrogen taxi).
17. **New tram lines in Tallinn**– Includes the development of two new tram lines.

18. **Making a domestic ferry climate neutral**– Includes the electrification of one ferry.

The following measures are still in discussion and henceforth are reported as planned in the WAM scenario:

1. **Additional spatial and land-use measures for urban transport energy savings to increase and improve the efficiency of the transport system** – This measure includes additional investments for the *Reduction of forced movement by passenger car, Reconstruction of city streets and Development of convenient and modern public transport* measures. This means that additional resources are planned to achieve additional energy efficiency. As this is a proposed measure, it is not yet clear when it will be implemented.
2. **Making an additional domestic ferry climate neutral** – Includes the transfer of one additional ferry sailing between the Estonian mainland and the islands to electricity or biofuel that meets the sustainability criteria.
3. **Additional promotion of economical driving** – This measure includes additional implementation of the measure "Promotion of economical driving", which means planning additional resources to achieve additional energy efficiency. As this is a proposed measure, it is not yet clear when it will be implemented.
4. **Road usage fees for heavy-duty vehicles based on mileage** – This measure includes the establishment of road user charges based on mileage, location, environmental aspects, etc.

Vehicle tyre pressure and tyre energy label – The measure introduces tyres with better rolling resistance which also improves the aerodynamics of vehicles. Training materials for truck drivers are being updated to emphasise the importance of checking tyres and tyre pressure.

9.2.2.2. Methodology

Two projections scenarios of air pollutant emissions have been calculated for the period 2021–2050. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020). The 'With Existing Measures' (WEM) scenario evaluates future AP trends under current policies and measures. In the second scenario a number of additional measures and their impact are taken into consideration, forming the basis of the 'With Additional Measures' (WAM) scenario.

Sybil baseline model was used for the AP projections in the road transport sector. The model uses a bottom-up ap- proach requiring data about the vehicle fleet, technology (EURO class) and road activity. The biggest strength of the model is compatibility with COPERT, which is used for the compilation of road transport in the national inventory report and kept up to date by EMISIA, the same team as for COPERT. On the other hand, its weakness is the high time consumption of calculating the effect of each individual measure. For that reason, it is easier to calculate separately the effects of the measure and insert the sum effect into the model.

The projections in the Transport sector are based on the information from the ITF report "The Future of Passenger Mobility and Goods" [40], the TalTech report "Traffic survey manual and the business as usual forecast"[41], the Ministry of Economic Affairs and Communication, the Ministry of Environment and input from the meeting points of the Government´s Climate and Energy Committee (2020). To estimate AP

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[40] International Transport Forum. (2020) The Future of Passenger Mobility and Goods Transport in Estonia. [www] https://www.itf-oecd.org/future-passenger-mobility-and-goods-transport-estonia (01.03.23)

[41] Tallinn University of Technology. (2020) Traffic survey manual and the business as usual forecast. [www] https://transpordiamet.ee/media/3125/download (01.03.23)

emissions emission factor data from the EMEP/EEA 2019 Guidebook along with country-specific emission factors were used.

The projections for the WEM scenario are also in line with Regulation (EC) No 2019/631 of the European Parliament and of the Council[42]. In addition, it is also taken to account that by 2035, the average emissions target for a new passenger car is 0 gCO_2/km and 130 gCO_2/km for light duty vehicles, which also helps to decrease AP emissions.

9.2.2.3. AP emissions projections

The majority of AP emissions in the transport sector come from the road transport, the emissions of which are projected to decrease in both the WEM and WAM scenario. The main reason for the downward trend in the scenarios is the introduction of electric vehicles and this is reinforced by measures to support the promotion of electric vehicles. Also, that from 2035, all new passenger cars must meet the criteria of 0 gCO_2/km according to Regulation (EC) No. 2019/631 of the European Parliament and Council, which also contributes strongly to the reduction of AP pollutants. Domestic aviation emissions are also expected to remain roughly the same between 2020 and 2050. AP emissions in rail transport will decrease when the electrification measure are implemented, and shipping emissions will also decrease compared to the reference year due to electrification (Figure 9.3 and Figure 9.4) .

The Transport sector's projected emissions in the WEM scenario are presented in Figure 9.3. In the WEM scenario, the NOx emissions are projected to decrease by 68.3%, NMVOC by 81.7%, PM2.5 by 76.5%, NH3 by 90.7% and SO2 by 62.5% from 2020 to 2050.

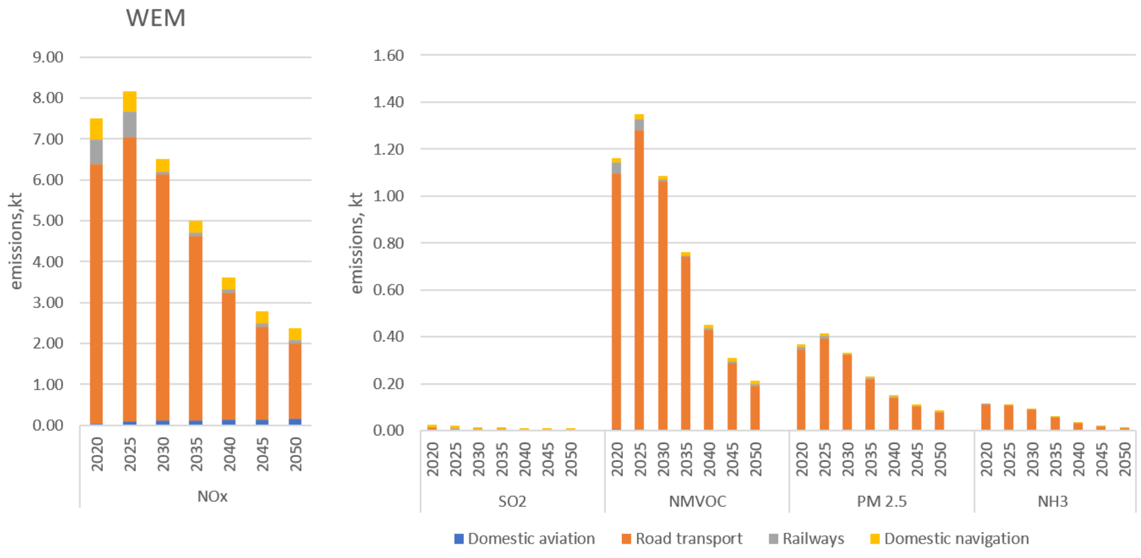

Figure 9.3 Total projected WEM scenario air pollutant emissions from Transport sector, kt

The Transport sector's projected emissions in the WAM scenario are presented in Figure 9.4. In the WAM scenario, the NO_x emissions are projected to decrease by 75.8%, NMVOC by 84.0%, $PM_{2.5}$ by 83.2%, NH_3 by 93.1% and SO_2 by 83.7% from 2020 to 2050.

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[42] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011. [www] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32019R0631

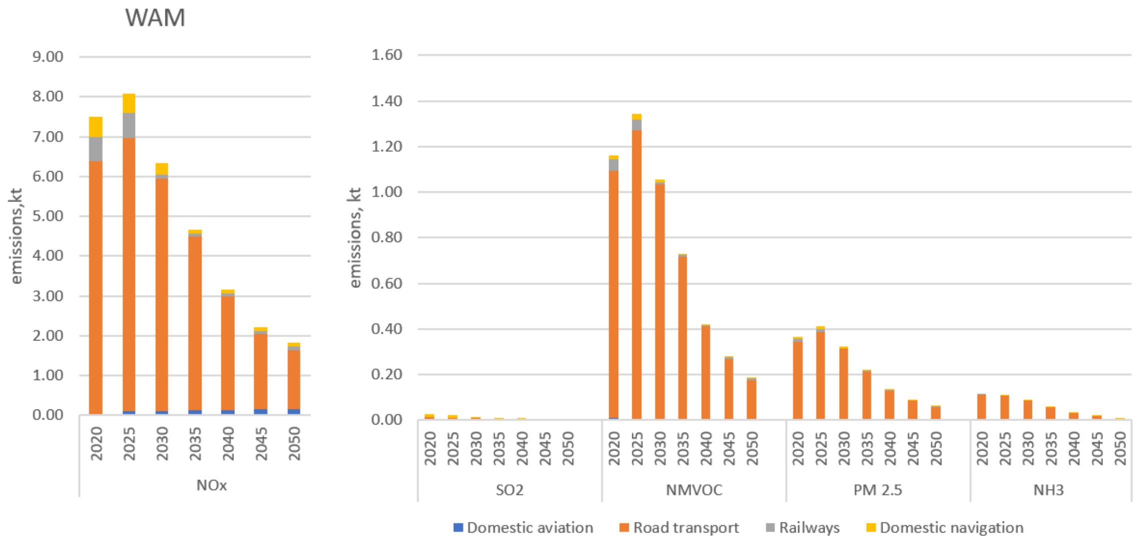

Figure 9.4 Total projected WAM scenario air pollutant emissions from Transport sector, kt

9.2.3. Industrial processes

Emissions from the industrial processes and solvent use sector are regulated by the duty for manufacturing industries to implement the **best available technologies (BAT)** (stipulated in the Industrial Emissions Act (IEA) (2013) and Industrial Emissions Directive 2010/75/EU). The purpose of the **Industrial Emissions Act** is to achieve a high level of protection of the environment taken as a whole by minimising emissions into the air, water and soil and the generation of waste in order to prevent adverse environmental impacts. In addition, the IEA determines industrial activities of high environmental hazard, provides the requirements for operation therein and liability for failure to comply with the requirements, and the organisation of state supervision.
A production plant has to comply with the BAT. The requirements of the IEA include emission limit values, and monitoring and emission reduction measures through the implementation of BATs if an environmental permit is issued. This does not result in an additional reduction of emissions because all production plants have to comply with BATs as they operate

9.2.3.1. Methodology

The ‘With Existing Measures’ (WEM) projections scenario includes air pollutant emission projections for the period 2021–2050 under current policies and measures. The reference year 2020 used in projections is consistent with Estonia’s 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020). As there are no additional measures currently planned, than the ‘With Additional Measures’ (WAM) scenario equals to WEM.

The following emission sources are reflected in the Industrial processes subector:

- mineral industry (production and use of cement, glass and lime; extraction and storage of mineral resources; construction and demolition);
- chemical industry;
- metal industry;
- road paving with asphalt;
- production of pulp, paper and food;
- wood processing;
- other industry.

The proportion of the industrial processes sector is low in the 2020 inventory of atmospheric pollutants in comparison with other sectors such as energy or transport. The small share is also partly a result of the classification structure of the inventory. For instance, all activities of industrial companies that are related to fuel combustion (technological furnaces, castings of iron and other technological combustion plants) are reflected in the Energy sector, more precisely under combustion in the manufacturing industry. In addition, the Solvents sector includes painting that contributes to NMVOC emissions and the industrial use of solvents.

2020, share of industry sources (without Solvent use) in total emissions constituted 0.3% of NO_x emissions, 3.9 % of $PM_{2.5}$ emissions, 3.4 % of NMVOC emissions and 0.95% of NH_3 emissions in Estonia. The proportion of sulphur dioxide is marginal.

The air pollutant emissions' projections in the Industrial processes sector are based on historical emission trends, coupled with projections of Estonia´s GDP[43] and population[44]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2019 Guidelines[45]. The projections for the industrial process sector are quantitative interpretations of the underlying indicators that, when averaged, are most likely to reflect future emissions of air pollutants from a given category. Where possible, long-term action plans of relevant companies, have been taken into account in the projection compiling process.

In the field of industrial processes, the only legislative measure is the Industrial Emissions Act[46] (IEA), Given that the industrial processes sector is governed by the IEA, and according to current reference documents for BATs (BREFs) all production plants have to comply with BATs as they operate, no new policy guidelines for achieving the atmospheric pollutant targets and leading to significant changes in production demand or concerning the BATs are expected to be adopted in the industrial processes sector. Therefore there is only WEM scenario for emissions from industrial processes sector (WEM=WAM).

The emissions reported in the Solvent use sector include in particular those of NMVOC, which accounted for nearly 46.2% of national emissions in 2020, as well as, to a limited extent, the emissions of $PM_{2.5}$ (0.77% of national 2020 emissions), NO_x 0.01%, NH_3 0.08 and 0.003% SO_2 of total emissions in 2020 originating from the following activities:

- use of solvents in households;
- use of paints;
- surface cleaning;
- dry cleaning;
- production and processing of chemical products;
- printing;
- other use of solvents;
- use of other products.

Emissions of pollutants from diffuse sources are calculated on the basis of the activity data of Statistics Estonia and Eurostat, historical emission trends, coupled with projections of Estonia´s GDP[47] and

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[43] Long-term GDP projection of the Ministry of Finance of Estonia [www] https://www.fin.ee/riigi-rahandus-ja-maksud/fiskaalpoliitika-ja-majandus/rahandusministeeriumi-majandusprognoos (03.03.23)
[44] Statistics Estonia, RV086: Population Projection Until 2080 by Sex and Age (based on the population figure as at 1 January 2019) [www] https://andmed.stat.ee/et/stat/rahvastik__rahvastikunaitajad-ja-koosseis__rahvaarv-ja-rahvastiku-koosseis/RV086 (03.03.23)
[45] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (03.03.23)

[47] Long-term GDP projection of the Ministry of Finance of Estonia [www] https://www.fin.ee/riigi-rahandus-ja-maksud/fiskaalpoliitika-ja-majandus/rahandusministeeriumi-majandusprognoos (03.03.23)

population[48]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2019 Guidelines[49].

Ca 76% of the NMVOCs from the sector come from Domestic solvent use including fungicides (2.D.3.a) and Coating applications (2.D.3.d). In both subcategories the consumption of relevant products has a positive correlation with GDP growth. On the other hand emission factors have decreased in the past, it is expected that the trend towards greater use of water-based paints will continue and emissions are projected to decrease until 2030 and afterwards in accordance with the NEC Directive (2016/2284/EU)[50] and Directive 2004/42/CE[51] on paints on limitation of VOCs in paints. Concerning Domestic solvent use (2.D.3.a) following regulations have an effect on reduction of NMVOCs in products: Regulation (EC) No 648/2004[52] on detergents (requirements on biodegradability, and ingredient lists), Regulation (EC) No 1223/2009[53] on cosmetic products (requirement of safety assessment and bans of certain hazardous components) and Regulation (EU) No 528/2012[54] concerning the making available on the market and use of biocidal products (imposing bans of certain hazardous components).

The paints directive has set limits until the year 2010 and other beforementioned regulations do not impose further restrictions. In the future decreases of emission factors may demand further legislative measures. The European Commission published a chemicals strategy for sustainability on 14 October 2020[55]. It is part of the EU's zero pollution ambition, which is a key commitment of the European Green Deal. The planned actions include: further bans of harmful chemicals in consumer products, account of the „cocktail effect" of chemicals when assessing risks, boosting the investment and innovative capacity for production and use of chemicals that are safe and sustainable by design, and throughout their life cycle. Specific new legislative measures could possibly be imposed on the basis of this chemicals strategy, that could also reduce NMVOC-s in consumer products.

Currently, there is only WEM=WAM scenario for emissions from Solvents sector.

9.2.3.2.AP emissions projections

Industrial processes

SO_2 emissions are marginal as the majority of these emissions come from burning fuels. SO_2 emissions in a magnitude 0.0003 kt yearly come from each of the following subsectors: Food and beverages industry

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Long-term GDP projection of the Ministry of Finance of Estonia [www] https://www.fin.ee/riigi-rahandus-ja-maksud/fiskaalpoliitika-ja-majandus/rahandusministeeriumi-majandusprognoos (03.03.23) 03.03.23)

[49] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (26.02.21)

[50] Directive (EU) 2016/2284 of the European Parliament and of 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 [www] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284 (03.03.23)

[51] Directive 2004/42/CE 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 [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0042 (03.03.23)

[52] Regulation (EC) No 648/2004 of the European Parliament and of the Council of 31 March 2004 on detergents [www] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32004R0648 (03.03.23)

[53] Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products [www] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32009R1223 (03.03.23)

[54] Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0528 (03.03.23)

[55] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Chemicals Strategy for Sustainability Towards a Toxic-Free Environment COM/2020/667 final [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A667%3AFIN (03.03.23)

(2.H.2), Quarrying and mining of minerals other than coal (2.A.5.a), Lead production (2.C.5) and Other metal production (2.C.7.c) in 2021–2050.

NO_x emissions are at a low level until 2050.

Approximately 40% of $PM_{2.5}$ emissions arise from construction and demolition (2.A.5.b) subsector. The rest of $PM_{2.5}$ emissions come mostly from Other metal production (2.C.7), Paper and pulp production (2.H.1) and Wood processing (2.I). Construction and demolition as well as other activities are in line with GDP growth. $PM_{2.5}$ emissions are projected to rise by 63% until 2050.

NMVOC emissions arise largely from Food and Beverages industry. Production of foodstuffs is in correlation with GDP growth and the emissions are projected to rise *ca* 29% until 2050.

NH_3 emissions arise from Other metal production (2.C.7.c) and also from Storage, handling and transport of chemical products (2.B.10.b).The forecast for 2050 is *ca* 2% lower than as in 2020.

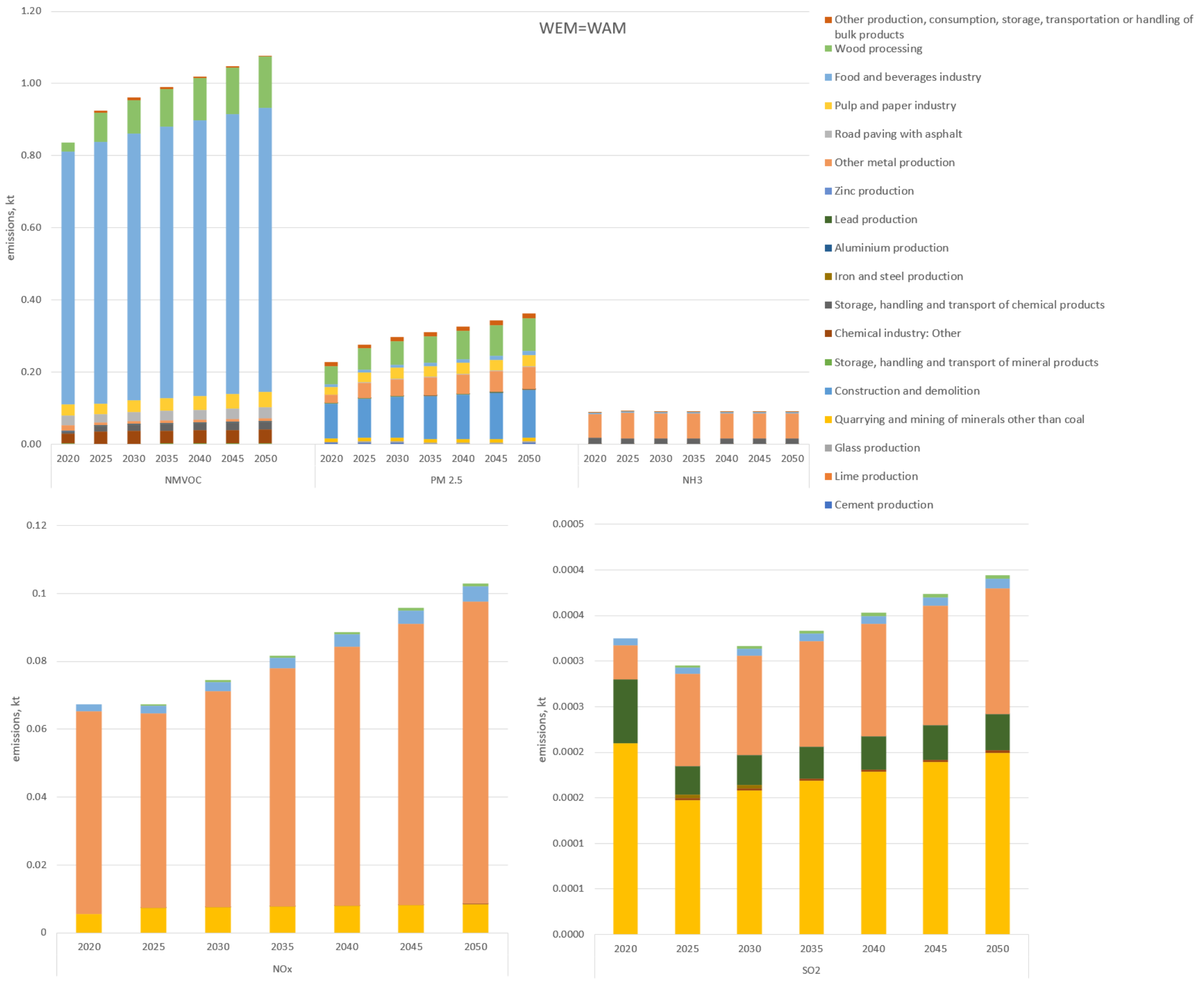

Figure 9.5 WEM=WAM projections from Industrial processes (including road paving with asphalt), kt

Emissions in the years 2021–2050 according WEM=WAM scenario are depicted in the Figure 9.5.

Solvent use

NMVOC emissions from Solvent and other product use are projected to stay at the same level until 2050. Although emission factors are projected to decrease until 2050 demand is rising. In 2050 the NMVOC emissions are projected to be 10.0% smaller than in 2018. In Degreasing (2.D.3.e) and Printing (2.D.3.h) subcategories emissions are only slightly rising until 2030 because the effect of Industrial Emissions Directive Directive 2010/75/EU[56] is curbing emission factors.

In the subcategory Other solvent use (2.D.3.i) most of the NMVOCs come from Application of glues and adhesives (SNAP 060405). This field of use is affected both from population as well from GDP growth. As population is declining but GDP growing, the emissions from this subcategory decrease little until 2030. After 2030 the emissions are projected to increase slightly. Industrial Emissions Directive 2010/75/EU is curbing the emission factors.

NMVOC emissions from Dry cleaning are decreasing 40% until 2050 because of downward trend since 2005.

Another activity with small NMVOC emissions in comparison to other activities is Other Product use 2.G (mainly use of tobacco and fireworks). These emissions do not correlate with GDP growth very well so they are projected to stay pretty much at the 2020 year´s level.

Concerning to other air pollutants their only noteworthy source is subcategory Other Product use 2.G (mainly use of tobacco and fireworks). The emissions of these pollutants probably stay at the same level because GDP growth does not seem to have a large effect on them.

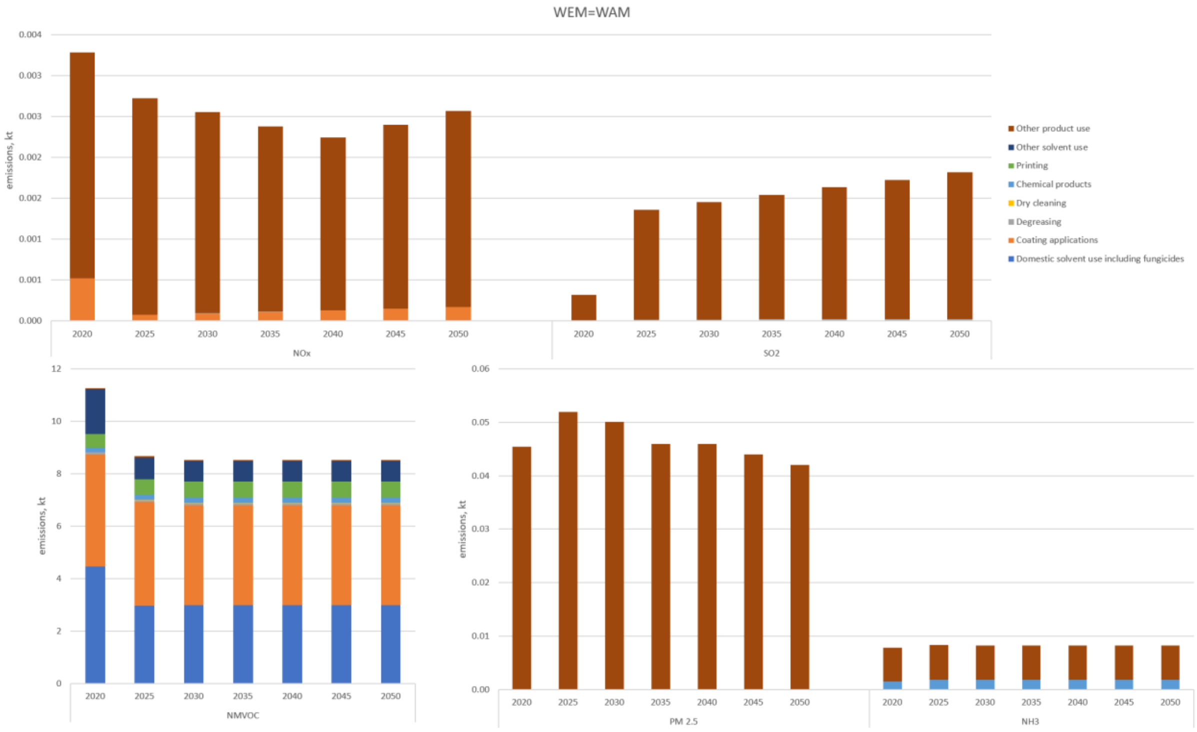

Figure 9.6 WEM=WAM projections from Solvent and other product use (excluding road paving with asphalt), kt

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[56] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010L0075 (03.03.23)

9.2.4. Agriculture

Development of the Agriculture sector and the implementation of various targeted measures are mostly governed by the **Common Agricultural Policy (CAP) Strategic Plan 2023– 2027** (approved 11.11.2022) and **Agriculture and fisheries development plan until 2030** (AFDP 2030) (MoRA, 2021). In addition, there are some measures from the **Estonian rural development plan 2014–2020** (ERDP 2014–2020) that are still applying as the funding for the implementation of the measures is in place until 2023 and/or 2024.

The CAP Strategic Plan 2023–2027 includes four specific objectives, that also contain climate-related actions:

1. Contribute to climate change mitigation and adaptation, including by reducing GHG emissions and enhancing carbon sequestration, as well as promoting sustainable energy. This specific objective includes the following identified needs:
    - To prefer environmentally sustainable production, investments, solutions based on the circular bioeconomy;
    - To increase carbon sequestration in soils and protect soil organic carbon stocks.
2. Foster sustainable development and efficient management of natural resources such as water, soil and air. This specific objective includes the following identified needs:
    - Continued support for land improvement investments;
    - Contribute to the use of agricultural practices that conserve surface and groundwater;
    - Neutralisation of acidic soils;
    - Encouraging the development and introduction of environmentally friendly technologies;
    - Development of environmental consulting;
    - Implementation of the requirements and measures resulting from the air pollutant emission reduction programme;
    - Maintenance of soil fertility.
3. Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes
4. Improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, food waste, as well as animal welfare. This specific objective includes the following identified needs:
    - Increasing organic production in organic agriculture by reducing the processing of organic products as conventional products;
    - Diversity of agricultural and garden (horticultural) crops, availability of varieties suitable for local conditions;
    - Increase livestock keepers' knowledge of livestock health and well-being in general.

As regards impact on the environment, the **Organic Farming Act** (2007) is important among the legislation regulating the agricultural sector, as it provides for the requirements for operating in the area of organic farming to the extent not regulated by the regulations of the EU, as well as for the grounds and extent of supervision exercised over persons operating in the area of organic farming, and for the liability for violation of the requirements established by such legislation. In addition, a number of secondary legislative acts have been issued on the basis of this act to regulate aspects of organic farming.

Actions to reduce nitrogen losses from agriculture, for example, based on the requirements of the *Nitrates Directive*, have led to reduced nitrogen emissions to the aquatic environment with indirect positive effects for the mitigation of climate gas emissions. The legislation which is relevant for the implementation of the *Nitrates Directive* is the *Water Act*, which was enacted in 1994 and has been revised since, especially in connection with the accession into the European Union. An updated *Code of Good Agricultural Practices* and a Government decree on water protection requirements for fertiliser, manure and silage (revised several times) were introduced. The **Water Act** (2019) is one of the principal legal acts that the prime measures in the *Estonian Water Management Plan measure programme 2015–2021* are grounded upon. Additional measures to promote water protection in agriculture are mainly based on the *ERDP* and its measures.

ERDP 2014–2020 measures that continue to contribute to WEM scenario AP emission reduction include:

1. **Agri-environment-climate measures with three sub-measures:**
   - Regional water protection support – The objectives are to prevent and reduce water nitrogen pollution to preserve the water quality by decreasing agricultural soil leaching.
   - Support for growing local plant varieties – The objective is to ensure the preservation of the local plant varieties valuable for cultural heritage and genetic diversity. The measure helps to preserve crop varieties more suitable for local conditions (more resistant to locally spread diseases and climate conditions) and therefore gives a good basis for developing new breeds and supports organic farming.
   - Support for keeping animals of local endangered breeds – The objective is to ensure the preservation of animal breeds that are endangered and considered important for cultural heritage and genetic diversity.
2. **Organic production** — The objectives of the measure are to develop organic production, increase the competitiveness of organic production, preserve and improve biodiversity and landscape diversity, preserve and enhance soil fertility and water quality, and develop animal welfare.
3. **Knowledge transfer and information actions** — The general objective of the measure is to develop and enhance the technical, economic and environmental knowledge of the enterprisers and their employees in the Agriculture, food and forest sector to improve the bioeconomy and adapt new challenges to use resources sustainably. The measure aims to promote the organisation of educational training, presentations, awareness-raising activities, organising workshops or visits to enterprises and long-term programmes.
4. **Advisory services, farm management and farm relief services** — The general objective of the measure is to enhance the sustainable management or effectiveness of agricultural holdings or enterprises by providing high-quality advisory services to people working in the agriculture sector. Advisory services include inter alia environmental and climatic topics by providing high-quality advisory services to the people working in the agriculture sector. Advisory services include inter alia environmental and climatic topics.

There are additional agriculture-related WEM measures from the CAP Strategic Plan 2023–2027 (approved 11.11.2022). These measures are similar to the measures implemented under ERDP 2014–2020. The CAP Strategic Plan contains important support activities and sectoral interventions affecting AP emissions which include:

1. **Eco-scheme for organic farming** – The support is granted to farmers who start conversion to organic farming and engage in organic farming. Support is granted on the basis of the area of their agricultural land under organic farming.
2. **Eco-scheme for ecological focus areas** – The support promotes the creation of non-productive areas and landscape features on arable land in order to contribute to biodiversity and mosaic landscapes.
3. **Support for maintenance of ecosystem services on agricultural land** – Intervention will support a diversified agricultural landscape, the preservation of landscape features and natural areas, with the aim of ensuring the natural enemies of arable land pests in providing natural pest management ecosystem services.
4. **Soil and water protection support** – In terms of soil protection, the aim of this intervention is to reduce carbon emissions and protect soil organic carbon stocks and peat soils. The highest

organic carbon emissions in agriculture occur from peat soils and cultivated peat soils have the highest organic carbon content and these soils are vulnerable to mineralisation. The aim of the intervention is to reduce the cultivation of peat soils and to promote the transfer of arable land under long-term grassland and vice versa, avoiding cultivation of arable crops instead of grassland.

5. **Support for the maintenance of valuable permanent grassland** – The aim of the intervention is to preserve permanent grasslands of a high biological value, where natural vegetation has been developed or preserved and thus the conditions for species richness are guaranteed. Support for the maintenance of valuable permanent grassland is intended for semi-natural grasslands located outside protected areas and permanent grassland intended by experts as valuable permanent grassland.
6. **Support for maintaining semi-natural grassland** – The aim of the intervention is to preserve semi-natural grasslands in Natura 2000 areas and thereby the richness of species on agricultural land. Semi-natural grasslands also play an important role in adapting to climate change and the sequestration of organic carbon into soils.
7. **Animal welfare support** – The overall objective of the intervention is to raise animal welfare awareness among livestock farmers and to support farmers who meet higher animal welfare standards and thereby improve animal welfare and health. In addition, the support helps to reduce the negative environmental impact of livestock farming on air and soil and to increase the number of animals grazed extensively in order to maintain grassland biodiversity without encouraging an increase in the total number of animals and stocking densities. The intervention shall support:
   - Environmentally friendly grazing of dairy cattle and horses;
   - Increased housing area per pig, feeding plans approved by a veterinarian, feed containing mycotoxin binders and/or acidifiers and the use of anaesthesia and analgesia in the case of castration of piglets;
   - Implementation of alternative systems in poultry farming, larger housing area per laying hen and quail.

5. **Support for the development of knowledge transfer and advisory services (AKIS)** — Coherent AKIS is important for the sustainable development of the Agriculture and food sector and helps to increase the competitiveness of companies in the sector, creating additional opportunities for the modernisation of agriculture and rural life, promoting and sharing knowledge, supporting innovation and digital transition, and encouraging their adoption.
6. **Support for Advisory Services** — This measure helps to increase awareness of the mutual impact of climate, climate changes and agriculture.
7. The **Cover crops** requirement is targeting arable land and land under permanent crops that shall be at least 50% under winter vegetation cover. 'Winter vegetation cover' means crops on arable land from 1 November to 31 March, including catch crops, stubble and plant remnants. By way of exception, the requirement for winter vegetation cover is 30% for horticultural producers. This measure was proposed by a study to find cost-effective mitigation measures.
8. **Environmentally friendly management** — This measure has sub-measures such as cultivation of catch crops and neutralization of acid soils. The aim of the neutralization of acid soils measure is to neutralize the acid soils to achieve the optimal conditions for the plant growth. As a result, the loss of agricultural land in use can be avoided and the soil carbon pool will be increased. The objective is to support practices that help reduce pressure on surface water, groundwater and human health and contribute to the preservation and enhancement of biodiversity.
9. **Investments in exploitation of bioresources** — The intervention is aimed at contributing to providing higher economic added value to bio-resources, increasing R & D and innovation capacity

Audits in large agricultural holdings — The objective of the measure is to develop an auditing system of nitrogen, phosphorus and CO_2 for large agricultural holdings and to give resulting improvement recommendations, thereafter. The measure would cover the development of methodology, training of the audit team and conducting the audits.

Studies and pilot projects — The studies and pilot projects would enable to evaluate the effect of different agricultural practices and technologies on climate more precisely and to develop country-specific emission factors. This is a prerequisite for the effective development and implementation of several agricultural and EU Common Agricultural Policy´s measures.

Replacing mineral fertilizers with organic fertilizers —

The WAM scenario includes one measure contributing to reducing AP emissions. **Improvement of manure management**. CO_2 reduction potential of this measure is reflected by significantly lower CH_4 emissions from covered storages compared to uncovered storages with a natural crust. Furthermore, more accurate reductions in AP emissions need to be explored through research and pilot projects.

9.2.4.1. Methodology

Two projections scenarios of air pollutant emissions have been calculated for the period 2021–2050. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020). The 'With Existing Measures' (WEM) scenario evaluates future AP trends under current policies and measures. In the second scenario a number of additional measures and their impact are taken into consideration, forming the basis of the 'With Additional Measures' (WAM) scenario.

Three components that influences WAM scenario emission calculations compared to WEM scenario is projected increased use of lower emission manure collection technologies in the livestock buildings, increasing the share of covering liquid manure storages and low-emission manure spreading technologies (e.g. injection of liquid manure) (Analysis of possibilities raising Estonia´s climate ambition, Government Environment and Climate Commission).

The fourth component – an assumption that has been projected into future and used in WAM calculations differently from WEM calculations is limiting of ammonia emissions from the use of mineral fertilisers by enhancing the share of rapid introduction of the fertilisers into the soil. This may be related to the measure Support for site-specific fertilization equipment.

The Tier 1 and Tier 2 methods of the EMEP/EEA Guidebook 2019[57] have been used in the projections concerning atmospheric pollutants. Tier 3 method is used for calculating NH_3 emissions from cattle and swine manure management, manure applied to soils and for finding emissions from urine and dung deposited by grazing animals by dairy- and non-dairy cattle and swine categories. These calculations show in WAM scenario the impact of the measure Improvement of manure management. In agricultural soils category the NH3 emissions from the application of synthetic N-fertilizers are also calculated with Tier 3 method as it uses in WAM scenario calculations the assumption of enhancing the share of rapid introduction of the fertilisers into the soil. The calculations are based on the 2020 and 2021 inventories of atmospheric pollutants

The projected numbers of animals have been mostly received from the expert judgements of the officials of the Ministry of Rural Affairs. Also, projected amounts of mineral fertilizers used have been received from the Ministry of Rural Affairs. The use of synthetic fertilizers in Estonia is projected to increase until 2030 compared to 2020 and then to stay at stable level. Global demand for meat- and dairy products along with

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[57] EMEP/EEA air pollutant emission inventory guidebook 2019. Part B: sectoral guidance chapters, 3.B Manure management 2019 and 3.D Crop production and agricultural soils 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (26.02.21).

suitable climatic conditions favour cattle production in Estonia to expand. With the supporting mechanisms of Common Agricultural Policy raising sheep and goats may be presumed to grow moderately. Demand after lamb and goat meat, wool and milk will grow. The number of horses is projected to continue to rise. The population of fur animals is expected to stay at the last three years average level. It is expected that the number of pigs will decrease slightly and will remain at the same level starting from 2030. The number of poultry production is expected to stay near today´s level. Average milk yield per cow should increase until 2030 and its projected values are in accordance with projections in GPCP 2050. The share of manure management systems is assumed to stay at present level in the future.

9.2.4.2. AP emissions projections

AP projections were made using both, WEM (Figure 9.7) and WAM (Figure 9.8) scenarios. The difference in the results of the two scenarios was due to the projected changes in the shares of the use of manure removal technologies with lower emissions, covers of the manure stores, injector spreading of liquid manure and manure and synthetic N-fertilizers applying methods. Thus, NH_3 emissions from Manure management and Agricultural soils were reduced in WAM scenario compared to WEM scenario.

According to the WEM scenario NH_3 emissions in Agriculture sector are projected to increase 4.3%, i.e. from 8.71kt to 9.09 kt between 2020 and 2050 and WAM scenario 3.0% i.e. from 8,71k t to 8.97 kt between 2020 and 2050. $PM_{2.5}$ emissions are projected to increase from 0.108 kt in 2020 to 0.113 kt by 2050 (4.8%) in Agriculture sector according to WAM and WEM scenarios. NMVOC emissions are projected to increase from 4.75 kt in 2020 to 5.01 kt by 2050 (5.6%) in Agriculture sector according to WAM and WEM scenarios. Projections of emissions from the Agriculture sector include NO_x emissions from the Manure management and Agricultural soils category NO_x emissions are projected to increase from 2.53 kt to 2.59 kt (2.6 %) between 2020 and 2050 according to WAM and WEM scenarios.

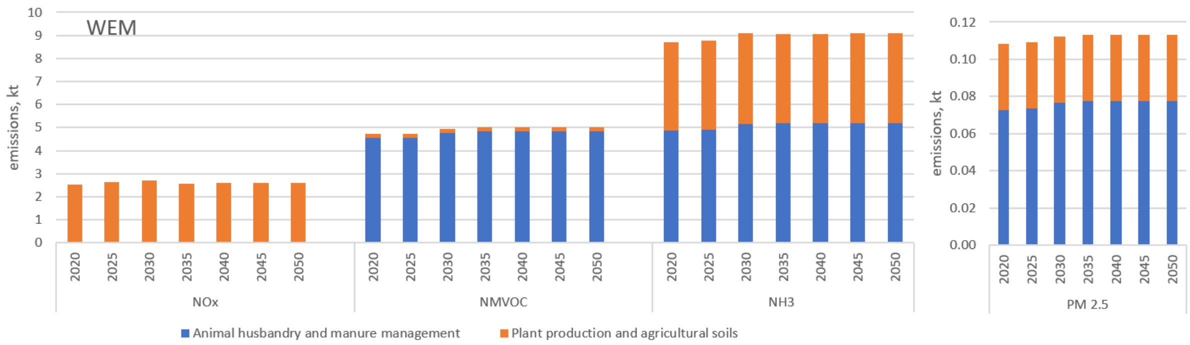

Figure 9.7 AP emissions from Agriculture sector according to WEM scenario, kt

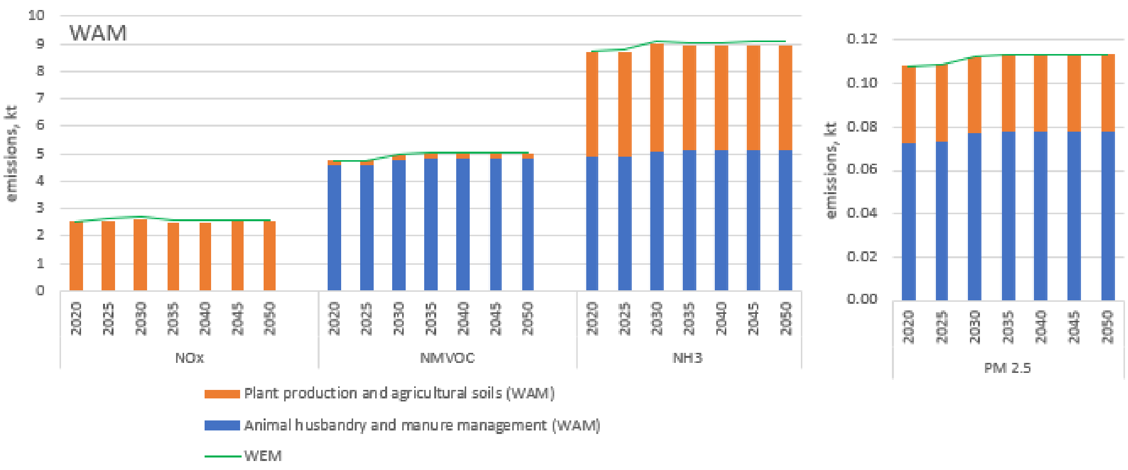

Figure 9.8 AP emissions from Agriculture sector according to WAM scenario, kt

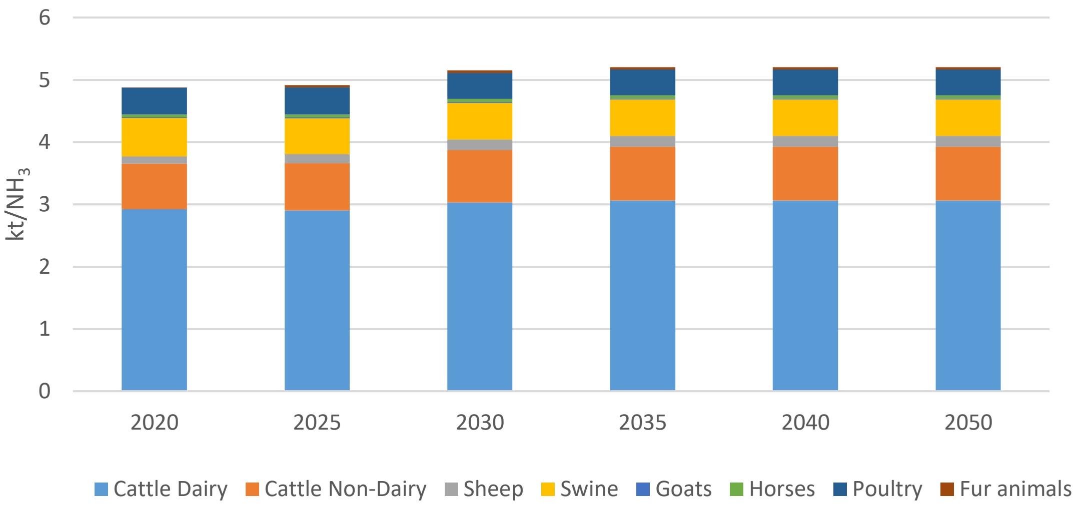

Figure 9.9 NH_3 emissions from Manure management subcategories according to WEM scenario, kt

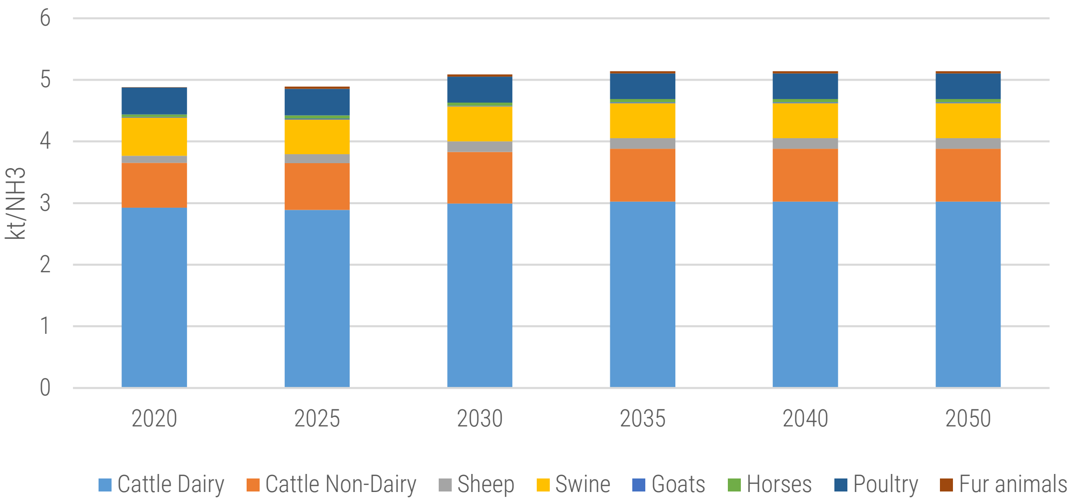

Figure 9.10 NH_3 emissions from Manure management subcategories according to WAM scenario, kt

9.2.5. Waste

The **Waste Act** (2004) provides waste management requirements for preventing waste generation and the health and environmental hazards arising from waste, including measures for improving the efficiency of the use of natural resources and reducing the adverse impacts of such use and progressive reduction of landfilling of waste that is suitable for recycling or other recovery. The act also includes organisation of waste management including bases and extent of state supervision.

In the beginning of 2021, the Minister of the Environment initiated the preparation of the National Waste Plan 2022– 2028 (NWP 2022-2028) (MoC, 2022b) which will be finalised in the first quarter of 2023. The vision for the NWP 2022– 2028 is avoiding waste generation. Products are reused and repaired, generated waste is collected separately which is part of everyday behaviour. The vision is supported by a user-friendly, efficient, transparent and functioning innovative waste management system based on the waste hierarchy. Also, new value is created from waste as raw material.

NWP 2022–2028 is based on three strategic goals:

1. sustainable, conscious production and consumption promotion of waste prevention and re-use;
2. increasing safe material circulation;
3. consideration of the effects of waste management on both the human and natural environment as a whole.

In the waste sector, the main measures having an effect on AP emissions that are already in place include:

1. **Limiting the percentage of biodegradable waste going to landfill and increasing the reuse and recycling of waste materials** – The focus of the measure is to increase the volume of recycling of municipal waste, including increasing the recycling of biodegradable waste and reducing the share of biodegradable waste in landfilling, also developing a nationwide waste collection network with a more efficient reporting information system. Consistent guidance on recycling and preparation for re-use of waste and an expanding and simple waste management system will help to increase the amount of waste collected separately and reduce the proportion of biodegradable waste in landfills.

2. **Promoting the prevention and reduction of waste generated, including the environmentally sound management of waste** – The general objective of the measure is to improve the resource efficiency of the Estonian economy and to promote waste prevention in order to reduce the negative effects on the environment and human health. The state supports waste prevention by disseminating information. Various initiatives will be used to implement the measure, environmental management measures will be implemented, additional studies will be carried out, investments will be made and the necessary legislation will be supplemented.

3. **Reducing environmental risks arising from waste, improvement of monitoring and supervision** – The general objective of the measure is to supplement the range of methods used for the management of hazardous waste and to reduce the environmental risks associated with waste disposal. Closed landfills must be properly managed. Strengthening the monitoring of waste management will help reduce illegal dumping.

4. **Enhancing safe circular material use rate** – In order to increase the recycling of different materials and the use of secondary raw materials, we promote the adoption of sustainable production and consumption models. Resource efficiency, including energy efficiency, must be improved in companies, for example by supporting industrial symbiosis, digitalisation and more resource-efficient technologies. Waste management is reorganised based on the waste hierarchy, adopting innovative solutions to reduce waste generation, increase material recycling and ensure the separate collection of waste.

The Circular Economy White Paper (MoC, 2022c) brings together the vision of the ministries and interest groups, the principles of the circular economy and the directions of circular economy development, which are the basis for future activities. The document supports various parties to make the circular economy an overarching framework in planning, consumption, production, politics, lifestyle, culture and values. In the future, the circular economy activity plan includes the activities and metrics of various fields which are highlighted.

9.2.5.1. Methodology

The 'With Existing Measures' (WEM) projections scenario includes air pollutant emission projections for the period 2021–2050 under current policies and measures. The reference year 2020 used in projections is consistent with Estonia's 2022 submission to the CLRTAP on 15th of March 2022 (Estonian Informative Inventory Report 1990–2020). As there are no additional measures currently planned, than the 'With Additional Measures' (WAM) scenario equals to WEM.

Air pollutant emissions in WEM=WAM scenario in Waste sector are mostly based on the NWP measure implementation. Greenhouse gas (GHG) projections activity data projection output (e.g. the amount of waste generated, landfilled, recycled, composted, etc) was used when compiling air pollutant emission projections for keeping the consistency between GHG and AP emission projections. Using this type of harmonization was useful because waste sector air emission inventory is based on the information provided by the companies and many of them do not make long-term forecasts. Projections are based on the NWP measures and activity data growth in line with the appropriate basic indicators e.g. population and GDP.

In Estonia, Open burning of waste is not a common practice for eliminating waste, as open burning of MSW is considered an illegal activity and is forbidden. To include it in the air pollutant emission calculations, An MoC expert judgement indicates that in 1990–2003, 2% of MSW was open burned, in 2004-2014 1% of MSW was open burned and starting from 2015, the amount of open burned waste decreased to 0.5% and is decreasing onward. The change in the open burning percentage is connected to the development of an organised waste collection system. As the activity is forbidden and no studies have been carried out on the specific composition of MSW burned, MoC's expert judgement was given about the open burning of MSW (mix of fractions). Without any available studies, it is currently impossible to define which type of waste is most used for open burning or eliminate any waste fractions.

9.2.5.2. AP emissions projections

Waste sector is not Estonia´s major source of emissions and WEM scenario emissions equal to WAM scenari emissions (see Figure 9.11).

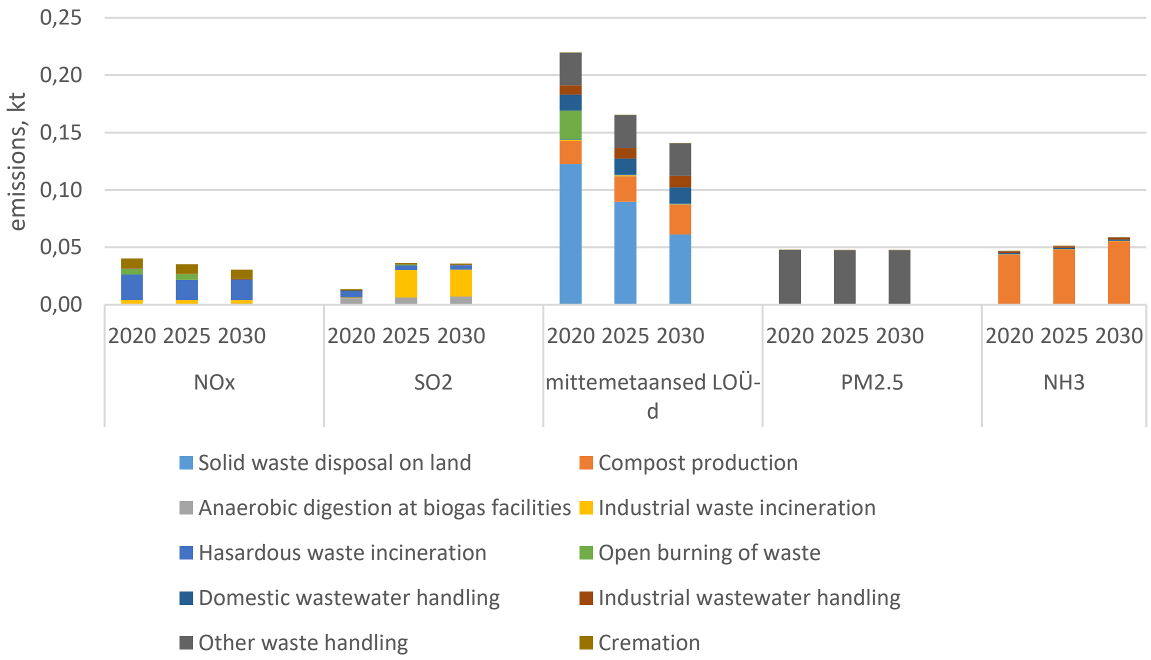

Figure 9.11 WEM = WAM emission projections in Waste sector, kt

NO_x emission projections is driven by industrial waste incineration category which is connected with GDP rise. Emission decrease in 2030 is connected with the assumptions that illegal open burning of MSW will stop.

SO_2 emission projections is driven by industrial waste incineration subcategory which is connected with GDP rise.

NMVOC emission projections are driven by solid waste disposal, compost and domestic wastewater handling categories. Solid waste disposal emissions are in decreasing trend thanks to the implemented waste reduction measures. Projections in wastewater other waste handling categories are relatively stable however as the amount of biodegradable waste composted is increasing than the share of emissions are also increasing.

$PM_{2.5}$ emission projections are driven by other waste handling and open burning of waste categories. Open burning of waste emissions are in decreasing trend thanks to the implemented waste reduction measures. iIllegal open burning of MSW will stop and other waste handling is projected to remain at the same level.

NH_3 emission projections is driven by compost category wihich is in increasing trend due to the increase of composting biodegradable waste.

9.3. Total projected AP emissions

Estonia's total projected AP emissions in the WEM and WAM scenario (excluding voluntary projections of NO_x emissions in the Agriculture sector) are presented in Figure 9.12. The overall main driver for decreasing AP projections is Energy industries subsector, due to the phasing out of oil shale pulverized combustion and using more renewable energy (wind and sun) by electricity producers. For NH_3, the main driver is Agriculture sector and increasing number on livestock (additional clarification are provided under each sectoral subchapters),

- NO_x – in 2020–2050, emissions are projected to decrease by 44.1% in WEM scenarios and 51.7% in WAM scenario. This estimate takes into account NO_x emissions form Agriculture sector.
- NMVOC – in 2020–2050, emissions are projected to decrease by 22.1% in WEM scenario and 24.2% in WAM scenario. This estimate takes into account NMVOC emissions form Agriculture sector.
- SO_2 – in 2020–2050, emissions are projected to decrease by 81.1% in WEM scenario and 90.3% in WAM scenario.
- NH_3 – in 2020–2050, emissions are projected to increase by 0.3% in WEM scenario and decrease by 1.0% in WAM scenario.
- $PM_{2.5}$ – in 2020–2050, emissions are projected to decrease by 67.4% in WEM scenario and 71.3 % in WAM scenario.

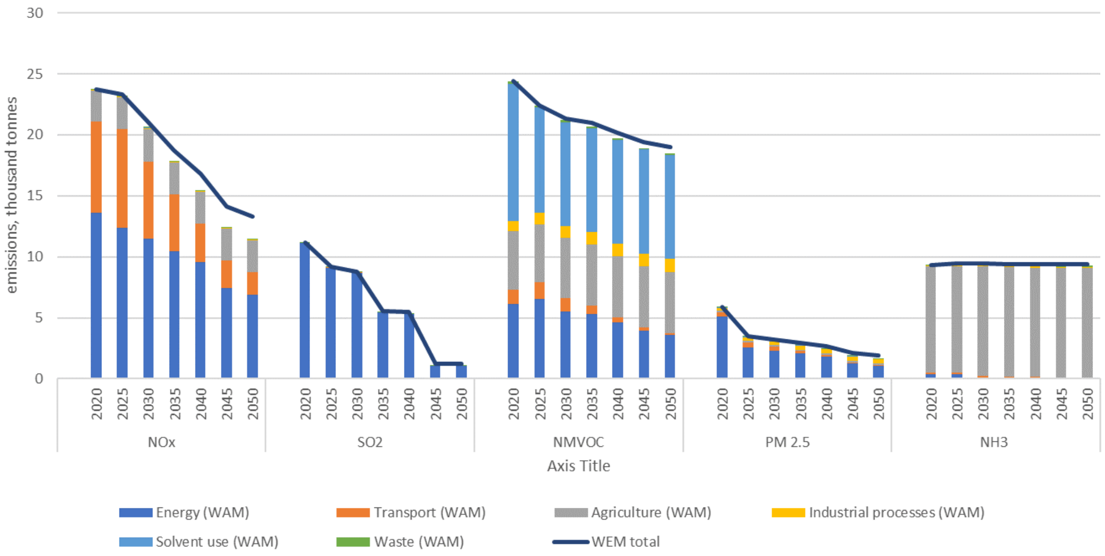

Figure 9.12 Sectoral WEM and total WAM scenario air pollutant emissions (excluding NO_x emissions projections from Agriculture sector) 2018–2050, kt

9.4. Explanations of circumstances justifying emissions that are temporarily higher than the ceilings established for it for one or more pollutants

The NEC Directive[58], which is part of the European Clean Air Policy Package, provides for the commitments of all Member States to reduce atmospheric pollutant emissions by 2020 and 2030 compared to 2005 (Table 9.2). As the 2020 commitments have already been met, than the comparison is done only for 2030.

Estonia's total projected NEC compliant AP emissions (i.e excluding NO$_x$ and NMVOC emissions from Agriculture sector) and % change compared to 2005 according to projections in the WEM and WAM scenario are presented in Table 9.2. Projections in the WEM and WAM scenario compared to NEC Directive commitments in Figure 9.13.

Table 9.2. Commitments to reduce emissions of certain atmospheric pollutants established by the NEC Directive for Estonia and % change compared to 2005 according to projections WAM scenario

Pollutant	WEM		WAM	
	Reduction target 2030	% change in 2030	Reduction target 2030	% change in 2030
NO$_x$	-30%	-55%	-30%	-78%
NMVOC	-28%	-40%	-28%	-51%
SO$_2$	-68%	-89%	-68%	-99%
NH$_3$	-1%	0.07%	-1%	-2%
PM$_{2.5}$	-41%	-68%	-41%	-83%

According to current projections, in WEM scenario, only NH$_3$ reduction commitment will not be complied. According to projections (compared to base year 2005), the 2030 target is exceeded by 0.07%. The reason for exceeding NH$_3$ emissions is connected with the increasing number of livestock. In addition, milk production of dairy cattle and the use of mineral fertilizers are projected to increase compared to 2005. The emission reduction for NH$_3$ according to the WAM scenario is projected as the result of implementing the ´Improvement of manure management´ measure in Agriculture sector which would enable to reduce projected NH$_3$ emissions 2% in 2030, compared to 2005.

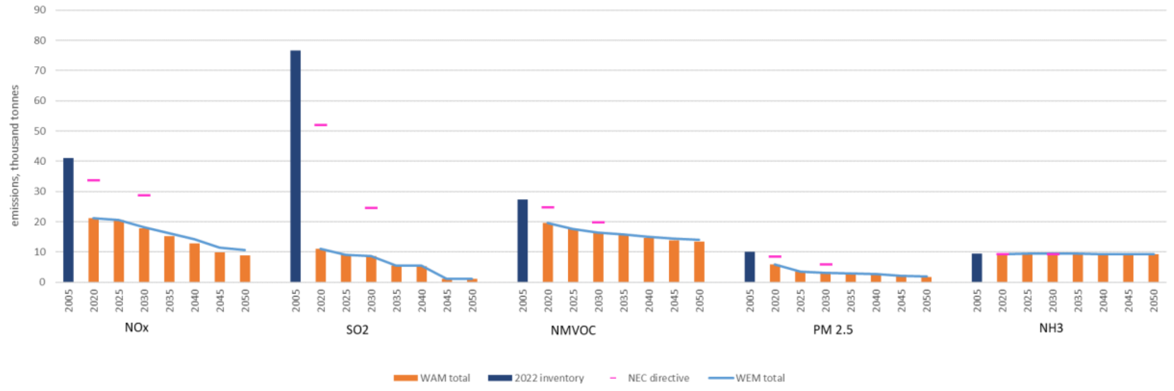

Figure 9.13 Total projected WEM and WAM scenario NEC compliant air pollutant emissions (i.e. excluding NO$_x$ and NMVOC emissions form Agriculture sector) in 2018–2050 and NEC Directive reduction targets in 2030, kt

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[58] Directive (EU) 2016/2284 of the European Parliament and of 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 [www] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284 (26.02.21)

Source: HDQ Cover Backgrounds. Kimiko Reece

10.REPORTING OF GRIDDED EMISSIONS AND LPS

10.1. Overview of the Gridded Emissions

10.1.1. Description of Gridded Emissions

The updated GRID emissions for 2019 for each GNFR (aggregated sectors) were submitted on 3 May 2021. Emissions data are disaggregated to the extended EMEP grid with a with the resolution of 0.1° x 0.1° long-lat. The previous gridded emissions reported in 2017 followed the old EMEP grid resolution of 50 km × 50 km.

Table 10.1 lists the aggregated sectors used for reporting emissions data and pollutants on grid, based on the Estonian air pollutants emission inventory.

Table 10.1 Activities and emissions reported for GRID data

GNFR	Emissions reported
A_PublicPower	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
B_Industry	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
C_OtherStationaryComb	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
D_Fugitive	NOx, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb
E_Solvents	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb, Cd, Hg, PCDD/F, PAHs
F_RoadTransport	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
G_Shipping	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, PCB
H_Aviation	NO_x, NMVOC, SO_x, PM_{10}, $PM_{2.5}$, BC, TSP, CO
I_Offroad	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
J_Waste	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
K_AgriLivestock	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, TSP
L_AgriOther	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, TSP
M_Other	NO

10.1.2. Methodological Issues

The disaggregation of emissions is similar to Estonia's emissions inventory structure where data pertaining to the point sources and diffuse sources.

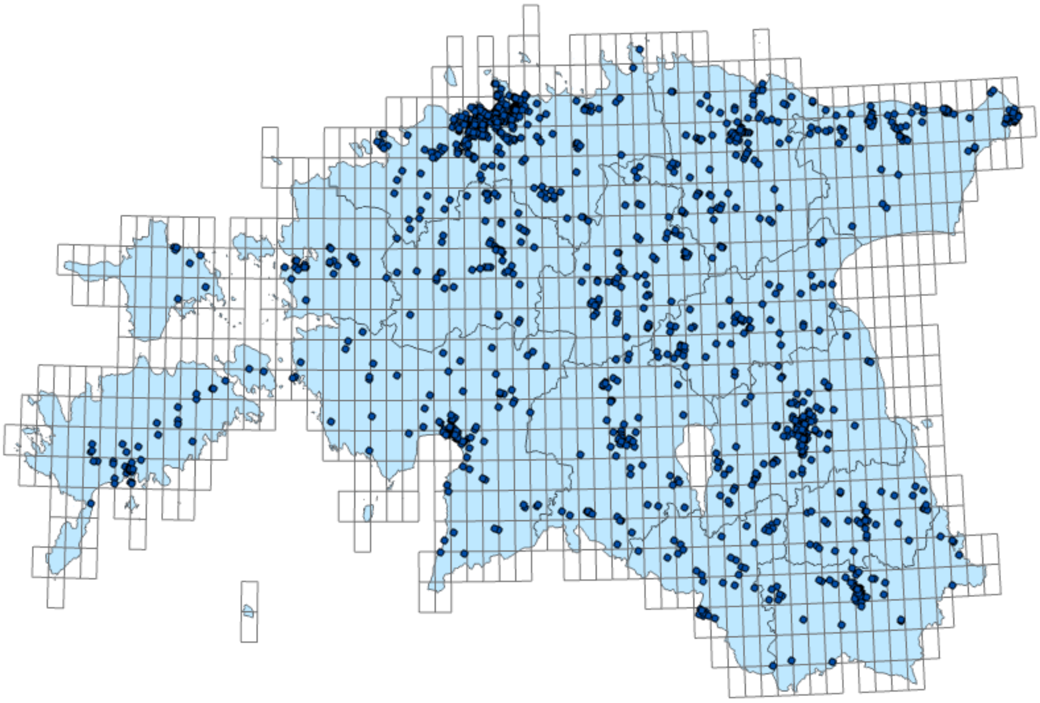

Figure 10.1 Point Sources distribution used for gridded emissions in 2019

The NFR-toolbox in the ArcGIS program where used to distribute spatially national emission on the grid in 0.1 x 0.1 degrees. LPS data for 1990, 1995, 2000, 2005, 2010, 2015 and 2019 and point sources data for 2019 were allocated directly to the grid by using their X and Y coordinates. The diffuse data were distributed by using different statistical and geographical data (e.g. road map, map on distribution of population etc.) from different institutions (see Table 10.2).

Table 10.2 Distribution of Point and Diffuse Sources by aggregated sectors

NFR	Description	
A_PublicPower	Point and diffuse sources	Distributions of point sources data; production data, enterprises location and capital data from business register; distribution of population; fuel consumptions etc.
B_Industry	Point and diffuse sources	Distributions of point sources data; buildings locations and type data from buildings registry; distribution of population; fuel consumptions, production data, enterprises location and capital data from business register etc.
C_OtherStationaryComb	Point and diffuse sources	Distributions of point sources data; buildings locations and type data from buildings registry; distribution of population; fuel consumptions etc.
D_Fugitive	Point and diffuse sources	Distributions of point sources data; petrol and natural gas distribution etc.
E_Solvents	Point and diffuse sources	Population density; distributions of point sources data; production data, enterprises location and capital data from business register etc.
F_RoadTransport	Diffuse sources	Road map with the traffic density of different types of road transport etc.
G_Shipping	Diffuse sources	Ais data
H_Aviation	Emissions by Airports	Emissions by Airports
I_Offroad	Diffuse sources	Number of vehicles by county; the length of the railway; agricultural parcels locations etc.
J_Waste	Point and diffuse sources	Distributions of point sources data; number of fires by locations, amounts of landfilled waste by landfill etc.
K_AgriLivestock	Diffuse sources	Farms and parcels location data from agricultural support and agricultural Parcels register; livestock data etc.
L_AgriOther	Diffuse sources	Farms and parcels location data from Agricultural Support and Agricultural Parcels register etc.

10.1.3. Planned Improvements

For the 2022 submission, Estonia is planning to report disaggregated air pollutant emissions on the new EMEP grid with the resolution of 0.1° x 0.1° long-lat from previous years where it is possible. Also Estonia is planning to obtain different additional data that is needed for the distribution of historical national emissions.

10.2. Overview of the Large Point Sources (LPS)

10.2.1. Description of LPS emissions

The emissions data from the Large Point Sources are presented for the years 1990, 1995, 2000, 2005, 2010, 2015 and 2019 by GNFR (aggregated sectors) codes in NFR 2014-1 format and submitted into EIONET's Central Data Repository on 27 April 2021.

Data for 1990-2000 contain emissions of all facilities that exceed the threshold values in accordance with the requirements of the Guidelines for Reporting Emissions based on thresholds specified in annex II to the E-PRTR Regulation.

For identification of LPS for the period from 2005 to 2019, the principle of E-PRTR activities and pollutant emission thresholds in accordance with the requirements of annex I and II of the E-PRTR Regulation has originally been used. This was the main reason in the difference of the facilities number and emissions between the 2017 and 2021 reports. The reasons for the data difference and recalculations are given in chapter 10.2.2.

All E-PRTR facilities are required to submit annual reports on ambient air pollution. The reports contain information on the parameters of each sources of pollution, on the amount of emissions by source and by the facility as a whole. It also provides data on combustion plants with an indication of the capacities, the amount of fuel used, electricity and heat production; data about solvent used, liquid fuel distribution, livestock and other data.

The more detail description of data collection system from facilities is presented in the Chapter 1.3 "The process of Inventory Preparation" of the Estonian Informative Inventory Report 1990-2019.

Table 10.3 present the number of LPS in 2019 by GNFR sectors and reported pollutants. Each LPS emission has been aggregated by GNFR sectors and stack height classes. In case, if the total emission of the facility exceeded the applicable threshold value and the facility has different activities or stack height classes, then the data is submitted on each activity or stack class separately, regardless of a threshold.

Figure 10.2 and Table 10.4 shows the number of LPS for the period 1990-2019.

Table 10.3 Activities and pollutants Under LPS in 2019

GNFR	Emissions reported	Number of LPS facilities	Height class
A_PublicPower	NO_x, SO_x, NMVOC, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, PCDD/F, PCB	10	1,2,3,4,5
B_Industry	NO_x, SO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, CO, PCDD/F	8	1,2,3,4
C_OtherStationaryComb	SO_x	1	1
D_Fugitive	NO_x, SO_x, NMVOC, NH_3, PM_{10}, CO	4	1,2
K_AgriLivestock	NH_3	26	1
L_AgriOther	NH_3	7	1
J_Waste	NH_3, PCDD/F	2	1

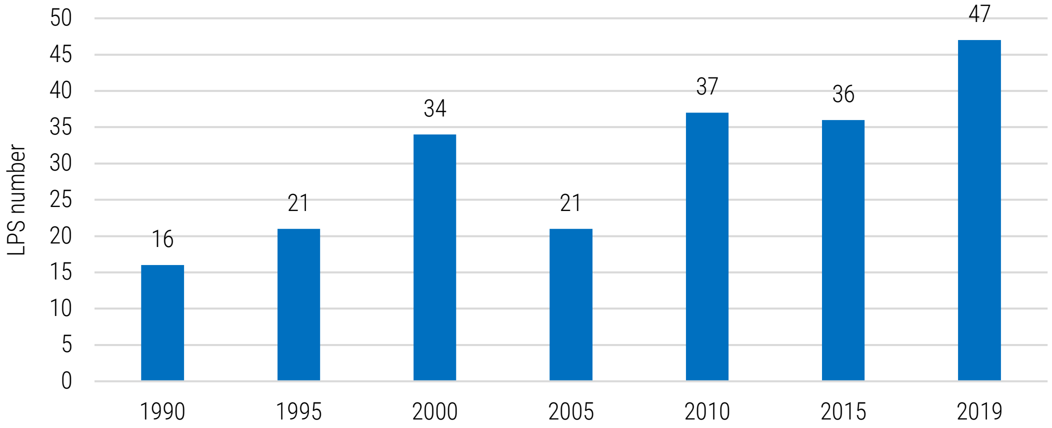

Figure 10.2 The number of large point sources in the period of 1990-2019

Table 10.4 The number of LPSs by GNFR sectors in the period of 1990-2019

GNFR	1990	1995	2000	2005	2010	2015	2019
A_PublicPower	6	7	9	7	7	9	10
B_Industry	10	11	19	9	6	8	8
C_OtherStationaryComb			2				1
D_Fugitive		1	4	3	5	3	4
E_Solvents		2	2	2			
K_AgriLivestock				1	17	17	26
L_AgriOther					9	15	7
J_Waste			1	1	1	1	2

During the period of 1990–2019, the number of LPS facilities had increased from 16 to 47 (see Figure 10.2). The main reason is that since 2007, agricultural facilities that have an integrated emission permit or have exceeded the national ammonia emission threshold are required to report emissions. For example, in 2019, out of 47 facilities, 26 are agricultural (see Table 10.4). That also explains the growth of ammonia emissions from the LPSs (see Table 10.5).

As can be seen on the Figure 10.3, the share of only four pollutants from LPS exceeds 50% of the total emission: SO_2 – 71.5%, Pb – 84%, Cd – 58%, Hg – 78% (main contributors are oil shale power plants). The main sources of particulates, NO_x and PCB emissions also oil shale PP. The share of other substances from LPS is not so significant.

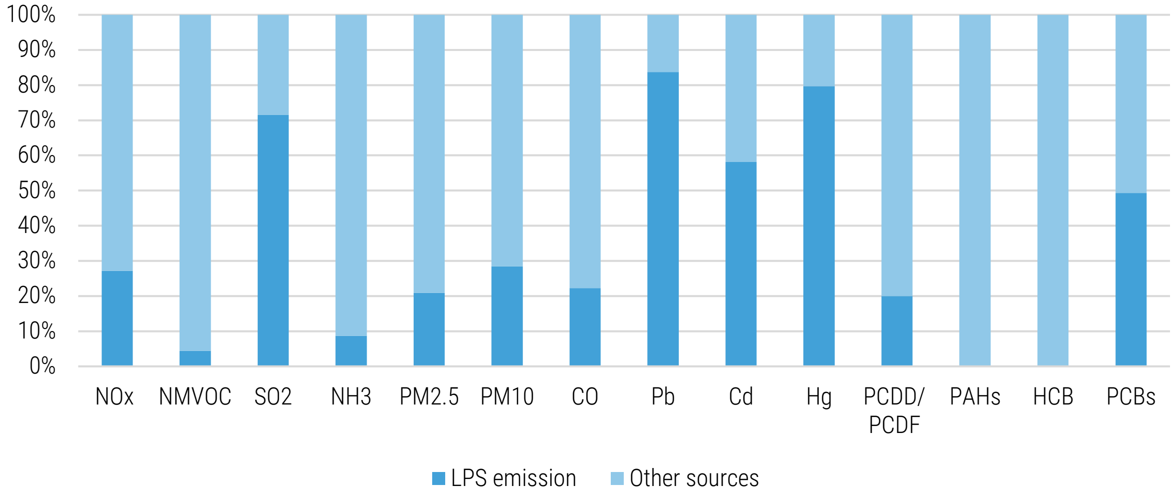

Figure 10.3 The contribution of LPS emissions in 2019 total emission

Figures 10.4-5 and Tables 10.6-7 illustrate the contribution of LPS emissions inside A_PublicPower and B_IndustrialCombustion sectors and into total emissions. For other sectors the LPS contribution in total emissions is not so significant.

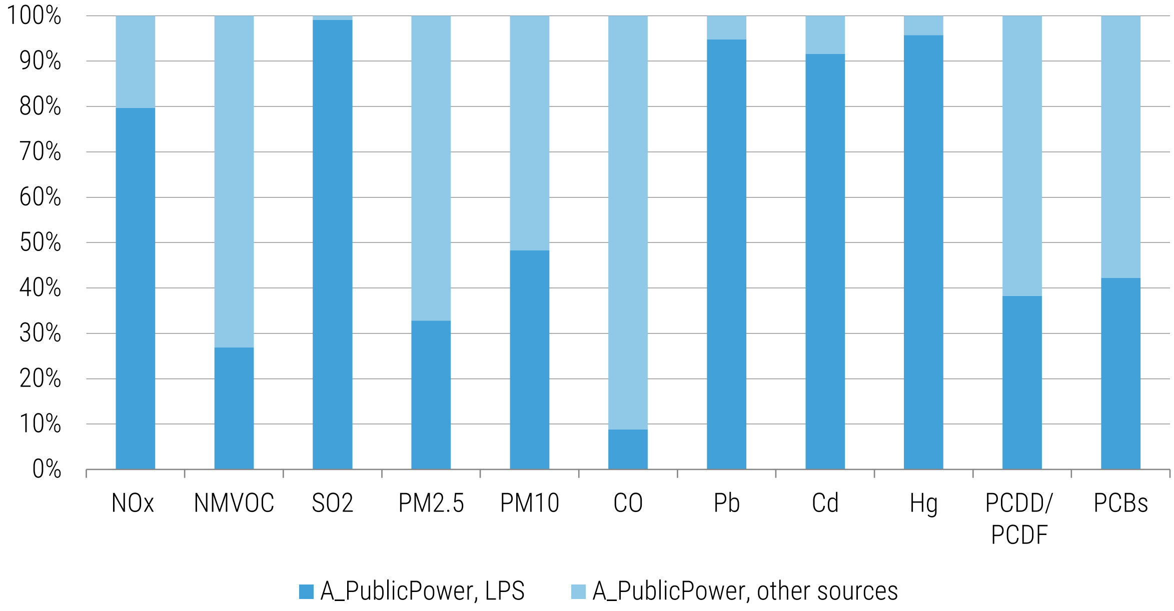

Figure 10.4 The contribution of LPS emissions in 2019 into A_PublicPower sector

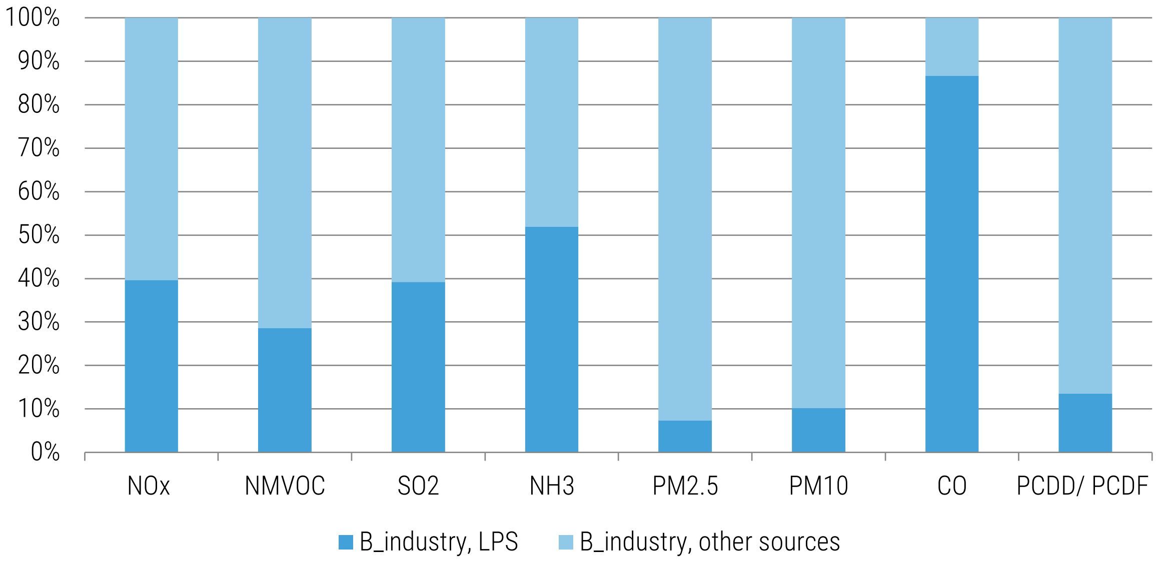

Figure 10.5 The contribution of LPS emissions in 2019 into B_IndustrialCombustion sector

It should be noted that during the period 1990-2019, the main large point sources, such as oil shale power plants, shale oil, cement, pulp and paper production factories, continued their operations. Emissions of all substances (excepted NH_3, CO and PCDD) are significantly dropped (see Table 10.5, Figures 10.6-8), mainly due to the reduction in energy production and also introduction of new technologies at oil shale power plants and a renovation of clearing installations in cement production. The detailed description can be found in the Pollutants Emission Trends and Energy Sector Chapters of IIR.

Emission of carbon monoxide has increased about 3 times since 1990 mainly due to the increase in shale oil production plants. The increase in ammonia emissions is due to the addition of agricultural enterprises to the list of LPS since 2010. An increase in the share of biomass burned has led to an increase in dioxin emissions.

Table 10.5 Pollutant emissions from LPSs in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
	kt							t			g I-Teq	kg
1990	19.000	14.412	202.713	0.529	NR	NR	10.151	120.877	4.194	1.054	0.716	0.930
1995	11.348	4.794	94.52	0.099	NR	NR	10.705	56.034	1.817	0.547	0.251	0.486
2000	12.510	4.046	87.447	0.092	5.229	19.704	9.668	28.436	0.482	0.457	0.000	0.431
2005	11.073	1.128	61.886	0.240	2.391	6.42	12.874	29.770	0.484	0.484	0.122	0.472
2010	14.138	0.450	71.800	0.560	5.178	11.365	20.878	35.508	0.592	0.592	0.542	0.594
2015	8.324	0.965	25.792	0.896	1.996	4.122	28.637	25.690	0.478	0.478	0.952	0.317
2019	5.468	0.814	14.116	1.016	0.503	1.110	37.300	6.500	0.201	0.199	1.069	0.142
Trend 1990-2019, %	-71.2	-94.3	-93.0	92.0	-90.4	-94.4	267.5	-94.6	-95.2	-81.1	49.3	-84.7

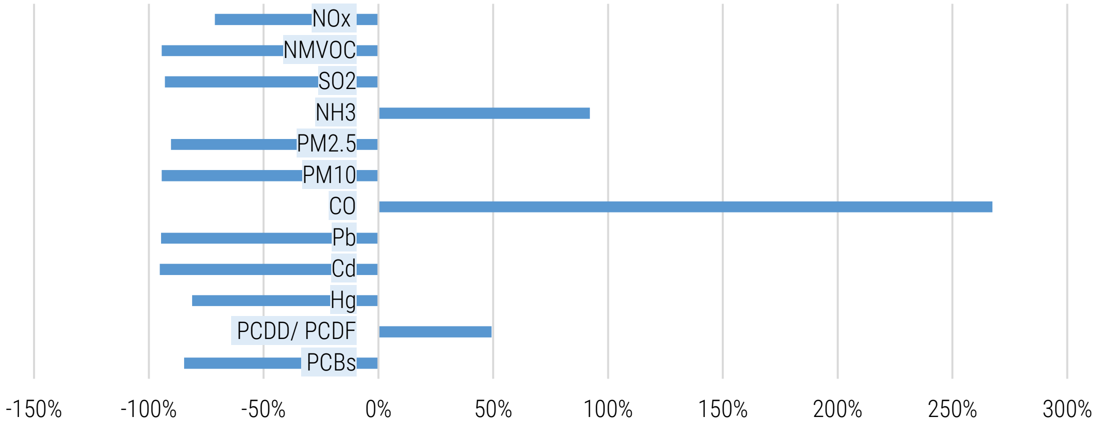

Figure 10.6 Change in pollutants emissions from LPS in the period 1990-2019

Table 10.6 LPS emissions from GNFR A_PublicPower in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
				kt					t		g I-Teq	kg
1990	17.542	NA	187.265	NA	NR	NR	1.211	59.135	0.985	0.985	0.153	0.930
1995	10.606	0.111	83.233	NA	NR	NR	1.039	31.042	0.517	0.517	NA	0.486
2000	10.438	NA	76.136	NA	3.968	16.992	NA	27.953	0.457	0.457	NA	0.431
2005	10.232	NA	59.088	NA	1.838	5.505	NA	29.770	0.484	0.484	NA	0.472
2010	13.238	NA	72.011	NA	5.127	11.353	NA	35.958	0.592	0.592	0.221	0.594
2015	7.795	0.103	24.395	NA	1.844	3.961	NA	25.690	0.478	0.478	0.229	0.317
2019	4.598	0.119	11.152	NA	0.379	0.780	0.558	6.500	0.201	0.199	0.484	0.142
Total 2019 A_PublicPower sector emission	5.767	0.441	11.249	0.218	1.153	1.614	6.354	6.855	0.220	0.208	1.264	0.337
Share in 2019 total A_PublicPower sector emission, %	79.7	26.9	99.1	0.0	32.8	48.3	8.8	94.8	91.6	95.7	38.3	42.2
Total 2019 emission	25.164	22.694	18.884	10.594	5.880	9.237	130.800	11.374	0.552	0.327	4.584	0.438
Share in total 2019 emission, %	18.3	0.5	59.1	0.0	6.4	8.4	0.4	57.1	36.5	60.8	10.5	32.5
Trend 1990-2019, %	-73.8		-94.0		-90.5	-95.4	-53.9	-89.0	-79.6	-79.8	215.3	-84.7

Table 10.7 LPS emissions from GNFR B_Industry in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
				kt					t		g I-Teq	kg
1990	1.458	14.412	15.448	0.529	NR	NR	8.940	61.742	3.209	0.069	0.563	NA
1995	0.742	3.851	11.287	0.099	NR	NR	9.666	24.992	1.3	0.030	0.251	NA
2000	1.962	0.680	10.531	0.092	1.261	2.712	9.668	0.483	0.025	NA	NA	NA
2005	0.841	0.235	2.798	0.172	0.553	0.915	12.874	NA	NA	NA	NA	NA
2010	1.080	0.000	1.610	0.052	0.402	0.767	20.878	NA	NA	NA	NA	NA
2015	0.529	0.741	1.397	0.264	0.152	0.160	28.625	NA	NA	NA	NA	NA
2019	0.869	0.596	2.714	0.304	0.124	0.326	36.737	NA	NA	NA	0.140	NA
Total 2019 B_Industry sector emission	2.189	2.085	6.914	0.584	1.683	3.188	42.374	0.686	0.019	0.017	1.033	0.061
Share in 2019 total B_Industry sector emission, %	39.7	28.6	39.3	52.0	7.4	10.2	86.7	0.0	0.0	0.0	13.5	0.0
Total 2019 emission	25.164	22.694	18.884	10.594	5.880	9.237	130.800	11.374	0.552	0.327	4.584	0.438

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
				kt					t		g I-Teq	kg
Share in total 2019 emission, %	3.5	2.6	14.4	2.9	2.1	3.5	28.1	0.0	0.0	0.0	3.1	0.0
Trend 1990-2019, %	-40.4	-95.9	-82.4	-42.6	-90.2	-88.0	310.9	-100.0	-100.0	-100.0	-75.1	

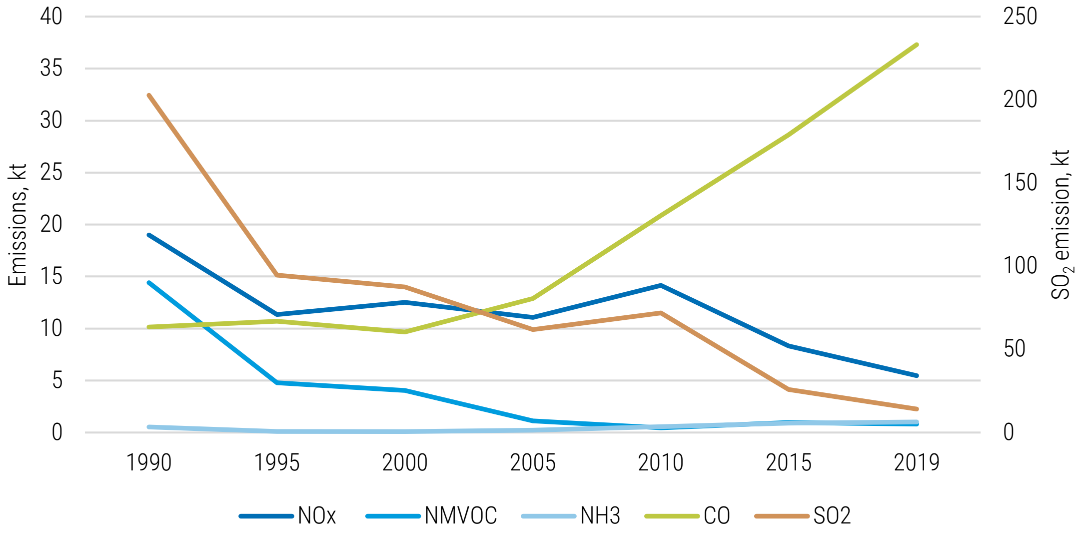

Figure 10.7 Main pollutant emissions from LPS in the period of 1990-2019

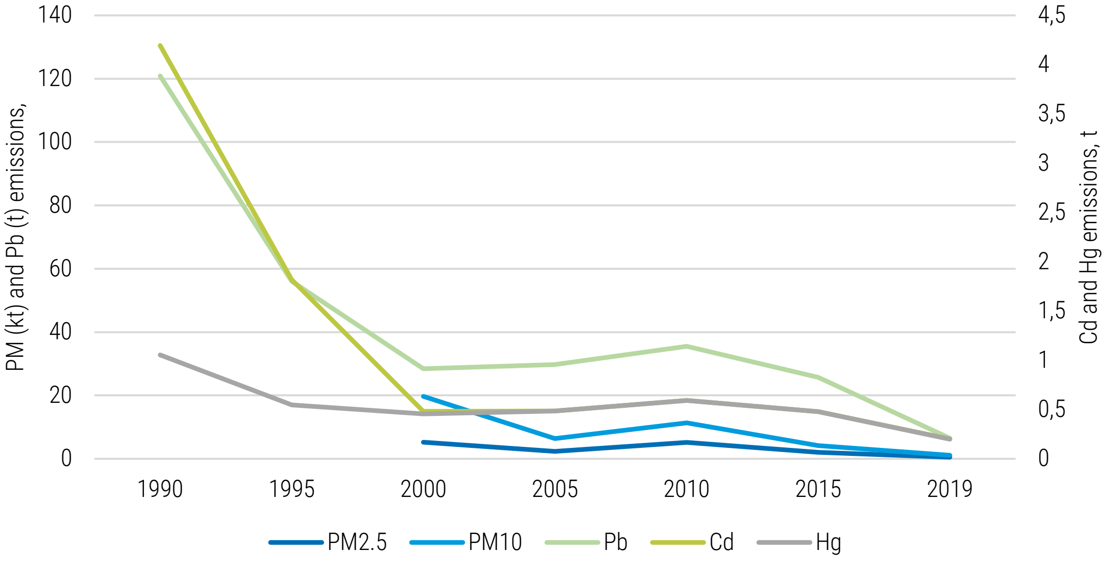

Figure 10.8 Pollutant emissions from LPS in the period of 1990-2019

10.2.2. Methodological Issues

The methods for emissions estimation are indicated in the relevant parts of the IIR, as well as in the E-PRTR reports. To estimate emissions, enterprises use various methods in accordance with the requirements of the pollution permits - measurement data, combined calculation methods, national methodologies. The operator can also calculate emissions through the use of other available methods, though this should be approved by the Environmental Board (regulated by the Atmospheric Air Protection Act). The operator shall indicate the method of emission calculation.

Emissions reported in the tables of Annex_VI for each facility are based on facility data, excluding POPs from fuel combustion, which have been recalculated in this year submission (Chapter 8.1.1). The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2 (chapter 6.5.2 – for the industrial and clinical waste incineration). Only dioxin emissions from cement production facility present by operator on the base of measurement. Also, some operators provide data only on TSP and in this case the emissions of fine particles are calculated by the experts of the inventory team.

10.2.3. Recalculations

As already noted in part 10.2.1, the number of facilities and emissions for the period from 1990 to 2000 is identical in both, 2017 and 2021 submissions.

In comparison with the previous submission for the period from 2005 to 2019, the principle of E-PRTR activities and pollutant emission thresholds in accordance with the requirements of annex I and II of the E-PRTR Regulation has originally been used. This was the main reason in the difference of the facilities number and emissions between the 2017 and 2021 reports (see Figure 10.9).

The second reason for the inconsistency of the 2015 data is the recalculation of NO_x, SO_2 and fine particulates emissions for 3 oil shale power plants and one municipal waste incineration plant, which used the validated average measurements values to calculate emissions. A detailed description is given in Chapter 8.1.1. of “Estonia IIR 2019”. However, despite a 20% increase in SO_2 emissions from oil shale stations, emissions decreased by about 14%, which was the result of the exclusion from the lists of two combustion plants burning shale gas, the capacity of which is less than 50 MWth, but the total SO_2 emission is more than 8 thousand tons.

The differences in the large point sources emissions data between the 2017 and 2021 submissions are presented in Tables 10.8-10.10. The largest impact on the change in ammonia emissions had the exclusion from the list of LPS non-Annex 1 agriculture facilities (cattle farms).

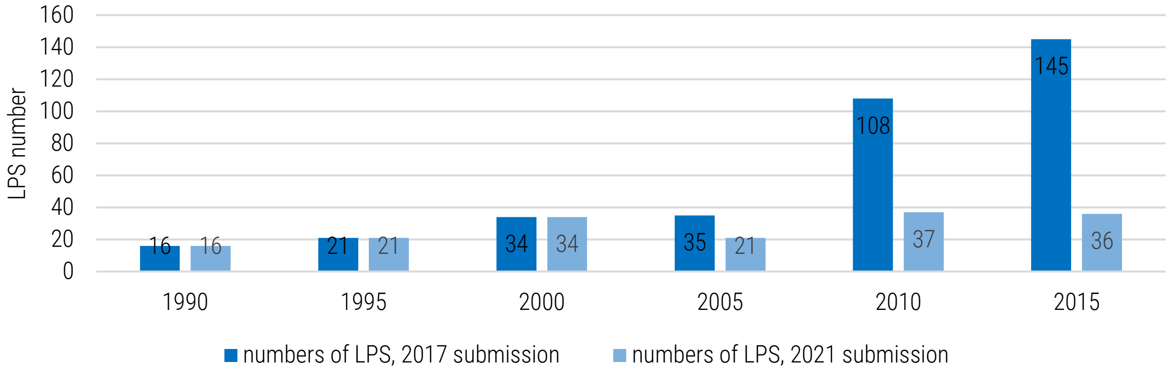

Figure 10.9 The differents in number of LPS in 2017 and 2021 submission

In comparison with the 2017 submission, also POPs emissions from the combustion activities have been recalculated (Chapter 8.1.1 2021 IIR)

Table 10.8 The differences in the LPS main pollutants emissions (kt) for 1990-2015 between 2017 and 2021 submissions

Year	NO_x			NMVOC			SO_x			NH_3			CO		
	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%
1990	19.000	19.000	0.0	14.412	14.412	0.0	202.713	202.713	0.0	0.529	0.529	0.0	10.570	10.570	0.0
1995	11.348	11.348	0.0	4.794	4.794	0.0	94.520	94.520	0.0	0.099	0.099	0.0	10.705	10.705	0.0
2000	12.510	12.510	0.0	4.046	4.046	0.0	87.447	87.447	0.0	0.092	0.092	0.0	9.668	9.668	0.0
2005	11.222	11.073	-1.3	4.763	1.128	-76.3	71.242	61.886	-13.1	0.316	0.240	-24.1	13.611	12.874	-5.4
2010	14.318	14.318	0.0	1.176	0.450	-61.7	80.578	73.622	-8.6	2.279	0.560	-75.4	20.878	20.878	0.0
2015	6.974	8.377	20.1	1.835	0.965	-47.4	29.937	25.792	-13.8	3.742	0.896	-76.1	28.637	28.637	0.0

Table 10.9 The differences in the LPS particulates (kt) and heavy metals (t) emissions for 1990-2015 between 2017 and 2021 submissions

Year	$PM_{2.5}$			PM_{10}			Pb			Cd			Hg		
	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%
1990	NR	NR		NR	NR		120.977	120.977	0.0	4.194	4.194	0.0	1.054	1.054	0.0
1995	NR	NR		NR	NR		56.162	56.162	0.0	1.817	1.817	0.0	0.547	0.547	0.0
2000	5.229	5.229	0.0	19.704	19.704	0.0	28.436	28.436	0.0	0.482	0.482	0.0	0.457	0.457	0.0
2005	2.861	2.391	-16.4	7.247	6.420	-11.4	30.043	29.770	-0.9	0.484	0.484	0.0	0.484	0.484	0.0
2010	5.960	5.530	-7.2	12.687	12.120	-4.5	35.977	35.977	0.0	0.592	0.592	0.0	0.593	0.592	-0.2
2015	1.392	1.996	43.4	2.881	4.122	43.1	25.690	25.690	0.0	0.478	0.478	0.0	0.478	0.478	0.0

Table 10.10 The differences in the LPS POPs emissions for 1990-2015 between 2017 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			HCB, kg			PCB, kg		
	2017	2021	%	2017	2021	%	2017	2021	%
1990	NE	0.716	100.0	NE	NA		NE	0.930	100.0
1995	NE	0.251	100.0	NE	NA		NE	0.486	100.0
2000	NE	NA		NE	NA		NE	0.431	100.0
2005	NE	0.122	100.0	NE	NA		NE	0.472	100.0
2010	0.017	0.542	3,156.4	NE	NA		NE	0.594	100.0
2015	0.424	0.952	124.7	0.012	0.000	-100.0	NE	0.317	100.0