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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

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

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

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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

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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 1990-2024 was submitted on 13th February 2026.

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 2023. The reasons for the recalculations are specified in The status of recalculations in the 2026 submission Table 0.1.

Table 0.1 The status of recalculations in the 2026 submission

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1c	Manufacture of solid fuels and other energy industries	Correction of emission factors	NO_x, NMVOC, TSP CO	2023
1A4bi	Residential: Stationary	Correction of activity data	NO_x, NMVOC , SO_x, NH_3, TSP, $PM_{2.5}$, PM_{10}, CO, Cd, Pb, Hg, As, Cr, Cu, Ni, Se, Zn, HCB, PCDD/F, PCB	2023
1A3bi	Road transport: Passenger cars	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, TSP, CO, Pb, Zn, PCDD/F, PAHs	1990-1994, 1997, 1999-2017
			NH_3,	1990-1991, 1994, 1997, 1999-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
			Cd	1990, 2012
			Hg	1990-1991, 1993, 1999-2017
			As	1990, 2004, 2014-2017
			Cr	1990-1991, 1994, 1997, 2000-2017
			Cu	1990-1991, 1993-1994, 1997, 1999-2017
			Ni	1990, 1994, 2000, 2002, 2004, 2012-2016
			Se	1990, 2012, 2014-2016
			HCB	1990, 1999, 2001, 2003-2005, 2007-2017
			PCBs	1990-1991, 2008-2017
1A3bii	Road transport: Light duty vehicles	Correction of activity data and emission factors	NO_x, NMVOC , SO_x, NH_3, TSP, CO, Pb, PCDD/F	1990-1994, 1997, 1999-2017
			NMVOC	2002-2022
			$PM_{2.5}$, PM_{10}, BC	2000-2017
			Cd	1990, 2011-2012, 2014-2016
			Hg	1990, 2012, 2015-2017
			As	1990, 2006-2007, 2009-2010, 2013, 2015-2017
			Cr	1990, 2002-2017

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
			Cu	1990, 2002, 2005-2017
			Ni	1990, 2009-2017
			Se	1990, 2009-2010, 2013, 2015-2017
			Zn	1990-1992, 2001, 2004-2017
			PAHs	1990-1993, 1997, 1999-2017
			HCB	1990, 2006-2017
			PCBs	1990, 2014-2016
1A3biii	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, TSP, CO, Pb, Zn, PCDD/F, PAHs	1990-1994, 1997, 1999-2017
			NH_3,	1990-1994, 1999-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
			Cd	1990, 2010, 2013-2014
			Hg	1990-1991, 1993, 1999-2017
			As	1990, 2008-2010, 2012-2013, 2016-2017
			Cr	1990-1993, 1999-2017
			Cu	1990, 2000-2017
			Ni	1990, 1993, 1997, 2000, 2007-2013, 2015-2017
			Se	1990, 2000, 2010-2013, 2017
			HCB	1990, 2007-2017
			PCBs	1990, 2010, 2013-2016
1A3biv	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NO_x, NMVOC, CO	1990-1994, 1997, 1999-2017
			SO_x	1990, 1993-1994, 1997, 1999-2005, 2008-2017
			NH_3	1990, 1992, 2001, 2005, 2007-2016
			$PM_{2.5}$, PM_{10},	2000-2017
			TSP	1990, 1997, 1999-2017
			BC	2000, 2003, 2007-2017
			Pb	1990-1994, 1997, 1999-2013
			Cd, As, Ni, Se	1990-1994, 1997, 1999-2007, 2009-2017
			Hg	1990, 2008, 2011-2016
			Cr	1990, 2008, 2010-2015
			Cu	1990, 2007, 2013-2015
			Zn	1990, 2002, 2005, 2007-2017
			PCDD/F	1990, 1992-1994, 1999-2017
			PAHs	1990, 2004, 2007-2017
			HCB	1990-1994, 1997, 1999-2007, 2009-2017

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
			PCBs	1990-1994, 1997, 2000-2001, 2003-2017
1A3bv	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NMVOC	1990, 1992, 2017
1A3bvi	Road transport: Automobile tyre and brake wear	Correction of activity data and emission factors	$PM_{2.5}$, PM_{10}, BC	2000-2001, 2003-2008, 2010-2014, 2022
			TSP, Pb, Cd, As, Cu, Ni, Se, Zn, PAHs	1990, 1997, 2000-2001, 2003-2008, 2010-2014, 2022
1A3bvii	Road transport: Automobile road abrasion	Correction of activity data and emission factors	$PM_{2.5}$, PM_{10}, BC	2022
			TSP	1990, 1997, 2022
1A3c	Railways	Correction of EF	NO_x, NMVOC, CO, Cd, PAHs	1990-1994, 1997, 1999, 2001, 2004-2008, 2010-2014, 2017
			SO_x,	1991, 2010, 2014, 2017
			NH_3	2017
			$PM_{2.5}$, PM_{10}, BC	2001, 2004-2008, 2010-2014, 2017
			TSP	1990-1994, 1997, 1999, 2001, 2004-2008, 2010-2014, 2017
			Cd, Se	1990-1993, 1997, 1999, 2001, 2017
			Hg	1990-1994, 1997, 1999, 2001
			Cr	1990-1994, 1997, 1999, 2017
			Cu	1990-1994, 1997, 1999, 2010, 2017
			Ni	1990-1991, 1999, 2004, 2010, 2017
			Zn	2001
			PCDD/F, HCB	1997
			PAHs	1990-1994, 1997, 1999, 2001, 2004-2008, 2010-2011, 2013, 2017
			PCBs	1992-1993, 1999
1B1c	Other fugitive emissions from solid fuels	Correction of activity data	NO_x, SO_x, NH_3, TSP, $PM_{2.5}$, PM_{10}	2023
2H2	Food and drink production	Correction of emissions data	SO_2, NH_3	2023
2C1	Iron and steel production	Correction of emissions data	PCDD/F	2020
2C3	Aluminium production	Correction of emissions data	$PM_{2.5}$, PM_{10}, TSP, PCDD/F, HCB	2023
2D3a	Domestic solvent use including fungicides	Corrections of activity data	NMVOC	2022-2023
2D3d	Coating applications	Corrections of activity data	NMVOC	2020-2023
2D3g	Chemical products	Correction of facilities pollutants emission	NMVOC	2023
2G	Other product use	Corrections of activity data	NMVOC, Cd, Cr, Cu, Ni, Se, Zn,	1990-2023
			CO	1994
			Pb	1999; 2007-2023
3B1b	Manure management - Non-dairy cattle	Update of activity data	NMVOC, NOx, NH_3 $PM_{2.5}$, PM_{10}, TSP	1990-2023
3Da1	Synthetic N-fertilizers		NH_3	1990-2023
3Da2a	Animal manure applied to soils	Update of activity data	NO_x, NH_3	1990-2023
3Da2c	Other organic fertilisers applied to soils (including compost)	Corrections of activity data	NO_x, NH_3	2022-2023

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NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
3Da3	Urine and dung deposited by grazing animals	Update of activity data	NO_x, NH_3	1990-2023
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Correction of calculation	$PM_{2.5}$, PM_{10}, TSP	1990-2023
3De	Cultivated crops	Correction of emission	NMVOC	2004
5A	Solid waste disposal on land	Corrections of activity data	NMVOC	1990-2023
5C1bv	Cremation	Corrections of activity data	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Se, PCDD/F, P(b)f, b(k)f, I(1,2,3-cd)p, HCB, PCB,	2021-2023
			Ni	2003; 2021-2023
			Zn	2008; 2021-2023
			B(a)p, PAH-4	2017; 2021-2023

Detailed sector by sector explanations concerning the recalculations are presented in Chapter 8.1.

The differences in total emissions between the 2025 and 2026 submissions are presented in the Table 0.2.

Table 0.2 Difference between the 2025 and 2026 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
1990	-0.53	-0.05	0.00	2.91	NR	NR	-0.01	NR	-0.17	0.06	0.01	0.00
1991	-0.56	-0.07	0.00	4.22	NR	NR	-0.01	NR	-0.25	0.06	0.01	0.00
1992	-0.60	-0.01	0.00	4.07	NR	NR	-0.02	NR	-0.11	0.05	0.01	0.00
1993	-0.72	-0.03	0.00	8.31	NR	NR	-0.02	NR	-0.17	0.06	0.01	0.00
1994	-0.66	-0.13	0.00	5.30	NR	NR	-0.01	NR	-0.43	0.07	0.01	0.00
1995	-0.69	-0.06	0.00	6.25	NR	NR	-0.02	NR	-0.20	0.09	0.01	0.00
1996	-0.67	-0.14	0.00	7.64	NR	NR	-0.04	NR	-0.40	0.12	0.02	0.00
1997	-0.63	-0.32	0.00	3.09	NR	NR	-0.04	NR	-0.19	0.19	0.03	0.00
1998	-0.81	-0.32	0.00	5.32	NR	NR	-0.05	NR	-0.21	0.22	0.03	0.00
1999	-0.97	-0.06	0.00	3.56	NR	NR	-0.05	NR	-0.23	0.23	0.04	0.00
2000	-0.97	-0.09	0.00	1.70	-0.03	-0.07	-0.05	-0.05	-0.31	0.26	0.04	0.00
2001	-0.85	-0.13	0.00	1.12	-0.04	-0.07	-0.06	-0.05	-0.35	0.35	0.05	0.00
2002	-1.02	-0.12	0.00	1.54	-0.04	-0.06	-0.07	-0.06	-0.37	0.38	0.05	0.00
2003	-0.88	-0.09	0.00	-1.01	-0.03	-0.07	-0.08	-0.06	-0.30	0.54	0.05	0.00
2004	-0.87	-0.30	0.00	0.21	-0.05	-0.31	-0.20	-0.06	-0.37	0.70	0.05	0.00
2005	-0.99	-0.11	0.00	2.28	-0.05	-0.32	-0.24	-0.08	-0.38	1.04	0.06	0.00
2006	-0.83	0.01	0.00	0.15	0.06	-0.22	-0.16	0.05	-0.13	1.77	0.10	0.00
2007	-0.34	0.19	0.00	1.27	0.09	-0.13	-0.10	0.20	0.26	1.37	0.10	0.00
2008	0.07	0.38	0.00	0.70	0.04	-0.29	-0.25	0.31	0.64	1.93	0.13	0.00
2009	-0.10	0.45	0.00	1.39	0.19	-0.16	-0.12	0.35	0.68	2.26	0.14	0.00
2010	-0.29	0.45	0.00	0.60	0.12	-0.10	-0.10	0.41	0.64	1.75	0.13	0.00
2011	0.12	0.45	0.00	2.16	0.13	0.00	0.00	0.52	0.83	1.41	0.14	0.00
2012	0.42	0.53	0.00	5.33	0.36	0.01	0.02	0.80	0.98	2.69	0.18	0.00
2013	0.61	0.51	0.00	0.05	0.27	-0.04	-0.04	0.95	1.08	2.57	0.17	0.00
2014	-0.43	0.97	0.00	-0.25	1.37	0.95	1.24	1.31	1.38	3.51	0.25	0.00
2015	-0.67	-0.02	0.00	-0.42	1.03	0.69	0.85	0.49	0.11	4.57	0.26	0.00
2016	-0.55	-0.06	0.00	-0.36	0.63	0.16	0.27	0.55	0.11	4.60	0.28	0.00
2017	0.10	0.36	0.00	-0.18	0.72	0.25	0.35	0.72	0.69	4.70	0.28	0.00
2018	0.27	0.36	0.00	-0.05	0.84	0.26	0.37	0.85	0.60	5.09	0.30	0.00
2019	-0.10	0.19	0.00	1.12	0.80	0.16	0.27	0.66	0.40	5.96	0.35	0.00
2020	0.29	0.24	0.00	1.72	3.26	2.42	2.54	0.85	0.33	6.90	0.37	0.00
2021	0.24	0.33	0.00	1.48	0.80	0.03	0.09	0.81	0.52	7.37	0.44	-0.17
2022	1.20	0.73	-0.01	1.98	1.11	5.05	3.05	0.99	1.24	6.98	0.41	0.18
2023	1.98	0.82	0.00	2.34	0.45	0.71	0.34	1.18	1.34	7.84	0.42	0.56

Table 0.2 continues

Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
1990	0.01	0.26	6.26	0.02	0.00	0.15	0.00	0.00	10.23	0.00
1991	0.01	0.27	6.52	0.02	0.00	0.16	0.00	0.00	10.49	0.00
1992	0.00	0.17	5.21	0.02	0.00	0.10	0.00	0.00	9.95	0.00
1993	0.01	0.24	6.38	0.02	0.00	0.14	0.00	0.00	11.43	0.00
1994	0.01	0.32	7.13	0.03	0.00	0.17	0.00	0.00	8.99	0.00
1995	0.01	0.31	7.38	0.04	0.00	0.17	0.00	0.00	7.44	0.00
1996	0.01	0.31	7.82	0.04	0.00	0.18	0.00	0.00	6.68	0.00
1997	0.01	0.35	8.24	0.04	0.01	0.20	0.00	0.00	6.48	0.00
1998	0.01	0.39	8.56	0.05	0.01	0.23	-0.01	0.00	7.28	0.00
1999	0.01	0.41	8.41	0.05	0.01	0.24	-0.01	0.00	7.30	0.00
2000	0.01	0.43	8.45	0.07	0.01	0.24	-0.01	0.00	7.24	0.00
2001	0.02	0.57	8.67	0.09	0.01	0.31	-0.02	0.00	8.83	0.00
2002	0.02	0.60	8.39	0.09	0.01	0.33	-0.01	0.00	8.58	0.00
2003	0.03	0.61	8.18	0.10	0.01	0.35	-0.01	0.00	8.05	0.00
2004	0.04	0.74	8.10	0.12	0.01	0.39	-0.02	0.00	10.80	0.00
2005	0.06	1.05	8.51	0.15	0.02	0.49	-0.02	0.00	11.35	0.00
2006	0.13	1.51	9.70	0.24	0.03	0.74	0.01	0.00	11.75	0.00
2007	0.08	1.21	10.25	0.24	0.03	0.70	0.09	0.01	10.92	0.00

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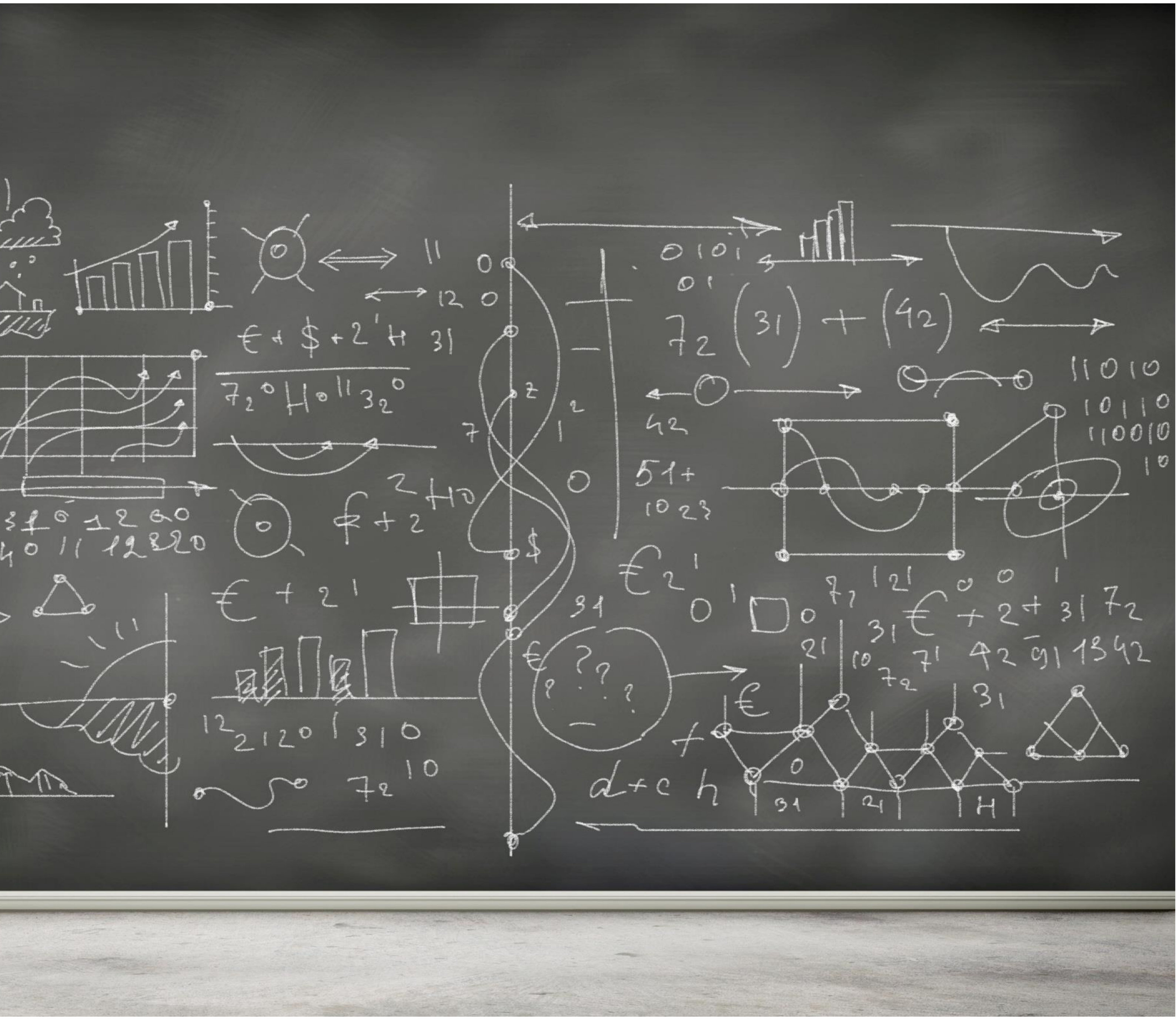
Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
2008	0.13	1.62	11.54	0.31	0.05	0.90	0.11	0.01	11.11	0.00
2009	0.18	1.94	12.74	0.37	0.07	1.01	0.15	0.02	11.35	0.00
2010	0.08	1.29	12.02	0.28	0.04	0.80	0.18	0.02	10.47	0.00
2011	0.06	1.24	12.46	0.28	0.04	0.82	0.18	0.03	3.38	0.00
2012	0.15	1.80	13.53	0.39	0.07	1.14	0.30	0.04	24.41	0.00
2013	0.14	1.71	13.88	0.41	0.07	1.14	0.42	0.05	8.15	0.00
2014	0.21	2.34	17.37	0.61	0.11	1.67	0.75	0.08	9.38	0.00
2015	0.28	3.17	18.55	0.64	0.15	1.90	0.29	0.08	5.90	0.00
2016	0.26	2.99	18.43	0.62	0.14	1.82	0.38	0.09	27.15	0.00
2017	0.27	2.96	18.60	0.66	0.14	1.81	0.34	0.09	29.58	0.00
2018	0.32	3.43	19.21	0.79	0.16	1.88	0.39	0.11	8.55	0.00
2019	0.50	5.65	21.07	1.07	0.26	2.25	0.37	0.12	7.31	0.00
2020	0.60	6.72	22.48	1.17	0.34	2.28	0.43	0.13	6.88	0.00
2021	0.60	6.21	22.21	1.26	0.35	2.50	0.46	0.17	6.15	-0.02
2022	0.49	5.22	21.50	0.99	0.28	2.19	0.35	0.11	8.17	0.02
2023	0.67	7.05	21.57	1.14	0.37	2.12	0.32	0.15	7.57	0.07



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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 2026. The report contains information on Estonian emission inventory from 1990 to 2024. 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 are reported for the years 2025, 2030, 2035, 2040, 2045 and 2050.

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 calculating emissions are laid down in several regulations of the Minister of the Environment. The Air Pollution Database consists of data on point sources (approximately 1,535 reports in 2024) and diffuse sources. The methodology and emission calculations for 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, the Ministry of Economic Affairs and Communications, the Ministry of Rural Affairs, Statistics Estonia, Estonian Rescue Board, Estonian Defence Forces, Estonian Road Administration, Estonian Tax and Customs Board, EVR Cargo Ltd, Tallinn Airport Ltd and the Estonian Environmental Research Centre (EERC).

An important objective of the inventory is to assess the effectiveness of governmental environmental policies to provide official emission data to national and international bodies. Emission data are updated annually and reported each year.

1.3. The Process of Inventory Preparation

The processes of inventory preparation vary for different emission sources.

The preparation of the Estonian national air pollutant emission inventory can be described as an annual cycle due to the annual reporting obligation. To improve inventory quality and ensure efficient use of resources, continuous analysis and methodological improvement form an integral part of the inventory process. The main inventory preparation activities are presented in Figure 1.1 and the structure of the inventory is shown in Figure 1.3.

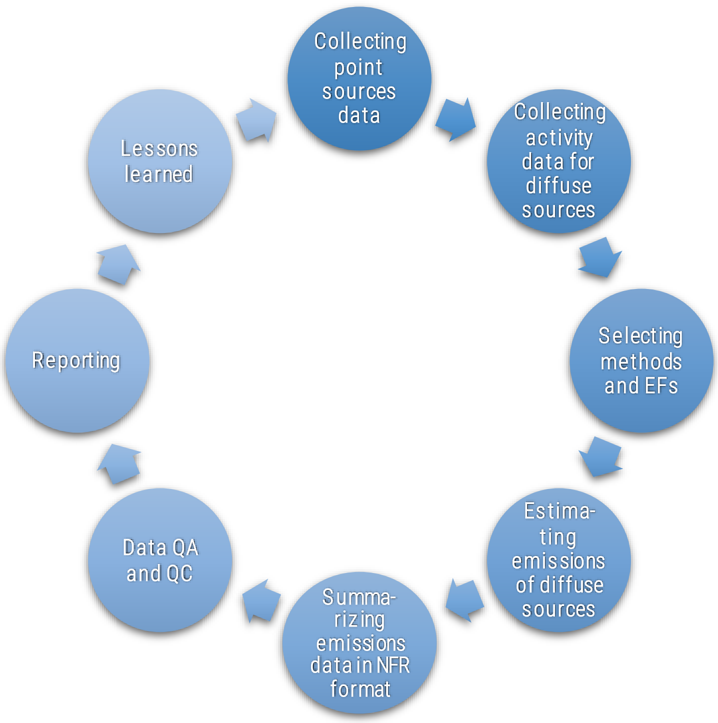

Figure 1.1 The main activities of inventory preparation

The national database contains data for both point and diffuse sources of emissions. The emission inventory for the period 1990–1999 is based on data on large point sources and diffuse sources. From 2000 to 2004, CollectER software was used for data collection for both point and diffuse sources. In order to collect data on point sources, the Estonian Environment Information Centre created a web-based air emissions data system for point sources (OSIS) in 2004, where operators of point sources directly completed 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)[2] managed by the Estonian Environmental Board (EEB).

[2] KOTKAS - AVE v2.13.38

The Integrated Environmental Information System contains data reported by the operators who have a pollution permit issued by the EEB. Each facility submits data on the emissions of pollutants together with fuel consumption, used solvents, quantities of distributed liquid fuels, etc. Operators are obliged to specify any data related to releases (deliberate, accidental, routine and non-routine), where such information is available. Data are presented for each emission source and for the facility as a whole. Emission data are available in SNAP (Source Nomenclature for Air Pollutants) and E-PRTR codes. Operators of point sources can directly enter their calculated or measured annual emissions into KOTKAS manually or use calculation modules, which use legally regulated national emission estimation methodologies. Operators can also calculate emissions using other available methods provided that it is 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 (such as POPs and, in some cases PM_{10} and $PM_{2.5}$) that are 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 the operator submits the report, the local Environmental Board specialist confirms receipt of the report; at this point, the final verification at ESTEA is carried out and the data are 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 ESTEA. The main diffuse sources are combustion in the residential sector, mobile sources, agriculture, certain solvent use and industrial activities and fugitive emissions from fuel consumption.

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

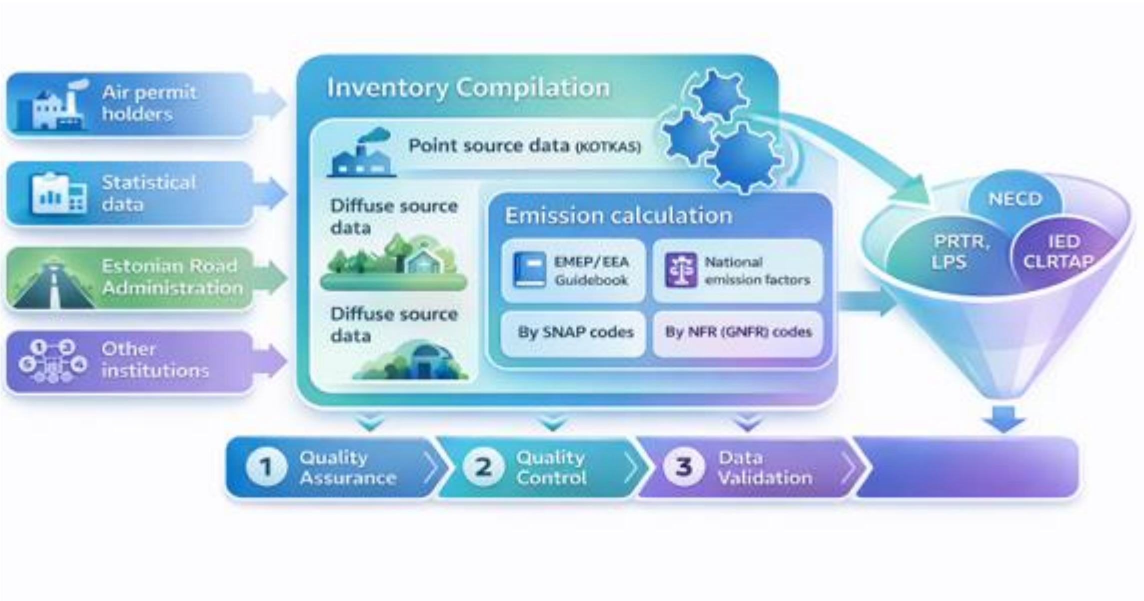

Figure 1.3 Air pollution inventory structure

1.4. Methods and Data Sources

Emission inventories are prepared using data reported by operators, nationally specific emission factors, and methodologies from the EMEP/EEA Air Pollutant Emission Inventory Guidebook for diffuse sources.

For the calculation of emissions from diffuse sources in the energy sector, the energy (EB) compiled by Statistics Estonia and fuel consumption data reports by point sources (PS) are used.

Diffuse sources Fuel = EB fuel – PS fuel

Emissions from road transport are calculated using COPERT 5 (version. 5.9.1). Total emissions are estimated based on a combination of technical data (e.g. emission factors) and activity data (e.g. number of vehicles, annual mileage per vehicle, average trip length and speed, fuel consumption and monthly temperatures).

Vehicle fleet data (passenger cars, light-duty and heavy-duty vehicles, buses and motorcycles) and annual mileage per vehicle are obtained from the Estonian Road Administration. Meteorological data are provided by the Meteorological Observation Department of ESTEA, and fuel consumption data are provided by Statistics Estonia.

Detailed descriptions of the methodologies applied are provided in the respective sectoral chapters of the IIR.

1.5. Key Categories

This chapter presents the results of Estonia's key source analysis.

The analysis is based on methodology described in the EMEP/EEA Guidebook 2023.

Key categories are emission source categories that have a significant influence on the total inventory, either in terms of their absolute emission level (for a given year) or their trend over time. Key categories are those that together account for 80% of the total inventory level or trend.

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

The energy (1A1a), stationary combustion in residential plants (1A4bi), and mobile sources (1A3bi, 1A3biii, 1A3c) are the main sources of NO_x emissions. In the energy sector, NO_x emissions primarily originate from oil shale-fired power plants.

Domestic solvent use (2D3a) and decorative coating application (2D3d) are the main sources of NMVOC emissions.

According to the level assessment, SO_2 emissions from the energy sector – particularly from the two oil shale-fired power plants and shale oil production facilities in Eastern Estonia (Eesti and Balti power plants) – accounted for 84.5% of total SO_2 emissions in 2024.

Agriculture is the key source of ammonia emissions, especially livestock manure management (dairy cattle, swine, and non-dairy cattle), manure application to soils (3Da2a), and the use of mineral fertilisers (3D1a).

Construction and demolition (2A5b) is a key source of particulate matter. In addition, combustion in residential plants (1A4bi) is a key source of TSP, PM_{10}, $PM_{2.5}$, BC, HCB, PAHs, and heavy metals.

According to the level assessment, 43.7% of CO emissions originate from the oil shale industry (1A1c). Residential combustion plants (1A4bi) are also a significant source 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 (73.3%)	1A1c (11.3%)								84.5
NO_x	1A1a (26.2%)	1A3bi (13.3%)	1A4bi (11.6%)	1A3biii (9.4%)	3Da1 (8.1%)	1A3bii (5.4%)	1A3c (4.1%)	3Da2a (3.8%)		81.9
NH_3	3B1a (27.9%)	3Da1 (19.4%)	3Da2a (19.2%)	3B1b (9.4%)	3B3 (6.4%)					82.3
NMVOC	2D3d (18.2%)	2D3a (16.3%)	3B1a (11.5%)	1A1c (10.7%)	1A4bi (7.8%)	2D3i (7.0%)	3B1b (4.5%)	2H2 (3.4%)	1A1a (2.8%)	82.2
CO	1A1c (43.7%)	1A4bi (39.7%)								83.4
TSP	2A5b (27.2%)	1A3bvii (16.9%)	1A4bi (14.5%)	3Dc (10.2%)	1A1a (8.8%)	2I (3.5%)				81.2
PM_{10}	1A4bi (23.3%)	3Dc (17.5%)	1A3bvii (14.5%)	2A5b (14.1%)	1A1a (8.5%)	1A3bvi (3.8%)				81.6
$PM_{2.5}$	1A4bi (42.4%)	1A3bvii (14.9%)	1A1a (11.7%)	1B1c (5.1%)	1A3bvi (3.7%)	1A1c (2.7%)				80.5
Pb	1A4bi (39.5%)	1A3bvi (35.2%)	1A1a (16.1%)							90.8
Hg	1A1a (53.5%)	1A4bi (20.3%)	5C1biii (9.8%)							83.5
Cd	1A4bi (57.7%)	1A1a (28.6%)								86.3
DIOX	1A1a (58.5%)	5E (20.8%)	1A4bi (7.0%)							86.4
PAH	1A4bi (73.9%)	1A1a (20.5%)								94.4
HCB	1A1a (34.9%)	1A4bi (31.9%)	5C2 (11.8%)	5C1biii (10.6%)						89.2

1.6. QA/QC and Verification Methods

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

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 summer 2016 by the EMEP Emission Centre (CEIP) acting as the review secretariat. The results are available on the CEIP homepage (http://www.ceip.at/review-process/centralised-review-stage-3/).
  In 2017-2024 the Estonian inventory has been subject to the comprehensive technical review of national emission inventories pursuant to the Directive on the Reduction of National Emissions of Certain

Atmospheric Pollutants (Directive (EU) 2016/2284). The recommendations from TERT and improvements made in the inventory are included in Annex II of the IIR.

- **Data collection:** Data collection includes both point source emissions and diffuse source activity data. Prior to using activity data, common statistical quality checking related to the assessment of trends is carried out.
  ESTEA uses only point source 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 in NFR, formats must be checked with RepDab.
- **Reporting**
- **Archiving**

1.7. General Uncertainty Evaluation

Uncertainty analysis has been carried out for the 2026 submission under the terms and conditions of the LRTAP Convention as part of the Estonian IIR 2026.

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 the reference year, and on activity data uncertainties and emissions factors for each NFR category and subcategory. Uncertainty levels were first calculated separately for each pollutant and for each NFR subcategory. These subcategory uncertainties were then combined to obtain the overall uncertainty of the national inventory. In addition, uncertainty assessments were performed for aggregated sectors, including stationary combustion, aviation, road transport, other transport, industrial processes, solvent use, agriculture, and waste management. The results are presented in the relevant chapters of the IIR.

The base year for all pollutants is 1990, except for PM_{10} and $PM_{2.5}$, for which the base year is 2000. The reference year is 2024.

Uncertainty values for emission factors were primarily based on the default values provided in the *EMEP/EEA Guidebook 2023*. Where default uncertainty values for specific pollutants were not available, expert judgement was applied. The recommended uncertainty ranges for activity data and emission factors from the Guidebook are presented in Table 1.3. Sector-specific uncertainty assumptions for activity data and emission factors used in this inventory are provided in Table 1.2 and Table 1.4, respectively.

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

NFR sector	Uncertainty, %	Data source
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
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					

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NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxins	PAHs	HCB	PCBs
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
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						

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NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxins	PAHs	HCB	PCBs
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				

1.7.2. Results of Uncertainty Evaluation

Table 1.5 presents the results of the uncertainty evaluation, including the estimated emissions for each pollutant in 1990 and 2024, the trend uncertainty for the period 1990–2024, and the total uncertainty of national emissions in 2024.

Table 1.5 Uncertainty evaluation

Pollutant	Total emission, 1990	Total emission, 2024	Unit	Trend in 1990-2024, %	Uncertainty, %	Trend uncertainty 1990-2024 %
NO_x	71.68	17.70	kt	-75.30	14.13	2.73
NMVOC	66.10	22.33	kt	-66.22	19.35	5.45
SO_x	279.00	9.32	kt	-96.66	8.34	0.09
NH_3	23.71	9.60	kt	-59.51	40.88	9.80
$PM_{2.5}$	10.15	4.48	kt	-55.88	26.14	14.22
PM_{10}	26.55	8.57	kt	-67.71	27.72	10.02
TSP	265.69	14.70	kt	-94.47	33.60	1.99
BC	1.54	1.09	kt	-29.39	44.28	37.98
CO	225.18	84.56	kt	-62.45	22.37	11.65
Pb	201.84	3.77	t	-98.13	46.22	0.96
Cd	4.48	0.41	t	-90.88	66.12	7.02
Hg	1.21	0.19	t	-84.59	35.99	4.04
PCDD/F	11.04	4.46	g I-TEQ	-59.63	129.52	53.93
B(a)p	2.82	1.02	t	-63.71	158.66	22.70
B(b)f	3.58	1.02	t	-71.42	141.16	22.32
B(k)f	1.70	0.63	t	-62.81	160.74	21.86
I(1,2,3-cd)p	1.79	0.90	t	-49.41	179.52	31.35
HCB	0.60	0.52	kg	-13.03	101.78	93.85
PCB	4.88	0.41	kg	-91.52	117.18	4.70

The results indicate that, for most pollutants, emissions mainly originate from public electricity and heat production and from residential and other non-industrial combustion. Road transport also represents a significant source. Agriculture is the main source of ammonia emissions.

The highest uncertainty levels were observed for POPs and heavy metals, mainly due to high uncertainty in emission factors for energy-related activities. Ammonia also showed relatively high uncertainty, at approximately 100%. Trend uncertainty was highest for HCB and PAHs.

1.8. General Assessment of Completeness

The next two tables present the emission sources that are not estimated (NE) in the inventory (see Table 1.6) and those that are included elsewhere (IE) (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 2019
1A3ai(i)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3aii(i)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3ai(ii)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3aii(ii)	NH_3, HMs, POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3bv	POPs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3bvi	PCDD/F, HCB, PCB	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3c	Pb, Hg, As, PCDD/F	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3dii	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
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 2019
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 2019
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 2019
1A4ciii	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3di(i)	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
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 2019
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), 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

NFR19 code	Substance(s)	Reason for not estimated
5B2	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
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, SO_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
5C1biii	NO_x, NMVOC, SO_x, PMs, BC, CO, Cu (2008-2023)	5C1bii
5D2	NMVOC (1994-2007)	5D1

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

2. POLLUTANT EMISSION TRENDS

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: 1990–2024;
- PM_{10}, $PM_{2.5}$ and BC: 2000–2024;
- All Heavy Metals: 1990–2024;
- POPs: 1990–2024.

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 2024. Emissions of all substances decreased significantly over the entire period (see Table 2.1 and Figures 2.1-2.3). Detailed information for each substance, including key sources and the reasons for the reductions, is provided below

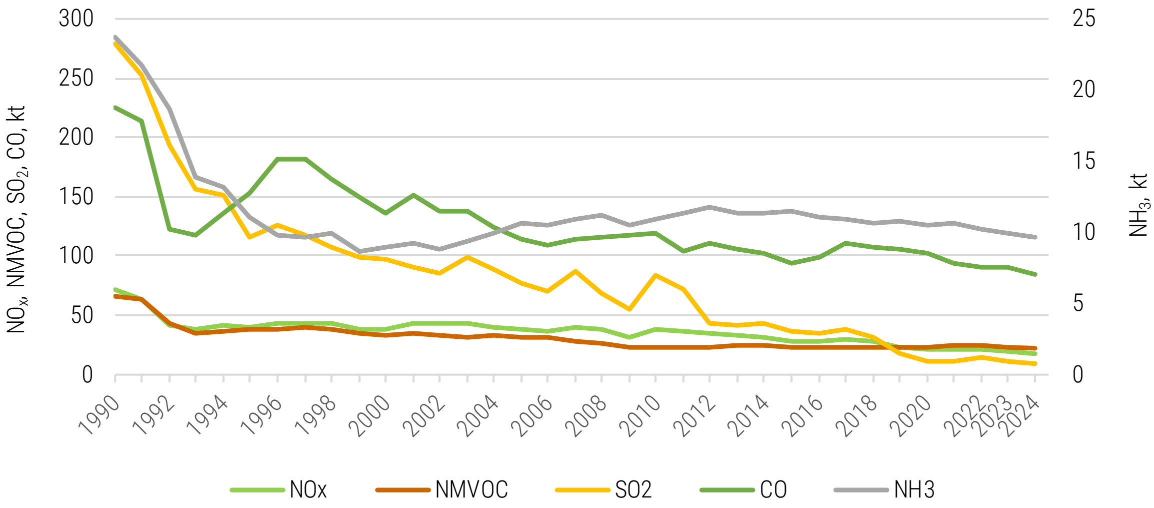

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Figure 2.1 Main pollutants emissions trends

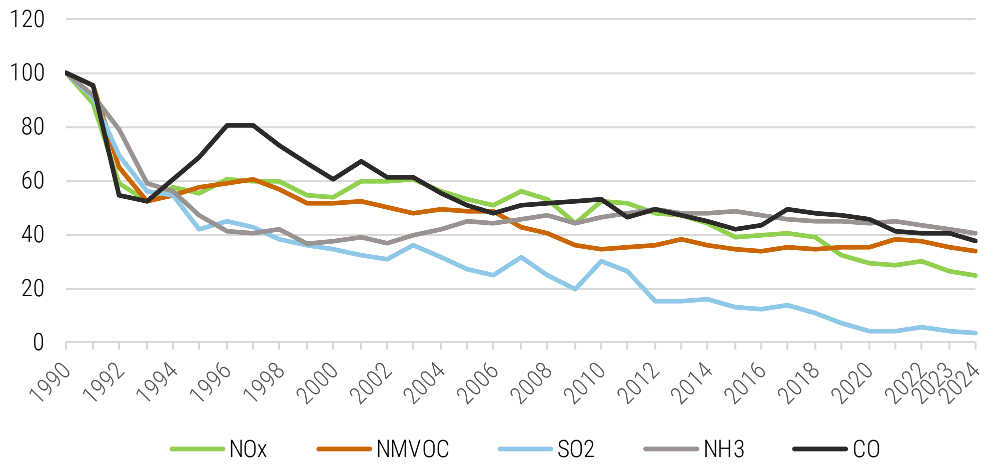

Figure 2.2 Indexed of main pollutants emissions (1990=100)

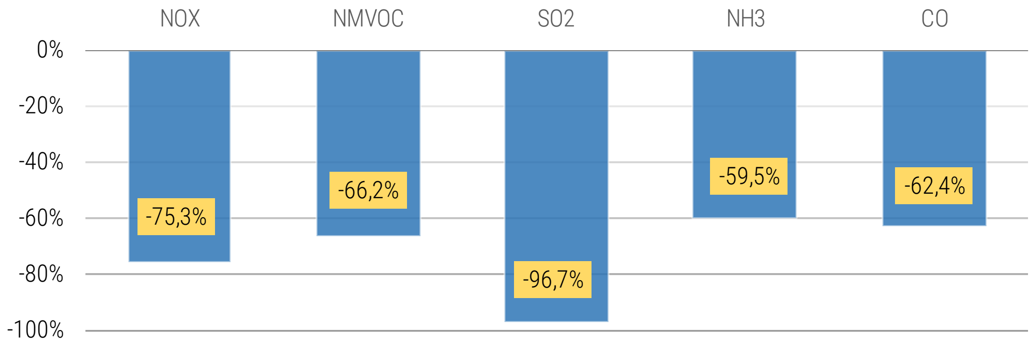

Figure 2.3 Reduction of main pollutants emissions

Table 2.1 Main pollutant emissions (kt)

Year	NO_x	NMVOC	SO_2	NH_3	CO
1990	71.68	66.10	279.00	23.71	225.18
1991	63.77	62.88	252.98	21.70	214.09
1992	42.09	43.07	193.15	18.67	123.00
1993	37.60	34.38	156.53	13.92	117.43
1994	41.00	36.23	151.56	13.22	136.47
1995	39.86	38.12	116.70	11.12	153.73
1996	43.44	38.87	125.50	9.74	181.41
1997	43.02	40.09	118.42	9.66	182.07
1998	42.91	37.53	106.67	10.01	164.53
1999	38.88	34.31	99.41	8.66	150.04
2000	38.32	33.97	97.02	8.95	136.44
2001	42.91	34.38	90.57	9.25	150.61
2002	42.73	32.95	85.62	8.77	137.54
2003	43.45	31.68	99.56	9.38	137.26
2004	40.37	32.73	88.48	9.92	123.86
2005	38.05	32.16	76.52	10.71	114.93
2006	36.47	31.93	69.82	10.49	108.33
2007	40.26	28.18	87.87	10.87	115.02
2008	37.90	26.50	69.28	11.19	115.50
2009	31.82	23.76	54.57	10.46	117.96
2010	37.70	22.73	83.11	10.99	119.33
2011	37.16	23.44	72.47	11.32	104.61
2012	34.19	23.72	42.55	11.73	110.48
2013	33.83	25.46	41.56	11.38	105.32
2014	31.87	23.93	43.99	11.40	101.68
2015	27.80	22.57	36.06	11.46	93.88
2016	28.32	22.39	35.01	11.08	98.40
2017	29.09	23.46	38.83	10.88	110.46
2018	28.11	22.99	30.79	10.67	106.98
2019	23.14	23.08	18.78	10.72	105.73
2020	20.91	23.04	10.93	10.47	102.47
2021	20.57	25.43	11.73	10.60	93.32
2022	21.50	24.80	14.79	10.22	91.22
2023	19.06	23.29	10.96	9.96	90.65
2024	17.70	22.33	9.32	9.60	84.56
Change 1990-2024, %	-75.3	-66.2	-96.7	-59.5	-62.4
Change 2005-2024, %	-53.5	-30.6	-87.8	-10.3	-26.4
Change 2023-2024, %	-7.1	-4.2	-15.0	-3.7	-6.7

2.1.1. Sulphur Dioxide

During the period 1990–2024, sulphur dioxide emissions decreased by 96.7%. This reduction was largely driven by a decline in energy production, as oil shale consumption - the main fuel in Estonia - fell from 277.4 PJ in 1990 to 91.6 PJ in 2024 (see Figures 2.3 and 2.4, and Tables 2.1 and 2.2). This decline, in turn, resulted from the restructuring of the economy. Electricity export opportunities have also decreased significantly.

The use of local fuels (including wood, oil shale oil) and natural gas has been constantly increasing since 1993, while the importance of heavy fuel oil in thermal energy production has declined. Gas consumption started to gradually decrease after 2008. In 2021, the import of Russian gas ceased, and now Estonia receives gas from Latvia and, since 2023, also from Finland.

The use of fuels with lower sulphur content - particularly for road transport and heating - has also contributed to the reduction in SO_2 emissions. Other reasons for the decrease in emissions are given below.

Table 2.2 SO_2 emissions by sector (kt), change in emissions and share of 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	9.19	3.21	1.86	0.04	0.000	0.004	279.00
1995	99.35	10.64	3.31	2.59	0.79	0.02	0.000	0.006	116.70
2000	89.01	2.66	2.37	2.55	0.36	0.02	0.042	0.007	97.02
2005	71.93	2.79	1.26	0.06	0.31	0.02	0.132	0.005	76.52
2010	81.22	1.12	0.58	0.01	0.11	0.03	0.032	0.012	83.11
2015	35.09	0.39	0.49	0.01	0.02	0.03	0.003	0.025	36.06
2020	10.18	0.44	0.25	0.01	0.02	0.02	0.001	0.014	10.93
2021	11.14	0.29	0.24	0.01	0.02	0.02	0.002	0.014	11.73
2022	14.15	0.29	0.29	0.01	0.02	0.02	0.002	0.011	14.79
2023	10.25	0.32	0.33	0.01	0.02	0.02	0.001	0.011	10.96
2024	8.68	0.26	0.33	0.01	0.02	0.02	0.001	0.007	9.32
Share in total 1990 emission, %	**84.3**	**10.5**	**3.3**	**1.2**	**0.7**	**0.02**	**0.0**	**0.0**	
Share in total 2024 emission, %	**93.1**	**2.8**	**3.5**	**0.1**	**0.2**	**0.2**	**0.01**	**0.1**	
Change 1990-2024, %	-96.3	-99.1	-96.5	-99.8	-98.8	-61.6	326.4	87.4	-96.7
Change 2023-2024, %	-15.3	-18.9	-0.7	-8.8	3.8	-16.6	25.7	-37.4	-15.0

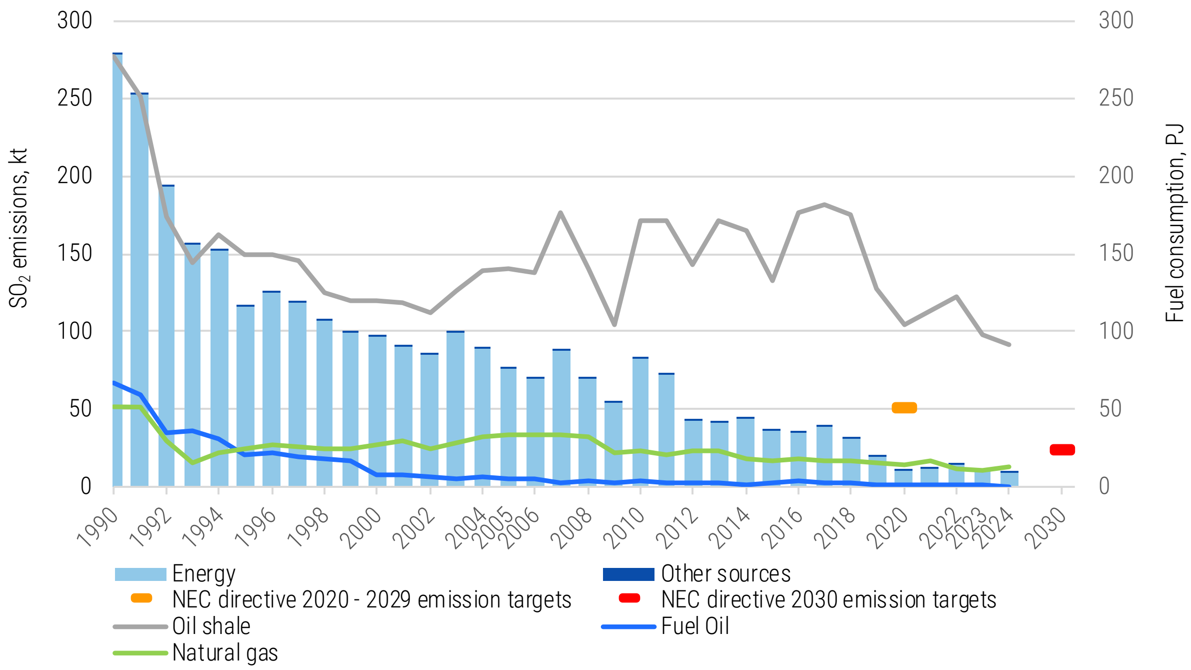

Figure 2.4 SO_2 emissions and NEC Directive (EU) 2016/2284 targets

The main reason for the drop in emissions since 2004 is the launch of two new boilers at the Narva Power Plants. 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 over five years of research and development were installed in the Narva Power Plants on four energy production units of the Eesti Power Plants in 2012. The semi-dry NID (Novel Integrated Desulphurisation) technology uses the fly ash present in the flue gas and does not require any additional compounds to bind the SO_2. With regard to the energy units which have not been equipped with the cleaning equipment, alternative methods are used for reducing SO_2 emissions, such as water injection into the 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 ensure compliance with 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 national programmes to prevent climate change and reduce emissions into the atmosphere. The energy development programme includes, among other measures, 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 earlier measures taken, in spring 2020, three power units at the Estonian Power Plant of Enefit Power AS were closed and one unit at the Baltic Power Plant has not been operating since 2020.

In 2024, SO_2 emissions decreased by about 15% compared to 2023. One of the contributing factors was the decrease in the amount of oil shale burned in power plants.

While 2021 was a year of economic recovery from the COVID-19 pandemic, which led to an increase in energy consumption, the war against Ukraine started by Russia in February 2022 caused an energy crisis in

Europe. Europe had previously been heavily dependent on cheap natural gas imports from Russia. This led to an increase in oil shale power generation (approximately 47% more than in 2021), which in turn led to an increase in SO_2 emissions.

According to Statistics Estonia and energy market data, in 2024 Estonia continued the transition of its energy sector, with a marked increase in renewable electricity production and a decreasing share of oil shale generation.

In 2024, renewable energy sources accounted for about 63% of Estonia's total electricity production, with both wind and solar energy surpassing one terawatt-hour of generation for the first time in history. Wind energy production increased substantially compared to the previous year, and solar generation also grew strongly thanks to expanded capacity and supportive market conditions[3].

Despite this growth, oil shale and other non-renewable sources still played a significant role in domestic electricity production, though their share decreased compared to previous years.

According to Statistics Estonia, electricity production increased by 7% compared to 2023. The increase in electricity production was due to an increase in oil shale consumption.

The share of the energy sector, including mobile sources, in total SO_2 emission was 99.9%; the combustion in energy industry (NFRs 1A1a-c) was responsible for about 93.5% of total emissions in 2024 (see Table 2.2 and Figure 2.5). The share of SO_2 emissions from the three large oil shale plants – Narva PPs (Eesti, Balti and Auvere PPs) has been steadily decreasing in recent years and in 2024 amounted to only 13% of the total SO_2 emissions. A large contribution (38% 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-indusrtial combustion sector in 2024 were approximately the same and amounted to 3%.

In 1990, the main polluters of SO_2 were combustion in the energy industries (84.3%) and combustion in the manufacturing industries (10.5%). In 2024, the dominant source was the same – energy industries, but the share of industrial combustion has decreased to 2.8%, 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 other sources is very small.

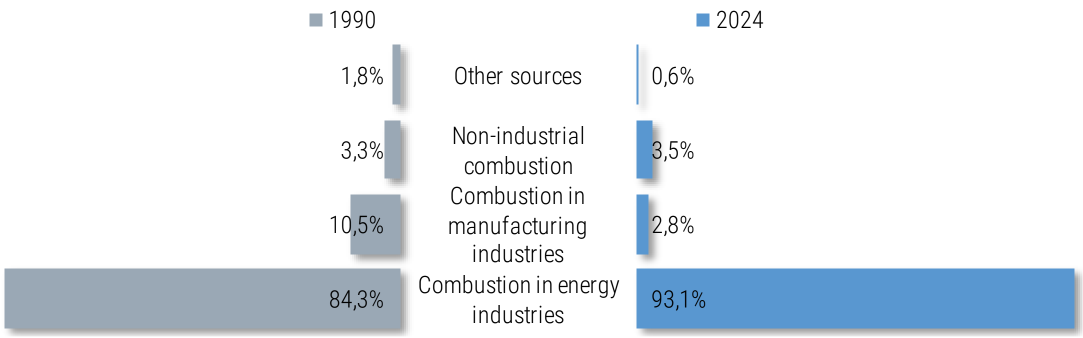

Figure 2.5 SO_2 emissions by sources of pollution in 1990 and 2024

Under the NEC Directive (EU) 2016/2284, Member States are required to comply with the emission reduction commitments set out in the Directive. Estonia fulfilled the requirements of the Directive and the Gothenburg Protocol under the LRTAP Convention, which required a 32% reduction in sulphur dioxide (SO_2) emissions

[3] Both solar and wind energy production exceeded one terawatt-hours last year | Elering

relative to 2005 levels by 2020. This target was already achieved in 2012. In 2024, SO_2 emissions were 87.8% lower than in 2005 (see Table 2.3).

Table 2.3 SO_2 emissions and compliance with NEC Directive (EU) 2016/2284 targets

National total for compliance calculations and checks (NECD)		Change 2005-2024, %	2020-2029 emission targets		2030 emission targets	
2005	2024		%	Emission, kt	%	Emission, kt
76.522	9.317	-87.8	32	52.035	68	24.487

2.1.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 75.3% compared to 1990 levels (see Figure 2.6, Tables 2.1 and 2.4). The reduction is mainly due to decreased energy production and changes in fuel consumption in the transport sector during 1990–1993 (petrol consumption in road transport dropped by 54% and diesel consumption by 37% during this period). The increasing share of cars equipped with catalytic converters in recent years has also contributed to the reduction of NO_x emissions. One of Eesti Energia's major achievements in recent years has been the installation of desulphurisation and denitrification systems in older energy production units at the Narva Power Plants using pulverised combustion technology. As a result, sulphur emissions have decreased threefold and nitrogen oxide emissions almost twofold.

In 2024, the main sources of nitrogen oxide emissions were the energy industry sector (28.7%) and road transport (28.0%). Non-industrial combustion accounted for 13.7%, other mobile sources for 13.1% and agriculture for 12.9% (see Table 2.4 and Figure 2.7).

Table 2.4 NO_x emissions by sector (kt), change in emissions and share of 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	5.97	2.70	25.50	7.68	0.11	0.20	4.77	0.02	71.68
1995	13.13	2.65	2.75	15.71	3.72	0.06	0.07	1.73	0.03	39.86
2000	12.30	2.57	2.62	14.20	4.68	0.07	0.20	1.64	0.04	38.32
2005	12.19	1.91	2.37	13.22	6.44	0.09	0.18	1.63	0.02	38.05
2010	15.36	1.58	2.91	9.99	5.65	0.12	0.04	2.02	0.03	37.70
2015	9.50	1.20	2.55	8.26	3.67	0.15	0.05	2.39	0.02	27.80
2020	5.99	0.49	2.67	6.56	2.45	0.07	0.07	2.57	0.04	20.91
2021	6.13	0.38	2.61	6.46	2.06	0.07	0.07	2.77	0.02	20.57
2022	7.27	0.38	2.62	6.18	2.29	0.10	0.07	2.56	0.02	21.50
2023	6.00	0.50	2.39	5.34	2.28	0.08	0.07	2.40	0.02	19.06
2024	5.08	0.50	2.43	4.95	2.32	0.05	0.07	2.29	0.02	17.70
Share in total 1990 emission, %	**34.5**	**8.3**	**3.8**	**35.6**	**10.7**	**0.1**	**0.3**	**6.6**	**0.03**	
Share in total 2024 emission, %	**28.7**	**2.8**	**13.7**	**28.0**	**13.1**	**0.3**	**0.4**	**12.9**	**0.1**	
Change 1990-2024, %	**-79.4**	**-91.7**	**-10.1**	**-80.6**	**-69.8**	**-50.2**	**-65.7**	**-52.0**	**-24.8**	**-75.3**
Change 2023-2024, %	**-15.3**	**-0.5**	**1.9**	**-7.3**	**1.8**	**-32.5**	**3.1**	**-4.6**	**-8.4**	**-7.1**

In 2024, NO_x emissions decreased by 7.1% compared to 2023 levels. Contributing factors included the decrease in the amount of oil shale burned in power plants and reduced fertilizer use in the agriculture sector.

During the same period, NO_x emissions from road transport decreased by 7.3%, mainly due to the decreasing number of older vehicles and the increasing number of newer vehicles subject to stricter emission standards. It is also worth to notice the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage).

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Emissions from the agriculture sector decreased by 4.6% due to reduced fertilizer use.

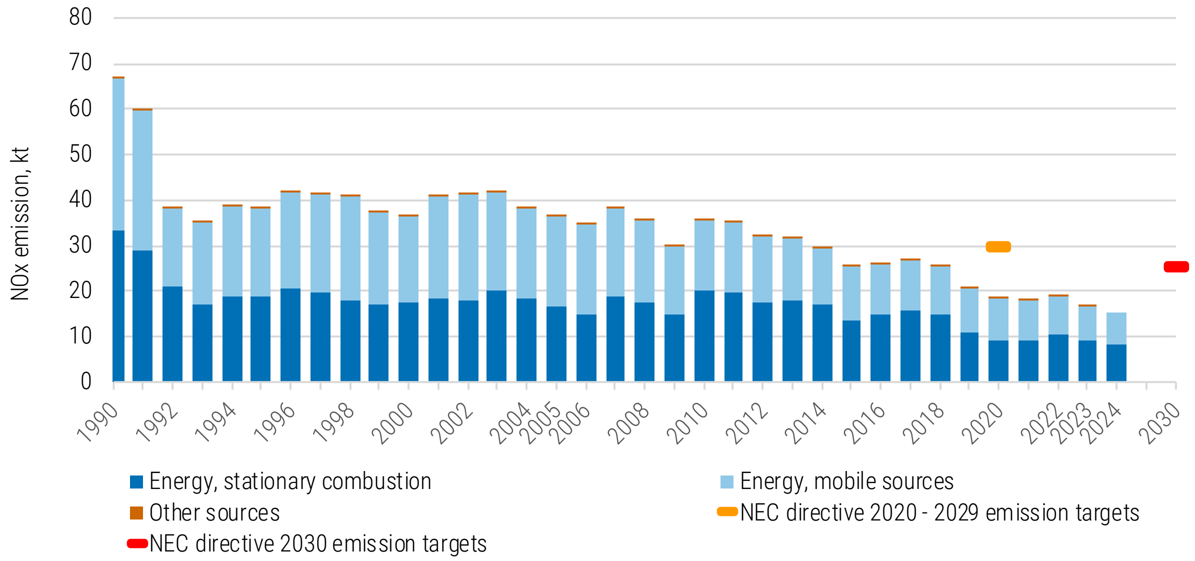

Figure 2.6 NO_x emissions and NEC directive 2016/2284 targets

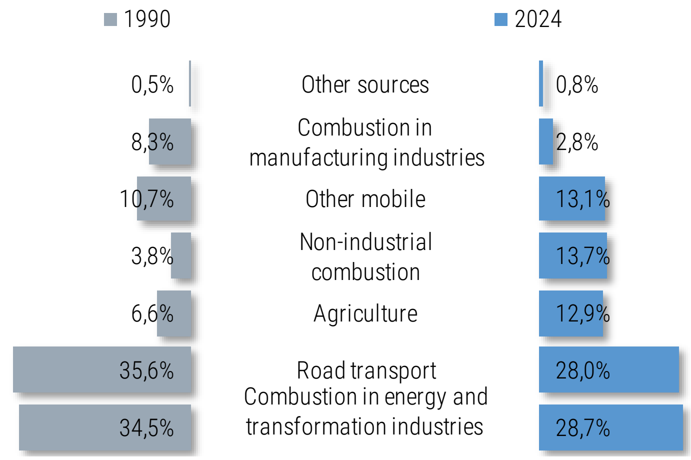

Figure 2.7 NO_x emissions by sources of pollution in the period of 1990 and 2024

Estonia fulfilled the requirements of the NEC Directive (EU) 2016/2284 and the Gothenburg Protocol under the LRTAP Convention, which required an 18% reduction in NO_x emissions relative to 2005 levels by 2020, already in 2015. In 2024, NO_x emissions were 57.7% lower than in 2005 (see Table 2.5 and Figure 2.6). It should be noted that the data in Tables 2.1 and 2.4 include emissions from agriculture and correspond to the National total for compliance calculations and checks under the CLRTAP. In contrast, the data in Table 2.5 and Figure 2.6 are presented in accordance with the National total for compliance calculations and checks under the NECD.

Table 2.5 NO_x emissions and compliance with NEC Directive (EU) 2016/2284 targets

National total for compliance calculations and checks (NECD)		Change 2005-2024, %	2020-2029 emission targets		2030 emission targets	
2005	2024		%	Emission, kt	%	Emission, kt
36.419	15.417	-57.7	18	29.863	30	25.493

2.1.3. Non-Methane Volatile Organic Compounds

Total emissions of non-methane volatile organic compounds(NMVOC) decreased by 66.2% between 1990 and 2024 (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	4.70	17.38	2.54	2.47	23.74	13.24	0.15	66.10
1995	1.02	0.27	4.27	10.90	0.68	1.63	12.30	6.81	0.24	38.12
2000	1.00	0.17	3.29	8.83	1.09	4.33	9.61	5.38	0.27	33.97
2005	1.76	0.29	2.56	5.27	1.08	4.20	11.53	5.29	0.18	32.16
2010	2.31	0.18	2.93	3.17	0.80	1.40	6.77	5.01	0.17	22.73
2015	2.37	0.13	2.15	1.62	0.66	1.14	9.44	4.94	0.11	22.57
2020	2.56	0.08	2.11	1.01	0.44	0.85	11.11	4.76	0.13	23.04
2021	2.26	0.04	2.03	0.92	0.35	0.78	14.24	4.69	0.12	25.43
2022	2.17	0.04	2.08	0.86	0.38	0.72	13.68	4.77	0.11	24.80
2023	3.08	0.09	1.81	0.81	0.36	0.46	11.84	4.71	0.13	23.29
2024	3.03	0.07	1.79	0.81	0.38	0.54	10.89	4.69	0.12	22.33
Share in total 1990 emission, %	2.4	0.4	7.1	26.3	3.8	3.7	35.9	20.0	0.2	
Share in total 2024 emission, %	13.6	0.3	8.0	3.6	1.7	2.4	48.8	21.0	0.6	
Change 1990-2024, %	**91.5**	**-76.3**	**-61.9**	**-95.3**	**-85.0**	**-78.3**	**-54.1**	**-64.6**	**-19.3**	**-66.2**
Change 2023-2024, %	**-1.7**	**-23.5**	**-0.9**	**0.2**	**4.9**	**15.5**	**-8.0**	**-0.4**	**-1.9**	**-4.2**

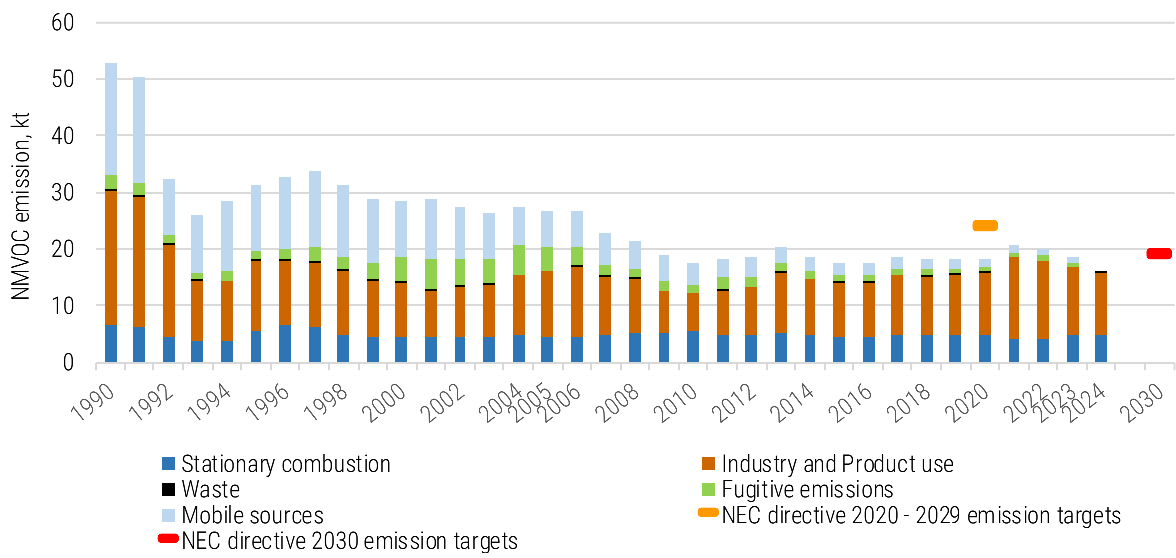

Figure 2.8 NMVOC emissions and NEC directive 2016/2284 targets

The decline in emissions since 1990 has primarily been driven by reductions in the road transport sector following the introduction of catalytic converters to reduce exhaust emissions and carbon canisters on petrol-driven vehicles to control evaporative emissions. These reductions were driven by increasingly stringent vehicle emission standards combined with limits on the maximum volatility of petrol. In addition, NMVOC emissions have been further reduced by the shift from petrol to diesel vehicles.

In addition, chemical production declined during 1990–2024. Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. This increase is mainly due to the growing use of wood and wood waste for combustion. The NMVOC emission factor for these fuels in domestic stoves is significantly higher than for other types of fuel combustion.

In 1990, the main sources of NMVOC were industrial processes and product uses (35.9%) and mobile sources (30.1%). In 2024, the dominant source remained industrial processes and product use (48.8%). Agriculture accounted for 20.3%, stationary combustion for 21.9%, and mobile sources for 5.4% (see Table 2.6 and Figure 2.9).

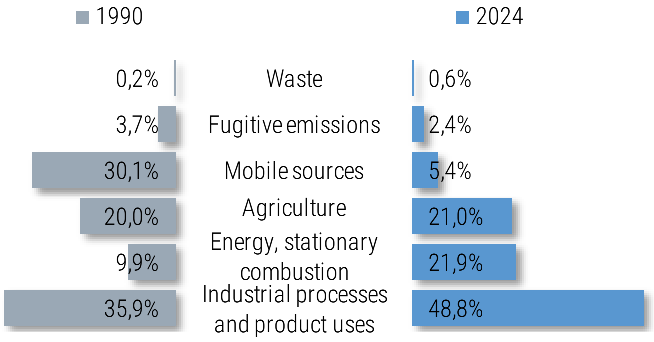

Figure 2.9 NMVOC emission by sources of pollution in 1990 and 2024

Total emissions of NMVOC in 2024 decreased by 4.2% compared to 2023 (see Table 2.6). One of the main reasons for this decrease was the reduction in emissions from the use of solvents and other products, which decreased by 9.0% compared to 2023. This was mainly due to a reduction in emissions from coating application consumption (20.2%), associated with a decrease in the amount of chemicals used. However, despite the overall downward trend, emissions increased in some sectors, including domestic solvent use, other solvent use and dry cleaning. In addition, emissions from the petroleum distribution sector increased, mainly due to higher emissions from marine terminals and storage related to refining activities.

Estonia fulfilled the requirements of the NEC Directive (EU) 2016/2284 and the Gothenburg Protocol under the LRTAP Convention, which required a 10% reduction in NMVOC emissions relative to 2005 levels by 2020, already in 2009. In 2024, NMVOC emissions were 34.4% lower than in 2005 (see Figure 2.8 and Table 2.7).

It should be noted that the data in Tables 2.1 and 2.6 include emissions from agriculture and correspond to the National total for compliance calculations and checks under the CLRTAP. In contrast, the data in Table 2.7 and Figure 2.8 are presented in accordance with the National total for compliance calculations and checks under the NECD.

Table 2.7 NMVOC emissions and compliance with NEC Directive (EU) 2016/2284 targets

National total for compliance calculations and checks (NECD)		Change 2005-2024, %	2020-2029 emission targets		2030 emission targets	
2005	2024		%	Emission, kt	%	Emission, kt
26.869	17.632	-34.4	10	24.182	28	19.346

2.1.4. Ammonia

Total NH_3 emissions decreased by 59.5% between 1990 and 2024 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 were the main sources of NH_3 emissions, accounting for 93.5% of total emissions in 2024.

Stationary fuel combustion activities account for 2.8% of total NH_3 emissions. Between 1990 and 2024, shale oil production at the Enefit 140 plant, a significant source of ammonia emissions within this sector, increased almost fourfold, contributing to a substantial rise in emissions. Increased biomass burning has also contributed to more than a threefold increase in ammonia emissions in this sector.

Transport emissions of NH_3 increased approximately fivefold between 1990 and 2024. The majority of NH_3 emissions in this sector originate from road transport. Ammonia is not formed in significant quantities during typical combustion in gasoline-powered vehicles but is produced as an undesirable by-product of NO reduction on the catalyst surface, leading to ammonia emissions in vehicle exhaust. Consequently, NH_3 emissions are low for older gasoline-powered vehicles and have increased following the widespread use of three-way catalytic converters.

The contribution of the waste sector (domestic wastewater treatment) and mobile sources to total ammonia emissions remained at the same level as in the previous year, accounting for 2% and 1%, respectively. All other sectors (industry and product use, fugitive emissions from fuels) accounted for approximately 1% of total NH_3 emissions (see Table 2.8 and Figure 2.11).

In 2024, NH_3 emissions decreased by approximately 3.7% compared to 2023, mainly due to reduced fertilizer use and a decrease in the number of non-dairy cattle, sheep, goats, laying hens, other poultry and broilers, as well as a decrease in shale oil production.

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

Year	Energy, stationary combustion	Mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	0.10	0.02	0.03	0.68	22.50	0.375	23.71
1995	0.16	0.03	0.02	0.30	10.30	0.324	11.12
2000	0.15	0.10	0.01	0.14	8.27	0.277	8.95
2005	0.19	0.20	0.01	0.22	9.83	0.249	10.71
2010	0.29	0.21	0.02	0.08	10.15	0.232	10.99
2015	0.27	0.17	0.01	0.08	10.72	0.219	11.46
2020	0.30	0.12	0.01	0.09	9.75	0.206	10.47
2021	0.27	0.10	0.01	0.11	9.90	0.207	10.60
2022	0.29	0.11	0.01	0.08	9.53	0.208	10.22
2023	0.33	0.10	0.01	0.05	9.26	0.201	9.96
2024	0.27	0.11	0.01	0.05	8.98	0.193	9.60
Share in total 1990 emission, %	0.4	0.1		2.9	94.9	1.6	
Share in total 2024 emission, %	2.8	1.1	0.1	0.5	93.5	2.0	
Change 1990-2024, %	**174.9**	**508.5**	**-63.2**	**-93.3**	**-60.1**	**-48.5**	**-59.5**
Change 2023-2024, %	**-20.2**	**0.6**	**-0.5**	**-15.8**	**-3.0**	**-3.8**	**-3.7**

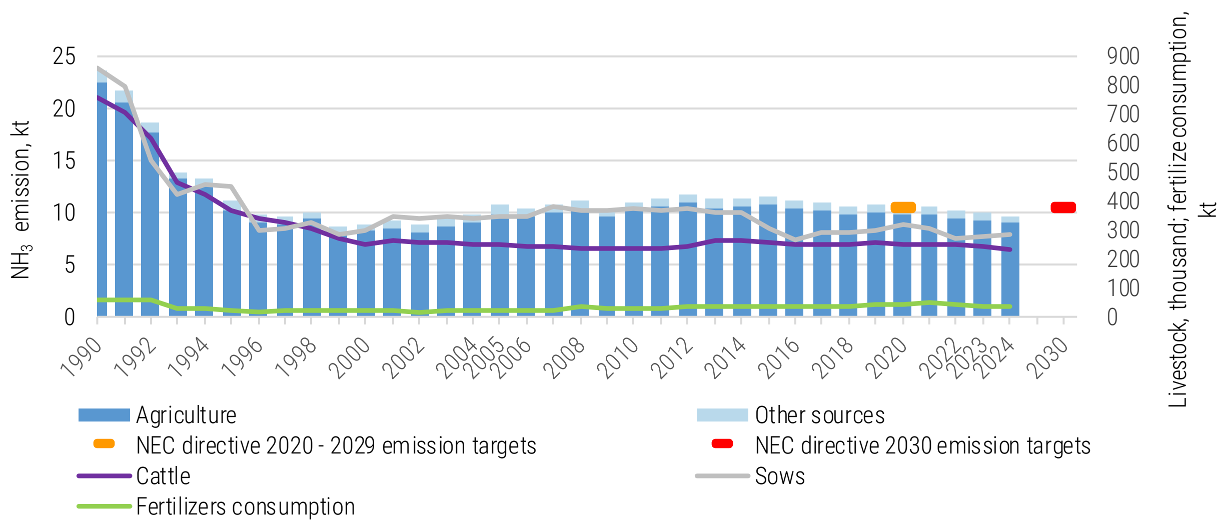

Figure 2.10 NH_3 emissions and NEC directive 2016/2284 targets

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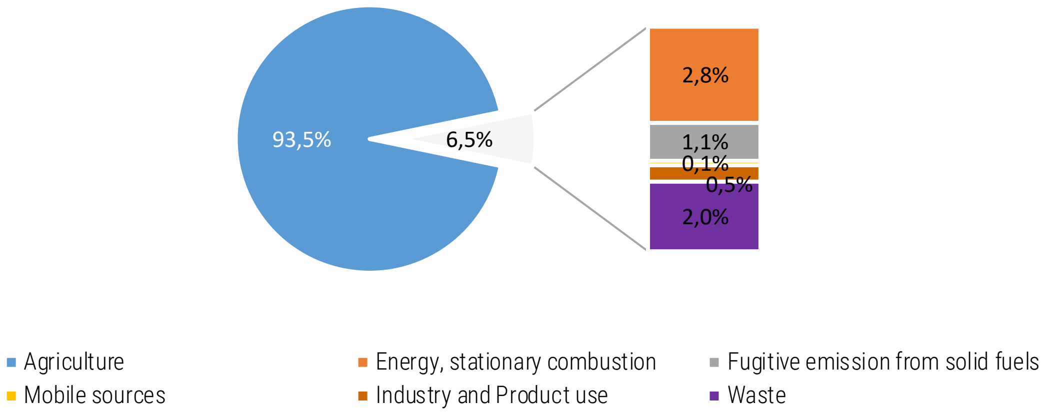

Figure 2.11 NH_3 emissions by sources of pollution in 2024

Under the NEC Directive (EU) 2016/2284 and the Gothenburg Protocol under the LRTAP Convention, Estonia is required to reduce ammonia emissions by 1% by 2020 compared to 2005 levels.

In 2024, ammonia emissions were 10.3% lower than in 2005. Technological innovations in the agricultural sector, as well as environmental protection measures (e.g. duration and timing of manure application), have contributed to reductions in agricultural emissions in recent years (see Table 2.9).

Table 2.9 NH_3 emissions and compliance with NEC Directive (EU) 2016/2284 targets

National total for compliance calculations and checks (NECD)		Change 2005-2024, %	2020-2029 emission targets		2030 emission targets	
2005	2024		%	Emission, kt	%	Emission, kt
10.706	9.599	-10.3	1	10.599	1	10.599

2.1.5. Carbon Monoxide

Between 1990 and 2024, carbon monoxide emissions decreased by 62.4%. This decline was driven, among other factors, by reduced fuel consumption in road transport (particularly between 1990 and 1992) and, in recent years, by a decrease in the number of petrol-fuelled cars. The sharp increase in emissions between 1994 and 1996 was caused by increased wood combustion in the household sector (see Figure 2.12).

Table 2.10 CO emissions by sector (kt), change in emissions and share of 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	3.63	54.28	117.42	29.90	0.49	0.57	0.32	225.18
1995	15.28	3.13	68.44	62.57	3.44	0.28	0.15	0.44	153.73
2000	15.60	1.83	54.77	56.99	5.84	0.29	0.64	0.48	136.44
2005	23.06	2.13	42.61	40.07	5.96	0.39	0.51	0.20	114.93
2010	34.51	1.75	52.65	24.83	4.40	0.51	0.53	0.14	119.33
2015	34.35	0.80	39.14	12.91	5.45	0.65	0.51	0.08	98.40
2020	50.62	0.51	39.11	7.91	3.21	0.31	0.72	0.08	102.47
2021	44.64	0.12	37.84	7.20	2.41	0.31	0.74	0.08	93.32
2022	42.10	0.11	38.89	6.62	2.23	0.44	0.76	0.07	91.22
2023	46.20	0.49	34.33	5.87	2.71	0.41	0.57	0.07	90.65
2024	40.10	0.27	34.09	6.12	2.96	0.30	0.66	0.07	84.56
Share in total 1990 emission, %	8.2	1.6	24.1	52.1	13.3	0.2	0.3	0.1	
Share in total 2024 emission, %	47.4	0.3	40.3	7.2	3.5	0.3	0.8	0.1	
Change 1990-2024, %	116.0	-92.5	-37.2	-94.8	-90.1	-40.2	16.0	-78.8	-62.4
Change 2023-2024, %	-13.2	-44.5	-0.7	4.2	8.9	-27.6	16.9	-4.7	-6.7

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 lower annual mileage of older vehicles compared to newer ones.

Carbon monoxide emissions in the other mobile sector have decreased by about 90.1% between 1990 and 2024 due to a significant decrease in petrol consumption.

In 1990, the main source of carbon monoxide emissions was road transport (52.1%), whereas in 2024 the dominant source was combustion in energy and transformation industries (47.4%). The second largest source is non-industrial combustion (40.3%) (see Figure 2.13). The share of the energy industries sector increased during the same period from 8.2% to 47.4%, mainly due to more than a twofold increase in shale oil production, which is one of the largest sources of carbon monoxide. This increase is also related to a growing trend towards the combustion of wood and wood waste, as the CO emission factor for these fuels is significantly higher in domestic stoves than for the combustion of other fuels.

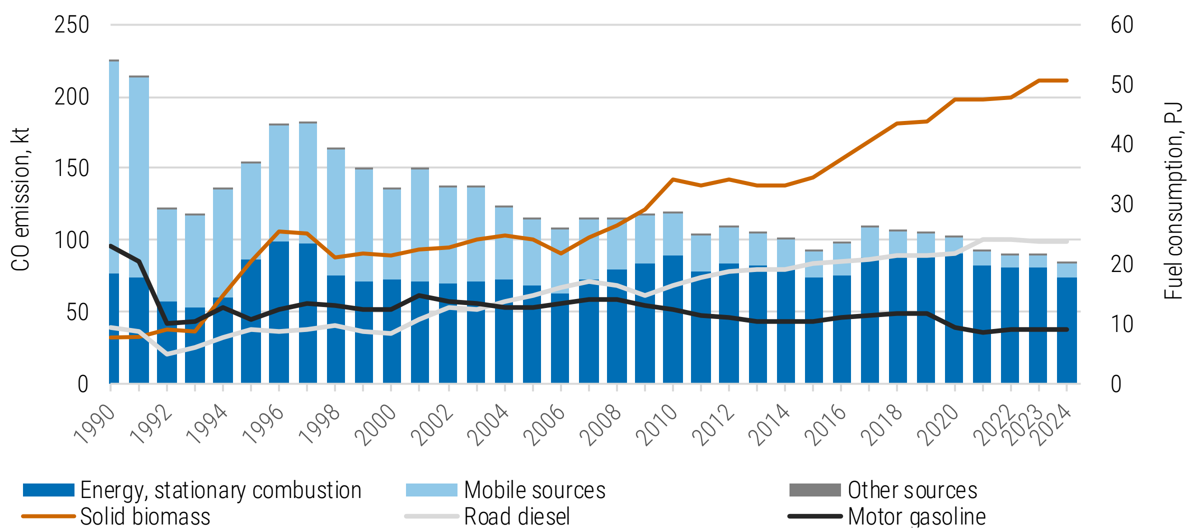

Figure 2.12 CO emissions by sources of pollution

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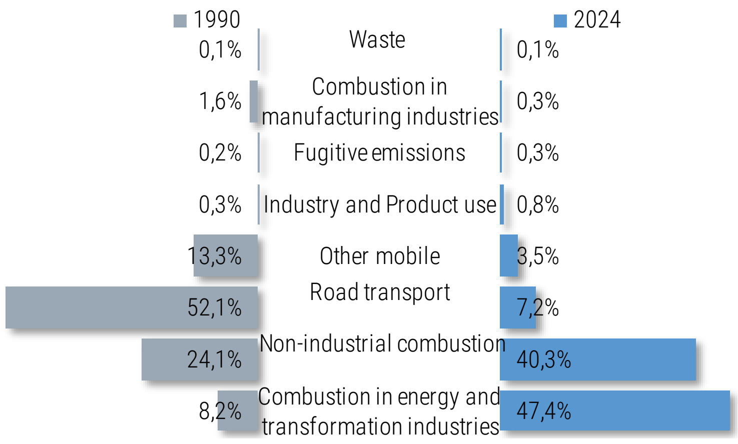

Figure 2.13 CO emissions by sources of pollution in 1990 and 2024

In 2024, carbon monoxide emissions decreased by 6.7% compared to the previous year with one of the contributing factors being the decrease in shale oil production.

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

This chapter presents emission trends for TSP 1990 to 2024 and $PM_{2.5}$, PM_{10} and BC from 2000 to 2024. Emissions of all substances decreased significantly over the period (see Table 2.11, Figures 2.14 - 2.16). Substance-specific trends, key sources and drivers of the decline are discussed below.

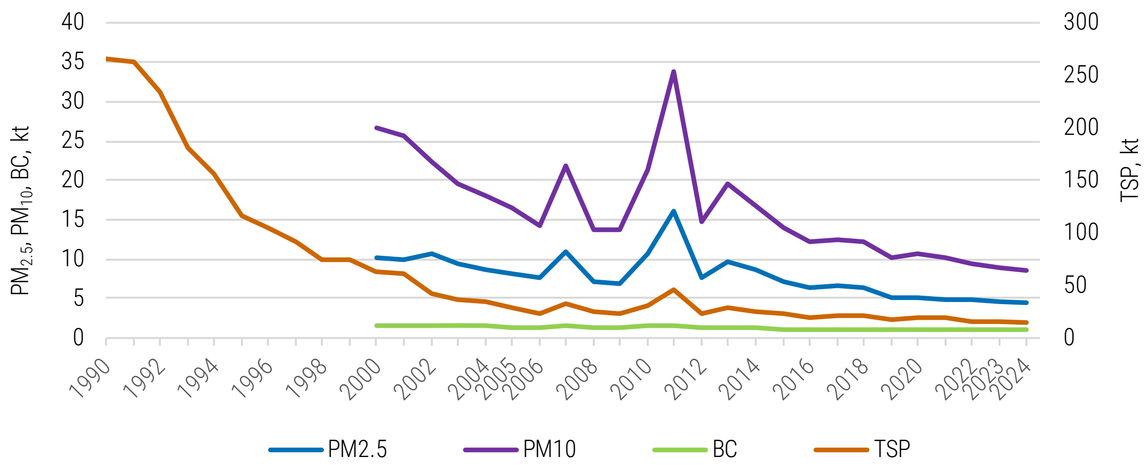

Figure 2.14 Particulates emissions trends

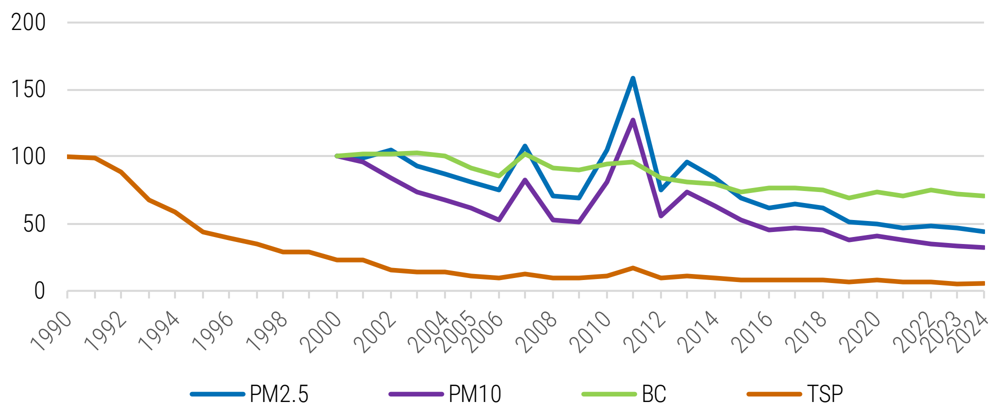

Figure 2.15 Indexed of particulates emissions (1990=100)

Table 2.11 Particulates emissions (kt)

Year	$PM_{2.5}$	PM_{10}	BC	TSP
1990	NR	NR	NR	265.69
1991	NR	NR	NR	262.30
1992	NR	NR	NR	233.73
1993	NR	NR	NR	181.13
1994	NR	NR	NR	155.77
1995	NR	NR	NR	115.95
1996	NR	NR	NR	104.19
1997	NR	NR	NR	91.81
1998	NR	NR	NR	75.27
1999	NR	NR	NR	75.16
2000	10.15	26.55	1.54	62.94
2001	10.05	25.65	1.57	60.43
2002	10.70	22.37	1.58	42.71
2003	9.52	19.44	1.58	37.23
2004	8.79	18.01	1.54	35.44
2005	8.23	16.55	1.41	28.79

Year	$PM_{2.5}$	PM_{10}	BC	TSP
2006	7.61	14.21	1.32	23.59
2007	11.02	21.78	1.56	32.00
2008	7.12	13.85	1.41	25.40
2009	6.98	13.74	1.38	23.59
2010	10.69	21.45	1.46	31.37
2011	16.10	33.81	1.47	45.50
2012	7.62	14.70	1.28	23.59
2013	9.75	19.61	1.25	28.58
2014	8.57	16.73	1.22	24.39
2015	7.02	13.87	1.14	22.60
2016	6.29	12.13	1.17	19.83
2017	6.62	12.56	1.17	20.40
2018	6.26	12.17	1.15	20.71
2019	5.21	10.22	1.07	17.82
2020	5.11	10.70	1.14	20.01
2021	4.75	10.19	1.10	19.49
2022	4.96	9.45	1.17	16.45
2023	4.68	8.82	1.11	15.00
2024	4.48	8.57	1.09	14.70
Change 2000-2024 (TSP 1990-2024), %	-55.9	-67.7	-29.4	-94.5
Change 2005-2024, %	-45.6	-48.2	-22.8	-48.9
Change 2023-2024, %	-4.3	-2.8	-1.8	-2.0

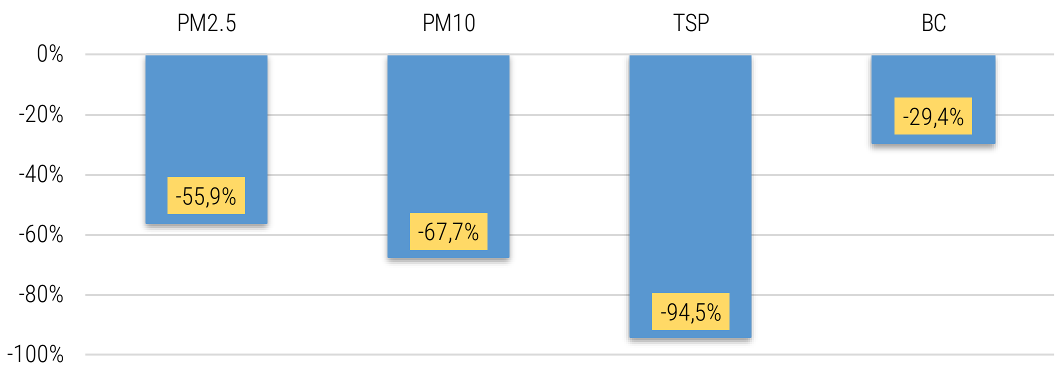

Figure 2.16 Reduction in TSP emissions (1990-2024) and $PM_{2.5}$, PM_{10} and BC emissions (2000-2024)

2.2.1 Total suspended particulate matter (TSP)

In 1990–2024, TSP emissions decreased significantly – by 94.5% (see Table 2.12 and Figures 2.16, 2.17). This decline was mainly due to improved efficiency of combustion plants and air pollution control equipment (particularly at oil shale power plants and the cement factory between 1990 and 1998), as well as a reduction in electricity production. Emissions were further reduced by the decommissioning of old units at oil shale power plants. The increase in TSP and fine particulate emissions in 2010 was driven by higher electricity production during the same period. The significant increase in particulate emissions in 2011 was due to a 34% rise in electricity production at Balti PP (Enefit Power AS) and resulted from malfunctioning electrostatic precipitators on two generating units at this power plant.

Table 2.12 TSP emissions by sector (kt), change in emissions and share of 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	83.12	4.59	2.32	0.64	0.82	8.41	3.58	0.07	265.69
1995	72.71	32.13	4.14	1.72	0.22	0.49	2.22	2.24	0.09	115.95
2000	49.84	0.91	3.31	1.68	0.23	0.57	4.04	2.06	0.30	62.94
2005	11.69	0.78	2.52	2.38	0.29	0.81	8.28	1.84	0.21	28.79
2010	14.78	0.42	2.66	2.33	0.23	1.12	7.83	1.89	0.13	31.37
2015	5.30	0.27	2.08	2.74	0.14	1.45	8.27	2.14	0.20	19.83
2020	1.79	0.08	2.21	3.28	0.09	0.64	9.59	2.20	0.13	20.01
2021	1.34	0.04	2.22	2.85	0.07	0.66	9.97	2.20	0.13	19.49
2022	1.76	0.05	2.38	2.75	0.08	0.97	6.18	2.16	0.13	16.45
2023	1.62	0.13	2.20	2.92	0.08	0.79	5.00	2.14	0.12	15.00
2024	1.60	0.11	2.17	3.01	0.08	0.51	5.02	2.07	0.11	14.70
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 2024 emission, %	10.9	0.7	14.8	20.5	0.6	3.5	34.2	14.1	0.8	
Change 1990-2024, %	**-99.0**	**-99.9**	**-52.6**	**29.8**	**-87.4**	**-37.5**	**-40.3**	**-42.0**	**74.1**	**-94.5**
Change 2023-2024, %	**-1.4**	**-18.9**	**-1.4**	**3.1**	**2.2**	**-35.0**	**0.5**	**-3.1**	**-0.8**	**-2.0**

The main sources of particulate emissions in 2024 where the IPPU sector (mainly construction and demolition), which accounted for 34.2% of the total TSP emission, mobile sources (21.1%), non-industrial combustion (14.8%) and agriculture (14.1%). TSP emissions by sector are presented in Table 2.12 and Figures 2.17–2.18.

In 2024, particulate emissions decreased slightly (by 2%), mainly due to lower emissions from combustion in manufacturing industries and the agriculture sector

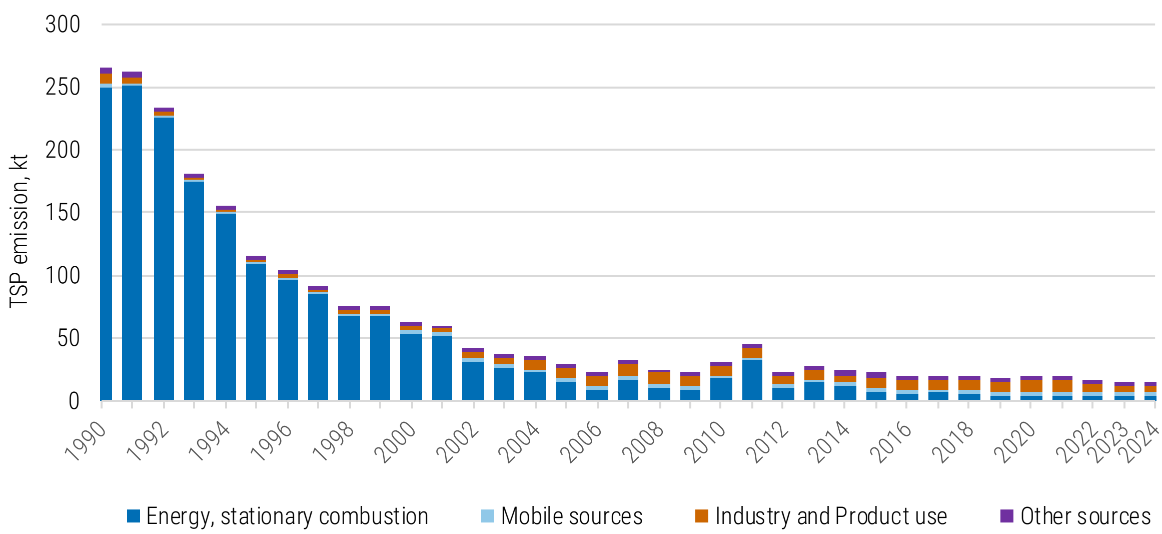

Figure 2.17 TSP emissions by sources of pollution

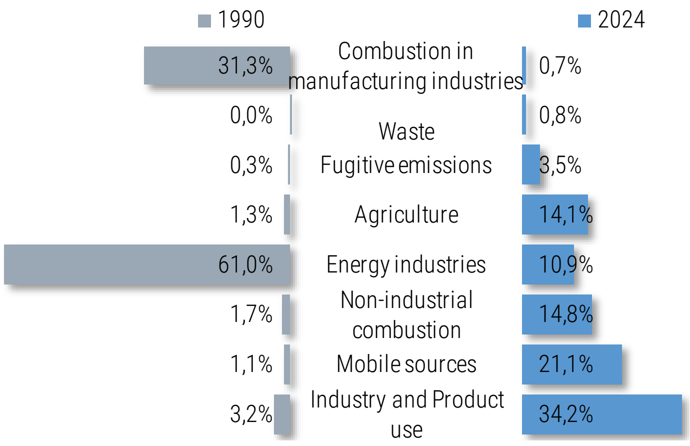

Figure 2.18 TSP emissions by sources of pollution in 1990 and 2024

In 1990, the main sources of TSP were the energy industry (61.0%) and combustion in manufacturing industries (31.3%). In 2024, the share of combustion in energy industries had declined to 10.9%, and the dominant source was industrial processes and product use (with construction having the largest impact) (34.2%).

While the shares of the energy and transformation sector and combustion in manufacturing industries decreased significantly compared to 1990, the share of mobile sources increased to 21.1%, and the shares of non-industrial combustion and agriculture increased to 14.0% (see Figure 2.18).

The main reasons for these changes are the increased share of wood combustion in the household sector (due to the high emission factor of particulates), the modernisation of air pollution control equipment at the cement plant and oil shale power plants, and a decrease in electricity production.

2.2.2 Particulate matter (PM_{10})

In 2000–2024, PM_{10} emissions decreased significantly – by 67.7% (see Table 2.13 and Figure 2.19). This decline was mainly due to improved efficiency of combustion plants and air pollution control equipment, particularly at oil shale power plants and the cement plant. Emissions were further reduced by the decommissioning of old units at oil shale power plants. Emissions from the non-industrial combustion sector decreased by 33.9% between 2000 and 2024, despite an increase in biomass use in the residential sector. This reduction is attributable to the growing share of new high-efficiency technologies in recent years.

The increase in fine particulate emissions in the industrial sector is associated with growth in the construction sector, particularly between 2000 and 2021. Thereafter, both building and road construction declined, leading to a reduction in emissions in 2023 compared to 2022. In 2024, emissions remained at the same level as in the previous year.

The increase in PM_{10} emissions in 2010 was driven by higher electricity production during the same period. The significant increase in particulate emissions in 2011 (see Table 2.11) resulted from a 34% rise in electricity production at Balti PP (Enefit Power AS) and from malfunctioning electrostatic precipitators on two generating units at this power plant.

Table 2.13 PM_{10} emissions by sector (kt), change in emissions and share of 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	Waste	Total
2000	18.02	0.47	3.07	1.10	0.21	1.45	1.64	0.298	0.29	26.55
2005	6.99	0.54	2.34	1.53	0.27	2.87	1.38	0.425	0.21	16.55
2010	12.30	0.31	2.49	1.43	0.20	2.58	1.42	0.59	0.13	21.45
2015	4.72	0.22	1.95	1.61	0.13	2.61	1.68	0.76	0.19	13.87
2020	1.38	0.07	2.07	1.85	0.08	2.98	1.80	0.34	0.12	10.70
2021	1.02	0.03	2.07	1.64	0.07	3.10	1.78	0.35	0.12	10.19
2022	1.13	0.04	2.22	1.58	0.07	2.00	1.76	0.51	0.12	9.45
2023	1.07	0.11	2.05	1.65	0.07	1.59	1.74	0.42	0.11	8.82
2024	0.99	0.09	2.03	1.69	0.07	1.59	1.72	0.27	0.11	8.57
Share in total 2000 emission, %	67.9	1.8	11.5	4.1	0.8	5.5	6.2	1.1	1.1	
Share in total 2024 emission, %	11.6	1.1	23.6	19.8	0.9	18.5	20.1	3.2	1.3	
Change 2000-2024, %	**-94.5**	**-80.7**	**-33.9**	**53.8**	**-64.7**	**9.3**	**5.3**	**-8.2**	**-62.7**	**-67.7**
Change 2023-2024, %	**-7.5**	**-19.6**	**-1.4**	**2.4**	**2.5**	**0.0**	**-0.9**	**-34.6**	**-1.8**	**-2.8**

In 2024, total PM_{10} emissions decreased by 2.8% compared to 2023, mainly due to lower emissions from the energy industries, the fugitive emissions sector and combustion in manufacturing industries.

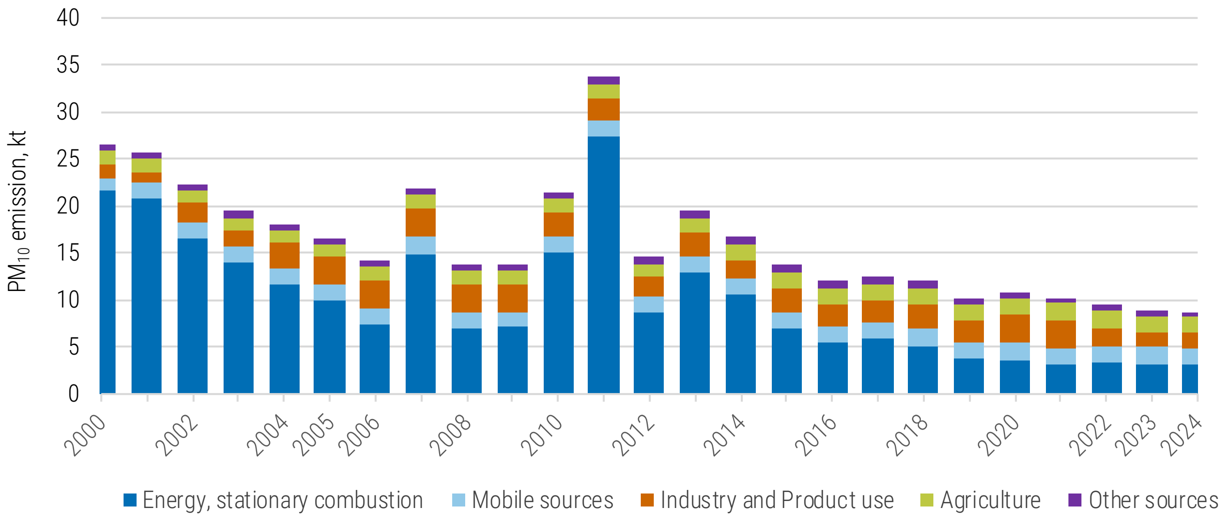

Figure 2.19 PM_{10} emissions by sources of pollution

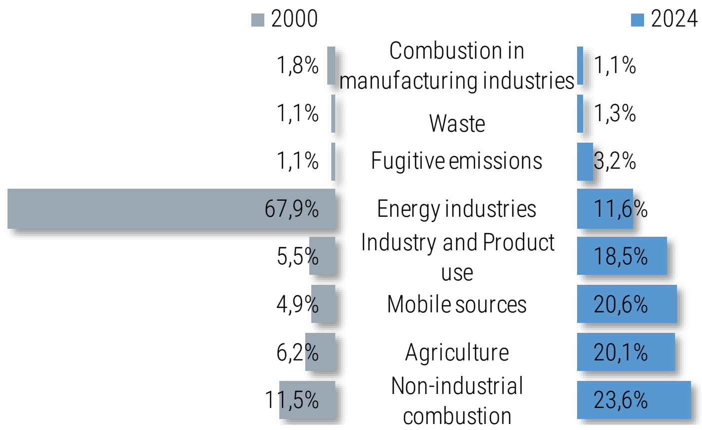

Figure 2.20 PM_{10} emissions by sources of pollution in 2000 and 2024

In 2000, the main sources of PM_{10} were the energy industry (67.9%) and non-industrial combustion (11.5%). In 2024, the dominant sources were non-industrial combustion (mainly the household sector, 23.6%), agriculture (20.1%), mobile sources (20.6%) and IPPU sector (18.5%). The share of combustion in energy industries declined to 11.6%.

The main reasons for these changes include an increase in the share of solid biomass combustion in the residential sector (due to the high emission factor of fine particulates) and the use of solid fuels in industrial combustion, the modernisation of air pollution control equipment at oil shale power plants, and a decrease in electricity production (see Figure 2.20).The contribution of other sources in total PM_{10} emission is presented in Table 2.13 and Figure 2.20.

2.2.3 Particulate matter ($PM_{2.5}$)

In 2000–2024, $PM_{2.5}$ emissions decreased by 55.9% (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. Emissions from the non-industrial combustion sector decreased by 34.3% between 2000 and 2024, despite an increase in biomass use in the residential sector. This reduction is attributable to the growing share of new high-efficiency technologies in recent years.

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

Table 2.14 $PM_{2.5}$ emissions by sector (kt), change in emissions and share of 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	Waste	Total
2000	4.70	0.36	2.93	0.78	0.20	0.41	0.19	0.29	0.29	10.15
2005	2.74	0.44	2.23	1.06	0.26	0.72	0.16	0.40	0.21	8.23
2010	5.62	0.25	2.37	0.92	0.19	0.50	0.17	0.55	0.12	10.69
2015	2.36	0.17	1.86	0.98	0.13	0.42	0.19	0.73	0.19	7.02
2020	0.83	0.06	1.96	1.08	0.08	0.45	0.20	0.32	0.12	5.11
2021	0.62	0.03	1.97	0.96	0.06	0.46	0.20	0.33	0.12	4.75
2022	0.67	0.03	2.11	0.92	0.07	0.36	0.19	0.49	0.12	4.96
2023	0.67	0.09	1.95	0.95	0.07	0.27	0.19	0.38	0.11	4.68
2024	0.64	0.07	1.93	0.96	0.07	0.26	0.19	0.25	0.11	4.48
Share in total 2000 emission, %	46.3	3.6	28.9	7.6	2.0	4.1	1.9	2.8	2.9	
Share in total 2024 emission, %	14.4	1.6	43.0	21.5	1.6	5.9	4.2	5.5	2.4	
Change 2000-2024, %	-86.3	-80.5	-34.3	24.2	-64.8	-36.3	-0.3	-15.0	-63.8	-55.9
Change 2005-2024, %	-76.5	-84.0	-13.7	-9.0	-73.0	-63.2	14.8	-39.1	-49.2	-45.6
Change 2023-2024, %	-3.4	-22.2	-1.4	1.9	2.6	-2.8	-1.6	-36.0	-3.0	-4.3

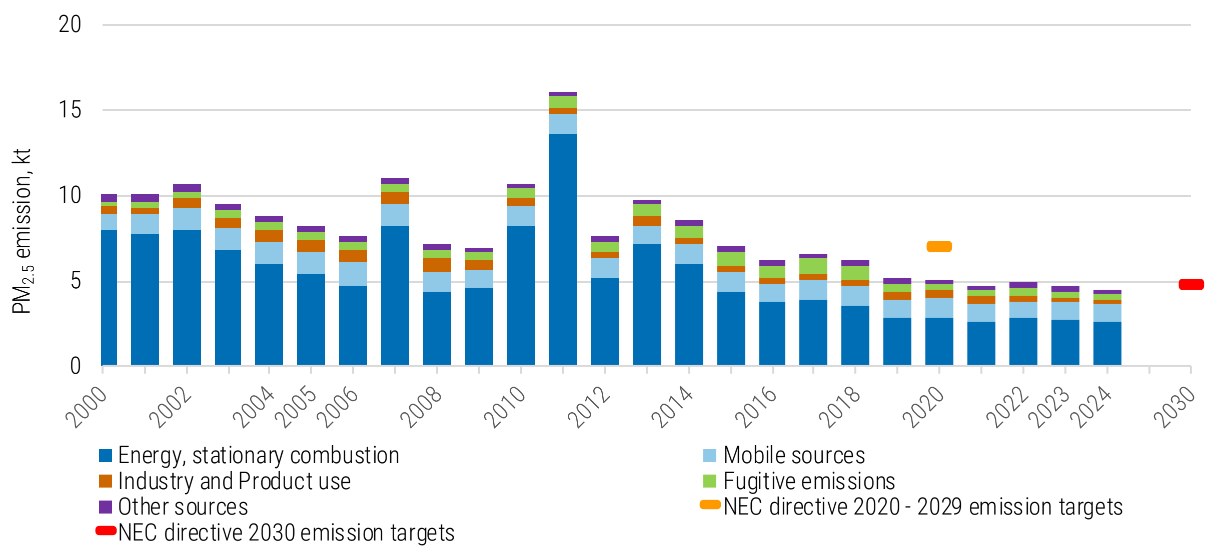

Figure 2.21 $PM_{2.5}$ emissions and NEC Directive (EU) 2016/2284 $PM_{2.5}$ targets

In 2000, the main sources of $PM_{2.5}$ were the energy industry (46.3%) and non-industrial combustion (28.9%). In 2024, the dominant source was the non-industrial combustion sector, whose share increased to 43.0% (mainly due to solid biomass combustion in the residential sector), while the share of the energy industries declined to 14.4% (see Figure 2.22). The main reasons for these changes include an increase in the share of wood combustion in the residential and industrial combustion sectors (due to the high emission factor of fine particulates), the modernisation of air pollution control equipment at oil shale power plants, and a decrease in electricity production. The contribution of other sources in total $PM_{2.5}$ emission is presented in Table 2.14 and Figure 2.22. In 2024, total $PM_{2.5}$ emissions decreased by about 4.3% compared to 2023, mainly due to lower emissions from combustion in manufacturing industries, the IPPU sector and fugitive emission sector.

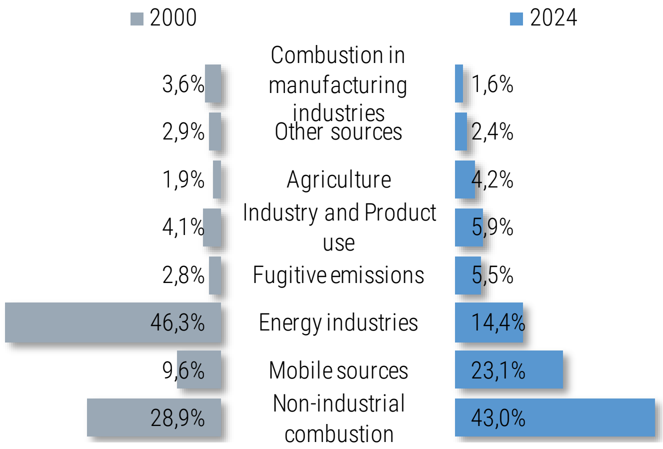

Figure 2.22 $PM_{2.5}$ emissions by sources of pollution in 2000 and 2024

Estonia fulfilled the requirements of the NEC Directive (EU) 2016/2284 and the Gothenburg Protocol under the LRTAP Convention, which required a 15% reduction in fine particulate matter ($PM_{2.5}$) emissions relative to 2005 baseline levels by 2020, already in 2015. $PM_{2.5}$ emissions decreased by 45.6% in 2024 compared to 2005 (see Table 2.15).

Table 2.15 $PM_{2.5}$ emission and compliance with NEC Directive (EU) 2016/2284 targets

National total for compliance calculations and checks (NECD)		Change 2005-2024, %	2020-2029 emission targets		2030 emission targets	
2005	2024		%	Emission, kt	%	Emission, kt
8.227	4.479	-45.6	15	6.993	41	4.854

2.2.4 Black carbon (BC)

In the period between 2000-2024, BC emissions decreased by 29.4% (see Table 2.16 and Figure 2.21). This decline was mainly due to improved efficiency of combustion plants and air pollution control equipment at oil shale power plants, as well as reduced emissions in the transport sector.

Table 2.16 BC emissions by sector (kt), change in emissions and share of 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	Fugitive emissions	Waste	Total
2000	0.148	0.049	0.991	0.214	0.108	0.029	0.000	0.000	1.539
2005	0.119	0.064	0.744	0.295	0.148	0.038	0.000	0.000	1.408
2010	0.171	0.035	0.898	0.224	0.113	0.019	0.000	0.000	1.460
2015	0.089	0.025	0.729	0.196	0.077	0.024	0.000	0.000	1.141
2020	0.081	0.007	0.823	0.162	0.047	0.019	0.000	0.000	1.138
2021	0.058	0.004	0.832	0.147	0.035	0.019	0.000	0.000	1.095
2022	0.061	0.005	0.904	0.137	0.041	0.018	0.000	0.000	1.166
2023	0.076	0.013	0.840	0.122	0.039	0.017	0.000	0.000	1.107
2024	0.075	0.011	0.831	0.115	0.040	0.016	0.000	0.000	1.087
Share in total 2000 emission, %	9.6	3.2	64.4	13.9	7.0	1.9		0.0001	
Share in total 2024 emission, %	6.9	1.0	76.4	10.6	3.6	1.4	0.0002	0.0001	
Change 2000-2024, %	**-49.7**	**-76.8**	**-16.2**	**-46.2**	**-63.4**	**-45.3**		**-34.7**	**-29.4**
Change 2023-2024, %	**-1.8**	**-10.1**	**-1.1**	**-5.9**	**2.6**	**-9.4**	**-33.3**	**0.0**	**-1.8**

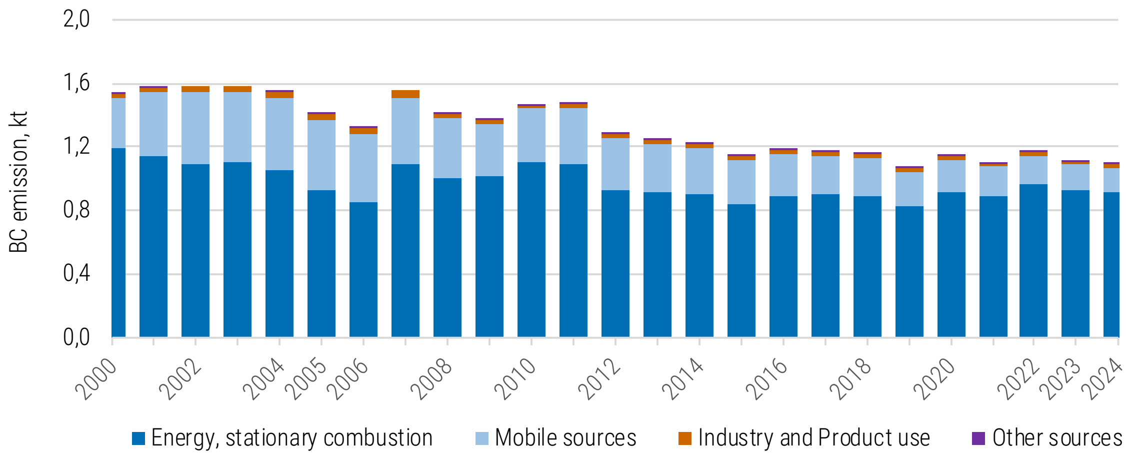

Figure 2.23 BC emissions by sources of pollution

In 2024, BC emissions decreased by 1.8% in comparison to 2023, mainly due to lower emissions from combustion in manufacturing industries, the IPPU sector and road transport.

The key sources of BC emissions in 2024 were non-industrial combustion (76.4%, mainly wood combustion), mobile sources (14.2%) and combustion in the energy and transformation industries (6.9%) (see Figure 2.24). Other sources mainly include fugitive emissions from the fuel and waste sectors, and their contribution is negligible.

The sectoral distribution of BC emissions is also presented in Table 2.16.

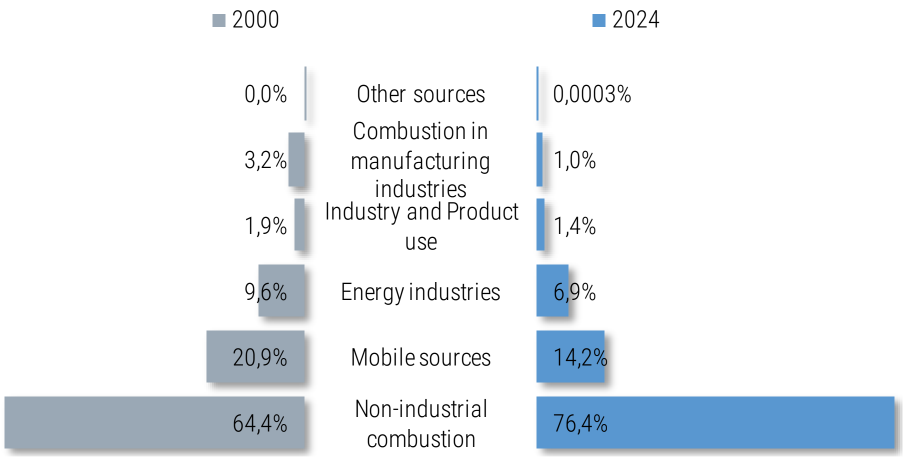

Figure 2.24 BC emissions by sources of pollution in 1990 and 2024

2.3. Heavy Metals

This chapter describes changes in heavy metal emissions from 1990 to 2024. Emissions of all substances decreased significantly over the entire period (see Table 2.17 and Figures 2.25–2.27). Heavy metals are mainly emitted from combustion in the energy and transformation industries and from mobile sources. Stationary combustion is the key source of heavy metal emissions in Estonia.

Substance-specific trends, key sources and the reasons for the decreases are described below.

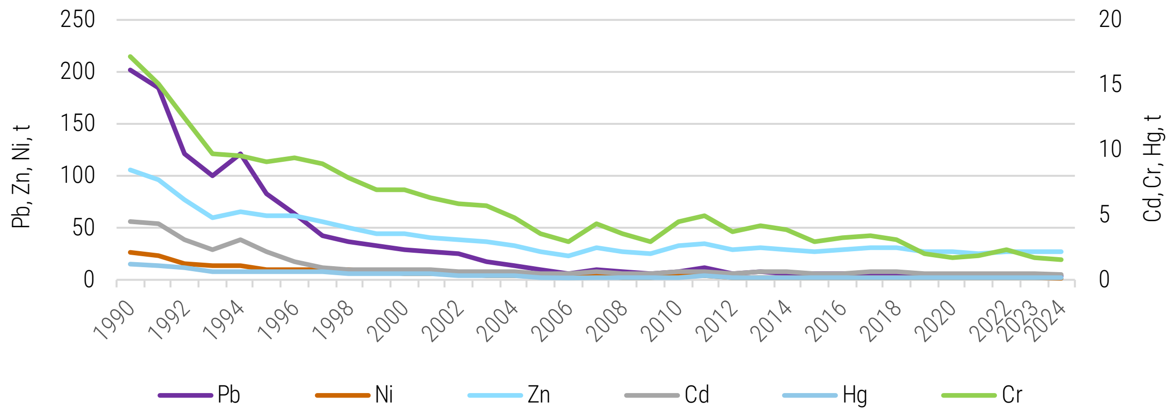

Figure 2.25 Heavy metals emissions

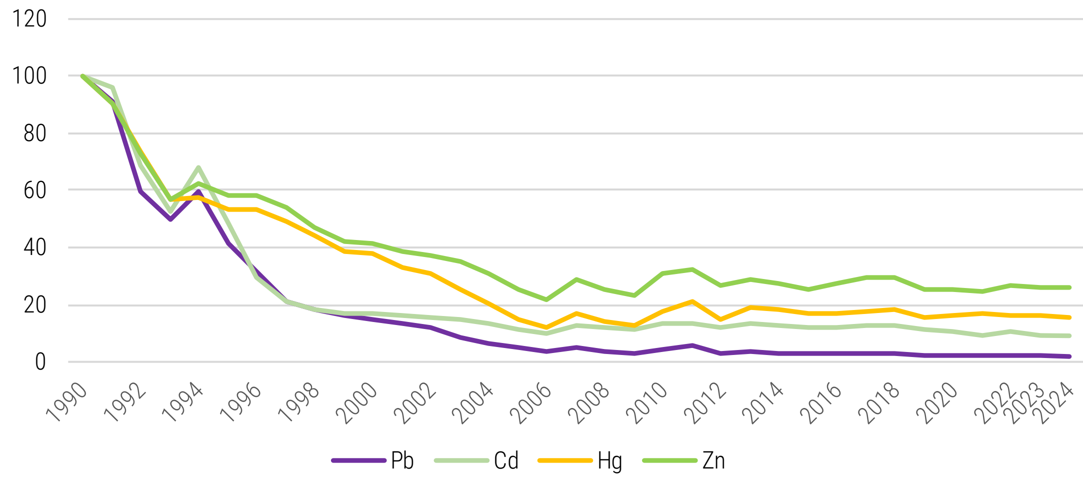

Figure 2.26 Indexed of heavy metals emissions (1990=100)

Table 2.17 Heavy metals emissions (t)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1990	201.84	4.48	1.21	19.80	17.18	16.47	26.41	9.21	105.70
1991	184.51	4.29	1.09	17.42	15.14	14.99	23.53	8.16	95.46
1992	120.55	3.08	0.89	14.17	12.44	9.25	15.79	6.94	77.24
1993	100.49	2.35	0.69	11.05	9.69	8.57	14.53	5.36	60.44
1994	120.48	3.05	0.69	10.69	9.61	10.16	13.18	5.26	65.63
1995	83.01	2.18	0.64	9.74	9.04	9.03	10.02	4.91	61.38
1996	64.36	1.33	0.65	10.11	9.43	8.80	10.55	5.10	61.43

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Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
1997	42.73	0.95	0.60	9.31	8.94	8.99	9.73	4.78	56.83
1998	37.32	0.84	0.54	8.25	7.91	8.69	8.98	4.26	49.92
1999	32.64	0.77	0.47	6.92	6.99	8.19	7.89	3.63	44.76
2000	29.94	0.76	0.46	6.71	6.91	8.32	6.09	3.63	44.02
2001	27.11	0.72	0.40	5.61	6.28	9.82	5.64	3.16	41.03
2002	24.57	0.69	0.37	4.98	5.92	10.04	5.24	2.91	39.32
2003	17.22	0.66	0.31	3.84	5.72	10.21	4.65	2.54	36.84
2004	13.30	0.60	0.25	2.75	4.78	10.38	4.02	1.97	32.52
2005	9.48	0.51	0.18	1.73	3.59	10.46	3.36	1.43	26.95
2006	6.70	0.45	0.15	1.00	3.00	11.12	2.64	1.17	22.98
2007	10.06	0.58	0.21	1.95	4.38	12.47	3.30	1.78	30.55
2008	7.63	0.53	0.17	1.20	3.48	11.96	2.87	1.29	27.04
2009	6.42	0.50	0.15	0.91	2.87	10.80	2.41	1.00	24.36
2010	8.70	0.59	0.21	2.02	4.51	11.97	3.35	1.79	32.72
2011	11.38	0.60	0.26	2.78	4.97	12.32	3.65	2.10	34.46
2012	6.53	0.53	0.18	1.31	3.74	12.41	2.93	1.41	28.20
2013	7.12	0.60	0.23	1.38	4.11	12.69	2.92	1.49	30.16
2014	6.57	0.57	0.23	1.20	3.78	13.16	2.66	1.37	28.98
2015	5.34	0.54	0.20	0.94	2.94	12.95	2.57	1.05	26.64
2016	5.55	0.55	0.21	1.05	3.25	13.65	2.78	1.18	29.06
2017	5.71	0.57	0.22	1.08	3.45	14.25	2.77	1.30	30.96
2018	5.59	0.56	0.22	0.97	3.16	14.65	2.47	1.21	31.57
2019	4.92	0.50	0.19	0.62	2.00	13.87	1.86	0.74	26.89
2020	4.24	0.48	0.20	0.52	1.69	13.05	1.71	0.57	26.47
2021	4.21	0.43	0.21	0.54	1.92	13.92	1.70	0.59	25.87
2022	4.49	0.46	0.20	0.68	2.29	14.47	2.13	0.72	27.93
2023	3.87	0.42	0.20	0.48	1.66	13.89	1.78	0.51	27.66
2024	3.77	0.41	0.19	0.43	1.55	13.69	1.53	0.46	27.27
Change 1990-2024, %	-98.1	-90.9	-84.6	-97.8	-91.0	-16.9	-94.2	-95.0	-74.2
Change 2023-2024, %	-2.6	-2.3	-4.6	-9.6	-6.7	-1.5	-13.8	-9.5	-1.4

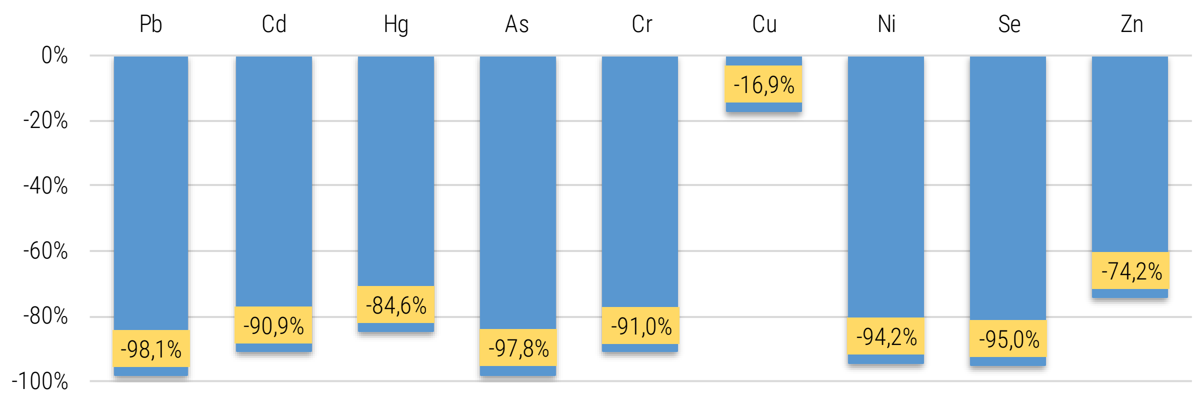

Figure 2.27 Reduction of heavy metals emissions

2.3.1 Priority heavy metals (Pb, Cd and Hg)

2.3.1.1 Lead (Pb)

In the period between 1990-2024, the emissions of lead decreased by 98.1% due to the modernisation of air pollution control equipment at the Narva oil shale power plants and Kunda Nordic Cement, as well as a reduction in energy production (see Table 2.18 and Figure 2.28 A further contributing factor was the discontinuation of leaded petrol use in Estonia in 2000 (see Figure 2.29), which resulted in a 98.2% reduction in lead emissions from road transport.

Table 2.18 Pb emissions by sector (t), change in emissions and share of 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	62.30	2.88	73.98	4.83	0.01	0.000	201.84
1995	29.90	25.32	3.11	24.20	0.46	0.02	0.001	83.01
2000	20.56	0.62	3.21	5.38	0.08	0.09	0.001	29.94
2005	3.61	0.20	2.61	2.76	0.03	0.27	0.002	9.48
2010	4.58	0.12	2.73	1.01	0.02	0.23	0.001	8.70
2015	1.74	0.09	2.05	1.14	0.03	0.30	0.003	5.34
2020	1.05	0.07	1.75	1.25	0.03	0.09	0.003	4.24
2021	0.85	0.02	1.69	1.31	0.02	0.31	0.003	4.21
2022	1.04	0.02	1.67	1.34	0.02	0.39	0.003	4.49
2023	0.70	0.06	1.57	1.34	0.02	0.18	0.003	3.87
2024	0.63	0.03	1.52	1.33	0.03	0.23	0.003	3.77
Share in total 1990 emission, %	28.7	30.9	1.4	36.7	2.4	0.0	0.000	
Share in total 2024 emission, %	16.8	0.9	40.3	35.3	0.7	6.0	0.1	
Change 1990-2024, %	**-98.9**	**-99.9**	**-47.2**	**-98.2**	**-99.5**	**1 460.1**	**556.3**	**-98.1**
Change 2023-2024, %	**-9.9**	**-40.8**	**-3.0**	**-0.7**	**6.5**	**23.9**	**1.3**	**-2.6**

Lead emissions by sector in 1990 and 2024 are presented in Table 2.18 and Figure 2.30.

The sectoral distribution of emissions has changed considerably over the last 34 years. In 1990, the main sources of lead emissions were road transport (39.0%), industrial combustion (30.9%, mainly cement manufacturing) and the energy industries (28.7%). In 2024, the dominant source was non-industrial combustion (40.3%), of which the residential sector accounted for 98% (mainly waste incineration). The second largest source was mobile sources (35.9%), followed by the energy industries (16.8%, mainly oil shale power plants) (see Figure 2.30 and Table 2.18).

The significant decline in the share of the industrial combustion sector (from 30.9% to 0.9%) is mainly attributable to the termination of clinker production. In the IPPU sector, the main source of Pb emissions is the use of fireworks.

Emissions decreased by 1.4% in 2024 compared to 2023, mainly due to reduced combustion in manufacturing industries, which was partly associated with a decrease in electricity generation from shale power plants.

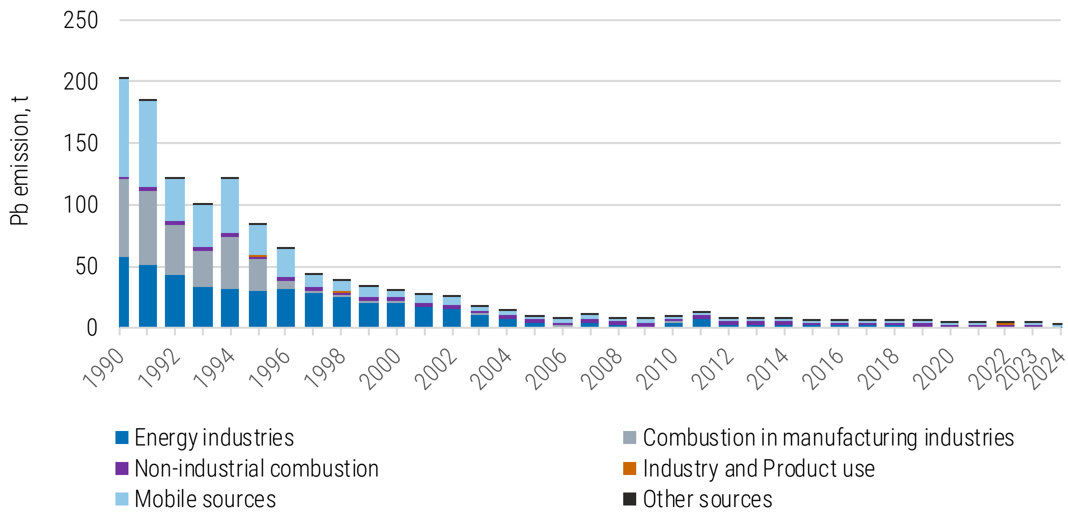

Figure 2.28 Pb emissions by sources of pollution

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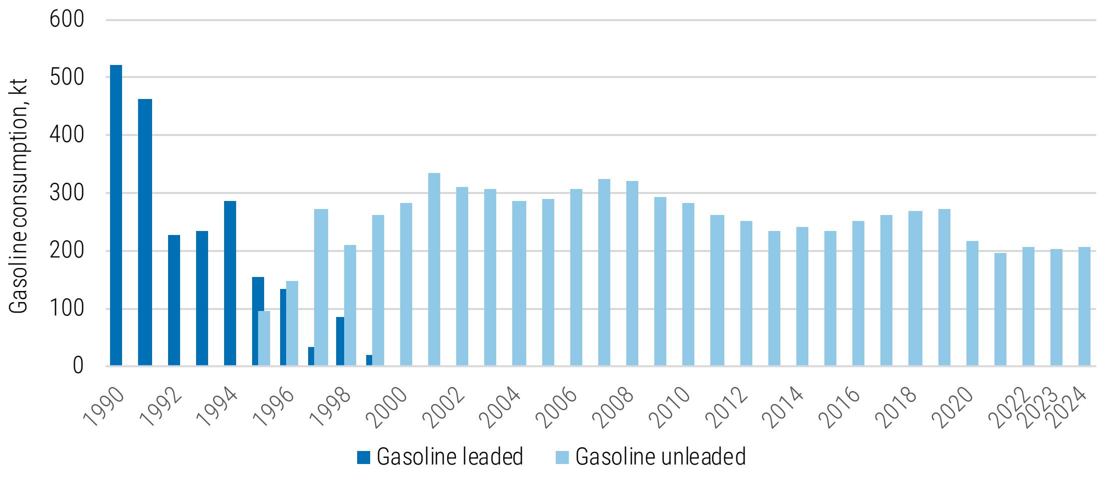

Figure 2.29 Gasoline consumption

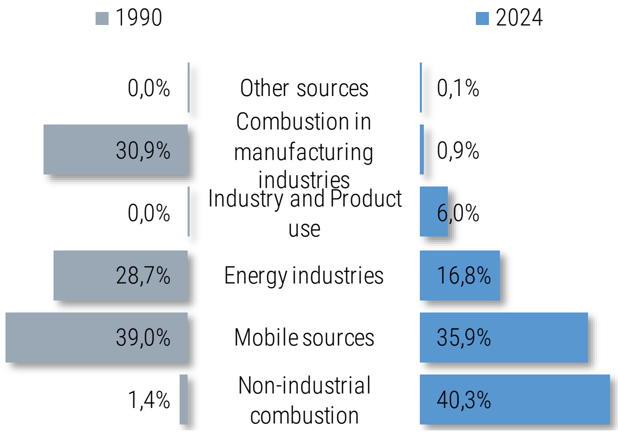

Figure 2.30 Pb emission by sources of pollution in the period of 1990 and 2024

2.3.1.2 Cadmium (Cd)

In the period between 1990-2024, cadmium emissions decreased by 90.9%, mainly due to the modernisation of air pollution control equipment at the Narva power plants and Kunda Nordic Cement, as well as a reduction 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 of 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	3.27	0.19	0.004	0.002	0.033	0.000	4.48
1995	0.53	1.34	0.29	0.003	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	0.004	0.001	0.019	0.001	0.51
2010	0.20	0.04	0.33	0.004	0.001	0.013	0.001	0.59
2015	0.20	0.04	0.28	0.005	0.001	0.017	0.001	0.54
2020	0.17	0.01	0.28	0.005	0.001	0.016	0.001	0.48
2021	0.13	0.01	0.27	0.006	0.001	0.016	0.001	0.43
2022	0.14	0.01	0.28	0.006	0.001	0.016	0.001	0.46
2023	0.13	0.01	0.26	0.006	0.001	0.016	0.001	0.42

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
2024	0.12	0.01	0.25	0.006	0.001	0.015	0.001	0.41
Share in total 1990 emission, %	22.0	72.8	4.2	0.1	0.0	0.7	0.00	
Share in total 2024 emission, %	28.9	3.4	62.1	1.4	0.2	3.7	0.2	
Change 1990-2024, %	-88.0	-99.6	34.3	34.1	-55.7	-55.0	2 083.5	-90.9
Change 2023-2024, %	-5.5	-2.3	-0.6	-0.2	2.9	-4.9	-1.7	-2.3

Cadmium emissions by sector in 1990 and 2024 are presented in Table 2.19 and Figure 2.32.

The sectoral distribution of emissions changed considerably over this period. In 1990, the main sources of cadmium emissions were combustion in manufacturing industries (72.8%, mainly cement production) and the energy industries (22%). In 2024, the dominant sources were non-industrial combustion (62.1%, mainly wood combustion in the residential heating sector) and the energy industries (28.9%, mainly oil shale power plants).

Emissions decreased by 2.3% in 2024 compared to 2023, mainly due to reduced energy industries, which was partly associated with a decrease in electricity generation from shale power plants.

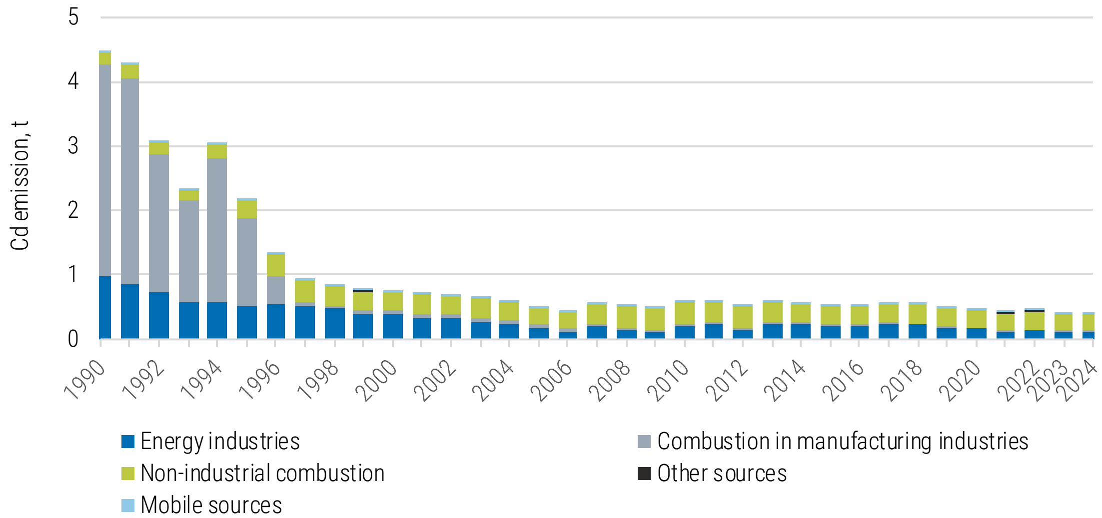

Figure 2.31 Cd emissions by sources of pollution

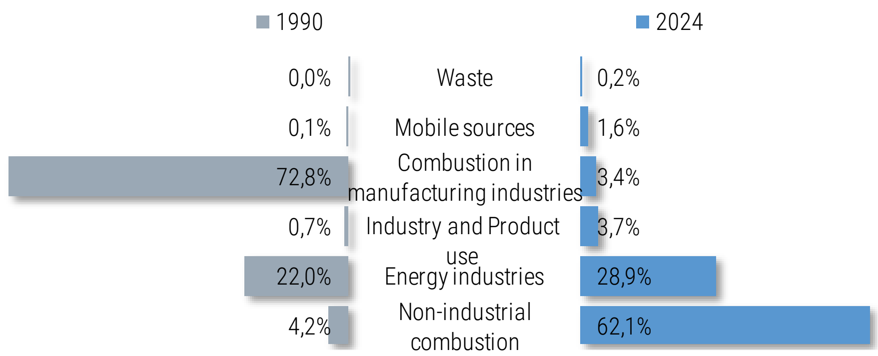

Figure 2.32 Cd emission by sources of pollution in the period of 1990 and 2024

2.3.1.3 Mercury (Hg)

In the period between 1990-2024, mercury emissions decreased by 84.6%, mainly due to the modernisation of air pollution control equipment at the Narva power plants and Kunda Nordic Cement, as well as a reduction 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 of 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
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	0.117	0.001	0.042	0.005	0.000	0.000	0.032	0.197
2023	0.111	0.003	0.040	0.005	0.000	0.000	0.036	0.195
2024	0.105	0.002	0.038	0.005	0.000	0.000	0.036	0.186
Share in total 1990 emission, %	84.4	7.6	7.4	0.4	0.1	0.0	0.1	
Share in total 2024 emission, %	56.4	1.0	20.6	2.5	0.1	0.0	19.4	
Change 1990-2024, %	-89.7	-98.0	-57.0	-12.4	-85.5	-93.4	5 514.4	-84.6
Change 2023-2024, %	-5.7	-39.9	-3.0	0.4	0.0	22.7	-1.1	-4.6

Mercury emissions by sector in 1990 and 2024 are presented in Table 2.20 and Figures 2.33 and 2.34.

The sectoral distribution of emissions changed over this period. In 1990, the energy industries were the main source of mercury emissions (84.4%, mainly oil shale power plants). By 2024, their share had decreased to 56.4%, while non-industrial combustion became another key source (20.6%, mainly residential combustion). The share of the waste sector was 19.4% (mainly cremation). The contribution of other sources (combustion in manufacturing industries, the IPPU sector and mobile sources) in 2024 was not significant.

Emissions decreased by 4.6% in 2024 compared to 2023, mainly due to reduced energy industries, which was partly associated with a decrease in electricity generation from shale power plants.

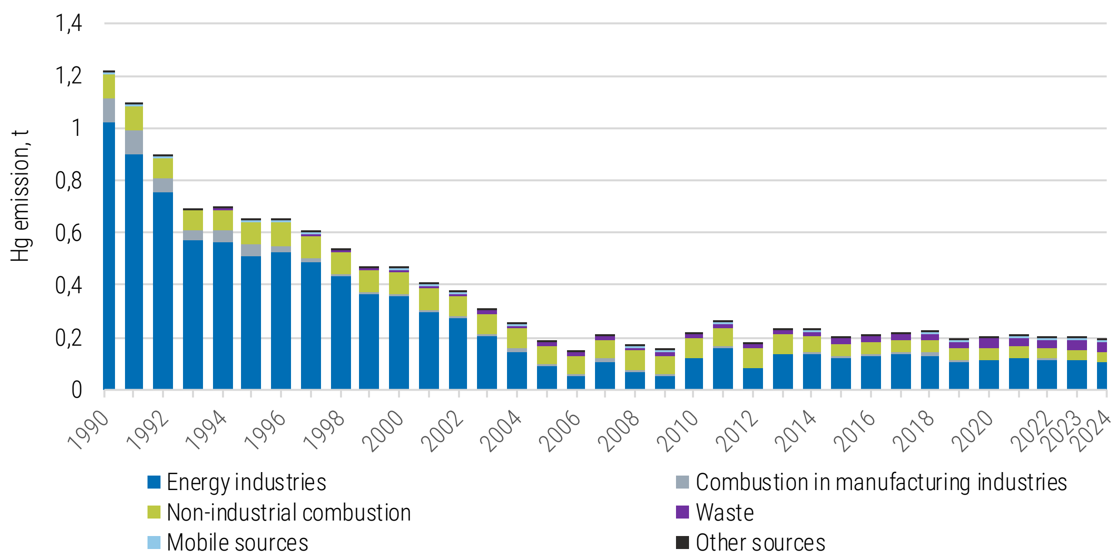

Figure 2.33 Hg emissions by sources of pollution

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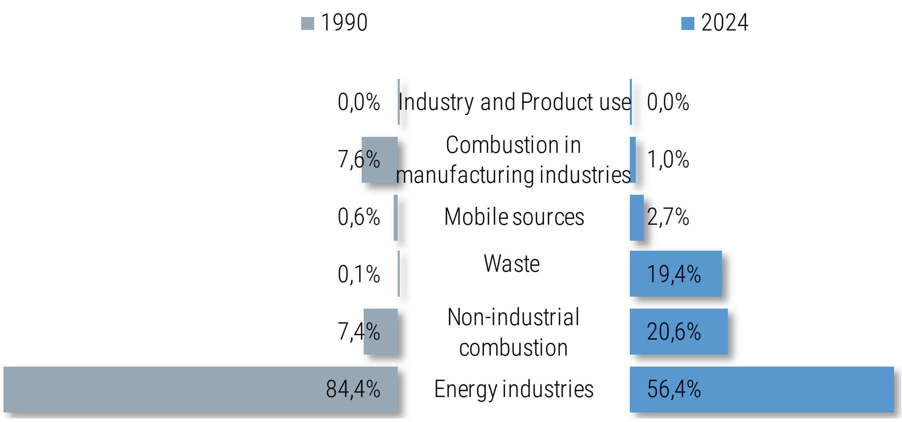

Figure 2.34 Hg emission by sources of pollution in the period of 1990 and 2024

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

In the period between 1990-2024, emissions of As, Cr, Cu, Ni, Se and Zn decreased by 97.8%, 91.0%, 16.9%, 94.2%, 95.0% and 74.2%, respectively, mainly due to the modernisation of air pollution control equipment at the Narva power plants and Kunda Nordic Cement, as well as a reduction in energy and clinker production (see Table 2.12 and Figure 2.35).

Emissions of the remaining heavy metals by sector in 1990 and 2024 are presented in Figure 2.35.

The energy industries are the main source of emissions for most heavy metals. Copper is an exception, as its main source is road transport, primarily due to tyre and brake wear.

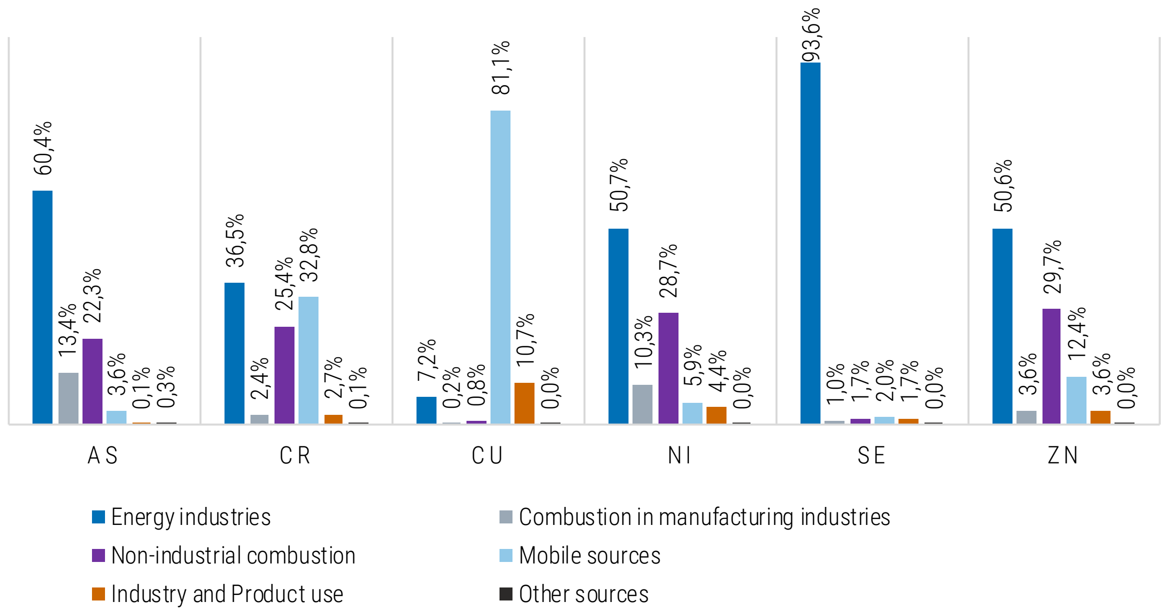

Figure 2.35 Other heavy metals emission by sources of pollution in 2024

2.4. Persistent Organic Pollutants (POPs)

This chapter describes the changes in emissions of persistent organic pollutants from 1990 to 2024.

In this period, dioxin, PAHs total, HCB and PCB emissions decreased by approximately 59.6%, 63.9%, 13% and 91.5% respectively (see Table 2.21, figures 2.36 - 2.38).

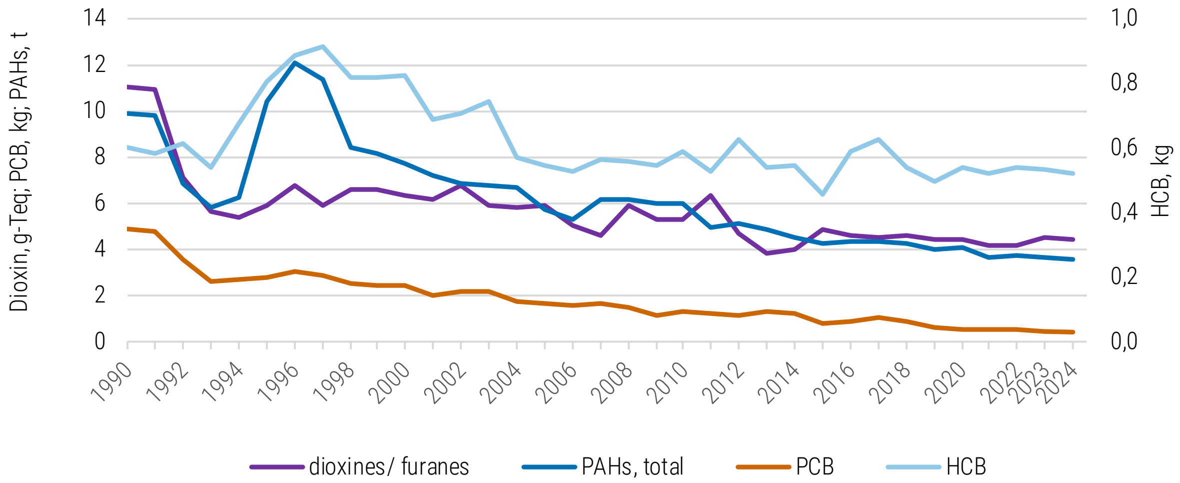

Figure 2.36 Persistent organic pollutants emissions

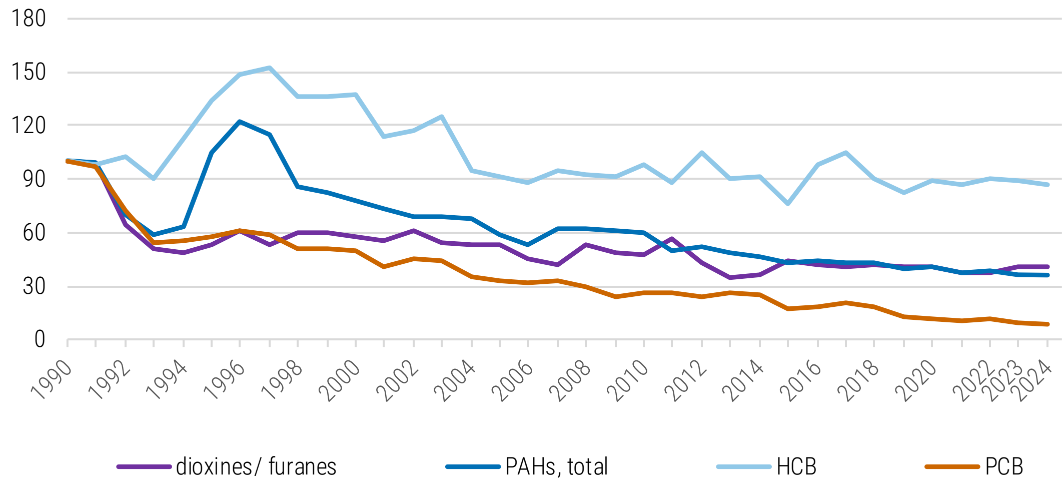

Figure 2.37 Indexed of persistent organic pollutants emissions (1990=100)

This chapter describes changes in emissions of persistent organic pollutants from 1990 to 2024.

During this period, emissions of dioxines, total PAHs, HCB and PCBs decreased by approximately 59.6%, 63.9%, 13.0% and 91.5%, respectively (see Table 2.21 and Figures 2.36–2.38).

Table 2.21 POPs emission

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	2.82	3.58	1.70	1.79	9.89	0.60	4.88
1991	10.92	2.81	3.57	1.68	1.77	9.84	0.59	4.75

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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	
1992	7.11	1.95	2.32	1.20	1.41	6.88	0.61	3.53
1993	5.66	1.63	1.87	1.03	1.28	5.81	0.54	2.65
1994	5.39	1.75	1.84	1.13	1.55	6.27	0.67	2.71
1995	5.87	2.88	2.89	1.87	2.73	10.37	0.80	2.79
1996	6.76	3.36	3.42	2.17	3.14	12.09	0.89	3.00
1997	5.90	3.15	3.09	2.06	3.06	11.36	0.91	2.88
1998	6.63	2.34	2.27	1.54	2.29	8.44	0.82	2.51
1999	6.63	2.26	2.23	1.47	2.18	8.14	0.82	2.47
2000	6.32	2.15	2.08	1.40	2.10	7.74	0.82	2.43
2001	6.13	2.00	1.93	1.31	1.96	7.20	0.69	2.01
2002	6.74	1.90	1.87	1.23	1.81	6.82	0.70	2.21
2003	5.95	1.89	1.82	1.23	1.85	6.80	0.75	2.15
2004	5.85	1.88	1.85	1.21	1.77	6.71	0.57	1.73
2005	5.89	1.62	1.62	1.04	1.49	5.77	0.55	1.62
2006	5.03	1.48	1.45	0.95	1.39	5.28	0.53	1.53
2007	4.59	1.73	1.63	1.12	1.70	6.18	0.56	1.61
2008	5.91	1.73	1.65	1.12	1.69	6.18	0.56	1.47
2009	5.33	1.68	1.56	1.09	1.68	6.01	0.55	1.14
2010	5.26	1.67	1.56	1.08	1.65	5.96	0.59	1.26
2011	6.30	1.40	1.32	0.90	1.35	4.97	0.52	1.26
2012	4.72	1.43	1.33	0.92	1.40	5.09	0.63	1.16
2013	3.83	1.37	1.31	0.87	1.29	4.84	0.54	1.28
2014	4.01	1.29	1.23	0.82	1.22	4.56	0.55	1.23
2015	4.83	1.22	1.16	0.77	1.15	4.30	0.46	0.83
2016	4.64	1.23	1.16	0.78	1.17	4.34	0.59	0.90
2017	4.55	1.22	1.16	0.77	1.15	4.30	0.63	1.01
2018	4.63	1.20	1.15	0.75	1.12	4.23	0.54	0.90
2019	4.46	1.12	1.08	0.70	1.05	3.96	0.50	0.63
2020	4.45	1.16	1.12	0.72	1.06	4.06	0.54	0.56
2021	4.17	1.04	0.98	0.65	0.97	3.65	0.52	0.50
2022	4.17	1.07	1.02	0.67	1.00	3.76	0.54	0.57
2023	4.52	1.04	1.04	0.64	0.92	3.64	0.53	0.44
2024	4.46	1.02	1.02	0.63	0.90	3.57	0.52	0.41
Change 1990-2024, %	-59.6	-63.7	-71.4	-62.8	-49.4	-63.9	-13.0	-91.5
Change 1995-2024, %	-24.1	-64.4	-64.6	-66.3	-66.9	-65.6	-35.1	-85.2
Change 2023-2024, %	-1.5	-1.8	-1.7	-0.7	-1.5	-1.9	-1.9	-5.8

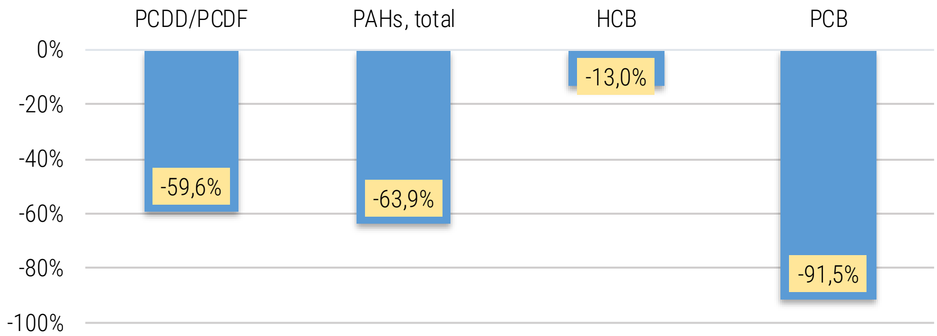

Figure 2.38 Reduction of persistent organic pollutants emissions

2.4.1 Dioxins/Furans (PCDD/PCDF)

In the period between 1990 and 2024, dioxin emissions decreased by 59.6%, mainly due to reduced production of energy and mineral products, as well as a decrease in the amount of incinerated waste.

One of the reasons for the significant decline in emissions between 1990 and 1994 was the reduction in coal and peat consumption in the residential sector, as the emission factor for dioxins from these fuels is considerably higher in domestic stoves than for the combustion of other fuels.

The increase in wood consumption in the same sector led to a rise in emissions from 1995 onwards. The increase in dioxin emissions between 2008 and 2011 was also associated with a higher share of solid biomass combustion in the energy industries (see Table 2.21 and Figure 2.39).

Table 2.22 PCDD/PCDF emissions by sector (g I-TEQ), change in emissions and share of 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	0.32	0.001	0.06	1.22	5.26
2015	1.55	0.46	0.57	0.32	0.001	0.03	1.89	4.83
2020	2.36	0.09	0.48	0.27	0.001	0.03	1.21	4.45
2021	2.17	0.08	0.45	0.24	0.001	0.03	1.20	4.17
2022	2.17	0.10	0.46	0.22	0.001	0.03	1.19	4.17
2023	2.63	0.21	0.37	0.20	0.001	0.03	1.08	4.52
2024	2.62	0.21	0.36	0.18	0.001	0.03	1.05	4.46
Share in total 1990 emission, %	19.4	10.6	57.4	2.5	0.2	0.1	9.6	
Share in total 2024 emission, %	58.9	4.6	8.2	4.0	0.0	0.8	23.5	
Change 1990-2024, %	22.5	-82.4	-94.3	-36.3	-96.5	128.2	-1.3	-59.6
Change 2023-2024, %	-0.2	-2.8	-1.8	-8.4	0.0	5.3	-3.3	-1.5

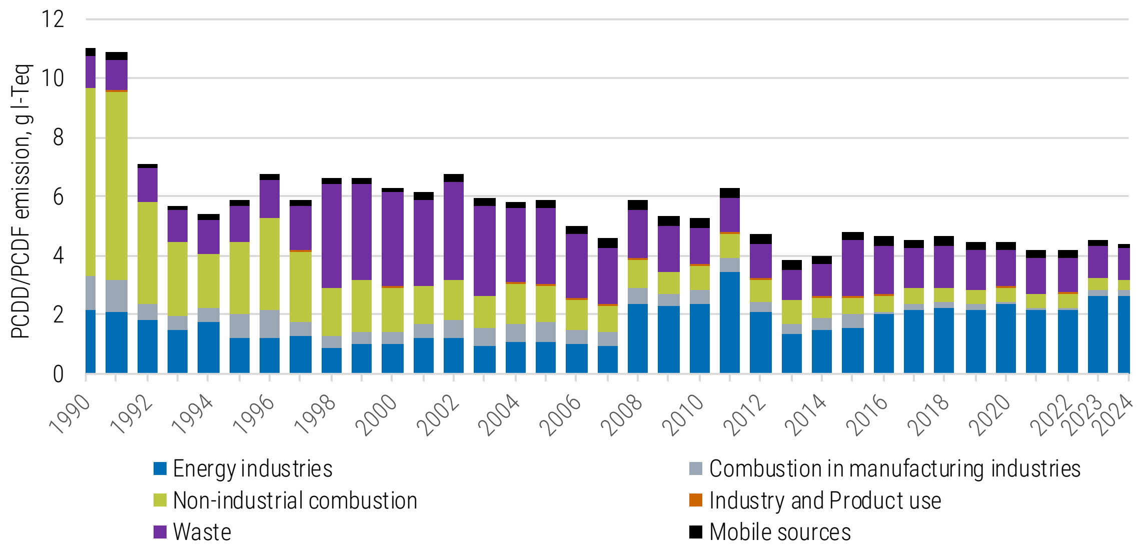

Figure 2.39 PCDD/PCDF emissions by sources of pollution

The main sources of dioxin emissions in 2024 were combustion in the energy industries (58.9%, including waste used as fuel), the waste sector (23.5%, mainly unintentional car and building fires) and the non-industrial combustion sector (8.2%). The contribution of other sources was not significant (see Figure 2.40).

In 2024, dioxin emissions decreased slightly compared to 2023.

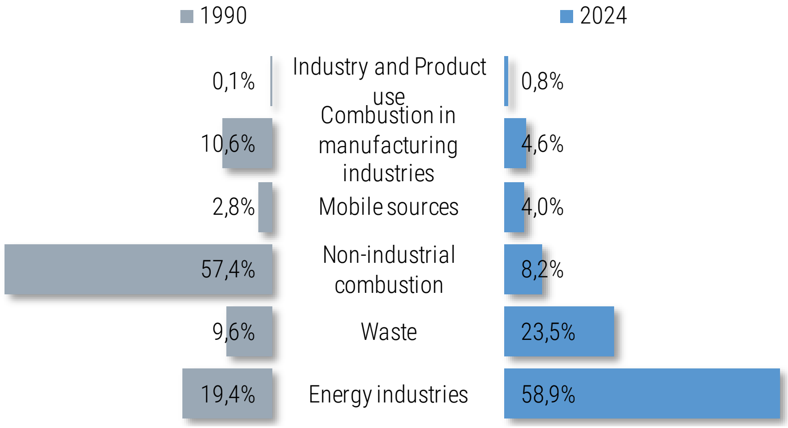

Figure 2.40 PCDD/PCDF emission by sources of pollution in the period of 1990 and 2024

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 of each substance for the period 1990–2024 are presented in Table 2.21.

In this chapter, the sum of these four substances (total PAHs) is analysed.

Between 1990 and 2024, PAH emissions decreased by 63.9%, mainly due to a reduction in electricity and heat production in the energy industries. One of the reasons for the significant decline in emissions between 1991 and 1994 was the decrease in coal and peat consumption in the residential sector, as the emission factor for PAHs from these fuels is considerably higher in domestic stoves than for the combustion of other fuels (see Table 2.21).

The increase in wood consumption in the same sector led to higher emissions from 1995 onwards. It should also be noted that emissions from the non-industrial combustion sector decreased between 2000 and 2024, despite an increase in biomass use in the residential sector. This reduction is attributable to the growing share of new high-efficiency technologies in recent years (see Figure 2.41).

Table 2.23 PAHs emissions by sector (t), change in emissions and share of 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	0.38	8.65	0.04	0.034	0.001	0.031	9.89
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

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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
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	4.30
2020	0.59	0.09	3.30	0.06	0.010	0.000	0.007	4.06
2021	0.44	0.04	3.09	0.06	0.007	0.000	0.007	3.65
2022	0.47	0.04	3.17	0.06	0.008	0.000	0.007	3.76
2023	0.67	0.12	2.77	0.06	0.008	0.000	0.006	3.64
2024	0.73	0.08	2.67	0.06	0.008	0.000	0.006	3.57
Share in total 1990 emission, %	7.6	3.9	87.5	0.4	0.3	0.0	0.3	
Share in total 2024 emission, %	20.5	2.3	75.0	1.8	0.2	0.0	0.2	
Change 1990-2024, %	**-2.5**	**-78.2**	**-69.1**	**44.4**	**-76.7**	**-69.0**	**-79.7**	**-63.9**
Change 2023-2024, %	**9.5**	**-29.8**	**-3.6**	**0.6**	**2.8**	**-10.7**	**-3.7**	**-1.9**

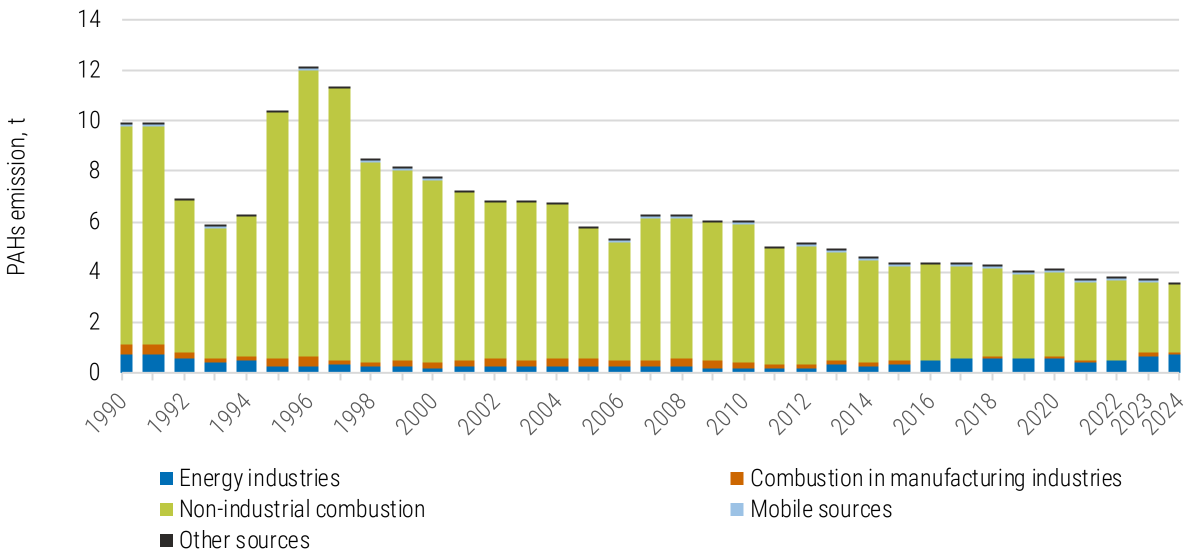


Figure 2.41 PAHs emissions by sources of pollution

Non-industrial combustion was the key source of total PAH emissions in 2024 (75.0%), mainly due to solid biomass combustion in the residential sector. The share of the energy industries was 20.5%. The contribution of other sources was insignificant (see Table 2.23 and Figure 2.42).

In 2024, PAH emissions decreased slightly compared to 2023.

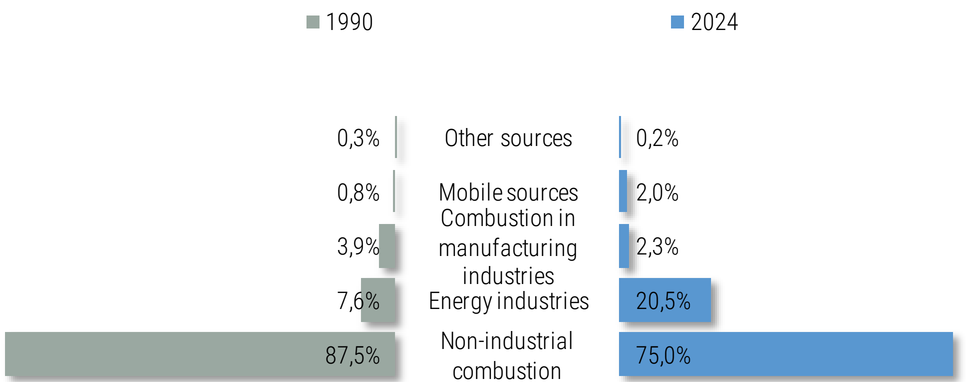


Figure 2.42 PAHs emission by sources of pollution in the period of 1990 and 2024

2.4.3 Hexachlorobenzene (HCB)

During the period of 1990–2024, HCB emissions decreased by about 13.9%, largely due to a reduction in the amount of openly burned waste. However, during the same period, emissions from the energy industries and the non-industrial combustion sector increased by 43.8% and 65.8%, respectively, as a result of increased biomass use. In 2024, HCB emissions decreased slightly compared to 2023.

Table 2.24 HCB emissions by sector (kg), change in emissions and share of 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	5 Waste	Total
1990	0.127	0.007	0.101	0.0002	0.001	0.000	0.056	0.307	0.599
1995	0.077	0.020	0.230	0.0001	0.001	0.000	0.056	0.419	0.803
2000	0.079	0.021	0.208	0.0002	0.001	0.000	0.056	0.459	0.823
2005	0.095	0.031	0.173	0.0003	0.001	0.000	0.056	0.190	0.545
2010	0.144	0.025	0.228	0.0003	0.001	0.002	0.056	0.131	0.587
2015	0.137	0.023	0.184	0.0003	0.001	0.002	0.025	0.084	0.456
2020	0.174	0.004	0.189	0.0003	0.001	0.001	0.035	0.133	0.537
2021	0.181	0.003	0.182	0.0002	0.001	0.002	0.030	0.124	0.523
2022	0.186	0.004	0.190	0.0002	0.001	0.002	0.041	0.115	0.538
2023	0.186	0.010	0.169	0.0002	0.001	0.002	0.037	0.127	0.531
2024	0.182	0.009	0.168	0.0002	0.001	0.002	0.038	0.122	0.521
Share in total 1990 emission, %	21.1	1.2	16.9	0.0	0.3			51.2	
Share in total 2024 emission, %	34.9	1.8	32.2	0.03	0.1	0.3	7.2	23.4	
Change 1990-2024, %	**43.8**	**29.2**	**65.8**	**-11.7**	**-62.0**			**-60.3**	**-13.0**
Change 2023-2024, %	**-2.1**	**-1.0**	**-0.8**	**-8.5**	**0.0**	**3.0**	**0.8**	**-3.9**	**-1.9**

The key sources of HCB emissions in 2024 were the energy industries, the non-industrial combustion sector and the waste sector (34.9%, 32.2% and 23.4%, respectively). Other sources accounted for only 9% of total emissions (see Table 2.24 and Figures 2.43–2.44).

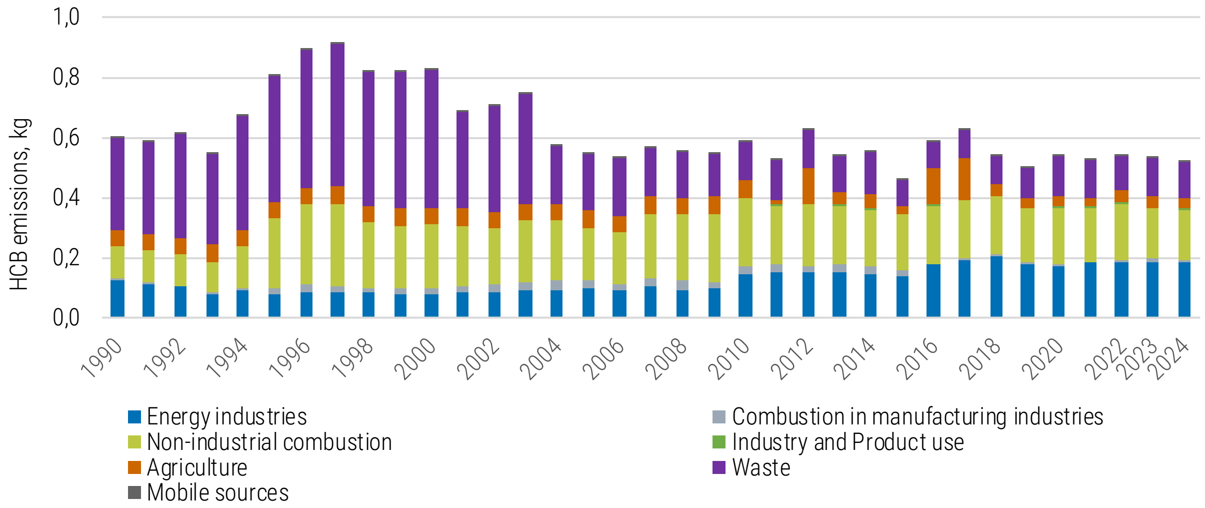


Figure 2.43 HCB emissions by sources of pollution

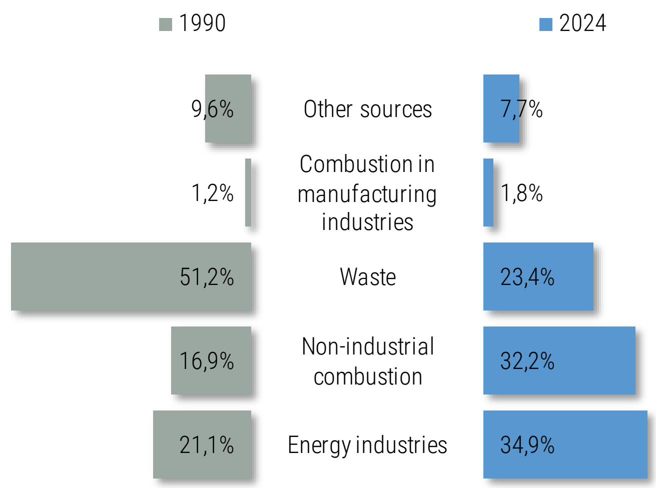


Figure 2.44 HCB emission by sources of pollution in the period of 1990 and 2024

2.4.4 Polychlorinated biphenyls (PCB)

During the period of 1990–2024, PCB emissions decreased by 91.5%, mainly due to a reduction in energy production as well as a decrease in the amount of openly burned waste. A significant decline in emissions between 1990 and 1994 was also observed as a result of reduced coal and peat consumption in the energy sector (see Tables 2.21 and 2.25 and Figure 2.45).

Table 2.25 PCB emissions by sector (kg), change in emissions and share of 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	0.0209	0.00006	0.96	4.88
1995	0.77	0.29	0.41	0.0000	0.0069	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
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
2023	0.18	0.03	0.01	0.0000	0.0003	0.00003	0.22	0.44
2024	0.19	0.01	0.00	0.0000	0.0003	0.00003	0.21	0.41
Share in total 1990 emission, %	46.4	9.0	24.4	0.0	0.4		19.7	
Share in total 2024 emission, %	46.7	1.6	0.9	0.008	0.1	0.007	50.7	
Change 1990-2024, %	-91.5	-98.5	-99.7	-45.7	-98.7	-49.8	-78.2	-91.5
Change 2023-2024, %	6.7	-80.2	-37.1	-10.7	0.0	1.4	-3.6	-5.8

The key sources of PCB emissions in 2024 were the waste sector (50.7%, mainly open burning of waste) and the energy industries (46.7%, mainly oil shale combustion). The share of other sectors were nonsignificant (see Table 2.25 and Figure 2.46).

In 2024, PCB emissions decreased by 5.8% compared to 2023, partly due to a decrease in electricity generation from shale power plants.

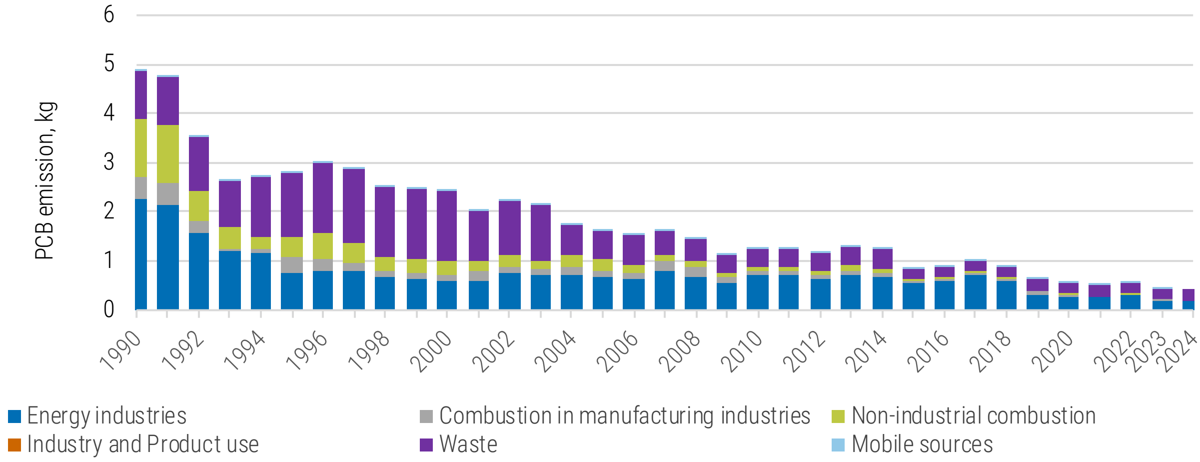


Figure 2.45 PCB emissions by sources of pollution

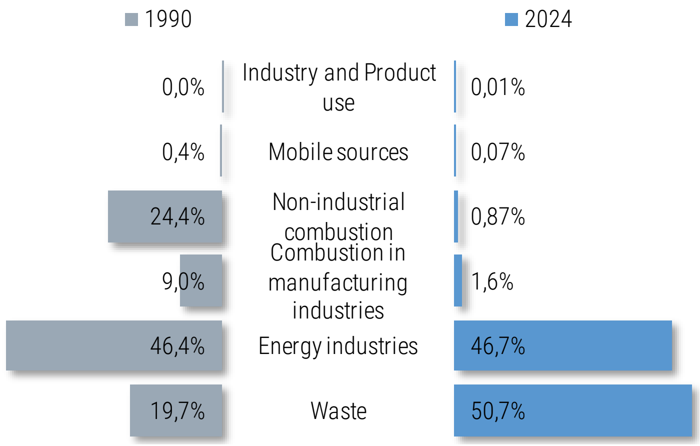


Figure 2.46 PCB emission by sources of pollution in the period oh 1990 and 2024

Photo: Enefit Green

3. ENERGY SECTOR (NFR 1)

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 and NMVOC.

Estonia is relatively rich in both mineral and biological natural resources. It is a unique country whose energy production depends mainly on the use of oil shale. In 2024, the share of domestic fuels – oil shale, wood and peat – in the primary energy supply accounted for approximately 68%, of which oil shale accounted for approximately 43% (see Figure 3.1). As in previous years, natural gas, fuel oils, coal and motor fuels were imported into Estonia in 2024. Coal consumption decreased by approximately 5 times compared to 2023 (from 135 TJ to 20 TJ) and significantly decreased compared to 2019 (approximately 98%), mainly due to the cessation of clinker production at the cement plant.

Due to concerns about energy security, the share of natural gas in Estonia's energy balance remained relatively small. Gas consumption began to decline gradually after 2008 and plummeted following the 2021–2022 energy crisis. After 2021, imports of Russian pipeline gas ceased entirely. Since then, Estonia has received natural gas primarily through regional interconnectors—from Latvia and, starting in 2023, from Finland. However, the trend reversed somewhat in 2024. Gas consumption in Estonia increased by approximately 8% in 2024 compared to 2023, primarily due to colder weather and a partial recovery in industrial demand in the Baltic region. At the same time, the supply structure continued to shift. LNG imports in 2024 were more concentrated: Finland accounted for approximately 60% of LNG supplies, Lithuania for approximately 24%, and other partners for smaller shares, reflecting ongoing regional diversification and dependence on the Baltic region and Finnish gas market infrastructure. Recent advances in the Estonian biogas and biomethane sector have contributed to energy supply diversification and decarbonization. Biomethane production and consumption increased by approximately 31% in 2024 compared to 2023. It is important to note that, according to national data on biomethane injection into the gas grid, the volume of biomethane produced in Estonia in 2024 accounted for approximately 7.4% of the total gas consumed through the grid. This means that the share of biomethane in Estonia's natural gas consumption has increased significantly in 2024 compared to 2023, adding a domestic renewable component that partially offsets natural gas imports.

In 2024, Estonia was among the countries experiencing negative economic growth, primarily due to high inflation, which impacted both household purchasing power and corporate profitability. The economic downturn continued in 2024, although the rate of contraction slowed compared to 2023.

Estonia's energy sector faced significant challenges related to global crises, volatile energy prices, and the need to adapt to sustainable development requirements. The country continued its efforts to reduce its dependence on fossil fuels and expand its renewable energy capacity.

Renewable energy development remained a key policy priority in 2024. Wind and solar energy continued to grow rapidly. In Estonia, renewable electricity is generated from hydropower, wind, solar, and biomass sources.

Hydroelectricity production has remained relatively stable in recent years. After increasing by 4% in 2023 compared to 2022 (reaching 24 GWh, or 0.4% of total electricity generation), hydroelectric power production declined slightly in 2024 due to weather conditions. Wind power continued to show an upward trend. Its share of total electricity generation increased from 11.9% in 2023 to approximately 14% in 2024, reflecting increased capacity and improved utilisation. Solar power demonstrated the strongest growth. Having reached 12.5% of total electricity generation in 2023 (an increase of 21% compared to 2022), its share further increased to approximately 16% in 2024, thanks to the rapid deployment of distributed photovoltaic systems and commercial solar power plants. Overall, the share of renewable energy in total electricity generation increased from 32.4% in 2023 to approximately 38% in 2024. For comparison, in 2005, electricity generated from renewable sources accounted for only 1.1%. This growth was driven by the expansion of wind and solar power plants, as well as biomass-fired combined heat and power (CHP) plants.

Despite the transition to renewable energy, the shale oil sector continued to play an important—albeit declining—role in Estonia's energy balance. Historically central to electricity generation and energy independence, shale oil production declined sharply in 2023 (by approximately 40% compared to 2022). In 2024, shale oil-based electricity generation will decline even further, albeit at a slower pace, as renewables and imports covered a larger share of demand.

According to Statistics Estonia, electricity production in 2023 decreased by nearly 37% compared to 2022, while electricity imports increased by 6.6%. In 2024, domestic electricity production partially recovered due to increased renewable energy, although Estonia remains structurally more dependent on imports than before the energy crisis.

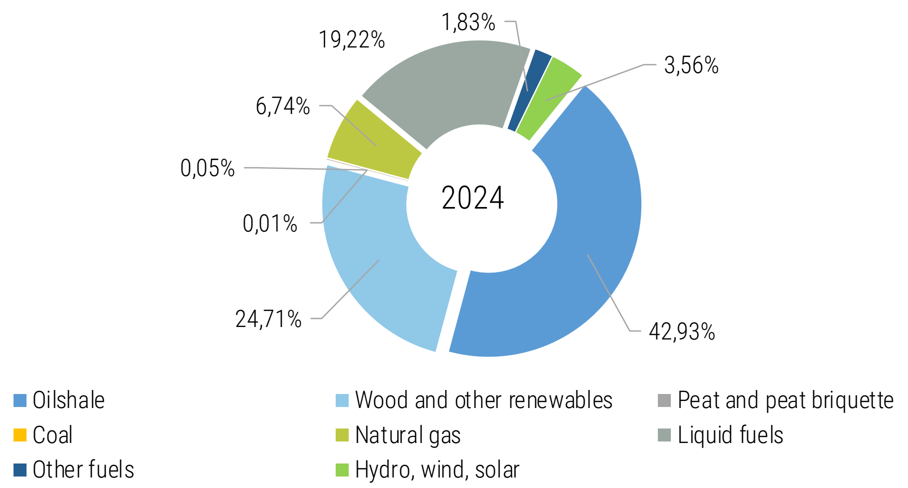


Figure 3.1 Structure of primary energy supply in Estonia in 2024

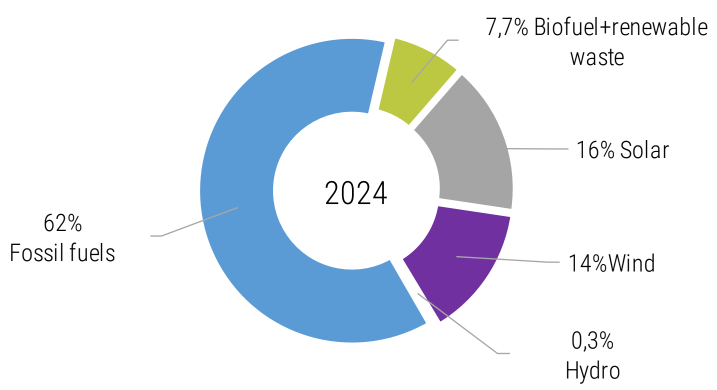


Figure 3.2 Gross electricity production by sources in 2024 *(Source: Statistics Estonia)*

The energy sector is the main source of SO_2, NO_x, CO, particulates, HMs and POPs in Estonia. In 2024, the energy sector contributed 99.9% of total SO_2 emissions, 86.7% of total NO_x emissions, 87.6% of $PM_{2.5}$ emissions, 29.6% of total NMVOC emissions, 99.1% of total CO emissions, and 93.9% of Pb emissions (see Figure 3.4 - 3.6 and Table 3.1).

Table 3.1 Pollutant emissions from the energy sector

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	66.69	28.96	279.00	0.15	NR	NR	253.64	NR	224.29
1995	38.02	18.77	116.70	0.20	NR	NR	111.39	NR	153.14
2000	36.44	18.71	96.97	0.26	9.26	23.17	56.54	1.51	135.32
2005	36.22	15.16	76.39	0.41	7.14	12.09	18.46	1.37	114.23
2010	35.61	10.78	83.06	0.52	9.90	17.31	21.53	1.44	118.66
2015	25.34	8.07	36.03	0.45	6.23	9.39	12.00	1.12	93.29
2020	18.23	7.04	10.92	0.43	4.34	5.80	8.09	1.12	101.67
2021	17.71	6.38	11.71	0.38	3.97	5.18	7.19	1.08	92.51
2022	18.84	6.24	14.78	0.41	4.28	5.55	7.99	1.15	90.39
2023	16.58	6.616	10.94	0.45	4.11	5.39	7.75	1.09	90.01
2024	15.33	6.619	9.31	0.38	3.92	5.15	7.49	1.07	83.83
Change 1990-2024, %	-77.01	-77.14	-96.66	160.71			-97.05		-62.62
Change 2023-2024, %	-7.54	0.04	-14.93	-14.87	-4.60	-4.35	-3.36	-1.66	-6.87

Table 3.1 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	201.82	4.45	1.21	19.80	17.16	15.51	26.35	9.20	105.13
1995	82.99	2.16	0.64	9.74	9.03	8.42	9.98	4.91	61.02
2000	29.85	0.74	0.46	6.70	6.87	7.62	6.05	3.63	43.61
2005	9.21	0.49	0.17	1.72	3.48	9.42	3.28	1.43	26.24
2010	8.47	0.57	0.20	2.02	4.36	10.86	3.29	1.78	32.04
2015	5.04	0.52	0.18	0.93	2.83	11.63	2.49	1.04	25.70
2020	4.14	0.46	0.16	0.51	1.62	11.71	1.64	0.56	25.55
2021	3.89	0.41	0.17	0.54	1.85	12.41	1.62	0.58	24.86
2022	4.09	0.44	0.17	0.68	2.24	12.89	2.05	0.72	26.87
2023	3.69	0.40	0.16	0.48	1.62	12.41	1.71	0.51	26.66
2024	3.54	0.39	0.15	0.43	1.51	12.22	1.46	0.46	26.28
Change 1990-2024, %	-98.24	-91.17	-87.57	-97.82	-91.22	-21.24	-94.45	-95.04	-75.00
Change 2023-2024, %	-3.96	-2.17	-5.45	-9.66	-6.91	-1.53	-14.39	-9.62	-1.44

Table 3.1 continues

Year	PCDD/F	PAHs (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	9.96	9.86	0.24	3.92
1995	4.63	10.33	0.33	1.48
2000	3.13	7.69	0.31	0.99
2005	3.25	5.75	0.30	1.03
2010	3.99	5.95	0.40	0.89
2015	2.90	4.29	0.34	0.62
2020	3.21	4.05	0.37	0.33
2021	2.94	3.63	0.37	0.27
2022	2.95	3.75	0.38	0.34
2023	3.41	3.63	0.37	0.22
2024	3.37	3.56	0.36	0.20
Change 1990-2024, %	-66.13	-63.89	52.05	-94.79
Change 2023-2024, %	-0.99	-1.94	1.46	-7.85

During the period of 1990–2024, the emissions of sulphur dioxide from the energy sector decreased by 96.7% and the emissions of nitrogen oxides by about 77.0% resulting from a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 277 PJ in 1990 to 91.6 PJ in 2024) (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 2024, SO_2 emissions in the energy sector decreased by 15% and NO_x emissions by 7.5% compared to 2023. The main reason for the decrease SO_2 and NO_2 emissions in the energy sector was the decrease in the amount of oil shale burned in power plants.

During this period, emissions of all heavy metals and PCB decreased, which is explained by a decrease in electricity generation from shale power plants (see Figure 3.4, Table 3.1).

The increase in emissions of dioxins resulted from the increase in the amount of biomass burned in the transformation energy and industrial combustion sectors by boilers with a capacity of less than 50 MW.

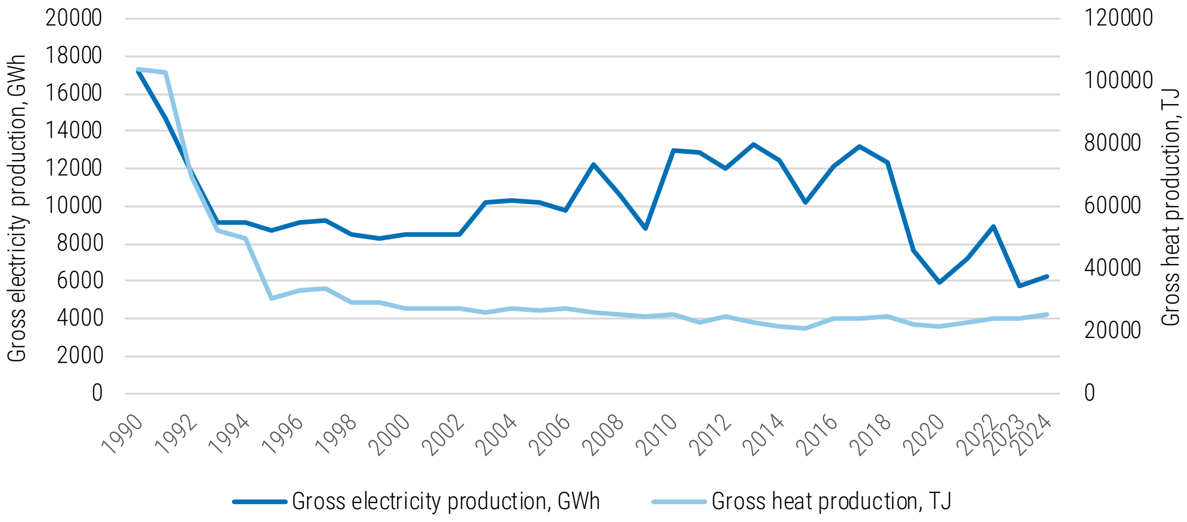


Figure 3.3 Electricity and heat production

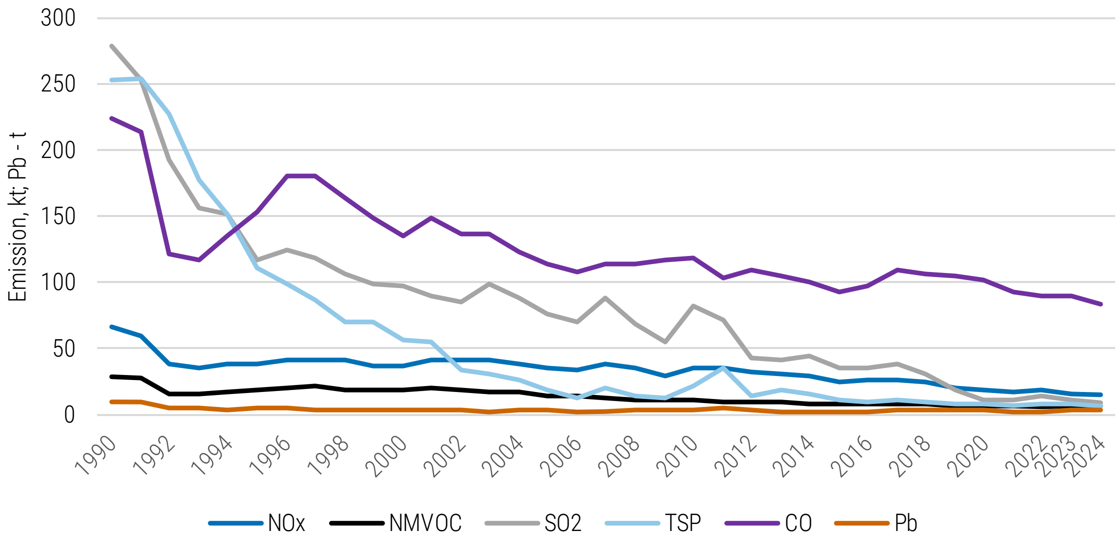


Figure 3.4 Pollutant emissions from the energy industry

Figure 3.5 Share of NO_x and SO_2 emissions from the energy sector in total emissions in 2024

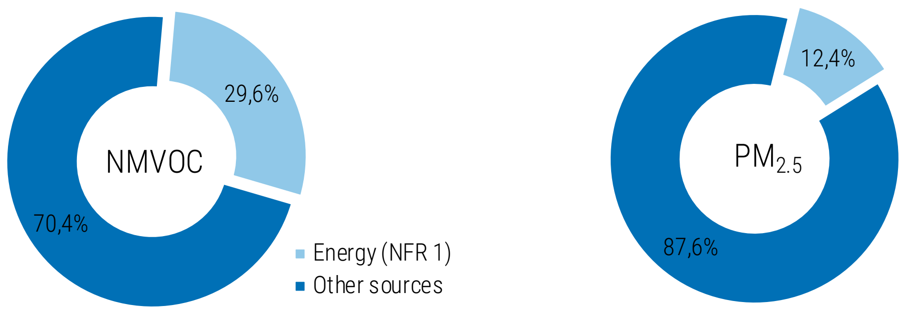


Figure 3.6 Share of NMVOC and $PM_{2,5}$ emissions from the energy sector in total emissions in 2024

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 – 99.4% in 2024, the same as in 2023. The share of mobile sources of the total emissions is very small – 0.31%, includes in other sources (see Figure 3.8-3.9).

The stationary fuel combustion sector is a key source for all pollutants except ammonia and NMVOC. Pollutant emissions in the 1990-2024 period and the distribution of emissions between stationary combustion and other sectors are presented in the Table 3.3, Figure 3.7-3.9.

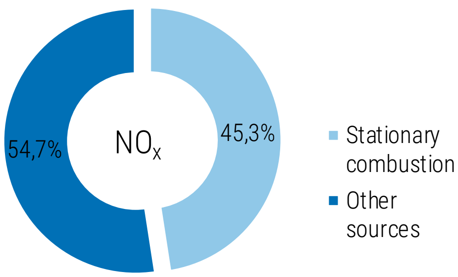
3.2.1.1. Source Category Description

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

NFR	Source	Description	Method	Emissions reported
	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 boilers of this activity and from 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 combustion plants of the activities other than 1A2a-f and also 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



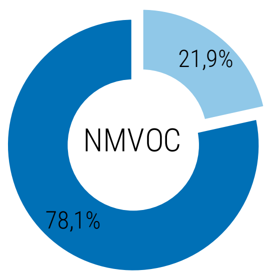


Figure 3.7 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2024

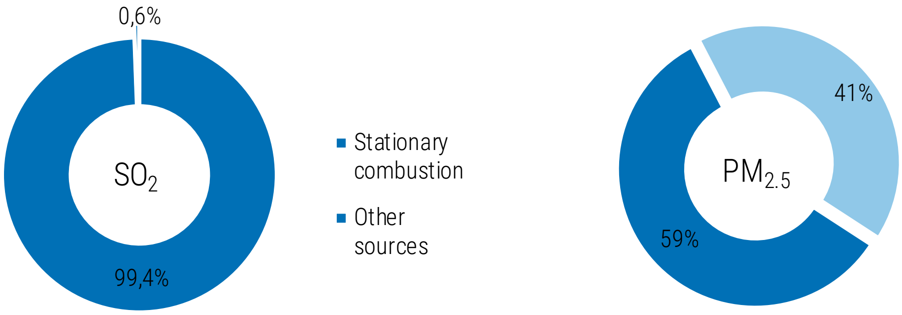


Figure 3.8 SO_2 and $PM_{2.5}$ emissions from stationary fuel combustion and other sources in 2024

Table 3.3 Pollutant emissions from stationary fuel combustion

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	33.41	6.57	273.88	0.10	NR	NR	249.86	NR	76.48
1995	18.53	5.56	113.29	0.16	NR	NR	108.97	NR	86.85
2000	17.49	4.46	94.04	0.15	7.99	21.56	54.06	1.19	72.20
2005	16.47	4.62	75.99	0.19	5.42	9.87	14.98	0.93	67.81
2010	19.85	5.42	82.92	0.29	8.24	15.10	17.85	1.10	88.91
2015	13.25	4.65	35.97	0.27	4.39	6.89	7.66	0.84	74.28
2020	9.15	4.74	10.87	0.30	2.85	3.52	4.08	0.91	90.24
2021	9.12	4.33	11.67	0.27	2.62	3.13	3.60	0.89	82.59
2022	10.27	4.29	14.73	0.29	2.81	3.39	4.19	0.97	81.11
2023	8.89	4.98	10.89	0.33	2.71	3.24	3.96	0.93	81.02
2024	8.01	4.99	9.26	0.27	2.64	3.11	3.88	0.92	74.46
Change 1990-2024, %	-76.02	-25.58	-96.62	174.95			-98.45		-2.63
Change 2023-2024, %	-9.84	-1.78	-14.97	-20.24	-2.59	-4.07	-1.99	-1.28	-8.09

Table 3.3 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	123.01	4.44	1.20	19.79	16.77	7.02	26.26	9.19	102.54
1995	58.33	2.16	0.64	9.73	8.79	3.35	9.94	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
2020	2.87	0.46	0.16	0.50	1.14	1.20	1.55	0.55	22.40
2021	2.56	0.41	0.16	0.53	1.35	1.48	1.53	0.58	21.59
2022	2.74	0.44	0.16	0.66	1.73	1.71	1.96	0.71	23.51
2023	2.33	0.40	0.15	0.46	1.11	1.23	1.62	0.50	23.29
2024	2.19	0.39	0.15	0.42	1.00	1.12	1.37	0.45	22.89
Change 1990-2024, %	-98.22	-91.30	-87.91	-97.89	-94.05	-84.11	-94.77	-95.13	-77.68
Change 2023-2024, %	-5.96	-2.21	-5.64	-9.97	-9.80	-9.22	-15.17	-9.81	-1.74

Table 3.3 continues

Year	PAH (4 total)	PCCD/F	HCB	PCB
	t	g I-Teq	kg	
1990	9.78	9.65	0.23	3.90
1995	10.29	4.45	0.33	1.47
2000	7.66	2.93	0.31	0.99

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Year	PAH (4 total)	PCCD/F	HCB	PCB
	t	g I-Teq	kg	
2005	5.70	2.97	0.30	1.03
2010	5.90	3.66	0.40	0.89
2015	4.22	2.58	0.34	0.62
2020	3.98	2.93	0.37	0.33
2021	3.57	2.70	0.37	0.27
2022	3.68	2.73	0.38	0.34
2023	3.56	3.21	0.36	0.22
2024	3.49	3.19	0.36	0.20
Change 1990-2024, %	-66.-33	-66.91	52.54	-94.77
Change 2023-2024, %	-2.0	-0.54	-1.46	-7.86

Combustion in energy industry (NFR 1A1) accounts for 93.7% of SO_2, 63.5% of NO_x, 41.3% of TSP and 53.8% 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 36.7% of the total NMVOC and 46% of CO emissions in stationary combustion, for approximately 3.5% of SO_2 and 56% of TSP emissions. The share of the Combustion in manufacturing industries is insignificant compared to other sectors and accounts for 2.8% of SO_2, for 2.8% of TSP, 1.48% of NMVOC and for the 0.4% of CO emissions in stationary combustion (see Figure 3.9-3.14).

The energy industry sector (NFR 1A1a-c) is responsible for the about 93.2% of Estonian total SO_2 emissions, 28.8% of NO_x, 47.4% of CO, 14.3% of $PM_{2.5}$, and 17% of Pb in 2024. The main contributors to SO_2 pollution are oil shale and shale gas work gas burning plants (about 80%).

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 26% of the fuel used in 2023 is biomass, which is burned together with oil shale. The share of biomass burned at the Auvere oil shale station was 24.7% 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 13.3% to the total SO_2 emissions in 2024. 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 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.

In 2024, as in previous years, the use of waste as fuel for heat and electricity generation continued, saving approximately 70 million m³ of natural gas through waste-to-energy conversion. Mixed municipal waste remaining after sorting municipal waste in Estonia is used to generate heat and electricity at Enefit Green AS's Iru Power Plant. In 2024, 226,000 tonnes were used for heat and electricity generation (approximately 10% less than in 2023). The mixed municipal waste used at Iru Power Plant is primarily generated on-site, but the plant also provides environmentally friendly waste management services to its Irish and Finnish partners. The Iru waste incineration plant impacts every resident of Estonia, as waste disposal at Iru is approximately half the cost of landfill disposal. The launch of the waste incineration plant can be seen as a national environmental project: the Estonian waste management system has become more environmentally friendly, and large-scale waste disposal has been eliminated.[4]

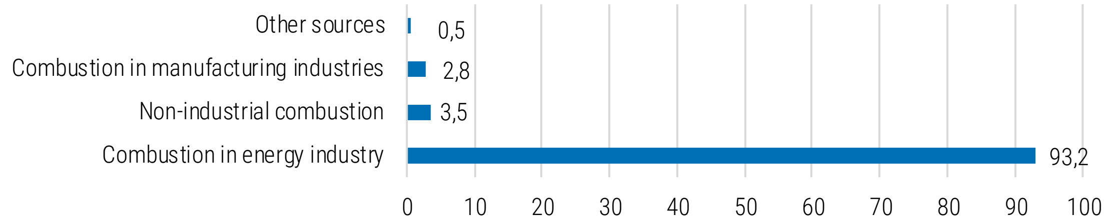

Figure 3.9 SO_2 emissions by sources of pollution in 2024 (%)

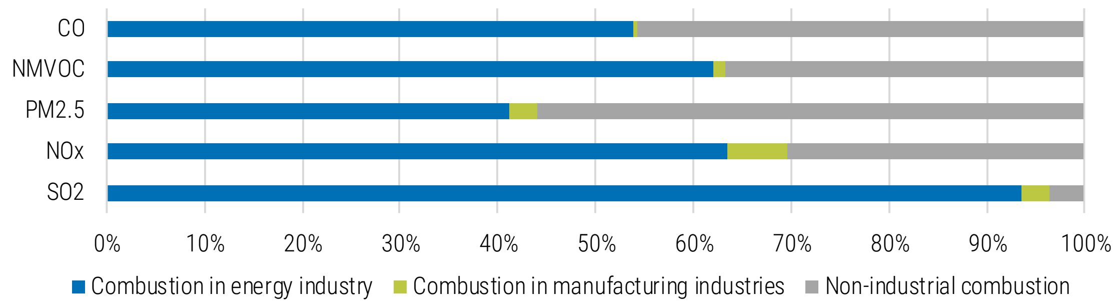

Figure 3.10 Distribution of pollutant emissions by sector in stationary combustion in 2024

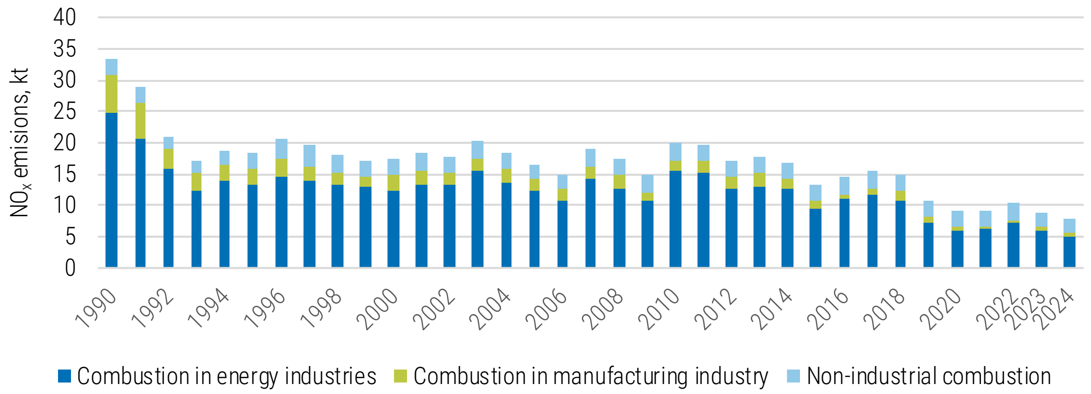

Figure 3.11 Distribution of NO_x emissions by sector in stationary combustion

[44] Eesti Energia Keskkonnaaruanne_2014_eng. https://www.energia.ee/-/doc/8457332/keskkond/pdf/keskkonnaaruanne_2024_eng.pdf

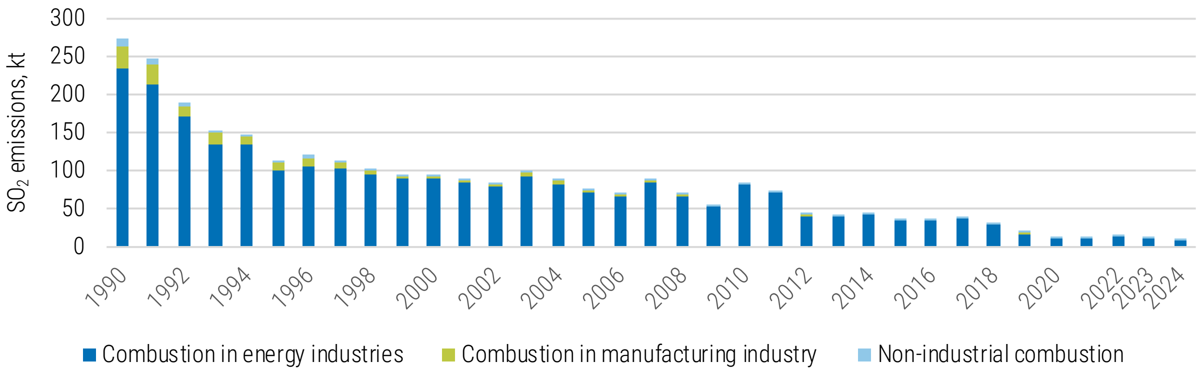

Figure 3.12 Distribution of SO_2 emissions by sector in stationary combustion

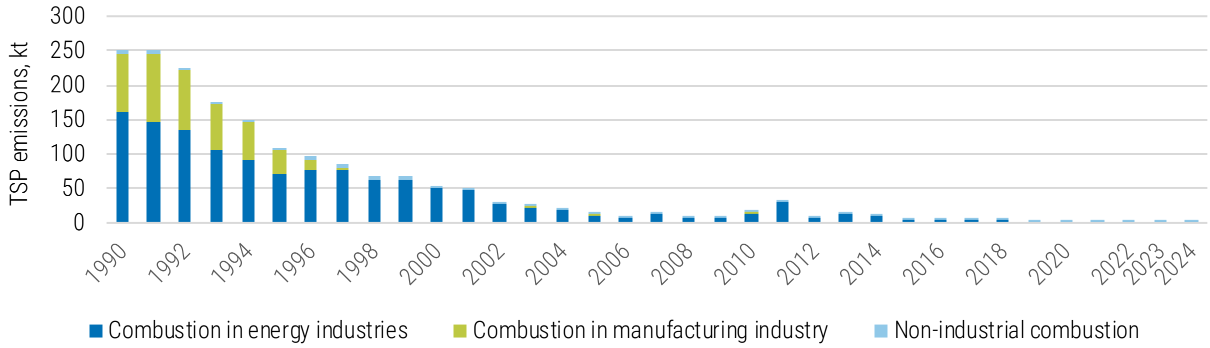

Figure 3.13 Distribution of TSP emissions by sector in stationary combustion

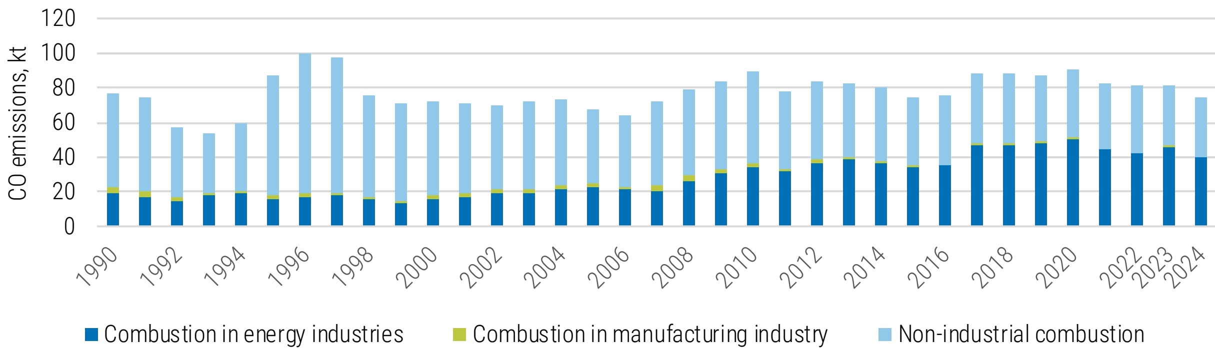

Figure 3.14 Distribution of CO emissions by sector in stationary combustion

3.2.1.2. Uncertainty

An uncertainty analysis for the stationary combustion activities alone (NFRs 1A1, 1A2, and 1A4) was carried out upon the 2026 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.

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Table 3.4 Uncertainties in stationary combustion sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	8.01	kt	45.26	8.75	2.37
NMVOC	4.89	kt	21.90	6.67	2.42
SO_x	9.26	kt	99.43	8.34	0.09
NH_3	0.27	kt	2.78	1.11	0.42
$PM_{2.5}$	2.64	kt	59.00	24.99	14.07
PM_{10}	3.11	kt	36.29	13.84	7.81
TSP	3.88	kt	26.40	7.71	0.76
BC	0.92	kt	84.33	44.24	37.95
CO	74.46	kt	88.06	22.31	11.12
Pb	2.19	t	57.98	44.90	0.94
Cd	0.39	t	94.49	66.10	7.02
Hg	0.15	t	77.96	35.35	3.91
PCDD	3.19	g I-TEQ	71.67	118.11	49.36
benzo(a) pyrene	1.00	t	98.14	158.65	22.69
benzo(b) fluoranthene	1.00	t	97.57	141.13	22.31
benzo(k) fluoranthene	0.61	t	97.07	160.70	21.84
Indeno	0.89	t	98.30	179.51	31.34
HCB	0.36	kg	68.92	94.33	38.83
PCB	0.20	kg	49.23	93.51	3.12

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. Data for large point sources reported by operators. The remaining ones are diffuse sources	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 93.2% of Estonian total SO_2 emissions, 28.8% of NO_x, 47.4% of CO, 14.3% of $PM_{2.5}$, and 17% of Pb. The largest contributors of all pollutants are oil shale and shale gas work gas burning power plants, while for CO and NMVOC 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 2024 is shown in Figure 3.15.

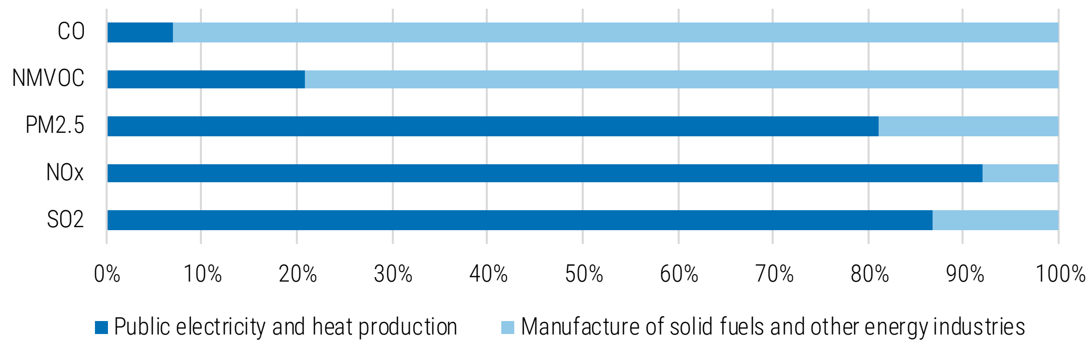

Figure 3.15 Distribution of pollutant emissions by sector in energy industries in 2024

During the 1990-2024 period, emissions of SO_2 decreased by 96.31% and NO_x emissions by 79.45%, 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 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 two times from 1990 to 2024.

The increase of carbon monoxide emissions by about 116% was in the result of increasing shale oil production level from 1990 to 2024 (see Figures 3.17, 3.18 and Table 3.18).

In 2024, emission of SO_2 , NO_x and TSP decreased by 15.3%, 15.28% and 1.41% respectively compared to 2023's figures. The main reason for the decrease in emissions is due to an decrease in electricity production of approximately 37%. According to the Statistics Estonia, the volume of electricity produced from oil shale has fallen by almost 40% over the year and amounts to only a third of all electricity produced. The same reasons were for decrease in heavy metals and PCB emission.

The decrease carbon monoxide, ammonia and NMVOC emissions by 13.2%, 23.9% and 1.7% in 2024 compared to 2023 is due to a slight decrease in the volume of shale oil produced (Table 3.18). A more detailed description of the reasons for the reduction in emissions can be found in chapter 3.1.

Table 3.6 Pollutant emissions from the energy sector

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	1.02	99.35	0.07	NR	NR	72.71	NR	15.28
2000	12.30	1.00	89.01	0.09	4.70	18.02	49.84	0.15	15.60
2005	12.19	1.76	71.93	0.14	2.74	6.99	11.69	0.12	23.06
2010	15.36	2.31	81.22	0.22	5.62	12.30	14.78	0.17	34.51
2015	9.50	2.37	35.09	0.21	2.36	4.72	5.30	0.09	34.35
2020	5.99	2.56	10.18	0.24	0.83	1.38	1.79	0.08	50.62
2021	6.13	2.26	11.14	0.21	0.62	1.02	1.34	0.06	44.64
2022	7.27	2.17	14.15	0.24	0.67	1.13	1.76	0.06	42.10
2023	6.01	3.08	10.25	0.28	0.67	1.07	1.62	0.07	46.20
2024	5.08	3.03	8.68	0.22	0.64	0.99	1.60	0.07	40.10
Change 1990-2024, %	-79.45	-1.46	-96.31	229.87			-99.01		115.96
Change 2023-2024, %	-15.28	-1.70	-15.30	-23.90	-3.41	-7.53	-1.41	-1.85	-13.20

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
2020	1.05	0.17	0.11	0.34	0.68	1.05	0.93	0.54	13.04
2021	0.85	0.13	0.12	0.39	0.91	1.35	1.01	0.57	12.51
2022	1.04	0.14	0.12	0.51	1.26	1.57	1.33	0.70	13.90
2023	0.70	0.13	0.11	0.31	0.67	1.09	1.02	0.48	14.15
2024	0.63	0.12	0.11	0.26	0.57	0.98	0.78	0.44	13.80
Change 1990-2024, %	-98.9	-88.02	-89.71	-98.57	-96.42	-77.38	-96.15	-95.25	-83.20
Change 2023-2024, %	-9.90	-5.53	-5.67	-14.63	-15.80	-9.94	-23.89	-10.0	-2.50

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
2020	0.59	2.36	0.17	0.29
2021	0.44	2.17	0.18	0.26
2022	0.47	2.17	0.19	0.33
2023	0.67	2.63	0.19	0.18
2024	0.73	2.62	0.18	0.19
Change 1990-2024, %	-2.51	22.54	43.80	-91.46
Change 2023-2024, %	9.54	-0.18	-2.11	6.66

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. This approach is used for all types of fuels, including municipal waste, and for all pollutants. 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. For example, emissions from the incineration of municipal waste include operator-reported emissions of pollutants calculated on the basis of measurement results and the quantities of waste incinerated, emissions of heavy metals estimated using national emission factors, and PCB emissions estimated using emission factors provided in the 2023 EMEP/EEA Guidebook.

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

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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
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.

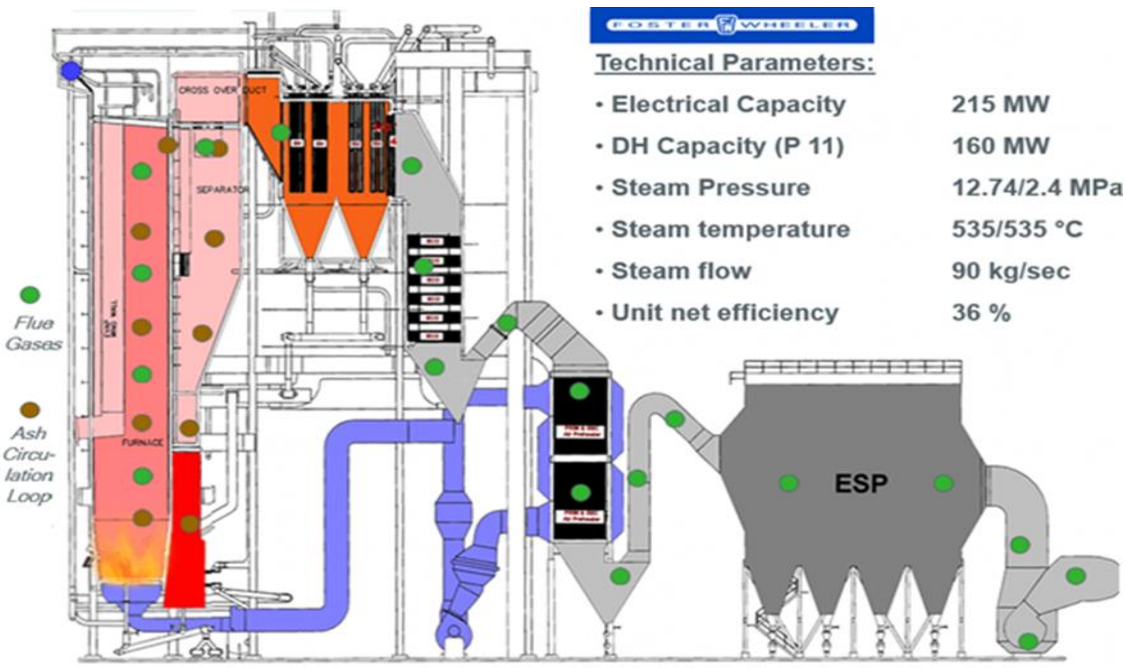

Figure 3.16 Existing EOS CFBC boiler drawing

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/Nm³	NO_x, mg/Nm³	SO_2, mg/Nm³
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 Enefit Power AS), KIVIÕLI KEEMIATÖÖSTUSE OSAÜHING (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.

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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 2024, the volume of shale oil produced changed very little compared to 2023, decreasing by only 2% (see Figures 3.17-3.18 and Table 3.18). In 2024, the majority of oil (77%) was produced using new solid-liquid technologies (SHC).

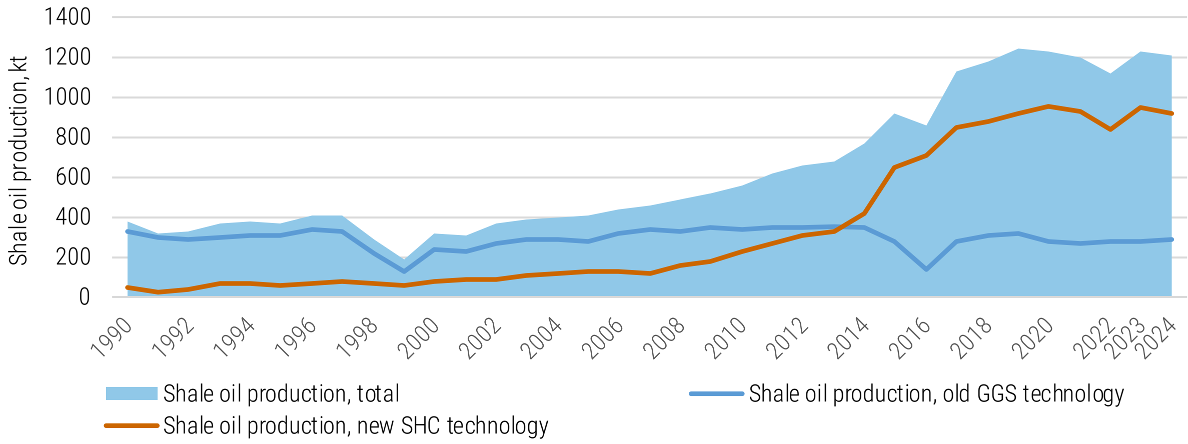

Figure 3.17 Shale oil production (kt)

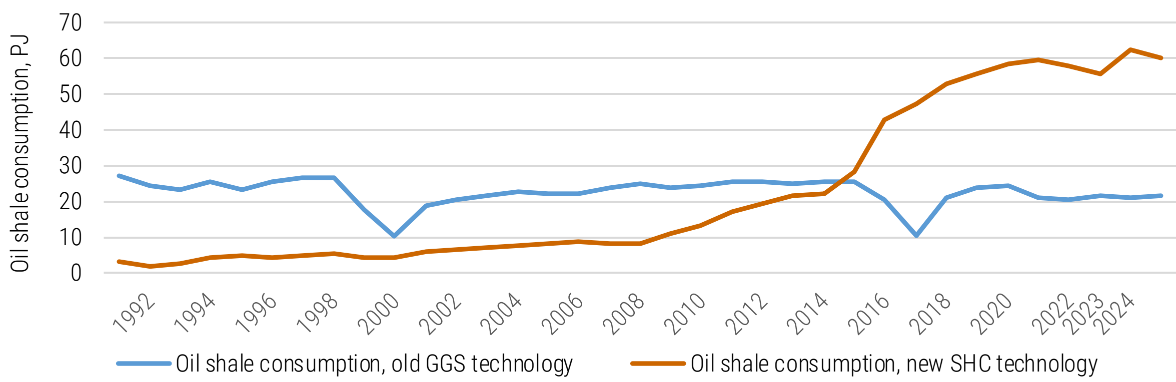

Figure 3.18 Consumption of oil shale in shale oil production with using of different technologies

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 and in this year submission. 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'.

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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
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; 2006-2024 – 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

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	
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; 2006-2024 – 606;*

[1]-SO_2 *electrostatic precipitator: 36,82*

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	17	17	17	17	
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

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Pollutant	Unit	<=1 MW	>1<50 MW	>=50 MW	
				oilshale oil, residual oil	light fuel oil
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; 2006-2024 – 404.6;

[3] – light fuel oil- SO_2 : 1990-2005 – 118; 2006-2010 – 95; 2011-2024 - 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	99.1	401.5	37.0	166.7
2005	532.5	90.9	84.6	19.3	27.1
2010	504.5	93.6	86.9	32.9	28.7
2015	275.2	75.7	41.1	18.4	14.0
2020	110.8	72.7	19.0	9.1	13.5
2021	107.4	63.4	12.2	5.8	9.4
2022	123.3	67.1	13.9	5.2	9.9
2023	120.3	75.0	17.3	7.2	9.2
2024	109.2	67.9	18.8	7.6	8.8

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).

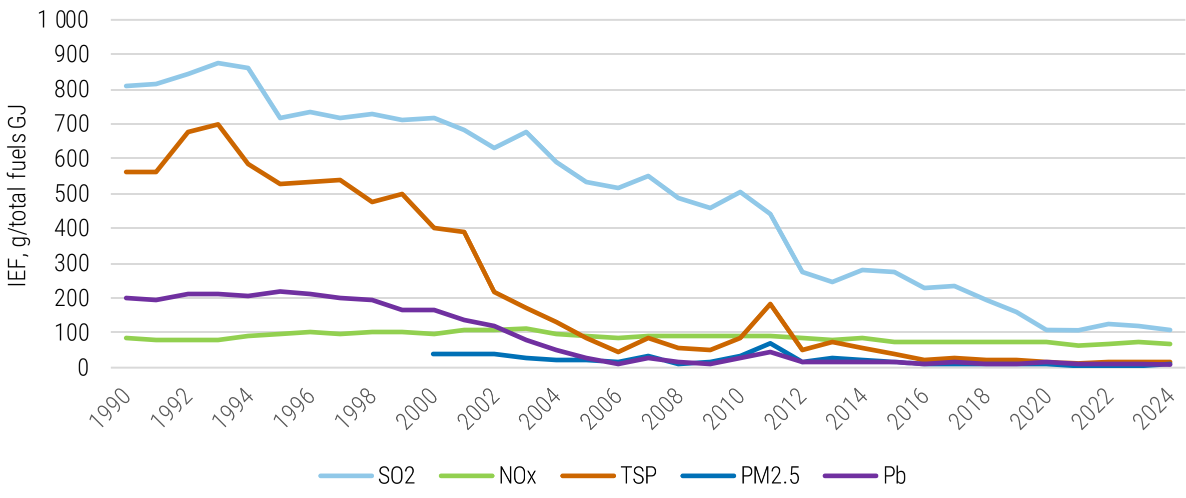

Figure 3.19 Implied emission factors for NFR 1A1a

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 1990-2024. The biggest decrease has been in terms of liquid fuels and natural gas, by about 98% and 82% respectively. The consumption of solid fuels decreased by 87%, mainly due to a decrease in electricity production, but it still remains one of the main fuel in this sector (involving mainly oil shale) (see Figures 3.20, 3.21 and Table 3.17). During this period, the consumption of coal decreased significantly (from 4,4 PJ in 1990 to 0, beginning from the 2018). Combustion of biomass has grown approximately by 25 times (from 1.35 PJ in 1992 to 33.3 PJ in 2024) and has taken the lead, leaving solid fuels behind.

Table 3.17 Fuel consumption in energy industries (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
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
2023	1.42	32.95	33.03	4.03	2.37
2024	0.91	26.73	33.28	5.69	2.24
Change 1990-2024, %	-98.0	-87.3		-82.3	
Change 2023-2024, %	-35.8	-18.9	0.8	41.5	-5.5

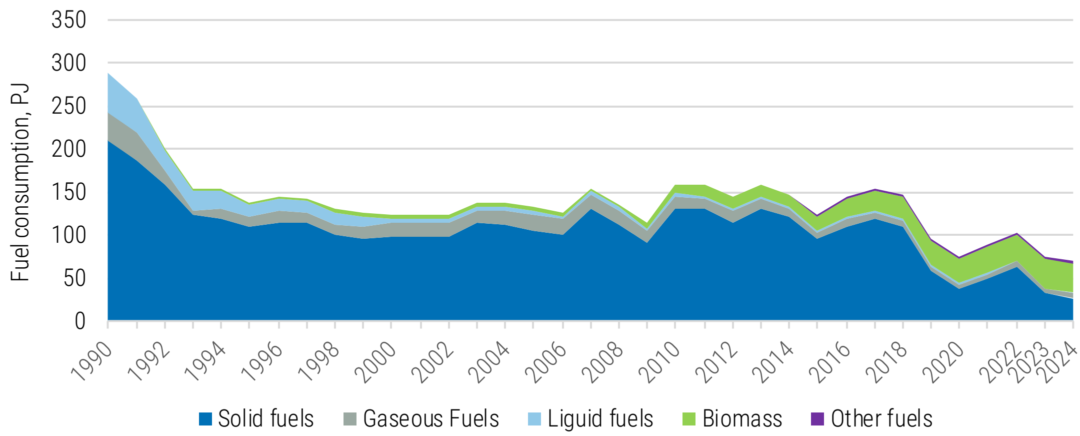

Figure 3.20 Fuel consumption in the energy industry sector

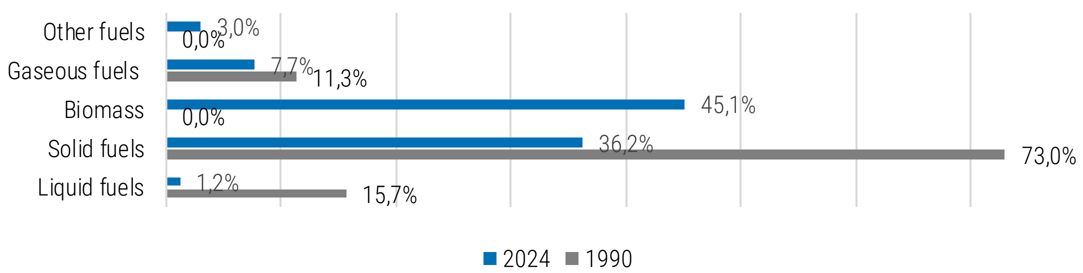

Figure 3.21 Distribution of fuel consumption in the energy industries in 1990 and 2024

Table 3.18 Shale-oil production

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
373.0	321.6	326.0	367.1	375.4	366.4	408.9	407.0	283.6	187.0	317.0	311.6
2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
363.8	389.0	402.2	405.3	441.0	456.5	486.5	518.3	555.4	619.8	653.5	675.1
2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
766.9	918.8	853.5	1,123.8	1,182.2	1,242.5	1,229.8	1,202.1	1,115.0	1,227.2	1,205.3	

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
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
2023	31.85	28.53	1.99	62.37	15.72	5.15	20.87	83.24
2024	29.03	28.70	2.24	59.97	14.77	6.62	21.39	81.36

3.2.2.3. Uncertainty

An uncertainty analysis for the energy industry sector alone (NFRs 1A1a, 1A1c) was carried out upon the 2026 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 3.20.

Table 3. 20 Uncertainties in energy industry sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	5.08	kt	28.72	2.73	0.29
NMVOC	3.03	kt	13.57	5.38	1.54
SO_x	8.68	kt	93.13	8.33	0.09
NH_3	0.22	kt	2.24	1.08	0.40
$PM_{2.5}$	0.64	kt	14.39	3.61	4.38
PM_{10}	0.99	kt	11.59	2.73	5.60
TSP	1.60	kt	10.89	1.37	0.43
BC	0.07	kt	6.86	1.86	0.63
CO	40.10	kt	47.42	8.87	3.11
Pb	0.63	t	16.79	8.12	0.12
Cd	0.12	t	28.95	14.31	0.31
Hg	0.11	t	56.36	27.10	2.45
PCDD	2.62	g I-TEQ	58.88	117.04	31.58
benzo(a) pyrene	0.21	t	20.33	40.66	9.26
benzo(b) fluoranthene	0.32	t	31.13	62.26	13.22
benzo(k) fluoranthene	0.11	t	17.72	35.44	6.78
Indeno	0.09	t	10.14	20.29	4.40
HCB	0.18	kg	34.92	87.29	29.95
PCB	0.19	kg	46.73	93.46	0.12

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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

Information about recalculations and changes made in the 2026 submission is presented in Chapter 8.

3.2.2.6. Source-Specific Planned Improvements

Not planned for the next submission.

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 3.21 and in the text below.

Table 3.21 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). Emissions of PCDD/F, HCB and PAHs from cement production were calculated on the basis of measurements. Note that clinker production in Estonia has been discontinued since 2020, and as a result, emissions data from clinker production are not included in the inventory under this NFR, and only particle emissions in sector 2A1 are reflected.

NFR 1A2gviii: Others include emissions from all boilers in the other manufacturing industry (excluding NFRs 1A2a-e, 1A2f) and 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.

Emission calculations for NFR category 1A2 are based on national activity data. In the current submission, updated activity data were only partially available for several fuel types. Therefore, the inventory continues to apply the latest available verified activity data (2023) for selected fuels, including some liquid fuels (e.g. liquid fuels, biogas and biomass), in order to maintain the consistency of the time series.

The data will be revised in the 2027 submission once verified information becomes available, together with any necessary time-series consistency updates and explanations.

Emissions of all pollutants from the NFR 1A2 sector have decreased across 1990-2024 (see Tables 3.22, 3.25, Figure 3.22).

The decrease in emissions of all substances from industrial combustion in 2024 compared to 2023 is explained by a decrease in solid fuel consumption, a slight increase in biomass consumption and an increase in gas consumption. (see Tables 3.22 and 3.25).

Table 3.22 Pollutants emissions from combustion in manufacturing industries

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	5.97	0.28	29.39	0.007	NR	NR	83.12	NR	3.63
1995	2.65	0.27	10.64	0.022	NR	NR	32.13	NR	3.13
2000	2.57	0.17	2.66	0.003	0.36	0.47	0.91	0.05	1.83
2005	1.91	0.29	2.79	0.004	0.44	0.54	0.78	0.06	2.13
2010	1.58	0.18	1.12	0.003	0.25	0.31	0.42	0.03	1.75
2015	1.20	0.13	0.39	0.002	0.17	0.22	0.27	0.03	0.80
2020	0.49	0.08	0.44	0.001	0.06	0.07	0.08	0.007	0.51

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Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
2021	0.38	0.04	0.29	0.001	0.03	0.03	0.04	0.004	0.12
2022	0.38	0.04	0.29	0.00	0.03	0.04	0.05	0.00	0.11
2023	0.49	0.09	0.32	0.00	0.09	0.11	0.13	0.01	0.49
2024	0.50	0.07	0.26	0.00	0.07	0.09	0.11	0.01	0.27
Change 1990-2024, %	-91.7	-76.3	-99.1	-80.1			-99.9		-92.5
Change 2023-2024, %	-0.5	-23.5	-18.9	2.7	-22.2	-19.6	-18.9	-10.1	-44.5

Table 3.22 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	62.30	3.27	0.09	1.28	0.62	2.37	5.05	0.004	14.88
1995	25.32	1.34	0.04	0.42	0.27	0.98	1.61	0.004	7.71
2000	0.62	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	0.13	0.08	0.38	0.004	3.05
2010	0.12	0.04	0.00	0.08	0.09	0.07	0.29	0.003	2.40
2015	0.09	0.04	0.00	0.08	0.07	0.05	0.29	0.002	2.27
2020	0.07	0.01	0.00	0.06	0.03	0.02	0.18	0.001	0.43
2021	0.02	0.01	0.00	0.05	0.03	0.01	0.15	0.000	0.34
2022	0.02	0.01	0.00	0.06	0.03	0.01	0.21	0.000	0.43
2023	0.06	0.01	0.00	0.06	0.04	0.03	0.16	0.005	1.03
2024	0.03	0.01	0.00	0.06	0.04	0.02	0.16	0.004	0.99
Change 1990-2024, %	-99.9	-99.6	-98.0	-95.5	-93.9	-99.1	-96.9	-0.5	-93.4
Change 2023-2024, %	-40.8	-2.3	-39.9	-0.7	-4.8	-16.4	-1.0	-6.6	-4.6

Table 3.22 continues

Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	1.17	0.38	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
2020	0.09	0.09	0.004	0.03
2021	0.08	0.04	0.003	0.001
2022	0.10	0.04	0.004	0.000
2023	0.21	0.12	0.010	0.034
2024	0.21	0.08	0.009	0.007
Change 1990-2024, %	-82.4	-78.2	29.2	-98.5
Change 2023-2024, %	-2.8	-29.8	-1.0	-80.2

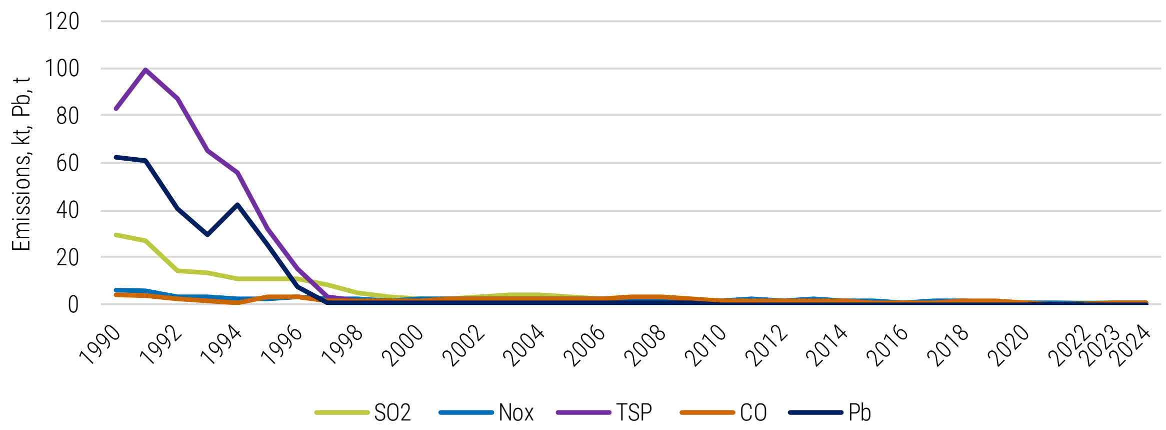

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Figure 3.22 Pollutant emissions from the manufacturing industries and construction

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).

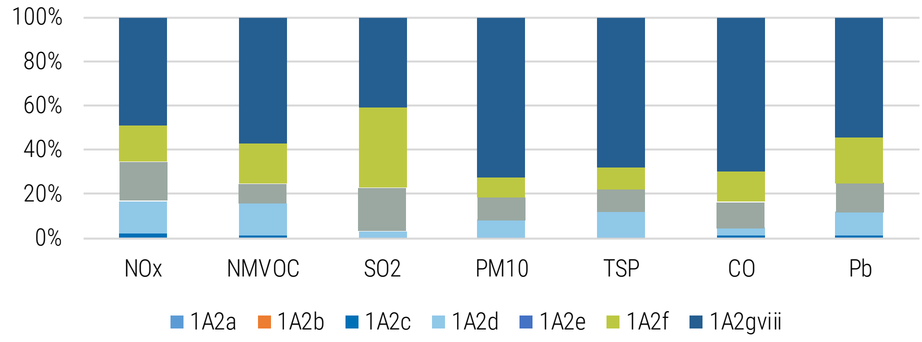

Figure 3.23 Distribution of pollutant emissions by sector in manufacturing industries in 2024

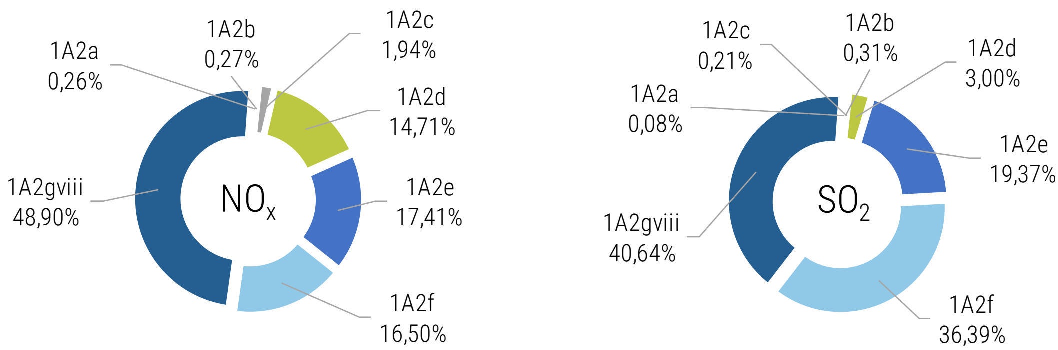

Figure 3.24 NO_x and SO_2 emissions from the combustion in manufacturing industries in 2024

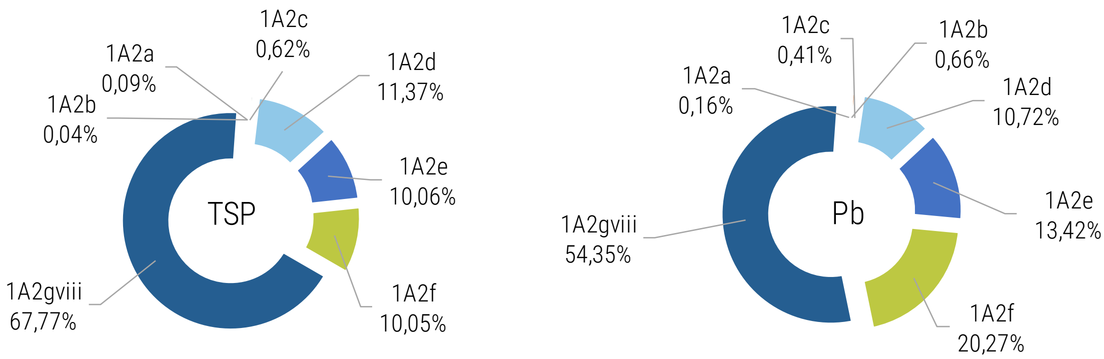

Figure 3.25 TSP and Pb emissions from the combustion in manufacturing industries in 2025

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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 analysis, 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 3.23). 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 3.23 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 3.24.

Details on fuel consumption by manufacturing industries are presented in the Table 3.25, Figure 3.27-3.28.

Table 3.24 Implied emission factors (IEF) for NFR 1A2, g/total fuels GJ

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	647.8	131.5	1.832.3	NR
1995	465.2	116.1	1.404.8	NR
2000	166.4	160.8	56.9	22.7
2005	152.7	104.6	42.6	24.3
2010	79.4	112.4	29.7	17.7
2015	32.3	99.1	22.4	13.8
2020	68.4	75.8	13.1	8.8
2021	49.7	64.0	6.6	4.3
2022	60.5	78.1	9.7	6.1
2023	60.0	92.3	24.6	17.0
2024	45.2	86.3	18.6	12.3

Table 3.25 Fuel consumption by manufacturing industries

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
2020	1.34	0.26	3.96	0.76	0.11
2021	1.06	0.01	4.13	0.69	NA
2022	1.28	NA	2.68	0.85	NA
2023	1.29	0.2	1.97	1.9	NA
2024	1.29	0.04	2.53	1.9	NA
Change 1990-2024, %	-95.45	-99.55	-68.38	618.70	-95.45
Change 2023-2024, %	0.23	-80.22	28.64	0.07	0.23

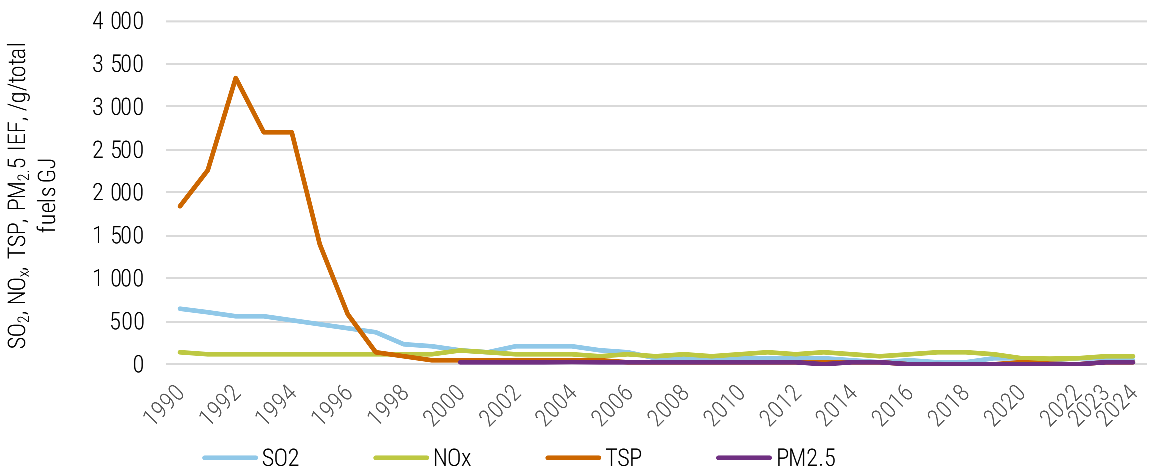

Figure 3.26 Implied emission factors (IEF) for NFR 1A2

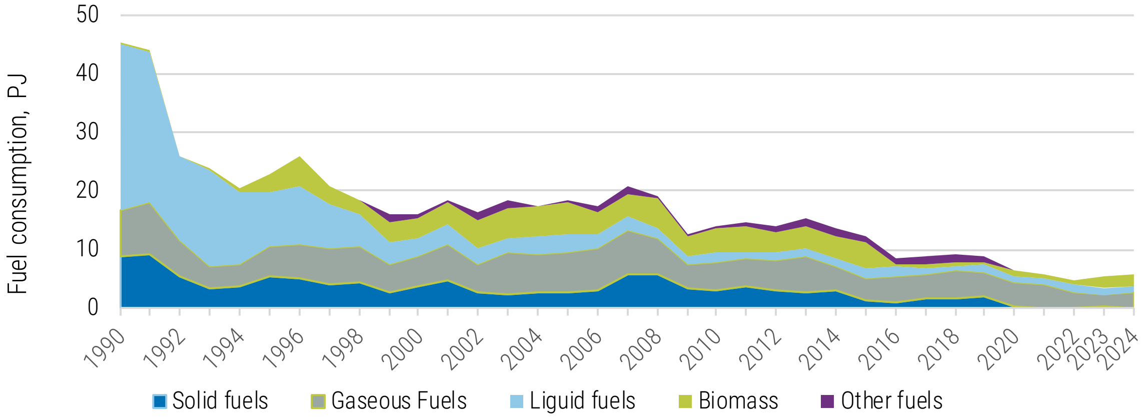

Figure 3.27 Fuel consumption by manufacturing industries

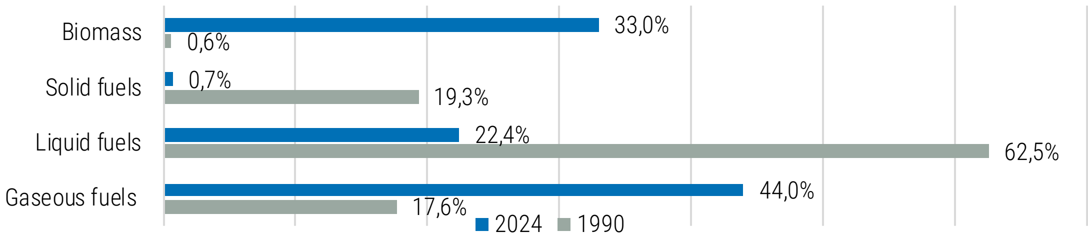

Figure 3.28 Distribution of fuel consumption in manufacturing industries in 1990 and 2024

3.2.3.3. Uncertainty

An uncertainty analysis was carried out to the year 2026 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 in manufacturing are given in the table 3.26.

Table 3. 26 Uncertainties in manucafturing industry sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	0.07	kt	0.30	0.01	0.003
NMVOC	0.26	kt	2.79	0.17	0.01
SO_x	0.00	kt	0.01	0.00	0.00
NH_3	0.07	kt	1.58	0.34	0.18
$PM_{2.5}$	0.09	kt	1.07	0.24	0.07
PM_{10}	0.11	kt	0.73	0.08	0.26
TSP	0.01	kt	1.05	0.23	0.29
BC	0.27	kt	0.32	0.02	0.04
CO	0.03	t	0.87	0.26	0.28
Pb	0.01	t	3.40	1.14	3.23
Cd	0.00	t	0.96	0.26	0.44
Hg	0.21	g I-TEQ	4.63	6.14	4.85
PCDD	0.02	t	2.31	3.02	0.74
benzo(a) pyrene	0.04	t	3.56	4.68	0.60
benzo(b) fluoranthene	0.01	t	2.09	2.69	1.08
benzo(k) fluoranthene	0.01	t	1.10	1.42	1.21
Indeno	0.01	kg	1.82	2.90	1.74
HCB	0.01	kg	1.63	3.06	1.17
PCB	0.07	kt	0.30	0.01	0.003

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

No recalculations were made for this sector in the 2026 submission.

3.2.3.6. Source-Specific Planned Improvements

Due to limited availability of activity data during the preparation of this report, some temporary assumptions were applied in the emission calculations to maintain the consistency of the time series. Recalculations are planned once revised and verified data become available.

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 3.27).

Table 3.27 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.

Emission calculations for NFR category 1A4 are based on national activity data. In the current submission, updated activity data were only partially available for several fuel types. Therefore, the inventory continues to apply the latest available verified activity data (2023) for selected fuels, including some liquid fuels (e.g. liquid fuels, biogas and biomass), in order to maintain the consistency of the time series.

The data will be revised in the 2027 submission once verified information becomes available, together with any necessary time-series consistency updates and explanations.

Emissions factors are provided in the Tables 3.29-3.32.

The residential stationary combustion sector is a key source of CO (40.1%), $PM_{2.5}$ (42.4%), PM_{10} (23.3%), TSP (14.5%), NO_x (11.8%), NMVOC (7.8%), some heavy metals and POPs of total emissions in 2024. The main source of pollution inside non-industrial combustion sector is residential stationary, which contributes to about 36% 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 1990-2024 period, the emission of all main pollutants from this sector have decreased, due to the significant reduction in the consumption of coal and peat. Some pollutants such as NH_3, Cd, Cr, Zn and HCB have increased due to an increase in wood combustion and higher wood emissions factors for these substance (see Table 3.28).

The decrease in emissions all substances by non-industrial combustion in 2024 when compared to 2023 is explained by decrease in wood consumption and also liguid fuels.

Table 3.28 Pollutant emissions from combustion in non-industrial sector

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	2.70	4.70	9.19	0.02	NR	NR	4.59	NR	54.28
1995	2.75	4.27	3.31	0.06	NR	NR	4.14	NR	68.44
2000	2.62	3.29	2.37	0.06	2.93	3.07	3.31	0.99	54.77
2005	2.37	2.56	1.26	0.05	2.23	2.34	2.52	0.74	42.61
2010	2.91	2.93	0.58	0.07	2.37	2.49	2.66	0.90	52.65
2015	2.55	2.15	0.49	0.05	1.86	1.95	2.08	0.73	39.14
2020	2.67	2.11	0.25	0.06	1.96	2.07	2.21	0.82	39.11
2021	2.61	2.03	0.24	0.05	1.97	2.07	2.22	0.83	37.84
2022	2.62	2.08	0.29	0.06	2.11	2.22	2.38	0.90	38.89
2023	2.39	1.81	0.33	0.05	1.95	2.05	2.20	0.84	34.33
2024	2.43	1.79	0.33	0.05	1.93	2.03	2.17	0.83	34.09
Change 1990-2024, %	-10.1	-61.9	-96.5	103.6			-52.6		-37.2
Change 2023-2024, %	1.9	-0.9	-0.7	-0.3	-1.4	-1.4	-1.4	-1.1	-0.7

Table 3.28 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
2020	1.75	0.28	0.04	0.10	0.43	0.12	0.43	0.009	8.94
2021	1.69	0.27	0.04	0.08	0.41	0.12	0.37	0.009	8.74
2022	1.67	0.28	0.04	0.09	0.44	0.12	0.42	0.009	9.17
2023	1.57	0.26	0.04	0.10	0.39	0.11	0.44	0.01	8.11
2024	1.52	0.25	0.04	0.10	0.39	0.11	0.44	0.008	8.10
Change 1990-2024, %	-47.2	34.3	-57.0	-58.9	18.2	-53.7	-59.1	-55.0	46.7
Change 2023-2024, %	-3.0	-0.6	-3.0	-0.9	-0.1	-0.4	-0.1	-0.2	-0.1

Table 3.28 continues

Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
1990	6.34	8.65	0.10	1.19

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Year	PCCD/F	PAH (4 total)	HCB	PCB
	g I-Teq	t	kg	
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
2020	0.48	3.30	0.19	0.02
2021	0.45	3.09	0.18	0.01
2022	0.46	3.17	0.19	0.02
2023	0.37	2.77	0.17	0.01
2024	0.36	2.67	0.17	0.00
Change 1990-2024, %	-94.3	-69.1	65.8	-99.7
Change 2023-2024, %	-1.8	-3.6	-0.8	-37.1

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 3.29), 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 3.31.

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 3.31. 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 3.30.

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 3.32). Data on the amount of the burned waste were obtained on the basis of the Statistics Estonia questionnaire (see Table 3.36). 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 3.32).

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. Growing awareness and constant notification of the volume of waste being burned is helping to reduce this figure in resent years (see Table 3.36).

Table 3.29 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 3.30 *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

Pollutant	Unit	Biomass			
		Conventional stoves, fireplaces, saunas, outdoor heaters (average)	Small boilers (<=50 kW_{th})	Advanced stoves and boilers	Pellet stoves and boilers
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 3.31 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 3.31 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	177.831	74.512	176.21	45.88
NMVOC	g/GJ	227.32	46.85	520.434	57.883	204.556	2.28
SO_2	g/GJ	0.86	0.79	9.643	11.00	10.89	12.34
NH_3	g/GJ	2.41	5.61	2.955	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	8605.442	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 3.32 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 3.33.

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 3.34, 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).

Table 3.33 Implied emission factors (IEF) for NFR 1A4, g/total fuels GJ

Year	SO_2	NO_x	NMVOC	TSP	$PM_{2.5}$
1990	365.2	107.4	186.9	182.3	NR
1995	147.7	122.7	191.0	185.0	NR
2000	108.6	120.1	151.0	151.8	134.7
2005	59.4	111.3	120.3	118.1	104.8
2010	23.1	115.4	116.5	105.6	94.2
2015	20.6	106.4	89.9	87.0	77.6
2020	10.1	106.4	83.8	87.7	78.1
2021	9.6	105.4	82.1	89.5	79.6
2022	12.0	110.0	87.2	99.7	88.6
2023	14.9	108.9	82.6	100.7	89.3
2024	14.3	106.8	78.7	95.4	84.7

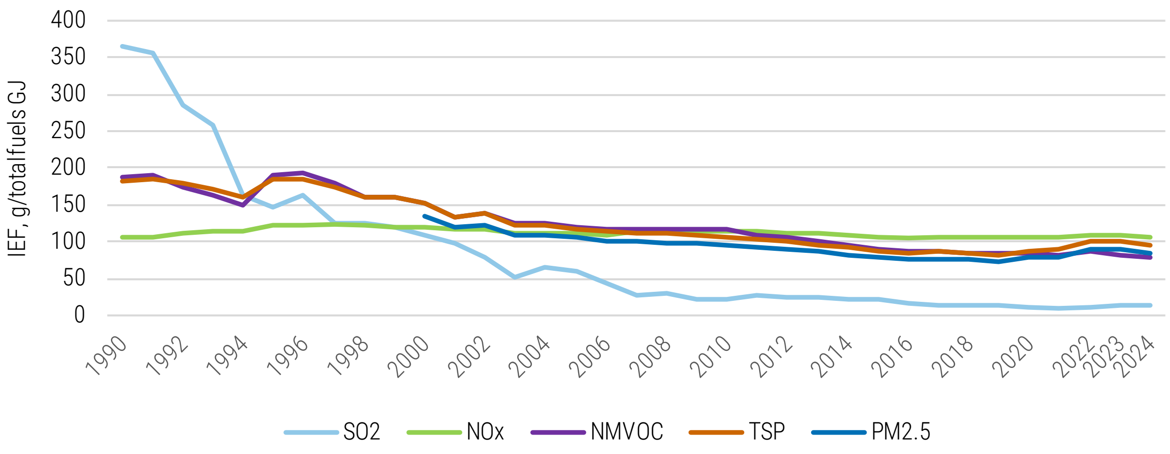

Figure 3.29 Implied emission factors (IEF) for NFR 1A4

Activity Data

The fuel consumption figures for the non-industrial stationary combustion sector are presented in Table 3.34 and Figure 3.30. The consumption of liquid and solid fuels (mainly coal and peat) has decreased across 1990-2024, by about 76.1% and 99.7% respectively. At the same time, wood burning and natural gas consumption increased by about 108% and 78.2%. The distribution of fuel consumption rates in 1990 and 2024 are shown in Figure 3.31.

Table 3.34 Fuel consumption in non-industrial combustion plants (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
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
2023	1.78	0.03	4.00	15.88	0.20
2024	1.78	0.02	4.97	15.81	0.19
Change 1990-2024, %	-76.1	-99.8	78.2	108.0	-39.7
Change 2023-2024, %	0.0	-41.7	24.2	-0.4	-3.9

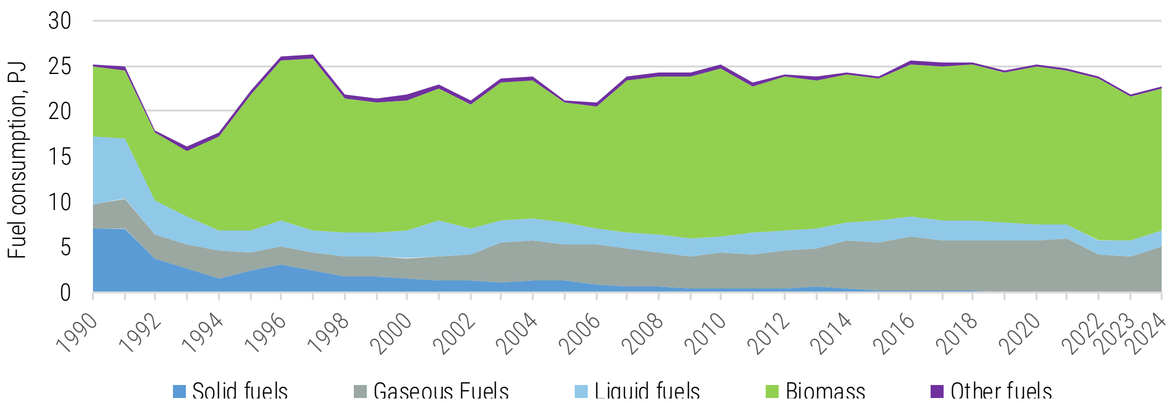

Figure 3.30 Fuel consumption in the non-industrial combustion plants

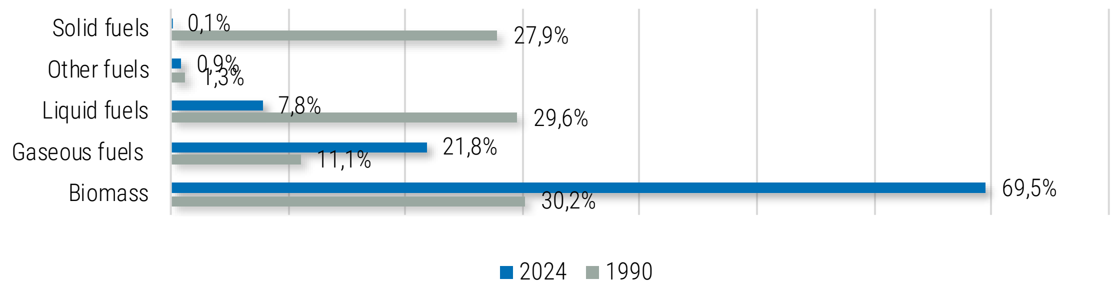

Figure 3.31 Distribution of fuel consumption in non-industrial combustion sector in 1990 and 2024

Fuel consumption figures by residential stationary sector are presented in Table 3.35. Figure 3.32 shows fuel consumption levels for each non-industrial sector in 2023. It should be noted that the domestic sector is the main source of wood burning.

Table 3.35 Fuel consumption in residential combustion plants (NFR 1A4bi), 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
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	NA	2.04	17.10	209.82
2023	0.18	0.01	2.31	15.46	201.87
2024	0.18	0.01	2.72	15.46	193.92
Change 1990-2024, %	-94.75	-99.85	14.23	203.51	-39.65
Change 2023-2024, %	0.00	-0.04	17.81	0.00	-3.94

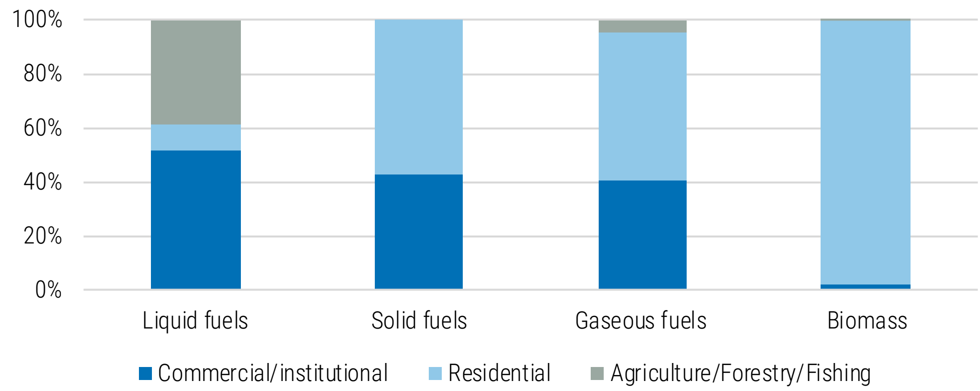

Figure 3.32 Fuel consumption by non-industrial sectors in 2024

Table 3.36 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

Year	Amount of waste
2015	15,009.040
2020	11,988.420
2021	11,566.100
2022	11,143.780
2023	10,721.463
2024	10,299.144

3.2.4.3. Uncetainty

An uncertainty analysis was carried out to the year 2026 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 non-industrial combustion are given in the table 3.37.

Table 3. 37 Uncertainties in non-industrial combustion sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	2.43	kt	13.73	8.31	2.35
NMVOC	1.79	kt	8.03	3.94	1.87
SO_x	0.33	kt	3.50	0.47	0.02
NH_3	0.05	kt	0.52	0.26	0.15
$PM_{2.5}$	1.93	kt	43.03	24.73	13.37
PM_{10}	2.03	kt	23.63	13.56	5.44
TSP	2.17	kt	14.78	7.59	0.58
BC	0.83	kt	76.42	44.20	37.94
CO	34.09	kt	40.32	20.47	10.68
Pb	1.52	t	40.33	44.16	0.88
Cd	0.25	t	62.15	64.52	6.23
Hg	0.04	t	20.64	22.70	3.01
PCDD	0.36	g I-TEQ	8.16	14.60	37.63
benzo(a) pyrene	0.77	t	75.50	153.32	20.70
benzo(b) fluoranthene	0.64	t	62.88	126.57	17.96
benzo(k) fluoranthene	0.49	t	77.27	156.72	20.73
Indeno	0.79	t	87.05	178.35	31.01
HCB	0.17	kg	32.19	35.65	24.65
PCB	0.004	kg	0.87	1.08	2.89

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

Information about recalculations and changes made in the 2026 submission is presented in Chapter 8.

3.2.4.6. Source-Specific Planned Improvements

Due to limited availability of activity data during the preparation of this report, some temporary assumptions were applied in the emission calculations to maintain the consistency of the time series. Recalculations are planned once revised and verified data become available.

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 3.38 gives an overview of all the transport sectors and the methodologies used for calculating emissions from the transport sector.

Table 3.38 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 relies on diesel and electric locomotives; steam locomotives were used historically	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

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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

It should be noted that in the 2024 emission calculations, diesel consumption was assumed to remain at the same level as in 2023, while the consumption of other fuels was based on the available 2024 data reported to Eurostat. This approach was applied because updated and verified activity data for the transport sector were only partially available at the time of the calculations. Therefore, a temporary assumption was used to maintain the consistency of the time series.

Work is ongoing and the calculations will be revised for the 2027 inventory submission. Where necessary, previous years will also be revised accordingly. Consequently, this inventory report includes fewer comparisons with previous years than in past reports, and deviations are not discussed in detail until final data become available. Aviation is the only subsector for which the data originate directly from the source, and therefore the comparisons are considered reliable.

The transport sector is a major contributor to national emissions. The transport sector includes the 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 2024 was the following: NO_x – 41.0%, BC – 14.2%, CO – 10.7% and NMVOC – 6.9%. The methodology of emissions calculations in regards to the 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 2024 was the following: $PM_{2.5}$ – 14.9%, PM_{10} – 14.5%, TSP – 16.9%. 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 71.5%. The emissions of NMVOC and CO from the transport sector have decreased by 93.1% and 92.3% respectively since 1990. The trend of the emissions of these categories is given in Figure 3.34 and Table 3.39.

Recalculations have been made for the following sectors: road transport (1A3bi-vii) and railways sector (1A3c). Recalculations in road transport entail using updated emission factors, which led to a change in total emissions. An expert mistake was found and corrected in railways sector. 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'.

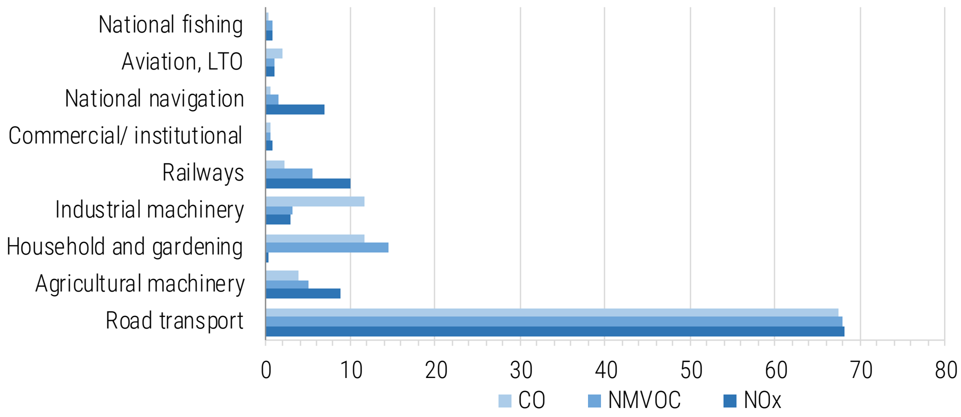

Figure 3.33 NO_x, NMVOC and CO emission shares in the transport sectors in 2024 (%)

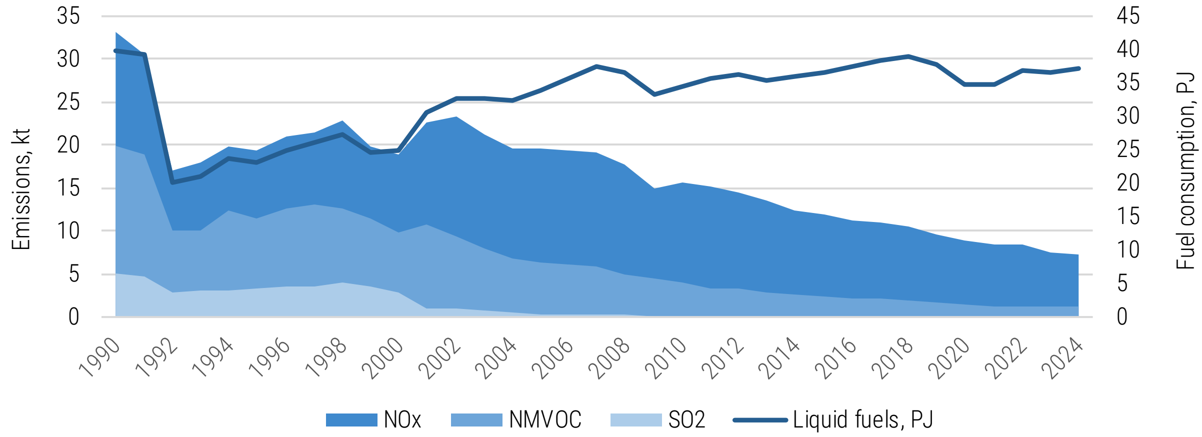

Figure 3.34 NO_x, NMVOC and CO emissions from the transport sector

Table 3.39 Total emissions from the transport sector

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	33.172	19.918	5.068	0.017	NR	NR	2.966	NR	147.316
1995	19.428	11.578	3.382	0.027	NR	NR	1.937	NR	66.009
2000	18.883	9.921	2.912	0.098	0.977	1.308	1.913	0.322	62.828
2005	19.657	6.350	0.370	0.202	1.321	1.797	2.671	0.443	46.029
2010	15.639	3.961	0.112	0.215	1.112	1.624	2.558	0.337	29.234
2015	11.936	2.281	0.032	0.165	1.109	1.739	2.885	0.273	18.360
2020	9.016	1.448	0.031	0.121	1.166	1.939	3.368	0.209	11.118
2021	8.520	1.277	0.026	0.105	1.021	1.703	2.926	0.182	9.603
2022	8.472	1.240	0.028	0.105	0.988	1.652	2.828	0.178	8.842
2023	7.617	1.175	0.029	0.105	1.015	1.725	3.001	0.161	8.584
2024	7.266	1.195	0.029	0.105	1.034	1.767	3.095	0.155	9.072
Change 1990-2024, %	-78.10	-94.00	-99.43	508.45	NR	NR	4.36	NR	-93.84
Change 2023-2024, %	-4.60	1.66	0.70	0.59	1.90	2.44	3.12	-3.87	5.68

Table 3.39 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	78.813	0.007	0.007	0.013	0.388	8.494	0.089	0.008	2.592
1995	24.656	0.003	0.004	0.007	0.232	5.062	0.047	0.004	1.535
2000	5.464	0.004	0.004	0.008	0.250	5.461	0.052	0.005	1.657
2005	2.792	0.005	0.005	0.010	0.338	7.388	0.072	0.007	2.284
2010	1.029	0.006	0.005	0.012	0.376	8.228	0.076	0.007	2.487
2015	1.166	0.006	0.005	0.013	0.439	9.607	0.081	0.008	2.903
2020	1.278	0.007	0.005	0.015	0.481	10.513	0.087	0.009	3.152
2021	1.331	0.006	0.005	0.015	0.501	10.935	0.087	0.009	3.273
2022	1.358	0.007	0.005	0.016	0.512	11.182	0.089	0.009	3.365
2023	1.363	0.007	0.005	0.016	0.512	11.178	0.090	0.009	3.368
2024	1.356	0.007	0.005	0.016	0.509	11.102	0.090	0.009	3.391
Change 1990-2024, %	-98.28	3.54	-28.02	23.13	31.03	30.71	0.30	13.17	30.84
Change 2023-2024, %	-0.54	0.21	0.38	-0.58	-0.67	-0.68	-0.21	0.96	0.68

Table 3.39 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	0.0007	0.0069
2000	0.199	0.007	0.014	0.009	0.006	0.036	0.0009	0.0014
2005	0.273	0.011	0.019	0.012	0.009	0.050	0.0012	0.0005
2010	0.323	0.012	0.020	0.014	0.009	0.056	0.0012	0.0005
2015	0.321	0.016	0.023	0.015	0.012	0.065	0.0008	0.0003
2020	0.274	0.017	0.023	0.015	0.013	0.069	0.0008	0.0003
2021	0.237	0.017	0.023	0.017	0.014	0.070	0.0008	0.0003
2022	0.219	0.017	0.024	0.017	0.014	0.071	0.0007	0.0003
2023	0.196	0.017	0.023	0.017	0.014	0.071	0.0008	0.0003
2024	0.180	0.017	0.024	0.017	0.013	0.071	0.0007	0.0003
Change 1990-2024, %	-41.45	-3.47	-23.86	0.60	8.51	-8.83	-56.19	-98.55
Change 2023-2024, %	-8.38	-2.83	2.60	4.96	-2.51	0.84	-2.11	-1.34

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 2024 was 1.1%, 1.0%, and 1.9% respectively. Other pollutants have an even smaller share.

All the changes in the time series result mostly from changes in fuel consumption and the number of landing and take-off operations (see Figure 3.35).

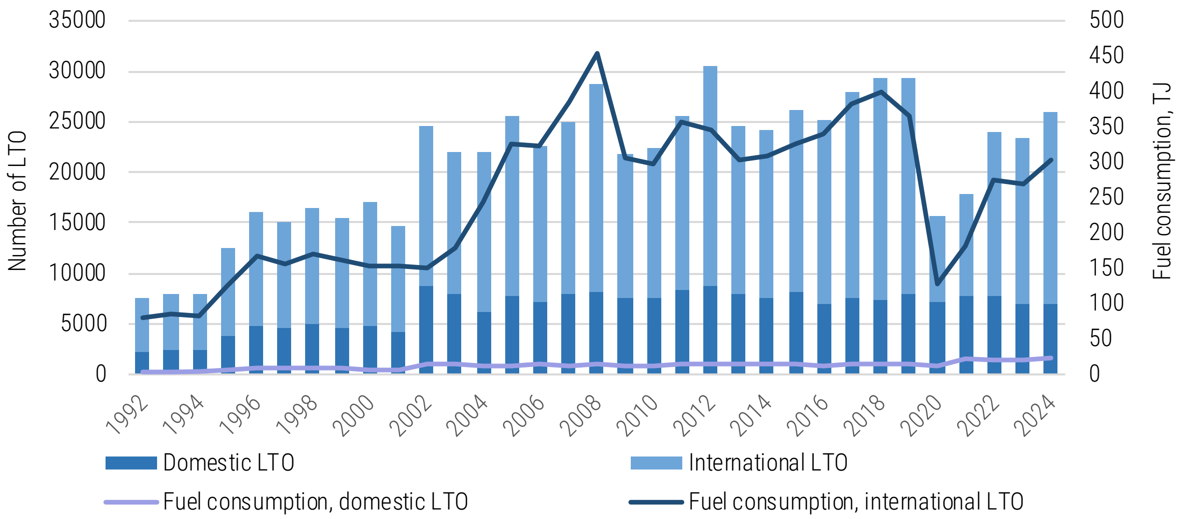

Figure 3.35 The number of LTO cycles and fuel consumption

Figure 3.36 illustrates the importance of the international aviation sector, which contributes the majority of the emissions from the aviation sector.

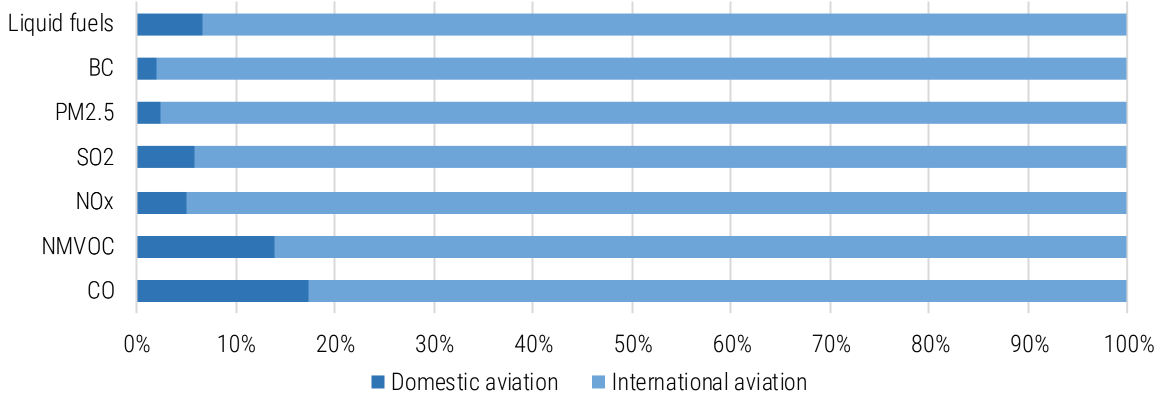

Figure 3.36 The share of pollutant emissions from the LTO cycle in aviation sector in 2024

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 3.37 and Table 3.40) 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 and seems to have reached a level with similar values between following years, although minor increase is seen. In 2024, NO_x, NMVOC, SO_2, and CO emissions increased by 13.6%, 3.4%, 12.7%, and 7.8% respectively, while PM decreased by 14.8% compared to 2023. The increase in the amount of fuel consumed and the number of landing and take-off operations resulted in an increase in emissions from the LTO-phase. PM has decreased separately from other pollutants due to the type of the aircrafts that used our airports and their different emission factors.

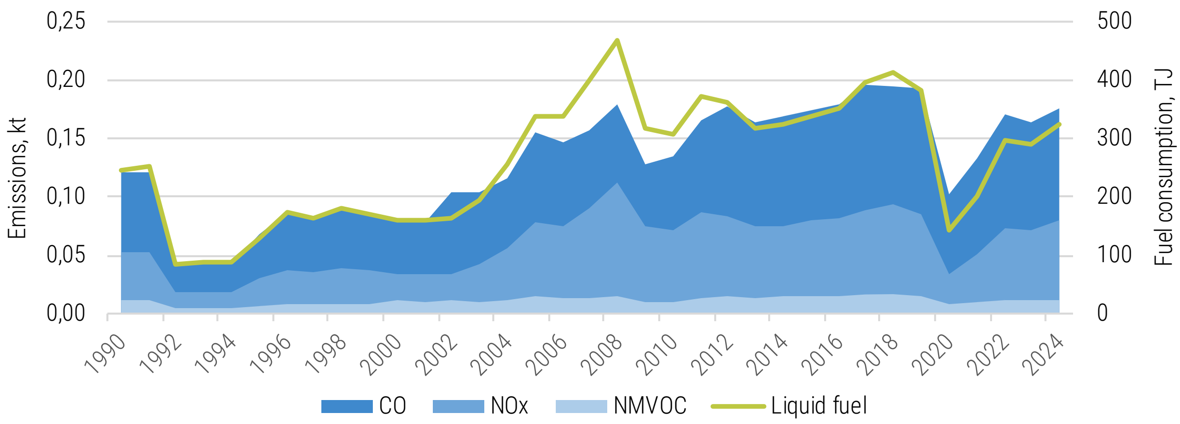

Figure 3.37 NOx, NMVOC and CO emissions from the LTO cycle in aviation sector

Table 3. 40 Emissions from the LTO cycle in the aviation sector (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
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
2023	0.071	0.012	0.006	0.0006	0.0006	0.0006	0.0002	0.164
2024	0.080	0.012	0.007	0.0005	0.0005	0.0005	0.0002	0.176
Change 1990-2024, %	53.6	-0.17	28.2			29.1		46.5
Change 2023-2024, %	13.6	3.4	12.7	-14.8	-14.8	-14.8	11.5	7.8

Table 3. 41 Emissions from the cruise phase in the aviation sector (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	0.472	0.018	0.037	0.007	0.007	0.007	0.004	0.042
2020	0.651	0.025	0.051	0.010	0.010	0.010	0.005	0.057
2021	0.513	0.020	0.040	0.008	0.008	0.008	0.004	0.045
2022	0.512	0.020	0.040	0.008	0.008	0.008	0.004	0.045
2023	0.534	0.020	0.042	0.008	0.008	0.008	0.001	0.047
2024	0.623	0.024	0.049	0.010	0.010	0.010	0.001	0.055
Change 1990-2024, %	61.8	64.3	61.1			61.1		58.0
Change 2023-2024, %	16.5	16.9	16.4	16.4	16.4	16.4	16.4	15.9

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 3.42) 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.

Fuel-based cruise emission factors are taken from the EMEP/EEA Guidebook as a single set for an average aircraft (see Table 3.43). 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 3.44). 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 3.42). 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 2024. Extrapolation has been done for 1990 and 1991.

Table 3. 42 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

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
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

Table 3. 43 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 3.44 Fuel consumption in the aviation sector (TJ)

Year	Domestic LTO	Domestic cruise	International LTO	International cruise	Total
1990	12.41	65.99	233.37	1256.23	1,568.00
1995	6.10	39.50	123.67	571.73	741.00
2000	6.58	27.42	154.65	730.35	919.00
2005	13.24	52.85	325.44	1,576.56	1,968.09
2010	12.34	26.77	296.38	1,112.11	1,447.60
2015	13.84	44.31	325.49	1,767.18	2,150.81
2020	12.84	37.43	128.32	876.59	1,055.17
2021	22.14	56.35	180.38	1,621.58	1,880.45
2022	21.43	46.38	276.00	2,124.77	2,468.59
2023	21.47	56.16	269.58	1,749.97	2,097.18
2024	21.87	54.51	302.18	2,048.02	2,426.58

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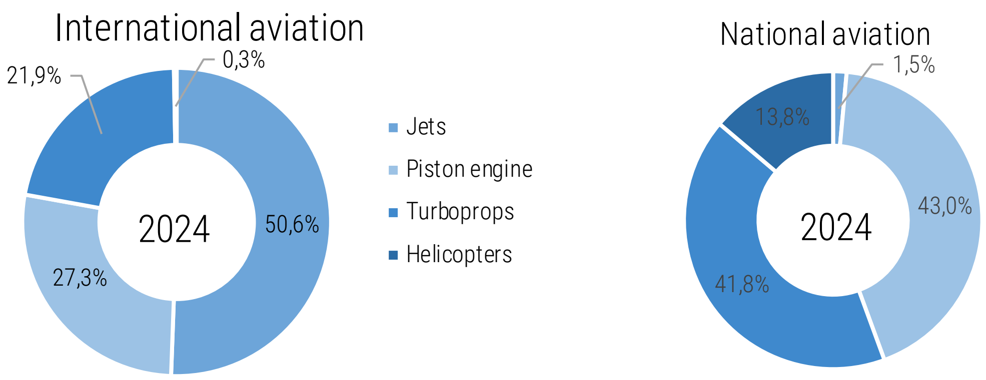

Figure 3.38 The share of different aircraft types in domestic and international civil aviation

3.3.2.3. Uncertainty

An uncertainty analysis was carried out for the 2026 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 3.45. No uncertainty estimation for cruise phase has been carried out.

Table 3.45 Uncertainties in the aviation (LTO) sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	0.08	kt	0.45	0.13	0.03
NMVOC	0.01	kt	0.05	0.01	0.003
SO_x	0.01	kt	0.08	0.02	0.001
$PM_{2.5}$	0.001	kt	0.01	0.003	0.001
PM_{10}	0.001	kt	0.006	0.002	0.0005
TSP	0.001	kt	0.003	0.001	0.0001
BC	0.0002	kt	0.02	0.007	0.003
CO	0.18	kt	0.21	0.05	0.02

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.

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 either seen a slight increase or remained steady, primarily due to the growing annual mileage of vehicles. It's also important to note that the rise in hybrid and electric vehicles has had a modest influence on the overall growth of particle emissions. The added weight of these vehicles, resulting from their batteries, contributes to this effect. 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 98.2% since 1990 (see Figure 3.39). The reduction of emissions is related to the prohibition on leaded petrol in 2000.

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 3.47). 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 2024.

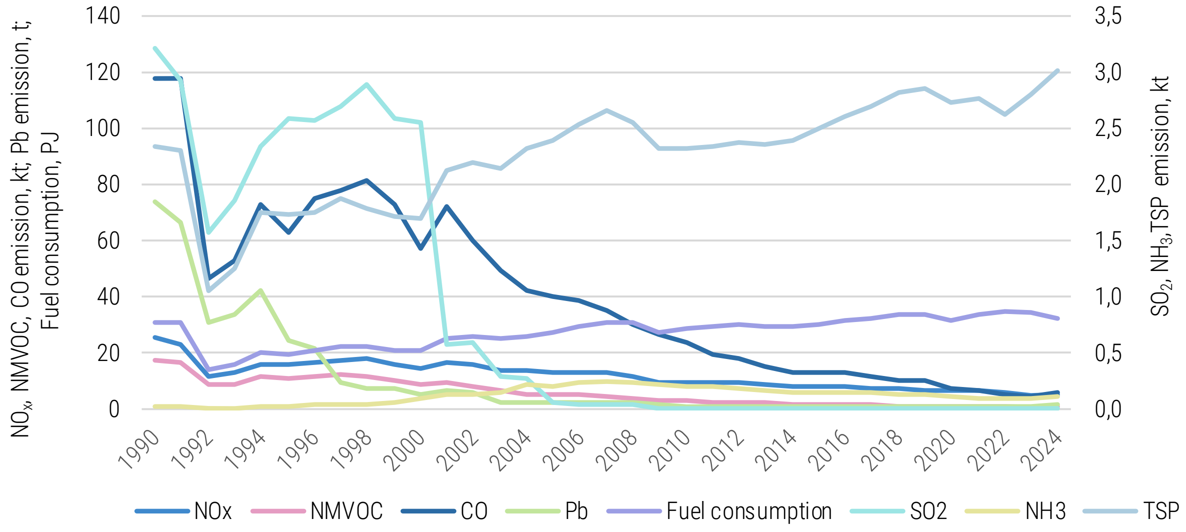

Figure 3.39 Fuel consumption and pollutant emissions from road transport

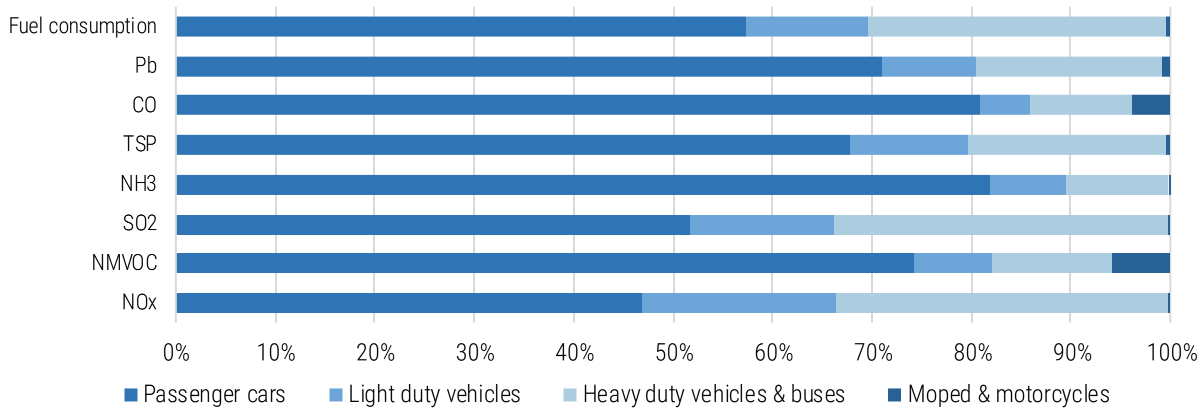

Figure 3.40 The share of pollutant emissions in the road transport sector in 2024

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 the road transport (see Figure 3.41 and Table 3.52). It should be noted that, around 2021, the trend stabilised and remained at the same level. This trend between 2003 and 2021 can be explained by the fact that the popularity of vehicles with petrol engines has declined, and diesel engines dominate due to their greater fuel efficiency and torque compared to petrol engines.

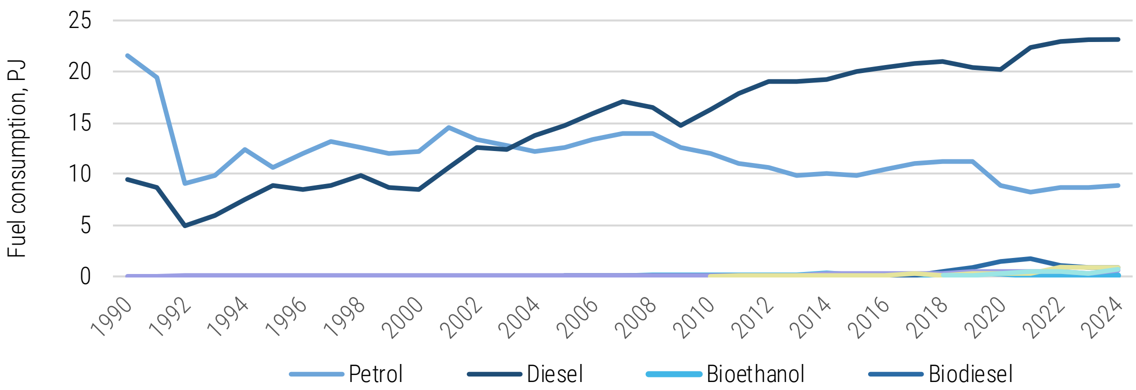

Figure 3.41 Fuel consumption in the road transport sector

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 80.6% and 95.3% respectively between 1990 and 2024. 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 57.9% in 2024 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 the road transport amounted to only 1.1% of the national total NH_3 emissions in 2024.

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 59.2% decrease in petrol consumption during the period of 1990–2024 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 the transport sector. Over the last 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 4.5% in 2024 (see Table 3.52).

TSP exhaust emissions from road transport vehicles have decreased by 75.9% during the 1990-2024 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 31.7% between 1990 and 2024 (1.2 thousand tonnes to more than 1.7 thousand tonnes) which is directly linked with the change in the annual mileage driven by the vehicles (an increase of 47.6%) 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 58.0% of Cd, 6.2% of Cr, 11.0% of Cu, 42.2% of Ni, 49.1% of Se, 19.3% of Zn, and only 0.004% of Pb across the entire total road transport sector in 2024.

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.

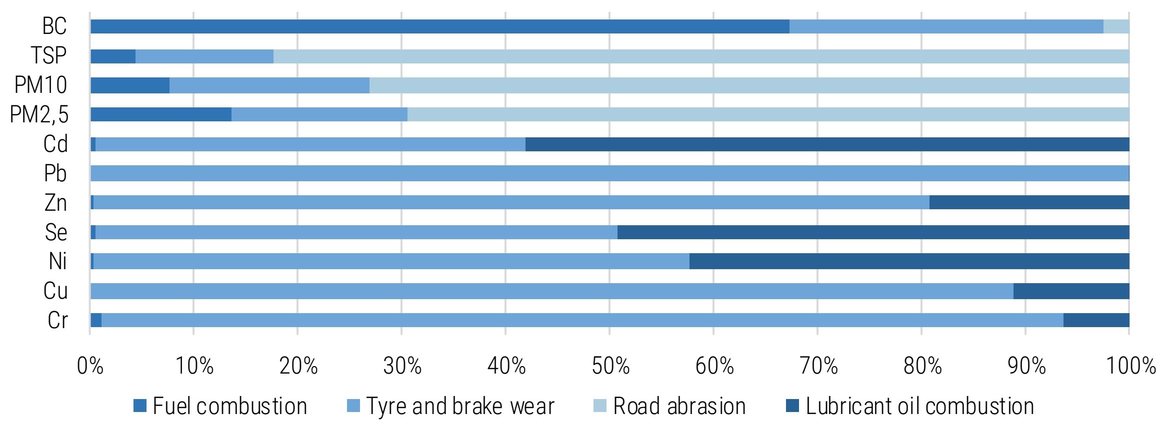

Figure 3.42 The share of different sources in pollutant emissions in 2024

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The emission trend in recent years has been influenced by improved fuel efficiency and reduced emissions from newer vehicles. In 2024, statistics revealed a 1.2% increase in the number of vehicles compared to 2023, and overall fuel consumption increased by 1.7%. The reduction of nitrogen oxides is largely due to the declining number of older vehicles and the increasing share of newer vehicles, which are subject to stricter emission standards. It is also worth noting that older vehicles tend to have lower annual mileage and are used less frequently than newer ones. Changes in emissions are largely dependent on the distribution of annual kilometres across the different subsectors within the road transport sector. In the reporting year, the annual mileage of heavy-duty vehicles (HDVs) was adjusted to a lesser extent than in previous years, in line with the principle that a significant share of mileage is driven abroad. As a result, HDVs had a greater impact on total emissions, which may have contributed to the observed increase.

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 3.46.

Passenger cars (1A3bi)

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 669 thousand between 1990 and 2024. Cars with petrol engines made up a majority of registered passenger cars in 1990 with 88% but in 2024 the share of petrol engine passenger cars was 49.1%. Figure 3.43 demonstrates the change of petrol engine passenger cars over the years. 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 eleven times (441 to 4,754 million km) and annual mileage per petrol cars decreased by 29.2% (5,276 to 3,736 million km). Overall fuel consumption in this subsector increased by 18.7% between 1990 and 2024. In detail, fuel consumed by diesel cars increased approximately ten times and petrol fuel amount decreased by 44.1% during the same period.

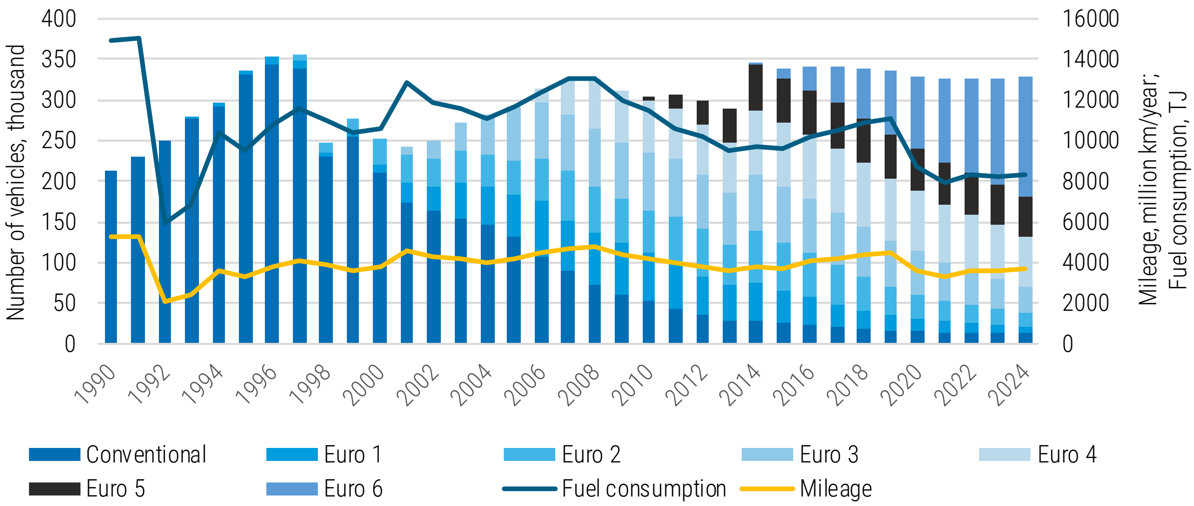

Figure 3.43 Petrol passenger cars: number of vehicles, annual mileage, and fuel consumption

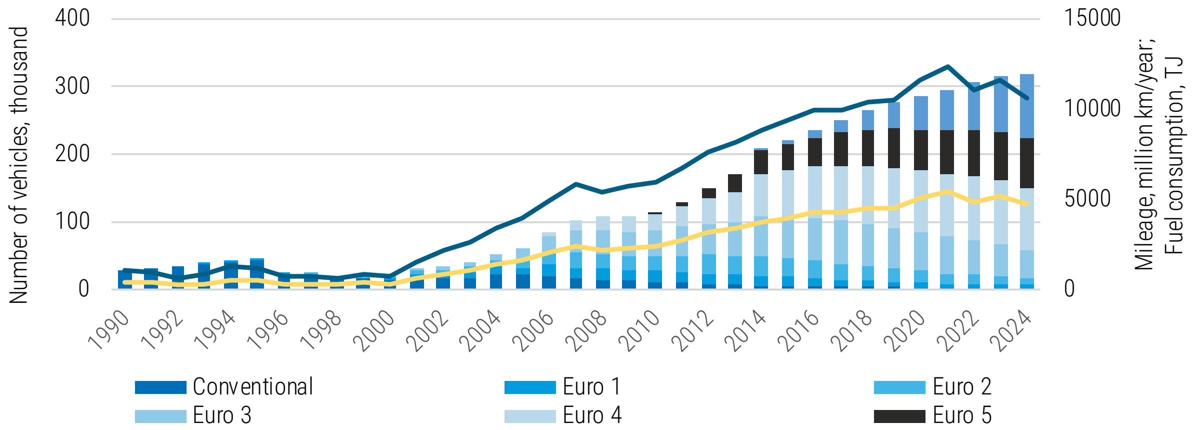

Figure 3.44 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption

During the period of 1990–2024 the pollutant emissions decreased significantly: 82.7% of NO_x, 95.9% of NMVOC, 99.6% of SO_2, and 95.2% of CO, despite an increase in activity data over the same period. This reduction in emissions can largely be attributed to improvements in fuel quality and the implementation of progressively stricter emission standards for new vehicle categories. As a result, new technologies have been gradually introduced, from Euro 1 to Euro 6 standards, while older vehicles are being used less frequently, contributing to a lower annual mileage. Nevertheless, medium-sized engines continue to dominate in both diesel and petrol-powered vehicles. Cars powered by alternative fuels, including hybrids, still account for only a small portion of the car fleet in 2024.

Light duty vehicles (1A3bii)

The light commercial vehicle fleet has grown over the last decades from 31 thousand vehicles to 88 thousand between 1990 and 2024. 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 79 thousand vehicles in 2024 (see Figure 3.45). The petrol light duty vehicle fleet decreased by 30.6% over the same period from 13 thousand to 9 thousand vehicles (see Figure 3.46). A similar trend can be seen in the annual mileage and fuel consumption – mileage and fuel consumption increased by 112% and 72% respectively in this subsector. As expected, annual mileage driven by petrol vehicles decreased by 71% and the total annual kilometres driven by diesel vehicles increased approximately four times. In addition, petrol fuel consumption decreased by 78% and diesel fuel consumption increased almost four times in this subsector during the same period.

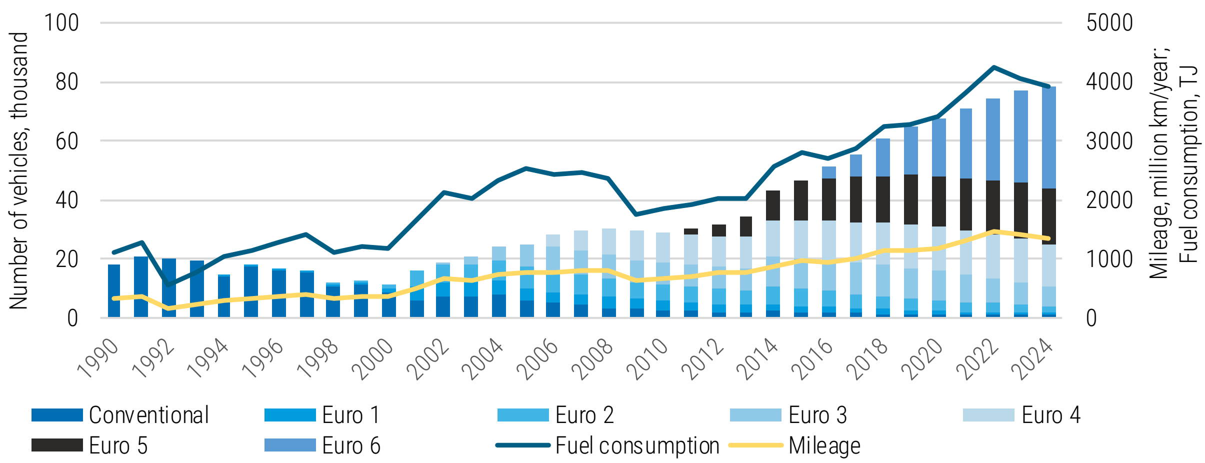

Figure 3.45 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption

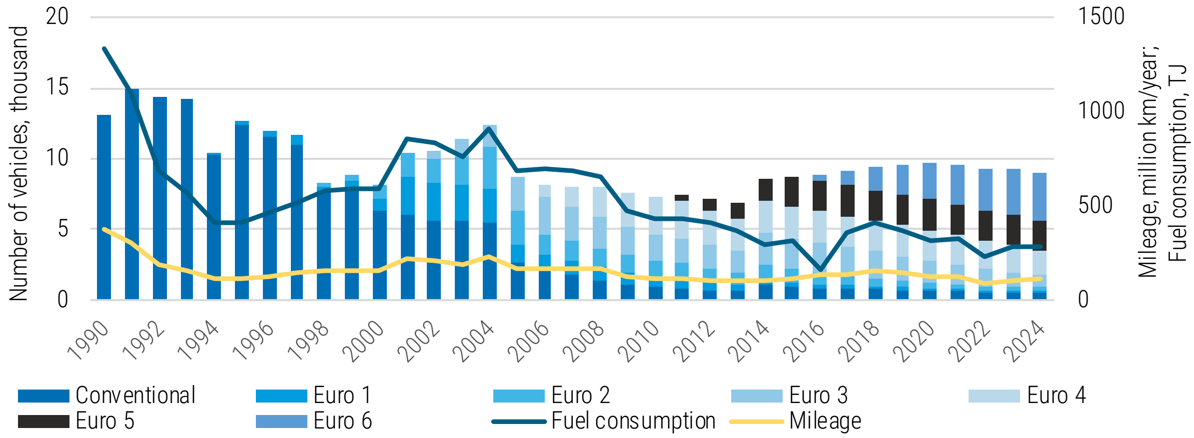

Figure 3.46 Petrol light duty vehicles: number of vehicles, annual mileage, and fuel consumption

The pollutant emissions decreased significantly: 40.0% of NO_x, 94.3% of NMVOC, 99.7% of SO_2 and 96.7% of CO, despite an increase in activity data over the period of 1990–2024. 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.

Heavy duty vehicles and buses (1A3biii)

The heavy duty vehicle and bus fleet has declined over the last decades from 45 thousand vehicles to 30 thousand between 1990 and 2024. Heavy duty vehicles and buses with diesel engines make up the majority of registered vehicles – 60.4% in 1990 and 52.3% in 2024. The number of petrol vehicles has declined by 95% and the number of diesel vehicles increased by 42%. Total annual mileage and fuel consumption decreased by 28% and 25% respectively during this period. In detail, mileage driven by diesel vehicles increased by 44% and fuel consumed increased approximately 27% (see Figure 3.47). However, the same indicators for petrol powered heavy duty vehicles decreased by 99% (see Figure 3.48).

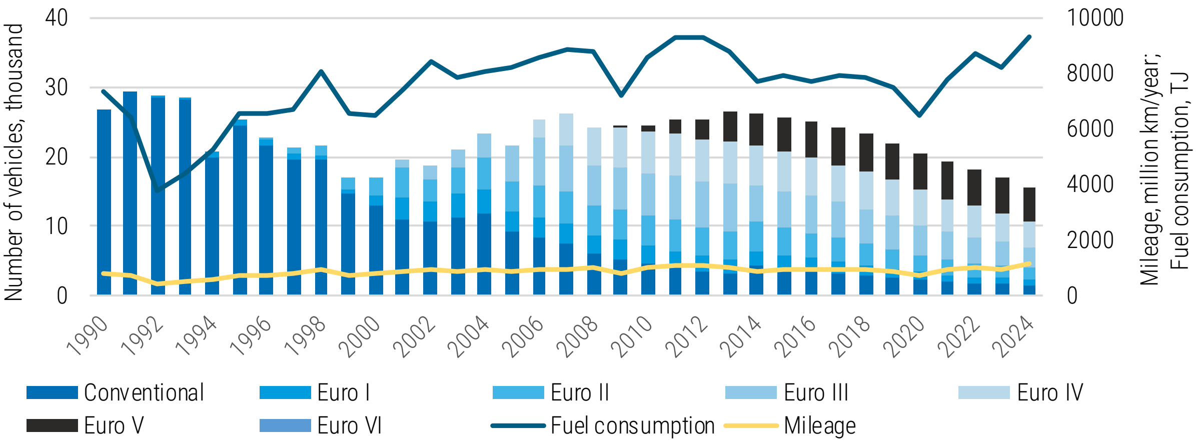

Figure 3.47 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption

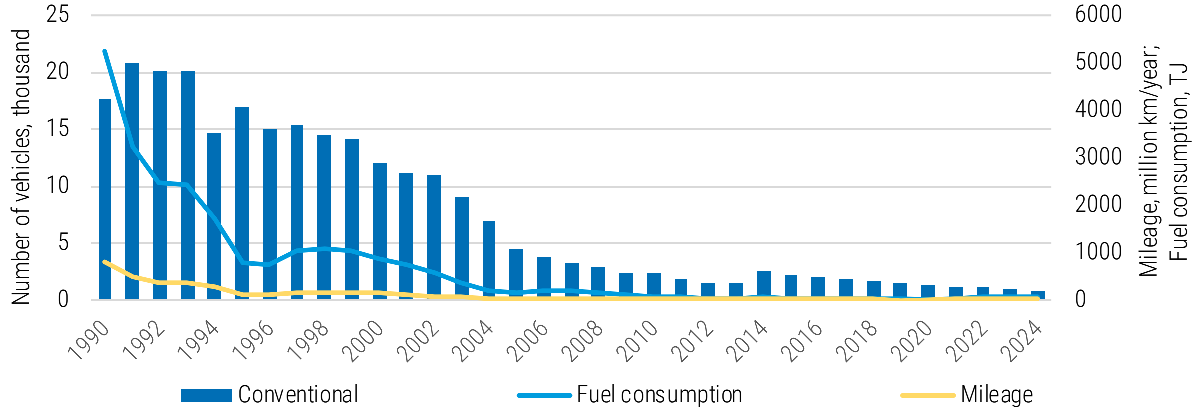

Figure 3.48 Petrol heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption

During the period of 1990–2024, the pollutant emissions decreased significantly: 84.3% of NO_x, 97.2% of NMVOC, 99.9% of SO_2 and 85.0% of CO.

Motorcycles and mopeds (1A3biv)

The number of motorcycles has grown over the last decades from 2 thousand vehicles to 51 thousand. Annual mileage and fuel consumption increased approximately twelve times in this subsector between 1990 and 2024 (see Figure 3.49).

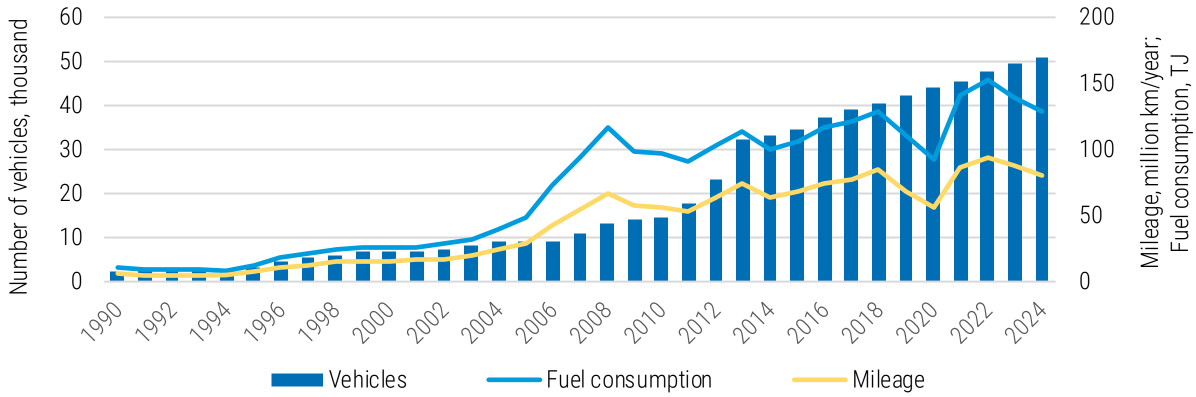

Figure 3.49 Motorcycles and mopeds: number of vehicles, annual mileage, and fuel consumption

During this period, NO_x, NMVOC and CO emissions increased by approximately 5.3 and 2 times respectively. Although, all the activity data and main pollutant emissions increased in the same time, SO_2 emissions declined by 97.0%.

Recalculations

All the emissions from the road transport have been recalculated for the period 1990-2024. Recalculations entail updated emission factors, and the taking into use of an improved new edition of the COPERT 5 program (version 5.9.2) for emission calculations. An overview of the updated data is given in Chapter 8.

Table 3.46 Emissions from road transport

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	25.50	17.38	3.213	0.016	NR	NR	2.321	NR	117.42
1995	15.71	10.90	2.593	0.026	NR	NR	1.720	NR	62.57
2000	14.20	8.83	2.553	0.097	0.776	1.102	1.680	0.214	56.99

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
2005	13.22	5.27	0.063	0.201	1.059	1.530	2.377	0.295	40.07
2010	9.99	3.17	0.006	0.214	0.921	1.427	2.331	0.224	24.83
2015	8.26	1.62	0.009	0.164	0.979	1.606	2.740	0.196	12.91
2020	6.56	1.01	0.011	0.120	1.084	1.854	3.277	0.162	7.91
2021	6.46	0.92	0.007	0.104	0.957	1.638	2.853	0.147	7.20
2022	6.18	0.86	0.008	0.105	0.916	1.577	2.746	0.137	6.62
2023	5.34	0.81	0.007	0.104	0.946	1.654	2.922	0.122	5.87
2024	4.95	0.81	0.006	0.105	0.963	1.694	3.014	0.115	6.12
Change 1990-2024, %	-80.6	-95.3	-99.8	553.7			29.8		-94.8
Change 2023-2024, %	-7.3	0.2	-8.8	0.6	1.9	2.4	3.2	-5.9	4.2

Table 3.46 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	73.98	0.004	0.005	0.011	0.377	8.18	0.057	0.006	2.36
1995	24.20	0.003	0.003	0.007	0.228	4.94	0.035	0.004	1.45
2000	5.38	0.003	0.003	0.007	0.245	5.31	0.037	0.004	1.56
2005	2.76	0.004	0.004	0.010	0.330	7.16	0.050	0.005	2.14
2010	1.01	0.004	0.004	0.011	0.369	8.00	0.056	0.006	2.34
2015	1.14	0.005	0.005	0.013	0.432	9.37	0.065	0.007	2.76
2020	1.25	0.005	0.005	0.014	0.475	10.31	0.071	0.008	3.03
2021	1.31	0.006	0.005	0.015	0.497	10.80	0.075	0.008	3.19
2022	1.34	0.006	0.005	0.015	0.507	11.02	0.076	0.008	3.26
2023	1.34	0.006	0.005	0.015	0.507	11.03	0.076	0.008	3.27
2024	1.33	0.006	0.005	0.015	0.504	10.95	0.076	0.008	3.29
Change 1990-2024, %	-98.2	34.1	-12.4	33.50	33.8	33.8	33.1	39.0	39.2
Change 2023-2024, %	-0.7	-0.2	0.4	-0.6	-0.7	-0.7	-0.5	0.7	0.6

Table 3.46 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	0.280	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	0.00013	0.00004
2000	0.196	0.004	0.009	0.008	0.006	0.027	0.00016	0.00004
2005	0.271	0.007	0.012	0.010	0.008	0.038	0.00025	0.00006
2010	0.321	0.008	0.013	0.012	0.009	0.043	0.00032	0.00007
2015	0.321	0.011	0.016	0.014	0.011	0.054	0.00031	0.00006
2020	0.273	0.014	0.018	0.015	0.013	0.059	0.00027	0.00005
2021	0.236	0.015	0.019	0.016	0.014	0.063	0.00023	0.00005
2022	0.218	0.014	0.019	0.016	0.013	0.063	0.00021	0.00004
2023	0.195	0.015	0.019	0.016	0.014	0.063	0.00019	0.00004
2024	0.179	0.014	0.019	0.017	0.013	0.063	0.00017	0.00003
Change 1990-2024, %	-36.3	128.9	25.8	32.6	36.2	44.4	-11.7	-45.7
Change 2023-2024, %	-8.4	-4.0	2.5	5.1	-2.5	0.6	-8.5	-10.7

3.3.3.2. Methodological Issues

Fuel combustion

Emission calculations from the 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 5.9.2), 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). Vehicle classes are defined by the vehicle category, the fuel type, the weight class, the 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 3.50) and the number of vehicles (see Table 3.51), 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 before the year 2014 was 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 3.52) by emission factors (see Tables 3.47-3.49). 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 3.47) 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 3.47 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
2023	2.8	5.3
2024	2.3	4.9

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 3.48 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 3.49 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 3.50 Annual mileage driven in the road transport sector (million km per year)

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	5,720.1	694.9	1,599.6	6.8	8,021.3
1995	3,869.3	443.5	835.7	7.8	5,156.3
2000	4,113.3	501.8	892.2	15.8	5,523.1
2005	5,781.7	951.2	890.3	28.5	7,651.7
2010	6,659.5	774.8	993.8	55.5	8,483.7
2020	7,825.3	1,092.7	926.6	68.9	9,913.5
2021	8,981.1	1,308.1	776.5	55.8	11,121.5
2022	9,027.1	1,443.6	953.7	86.4	11,510.7
2023	8,759.6	1,553.1	1,081.6	93.8	11,488.1
2024	9,186.9	1,532.4	1,012.6	88.0	11,819.9

Table 3.51 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	564.8	55.6	31.0	34.6	686.0
2020	623.1	77.4	31.4	43.9	775.7
2021	634.3	80.7	31.2	45.4	791.6
2022	649.9	83.9	31.0	47.6	812.4
2023	661.0	86.5	30.5	49.4	827.4
2024	669.0	88.0	29.8	50.7	837.5

Table 3.52 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
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
2023	8,766.5	23,124.5	95.0	841.5	348.0	793.0	323.0	34,291.6
2024	8,770.3	23,127.6	88.3	841.5	605.0	797.0	650.0	34,879.7

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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 3.53).

Table 3.53 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[5]	-	-

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 3.54). Necessary lubricant metal content factors for heavy metal emissions calculations are provided in Table 3.49. The full total of heavy metals in fuel is presumed to be emitted into the atmosphere.

Table 3.54 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

[5] 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.

Category	Fuel/engine category	Age	Lubricant oil consumption
	Diesel	Old	1.49
	Diesel	New	1.28
Light duty vehicles	Petrol	Old	1.45
	Petrol	New	1.28
	Diesel	Old	1.49
	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 2026 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 3.55.

Table 3.55 Uncertainties in the road transport sector

Pollutant	Emissions, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	4.95	kt	27.95	3.41	0.43
NMVOC	0.81	kt	3.64	0.45	1.02
SO_x	0.01	kt	0.07	0.01	0.01
NH_3	0.10	kt	1.09	0.18	0.07
$PM_{2.5}$	0.96	kt	21.51	3.12	1.13
PM_{10}	1.69	kt	19.76	3.01	0.84
TSP	3.01	kt	20.50	3.44	0.18
BC	0.11	kt	10.57	1.22	1.07
CO	6.12	kt	7.23	1.19	3.03
Pb	1.33	t	35.27	10.60	0.22
Cd	0.01	t	1.41	0.42	0.04
Hg	0.005	t	2.55	0.35	0.05
PCDD/F	0.18	g I-TEQ	4.01	8.23	1.86
B(a)p	0.01	t	1.36	1.94	0.61
B(b)f	0.02	t	1.87	2.35	0.52
B(k)f	0.02	t	2.67	3.34	0.89
I(1,2,3-cd)p	0.01	t	1.46	2.02	0.66
HCB	0.0002	kg	0.03	0.07	0.003
PCBs	0.00003	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

There is a need for, and an ongoing study aimed at, further specifying the activity data and recalculating it, if necessary. The current approach, in which annual mileage per vehicle category is based on odometer readings taken during the annual technical inspection, appears to be insufficient to ensure reliable activity data. Several factors may contribute to deviations from the actual situation. For example, newer cars are inspected every two years, while older cars may be used less frequently. Therefore, a study is currently underway to improve the reliability of the activity data.

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 transport emissions 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. Currently, electric locomotives are used only for passenger transport on routes near Tallinn. But railway electrification projects are underway between different cities, Tallinn, Tartu and Narva, with the goal of transitioning the majority of passenger transport to electric locmotives.

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. Freight transport has decreased past years due to the Ukrainan war and sanctions to the Russia.

Nowadays, emissions from rail use originate primarily from the combustion by locomotives of diesel. The use of light fuel oil was last time reported in 2010. 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.

Due to the reason that the use of diesel remained same as in the year 2023, as explained before, and this subsector is highly dependent of the amount of diesel, the total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide in the transport sector in 2024 were not calculated. The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 70.4%, 71.5% and 74.5% respectively. During the same period, fuel consumption decreased 70.1%.

Fuel consumption and emissions remained same as previous year due to the reasons explained in the transport introduction section. The trend of all the emissions is given in Table 3.56.

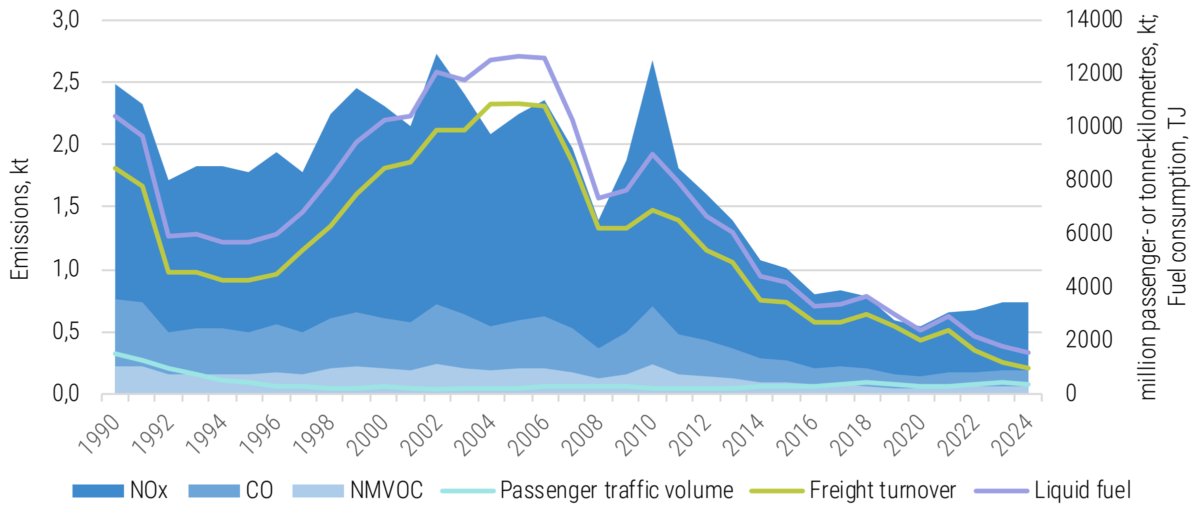

Figure 3.50 NO_x, NMVOC and CO emissions from the railway sector

Table 3.56 Emissions from railway transport

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	2.484	0.228	0.5671	0.0005	NR	NR	0.105	NR	0.761
1995	1.774	0.159	0.3651	0.0003	NR	NR	0.070	NR	0.502
2000	2.303	0.204	0.1774	0.0004	0.054	0.059	0.085	0.035	0.613
2005	2.249	0.198	0.1680	0.0004	0.053	0.057	0.083	0.034	0.593
2010	2.677	0.236	0.0703	0.0005	0.063	0.068	0.098	0.041	0.706
2015	1.017	0.090	0.0004	0.0002	0.024	0.026	0.037	0.015	0.268
2020	0.538	0.047	0.0002	0.0001	0.013	0.014	0.020	0.008	0.142
2021	0.663	0.059	0.0002	0.0001	0.015	0.017	0.024	0.010	0.175
2022	0.668	0.059	0.0003	0.0001	0.016	0.017	0.024	0.010	0.177
2023	0.734	0.065	0.0003	0.0001	0.017	0.018	0.027	0.011	0.194
2024	0.734	0.065	0.0003	0.0001	0.017	0.018	0.027	0.011	0.194
Change 1990-2024, %	-70.4	-71.5	-100.0	-70.2			-74.5		-74.5
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3.56 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	0.016	0.0007	0.00094	0.00048	0.004	0.080	0.005	0.0007	0.070
1995	0.005	0.0004	0.00031	0.00016	0.002	0.057	0.003	0.0004	0.041
2000	0.001	0.0004	0.00005	0.00002	0.002	0.073	0.003	0.0004	0.044
2005	NE	0.0004	NE	NE	0.002	0.071	0.003	0.0004	0.042
2010	NE	0.0005	NE	NE	0.003	0.085	0.004	0.0005	0.050
2015	NE	0.0002	NE	NE	0.001	0.032	0.001	0.0002	0.019
2020	NE	0.0001	NE	NE	0.001	0.017	0.001	0.0001	0.010
2021	NE	0.0001	NE	NE	0.001	0.021	0.001	0.0001	0.012
2022	NE	0.0001	NE	NE	0.001	0.021	0.001	0.0001	0.013
2023	NE	0.0001	NE	NE	0.001	0.023	0.001	0.0001	0.014
2024	NE	0.0001	NE	NE	0.001	0.023	0.001	0.0001	0.014
Change 1990-2024, %		-79.7			-82.4	-70.9	-79.8	-79.7	-80.3
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

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Table 3.56 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
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
2023	NE	0.0004	0.001	0.0005	0.0001	0.002	NA	NA
2024	NE	0.0004	0.001	0.0005	0.0001	0.002	NA	NA
Change 1990-2024, %		-93.9	-92.6	-89.3	-95.8	-92.7		
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR

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 3.59) by respective emission factors. According to the suggestions by national statistics, 66% of fuel is consumed by freight turnover and 34% by passenger traffic. At the moment, companies ar not reporting exact data to apportion the fuel between line-haul and shunting locomotives, but the research by Finnish agency LIPASTO is used and the distribution is 70% and 30%, respectively line-haul locomotives and shunting locomotives. It is easier with passenger traffic because from the year 2014 only newer rail-cars are used and there is no need for shunting locomotives. Before 2014 the division was 98% rail-cars and 2% shunting according to the LIPASTO research. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Guidebook 2023 and are presented in Table 3.57.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.59) by emission factors (see Table 3.57). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation:

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

where

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

Table 3.57 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

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Pollutant	Diesel / light fuel oil				Coal	
	Unit	Line-haul locomotives	Shunting locomotives	Rail cars	Unit	Value
		Value	Value	Value		
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 3.58 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%

Table 3.59 Fuel consumption in the railway sector

Year	Fuel consumption		
	Coal	Diesel	Light fuel oil
	TJ		
1990	119	0	1,946
1995	39	0	1,396
2000	6	0	1,819
2005	0	0	1,777
2010	0	635	1,481
2015	0	804	0
2020	0	425	0
2021	0	525	0
2022	0	529	0
2023	0	581	0
2024	0	581	0

3.3.4.3. Uncertainty

An uncertainty analysis was carried out for the 2026 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 3.70.

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

In the future, it is strongly advised to obtain data from national statistics to apportion the fuel between freight turnover and passenger taffic, as well as division between different locomotives. The improvement process takes several years and until then the current methodology is used and reliable.

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. Due to the reason that the use of diesel remained same as in the year 2023, as explained before, and this subsector is highly dependent of the amount of diesel, the total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide in the transport sector in 2024 were not calculated. Detailed emission data are provided in Table 3.60.

Fuel consumption and emissions remained same as previous year due to the reasons explained in the transport introduction section. The trend of previous years is shown in Figure 3.51.

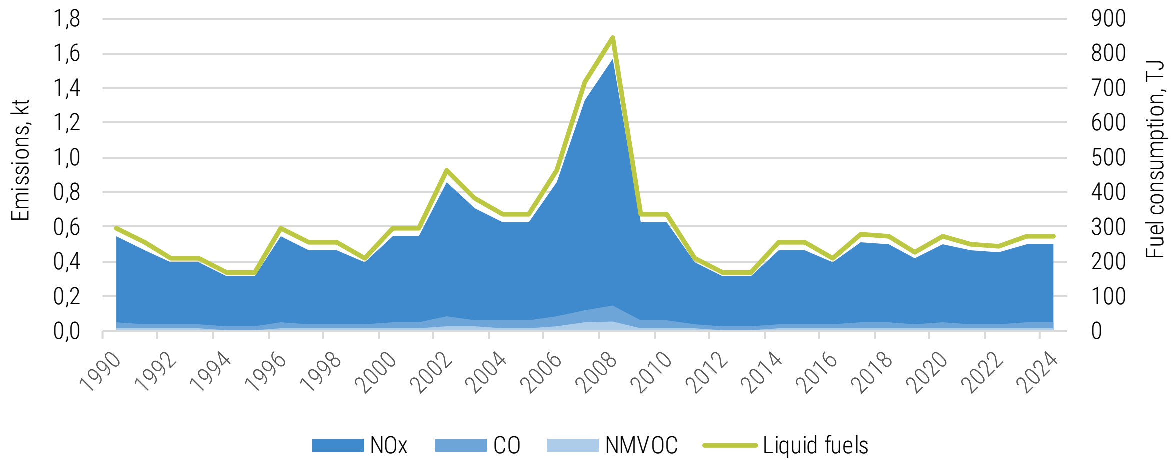

Figure 3.51 NO_x, NMVOC and CO emissions from the national navigation sector

Table 3.60 Emissions from national navigation

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
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
2023	0.507	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2024	0.507	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
Change 1990-2024, %	-7.7	-7.7	-81.5				-7.7		-7.7
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3.60 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
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
2023	0.0008	0.0001	0.0002	0.0003	0.0003	0.0013	0.0065	0.0001	0.0078
2024	0.0008	0.0001	0.0002	0.0003	0.0003	0.0013	0.0065	0.0001	0.0078
Change 1990-2024, %	-7.7	-7.1	-7.6	-7.9	-7.7	-7.7	-7.7	-7.1	-7.7
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3.60 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
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
2023	0.000840	0.000013	0.000065	0.000065	0.000006	0.000149	0.000517	0.000245
2024	0.000840	0.000013	0.000065	0.000065	0.000006	0.000149	0.000517	0.000245
Change 1990-2024, %	-7.7	-7.1	-7.1	-7.1	-14.3	-7.5	-7.7	-7.9
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR

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 3.63) by respective emission factors. Default emission factors for the main pollutants are taken from EMEP/EEA Guidebook 2023 and are presented in Table 3.61.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.63) by emission factors (see Table 3.62). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation:

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

where

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

Table 3.61 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
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 3.62 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 3.63 Fuel consumption in the navigation sector (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
2020	0	271	271
2021	0	250	250
2022	0	243	243
2023	0	273	273
2024	0	273	273

3.3.5.3. Uncertainty

An uncertainty analysis was carried out for the 2026 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 3.70.

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.

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.

Due to the reason that the use of diesel remained same as in the year 2023, as explained before, and this subsector is highly dependent of the amount of diesel, the total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide in the transport sector in 2024 were not calculated.

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. Fuel consumption and emissions remained same as previous year due to the reasons explained in the transport introduction section. Previous 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 3.64.

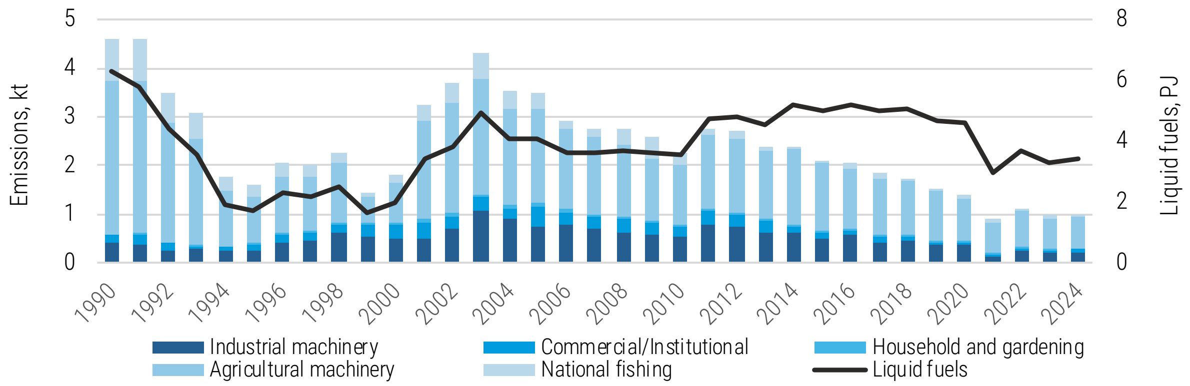

Figure 3.52 NO_x emissions from other non-road machinery

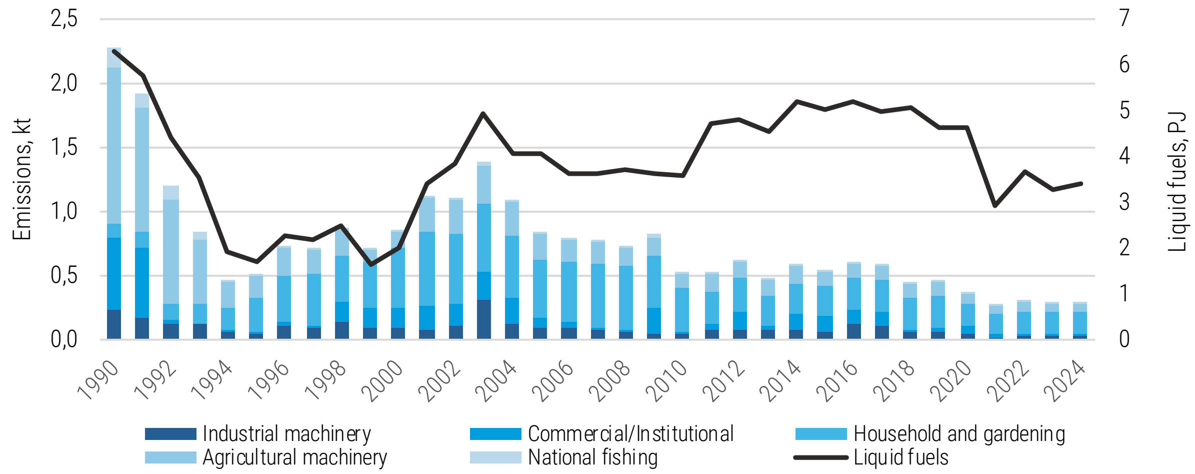

Figure 3.53 NMVOC emissions from other non-road machinery

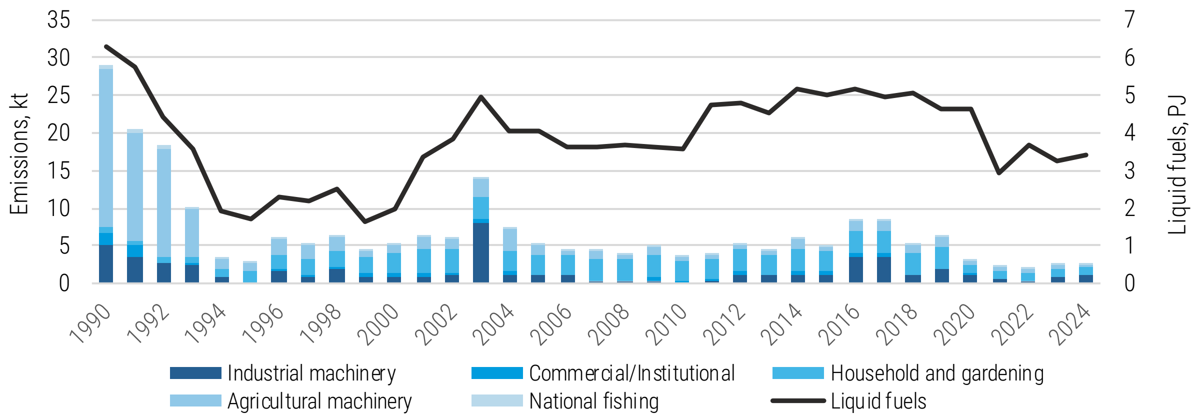

Figure 3.54 CO emissions from other non-road machinery

Table 3.64 Emissions from other non-road machinery

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

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Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
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
2023	0.974	0.274	0.003	0.0006	0.043	0.043	0.043	0.025	2.336
2024	0.996	0.287	0.002	0.0006	0.044	0.044	0.044	0.025	2.538
Change 1990-2024, %	-78.3	-87.4	-99.8			-68.7	-91.6		-91.2
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3.64 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
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
2023	0.0233	0.0008	0.00002	0.00003	0.0038	0.1277	0.0059	0.0008	0.0758
2024	0.0245	0.0008	0.00002	0.00003	0.0039	0.1313	0.0061	0.0008	0.0779
Change 1990-2024, %	-99.5	-46.9	-93.8	-94.0	-47.0	-43.7	-70.2	-46.9	-47.7
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 3.64 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
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
2023	0.00009	0.00228	0.00373	0.000007	0.000001	0.00602	0.00005	0.00002
2024	0.00009	0.00234	0.00384	0.000007	0.000001	0.00619	0.00005	0.00003
Change 1990-2024, %	-94.0	-47.0	-41.7	-93.5	-90.9	-44.4	-93.9	-93.9
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR

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 2023, 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 3.65 and Table 3.66). 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 2023, 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 3.69) by emission factors (see Table 3.67). 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:

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

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

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 3.68). Equation:

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

Table 3.65 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 Petrol 4-stroke	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
		CO	1,214.855	836,966	768,445	774.457	8041.57				778.282

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Table 3.66 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 3.67 Sulphur content of fuel (by weight)

NFR	Fuel	1990	2000	2001	2003	2004	2005	2006	2009	2010	2012
1A2gvii 1A4aii	Petrol	0.1%	0.1%	0.05%	0.015%	0.013%	0.005%	0.002%	0.002%	0.002%	0.001%
1A4bii 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 3.68 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 3.69 Total fuel consumption in other mobile sectors (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
2020	4,390	224	4,613
2021	2,764	170	2,934
2022	3,507	167	3,674
2023	3,072	200	3,271
2024	3,176	216	3,392

3.3.6.3. Uncertainty

An uncertainty analysis was carried out for the 2026 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 3.70.

Table 3.70 Uncertainties in non-road mobile machinery sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	2.24	kt	12.64	5.41	0.60
NMVOC	0.37	kt	1.66	0.52	0.32
SO_x	0.02	kt	0.16	0.07	0.01
NH_3	0.001	kt	0.01	0.002	0.0003
$PM_{2.5}$	0.07	kt	1.57	0.52	0.10
PM_{10}	0.07	kt	0.84	0.29	0.03
TSP	0.08	kt	0.55	0.21	0.01
BC	0.04	kt	3.62	1.31	0.99
CO	2.78	kt	3.29	0.94	1.71
Pb	0.03	t	0.67	0.22	0.02
Cd	0.001	t	0.24	0.07	0.005
Hg	0.0002	t	0.11	0.05	0.01
PCDD/F	0.001	g I-TEQ	0.02	0.05	0.22
B(a)p	0.003	t	0.27	0.32	0.15
B(b)f	0.005	t	0.45	0.53	0.13
B(k)f	0.0005	t	0.09	0.15	0.14
I(1,2,3-cd)p	0.0001	t	0.01	0.02	0.13
HCB	0.001	kg	0.11	0.10	0.12
PCBs	0.0003	kg	0.07	0.06	0.04

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.

There is an idea to see whether it is possible to obtain enough data to improve the calculations to Tier 3, at least in some of the sectors.

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 seagoing vessels and shielding vessels of all flags engaged in international waterborne transport. Emissions from international navigation are reported as a memo item and are not included in the national totals.

Fuel consumption and emissions remained same as previous year due to the reasons explained in the transport introduction section.

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 19% between 1990 and 2024. 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 reexports 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 12.2%, 23.8%, and 21.1% in comparison to 1990's figures. Sulphur oxide emissions have decreased by 43.0% 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 3.71.

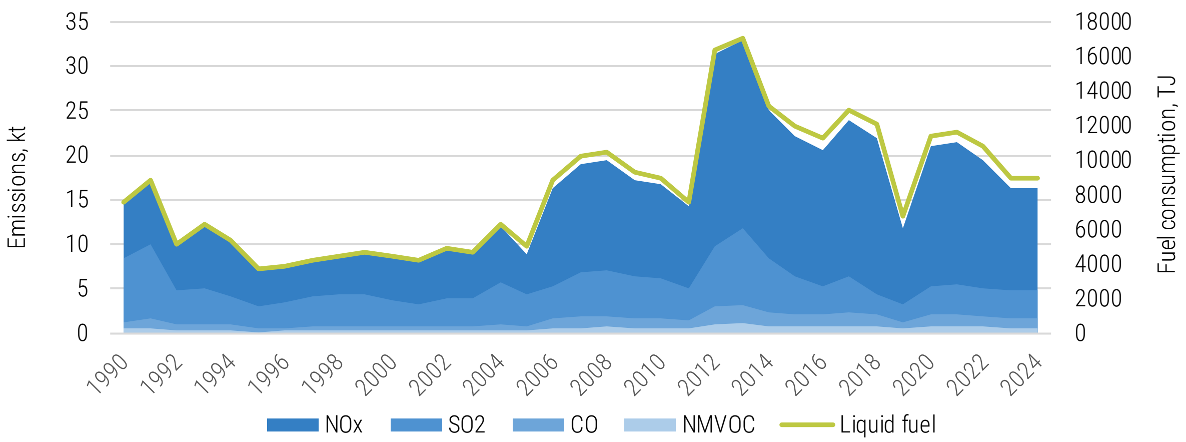

Figure 3.55 NO_x, NMVOC, SO_x and CO emissions from the international maritime navigation

Table 3.71 Emissions from the international maritime navigation

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
2020	20.955	0.783	5.238	NE	1.088	1.171	1.171	0.162	2.079
2021	21.475	0.801	5.476	NE	1.130	1.217	1.217	0.167	2.131
2022	19.595	0.734	5.176	NE	1.058	1.139	1.139	0.154	1.954
2023	16.430	0.623	4.844	NE	0.964	1.035	1.035	0.134	1.658
2024	16.423	0.623	4.844	NE	0.964	1.035	1.035	0.134	1.658
Change 1990-2024, %	12.2	23.8	-43.0				4.9		21.1
Change 2023-2024, %	NR	NR	NR		NR	NR	NR	NR	NR

Table 3.71 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
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	0.004	0.006	0.012	0.124	0.053	5.410	0.008	0.317
2023	0.037	0.004	0.005	0.011	0.116	0.045	5.091	0.007	0.269
2024	0.037	0.004	0.005	0.011	0.116	0.045	5.091	0.007	0.269
Change 1990-2024, %	17.0	13.4	27.5	18.2	5.4	21.1	4.6	8.9	21.1
Change 2023-2024, %	-13.3	-11.4	-17.7	-13.8	-6.5	-15.2	-5.9	-8.8	-15.2

Table 3.71 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
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
2023	0.083	0.001	0.005	0.004	0.001	0.012	0.027	0.092
2024	0.083	0.001	0.005	0.004	0.001	0.012	0.027	0.092
Change 1990-2024, %	9.4	11.7	10.5	13.4	6.2	10.9	14.6	5.4
Change 2023-2024, %	NR	NR	NR	NR	NR	NR	NR	NR

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 3.74-3.75). Although, there are no activity data available at the level required by the Tier 3 methodology, adjustments, suggested by the EMEP/EEA Guidebook 2023 (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 3.76) is multiplied by respective emission factors (see Table 3.72). Default emission factors for the main pollutants and heavy metals are taken from the EMEP/EEA Guidebook 2023.

SO_2 emissions are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.76) by emission factors (see Table 3.72). SO_2 emissions are estimated based on the assumption that all sulphur in the fuel is completely converted into SO_2. Equation:

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

Table 3.72 Emission factors for the international maritime navigation, (kg/t)

Pollutant	Unit	Bunker fuel oil Value	Marine diesel oil 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 3.73 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%	

Table 3.74 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2024

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
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
2023	322	120	148	8,012	216	42	234	9,094
2024	233	106	145	8299	103	47	238	9,171

Table 3.75 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2024 (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
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
2023	3,914	2,689	2,060	234,554	13,068	18	1,739	258,042
2024	3,663	2,039	1,960	241,776	6,182	18	1,821	257,459

Table 3.76 Fuel consumption in the international maritime navigation (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

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Year	Bunker fuel oil	Marine diesel oil/ Marine gas oil	Total
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
2020	6,554	4,822	11,376
2021	6,868	4,780	11,648
2022	6,706	4,145	10,851
2023	6,162	2,837	8,999
2024	6,162	2,834	8,996

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.

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 3.77):

Table 3.77 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% to total national emissions and have decreased by about 78% up to 2024 compared to 1990 due to decreasing emissions from gasoline distribution, but increased by 15.5% compared to 2023 due to increased emissions from the petroleum distribution sector, primarily from marine terminals and also from storage in refining activities (see Figure 3.56, Figure 3.57 and Table 3.80). Emissions of other pollutants are very small compared to the emissions from the other sectors (see Table 3.78).

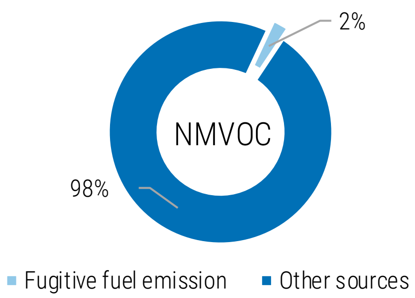

Figure 3.56 NMVOC emission distribution in 2024

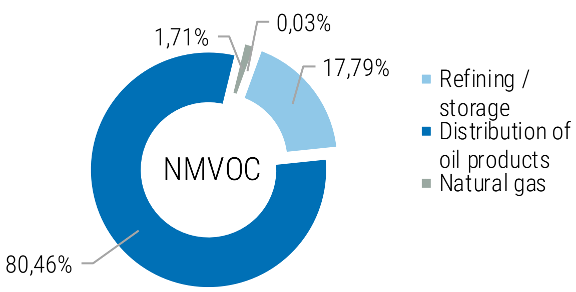

Figure 3.57 NMVOC emission distribution within the fuel fugitive emission sector in 2024

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Figure 3.57 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (80.5%).

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 3.78 Fugitive emission in the period (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
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
2023	0.079	0.464	0.020	0.012	0.384	0.418	0.786	0.00000	0.409
2024	0.053	0.536	0.016	0.012	0.245	0.274	0.511	0.00000	0.296
Change 1990-2024, %	-50.2	-78.3	-61.6	-63.2			-37.5		-40.2
Change 2023-2024, %	-32.5	15.5	-16.6	-0.5	-36.0	-34.6	-35.0	-33.3	-27.6

3.4.2. Uncertainty

An uncertainty analysis for Fugitive emissions sector 1B was carried out to the year 2025 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 3.79.

Table 3.79 Uncertainties in fugitive emission sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	0.053	kt	0.30	0.150	0.019
NMVOC	0.536	kt	2.40	0.990	0.292
SO_x	0.016	kt	0.18	0.035	0.001
NH_3	0.012	kt	0.13	0.057	0.006
$PM_{2.5}$	0.245	kt	5.48	5.158	1.028
PM_{10}	0.274	kt	3.19	2.810	0.552
TSP	0.511	kt	3.48	3.115	0.156
BC	0.000002	kt	0.00	0.000	0.000
CO	0.296	kt	0.35	0.291	0.035
Pb	0.0001	t	0.002	0.002	0.000
Cd	0.0000001	t	0.000024	0.000	0.000
Hg	NA	t	NA	NA	NA
PCDD	0.00007	g I-TEQ	0.00007	0.00015	0.00006
benzo(a) pyrene	0.00003	t	0.00003	0.00006	0.00002
benzo(b) fluoranthene	0.00003	t	0.00003	0.00006	0.00002
benzo(k) fluoranthene	0.00005	t	0.00005	0.00010	0.00004
Indeno	0.00003	t	0.00003	0.00007	0.00003
HCB	NA	kg	NA	NA	NA
PCB	NA	kt	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[6] (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 2023. In the table below NMVOC emissions from gasoline distribution and terminals are presented.

Table 3.80 NMVOC emissions from liquid fuel distribution (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gasoline distribution	2.055	0.971	1.108	0.381	0.413	0.434	0.433	0.405	0.399	0.429	0.451	0.419
Terminals	0.323	0.625	3.157	3.199	2.626	1.2	0.629	0.799	0.644	1.265	0.854	0.74

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gasoline distribution	0.380	0.353	0.357	0.363	0.372	0.382	0.296	0.281	0.268	0.266	0.333
Terminals	0.737	0.594	0.642	0.521	0.474	0.262	0.414	0.336	0.319	0.084	0.098

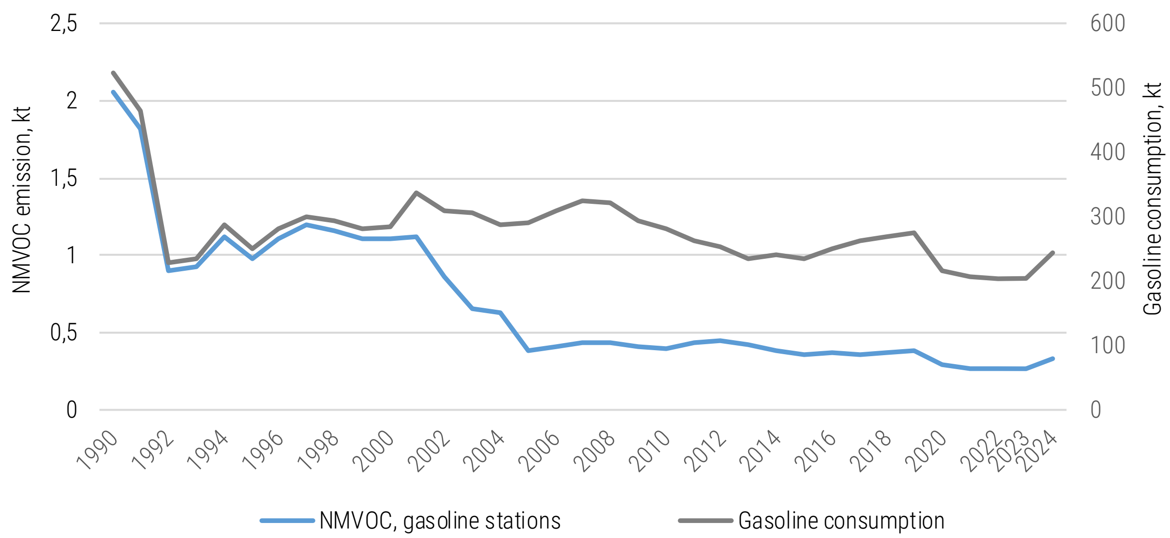

Figure 3.58 NMVOC emissions and gasoline distribution

[6] 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

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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 2005-2024 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 3.81 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 2005-2024, 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[7].

The RVP for gasoline (gasoline 95/98) in Estonia according to the Register of Fuel Monitoring in the period 2005-2024 is presented in Table 3.81.

Table 3.81 Annual average RVP of gasoline 95/98, annual average temperature in Estonia, TVP and NMVOC EF in the period 2005-2024

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
2020	74.05	22.83	986.06
2021	73.45	22.59	975.70
2022	71.13	21.68	936.77
2023	71.35	21.01	907.50
2024	71.40	21.96	948.76

Activity data

Activity data on the subject of gasoline consumption is available from Statistics Estonia (see Table 3.82).

Table 3.82 Consumption of motor gasoline (kt)

Year	Gasoline consumption
1990	523
1995	251
2000	283
2005	290
2010	282
2015	235
2020	216
2021	207
2022	205.04
2023	203.99
2024	204.15

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

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.

Gas consumption in Estonia increased by approximately 8% compared to 2023, mainly due to colder weather conditions and partial recovery in industrial demand across the Baltic region. Natural gas is importe into Estonia mainly form Finland (60%) and Lithuania (24%) and smaller shares from other partners, reflecting continued regional diversification and reliance on the Baltic–Finnish gas market infrastructure. Imports of Russian pipeline gas ceased completely.

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.[8]

The gas network in Estonia is 2314 km long.The Estonian natural gas transmission network currently consists of 976.3 km of pipelines, of which 39.0 km is the BC offshore pipeline, 4 gas metering stations where the measurement of gas quantities entering the transmission network and the determination of gas quality takes place, 36 gas distribution stations where the pressure of gas exiting the transmission network is reduced, quantities are measured, odorization is carried out, and the agreed consumption regime is ensured, and 1 gas regulation station (Kiili GRJ), which allows parts of the transmission network to be operated at different working pressures (see Figure 3.59). Additionally, at the Kiili GRJ, the quantity of gas exiting the Balticconnector system pipeline is measured. The Paldiski gas metering station enables the bi-directional measurement of gas passing through the Balticconnector on the Estonian side. Under the agreement on cooperation, gas quantities will be alternately measured on the Finnish side at the Inkoo gas metering station and on the Estonian side at the Paldiski gas metering station. At the end of 2022. a network connection for the possible connection of a floating LNG terminal to the transmission network was also complete.

[8] Eesti Gaas. Annual Report 2006

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 in NMVOC emissions in 2024 compared to 1990 is the decrease in gas consumption over the same period (see Table 3.83, Table 3.86, and Figure 3.60).

Table 3.83 NMVOC emissions from gas distribution (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
NMVOC	0.093	0.036	0.031	0.028	0.026	0.027	0.026	0.018	0.019	0.017	0.018	0.019
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
NMVOC	0.015	0.013	0.014	0.014	0.014	0.013	0.012	0.013	0.01	0.009	0.0092	

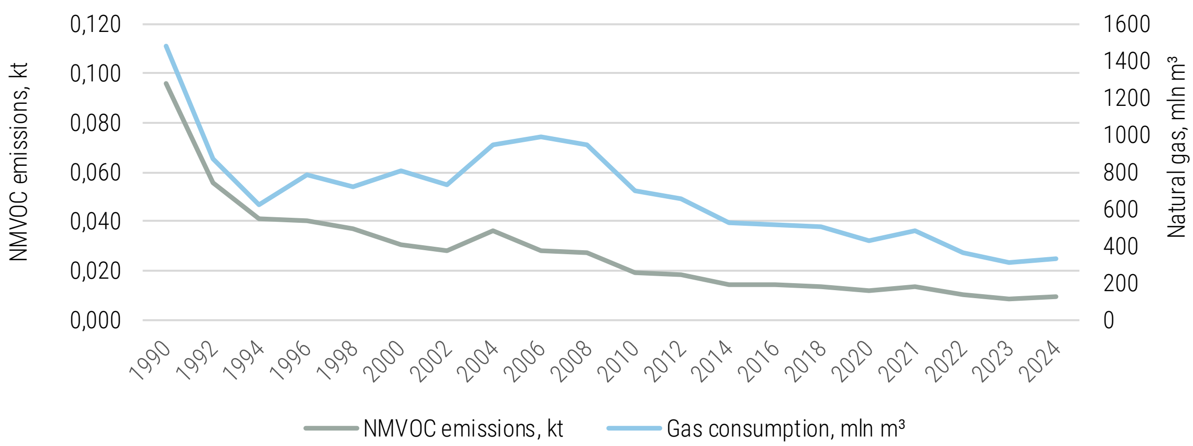

Figure 3.60 NMVOC emissions from natural gas distribution

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 3.84-3.85. 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 3.84 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 3.85 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

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 3.86). This year submission gas consumption data for the period 1990-2009 and 2018-2024 were corrected according to the IEA questionnaire data. Accordingly, emissions are also adjusted.

Table 3.86 Gas consumption (mln m^3)

1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
1.482	712	812	979	992	986	946	642	701	632	657	678
2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
530	471	518	492	506.4	464.7	426.4	486.4	363.4	311.7	331.79	

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. Approximately 60% of oil shale is extracted by underground methods and 40% from quarries using open pit methods. After 2018, oil shale mining began to decline significantly. For examle, in 2024 oil shale mining had decreased threefold compared to 1990 levels and halved compared to 2018 levels.

In 2024, three companies (Enefit Power, Viru Keemia Grupp and Kiviõli Keemiatööstus) produced a total of 8.5 million tonnes of oil shale, which was 16% less than in 2023 and as result emissions decreased too.

Since data from enterprises are available only from 2000, and for some substances only since 2008, 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 3.87 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
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
2023	0.08	NA	0.02	0.01	0.33	0.38	0.72	0.35
2024	0.05	NA	0.02	0.01	0.23	0.24	0.45	0.24
Change 1990-2024, %	-50.28		-61.65	-66.87			-44.37	-51.60
Change 2023-2024, %	-32.48		-16.60	-0.51	-36.92	-36.80	-36.79	-31.27

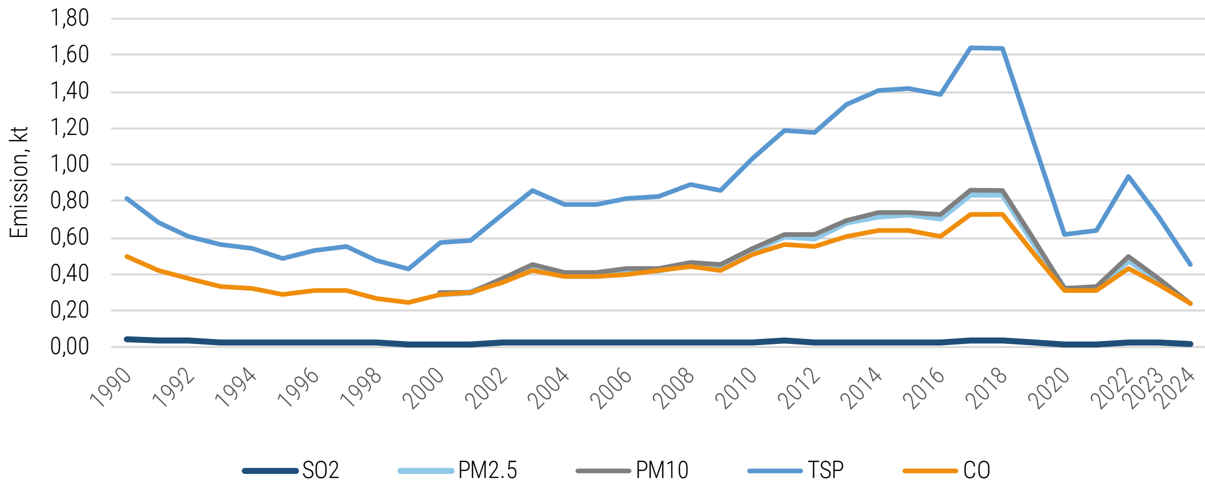

Figure 3.61 Pollutants emission from oil shale mining

3.4.5.2.Methodological Issues

Emission factors

The table 3.87 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.

The first recalculation of emissions was made in 2022 for the period from 1990 to 1999, using emission factors calculated based of enterprise data. Last 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. Starting this year, only enterprise data is used in the inventory.

Emission factors used in the calculations are presented in the tables 3.88 and 3.89.

Table 3.88 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 3.89 $PM_{2.5}$ and PM_{10} EF, %TSP

$PM_{2.5}$	PM_{10}
5	49

Activity data

Data on oil shale production are presented in Table 3.90 (Source: Estonian Statistics).

Table 3.90 Oil shale mining, kt

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
22486	19612	17030	14262	14018	12102	13067	12860	10913	9602	9970	9894	10513	12608	11736	12349	11977	13992
2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
13706	12605	15109	15865	14944	15028	14959	14908	12691	15633	15944	12128	9195	9209	10707.5	10161	8549	

4. INDUSTRIAL PROCESSES AND PRODUCT USE (NFR 2)

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 2023, 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	Note	Emissions reported
2A			Mineral Products		
	2A1	Cement production	Includes emissions from cement production. Data reported by one operator.	Production was discontinued in 2020	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

NFR		Source	Description	Note	Emissions reported
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
	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 2000–2024.

The share of industrial sources in total emissions in 2024 was: NO_x - 0.37%, NMVOC – 4.35%, $PM_{2.5}$ – 4.8%, PM_{10} – 17.81% and TSP about 33.73%. The shares of other pollutants were not so significant.

The pollutants emissions from the industrial sector are presented in Table 4.2.

The emissions of NMVOC, NH_3 and NO_x decreased compared to 1990 by 93.68%, 94.29% and 65.56%, respectively. The main reason is that the production of chemical products decreased significantly during the period 1990–2024. PM_{10} and TSP emissions changed little, which can be explained by some stability in construction activity in 2024 compared to 2023.

Table 4.2 Pollutant emissions from the industrial sector

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	0.191	15.341	0.0003	0.667	NR	NR	8.275	NR	0.340
1995	0.070	4.379	0.0001	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
2020	0.066	0.875	0.0003	0.079	0.401	2.932	9.527	0.001	0.631
2021	0.063	0.937	0.0004	0.102	0.403	3.022	9.885	0.001	0.650
2022	0.072	0.969	0.0004	0.072	0.298	1.917	6.077	0.001	0.677
2023	0.063	0.944	0.0003	0.045	0.221	1.528	4.938	0.0005	0.482
2024	0.066	0.970	0.0004	0.0381	0.215	1.527	4.958	0.0005	0.585
Change 1990-2024, %	-65.56	-93.68	52.12	-94.29			-40.08		72.16
Change 2023-2024, %	3.61	2.76	34.39	-17.08	-2.94	-0.07	0.42	-3.64	21.44

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	0.0004	0.003	0.019	0.014	IE	0.00006
1995	0.005	0.0004	0.0002	0.0001	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
2020	0.006	0.0001	0.033	0.009	0.014	0.141	0.035	0.001	0.00003
2021	0.006	0.0001	0.024	0.012	0.010	0.143	0.031	0.002	0.00003
2022	0.005	0.0000	0.008	0.016	0.001	0.146	0.029	0.002	0.00003
2023	0.007	0.0000	0.005	0.019	0.0008	0.151	0.032	0.002	0.000028
2024	0.013	0.000	0.0046	0.008	0.0007	0.145	0.034	0.002	0.000029
Change 1990-2024, %	0.99	-100.00	860.98	2154.84	-79.76	678.04	133.83		-49.83
Change 2023-2024, %	86.85		-6.85	-57.03	-12.23	-4.02	5.37	3.05	1.42

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 2024 are shown in Figure 4.2 and Figure 4.3.

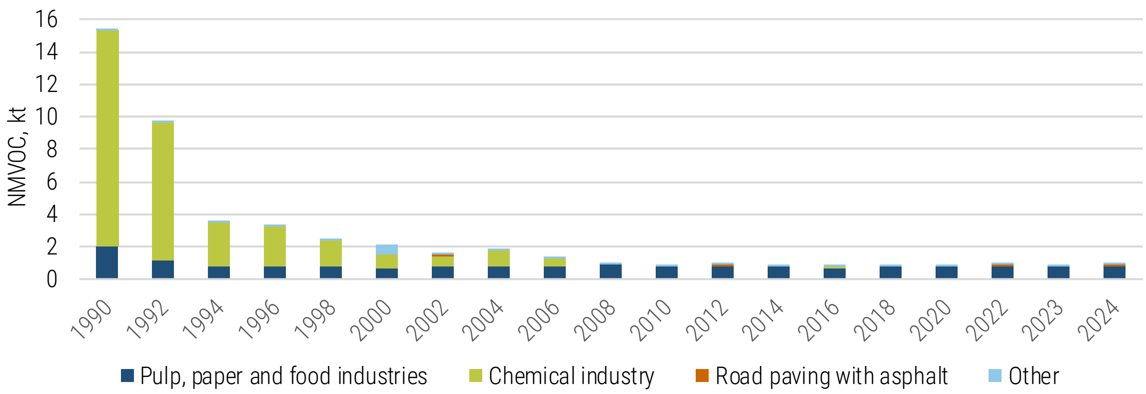

Figure 4.1 NMVOC emissions from the industrial sector

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The biggest polluter of NMVOC emissions in 2024 were Pulp, paper and food industries – 83.2% (mainly food production), the wood processing is 12.2% and the chemistry industry is responsible for the 2.5% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (82.8%, mainly construction and demolition sector).

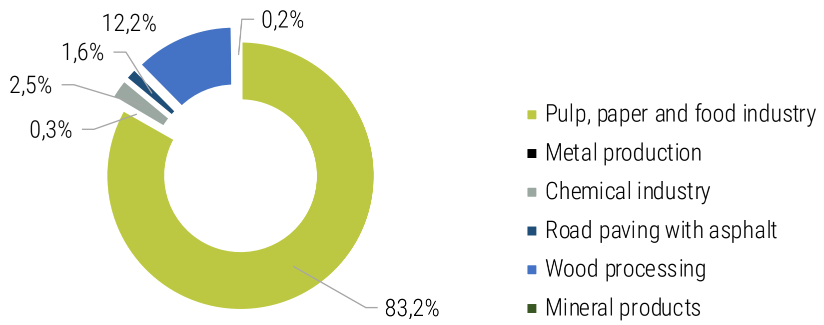

Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2024

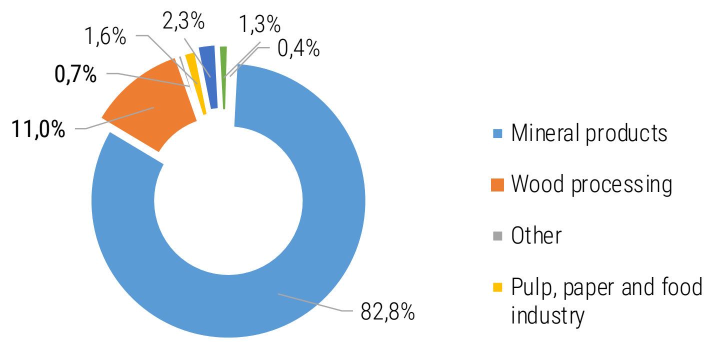

Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2024

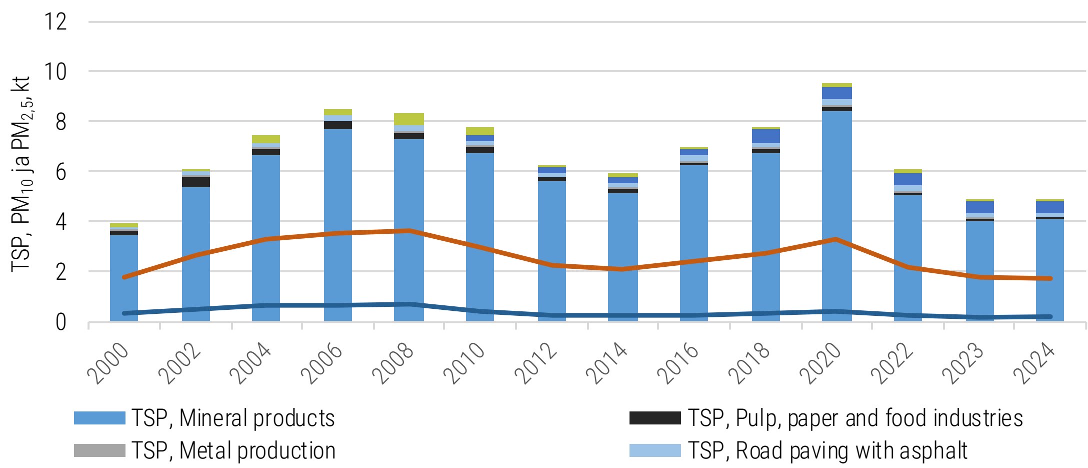

Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2024

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 2023 compared to 2022 (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 (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	1.600	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	0.0001	0.0004	NE	0.211	2.077	6.715	0.0001	0.005

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Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2015	0.006	0.001	0.0001	NE	0.226	2.269	7.437	0.0000	0.006
2020	0.006	0.002	0.0002	0.001	0.256	2.578	8.461	0.0001	0.010
2021	0.005	0.003	0.0002	0.001	0.265	2.679	8.828	0.0001	0.013
2022	0.006	0.002	0.0003	0.001	0.152	1.544	5.046	0.0001	0.013
2023	0.0040	0.0038	0.0003	0.0012	0.1216	1.2396	4.039	0.0001	0.010
2024	0.0055	0.0016	0.0004	0.0009	0.1224	1.2632	4.12	0.0001	0.015
Change 2005-2024, %	-45.03	-97,94			-63.31				
Change 2023-2024, %	36.31	-56.54	36.09	22.63	0.71	1.91	2.01	3.69	45.14

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.

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
1995	571.0	43.750	2.275	0.049	1.505	0.175	10.080
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). Later Kunda Nordic was required to carry out dioxin emission measurement twice a year. Now, Kunda Nordic is obliged to carry out measurements omce 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
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

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
2022				32.010	0.07	0.0022	65.875	0.2	0.013
2023				16.650	0.07	0.001	69.131	0.2	0.014
2024				16.84	0.07	0.0012	69.131	0.2	0.014

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. The Estonian Inventory team considers that all emissions from quarry blasting activities (gases from explosives and dust emitted from the soil, as well as NH_3) should be reported in NFR category 2A5a, which covers mining activities.

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. Reporting NMVOC emissions under category NFR 2A5c is justified and appropriate, as these emissions are directly related to asphalt mix production processes (e.g., loading bitumen tanks and loading finished asphalt concrete), rather than road construction activities. These NMVOC emissions occur on the same site and concurrently with other asphalt production operations, such as the storage and handling of mineral materials. Given this, the Estonian inventory team believes it is feasible to continue reporting NMVOC emissions from asphalt production under category 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.

Calculations of emissions from the construction sector were made based on data on the area of 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 and railway construction. The activity data is given in the „Activity" section.

The construction sector is remains one of the key sources of particulate matter emissions (Figure 4.5).

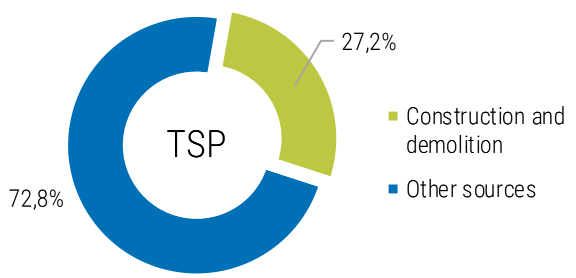

Figure 4.5 The share of construction and demolition sector in total TSP emissions in 2024

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

The calculation for building used data on area completed new construction, as well as additionally for reconstructed or expanded buildings (floor area, table EH045 of the statistics database). Floor area means: total floor area of functionally connected rooms and secondary rooms. Unfortunately, we have no other information and in this case it is equivalent to the affected area. Calculations are made according to the formula and the values of the coefficients are given in the table below.

It should be noted that the calculations 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:

$$EM_{PM_{10}} = EF_{PM_{10}} \cdot A_{affected} \cdot d \cdot (1 - CE) \cdot \left(\frac{24}{PE}\right) \cdot \left(\frac{s}{9\%}\right) \quad (1)$$

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 area of the completed dwelling (houses and apartments) and non-residential buildings (new construction) and demolition and also reconstructed or expanded buildings for the years 2000-2024 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 were 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.

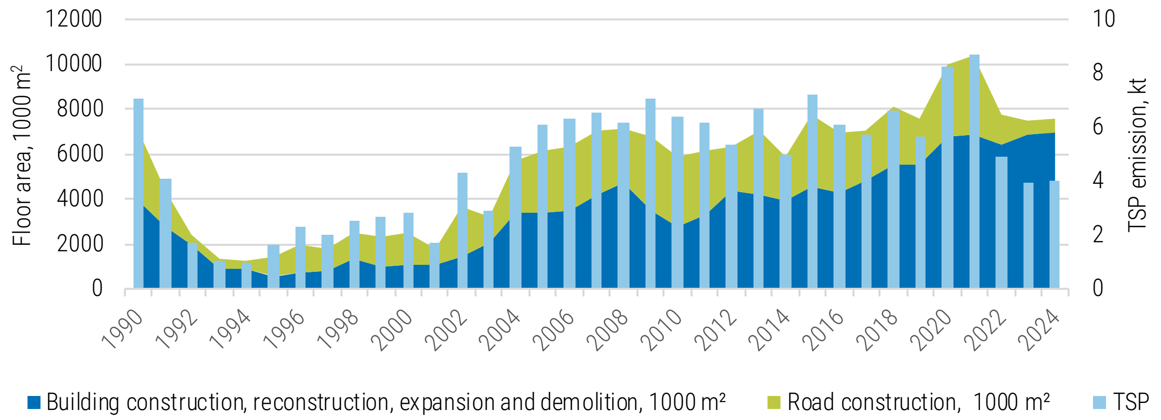

Figure 4.6 Building and road construction and TSP emission

Table 4.7 Activity data for PM emission calculations from the construction sector (1000 m² 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
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
2023	826.2	1,822.0	4,206.3	444.0	154.2
2024	631.3	2,349.2	3993.3	516.0	102.3

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 and AS Eskaro (paints and varnishes), NPM Silmet OÜ (rare metals), OÜ EUROBIO LAB (manufacture of cosmetics), VNK AS (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.

The share of NMVOC emissions from the chemical industry in the total country emissions amounted to approximately 21% in 1990 and only 0,12% in 2024 (see Figure 4.7). The main reason for this is the decrease in the manufacturing of chemical production at shale oil enterprises.

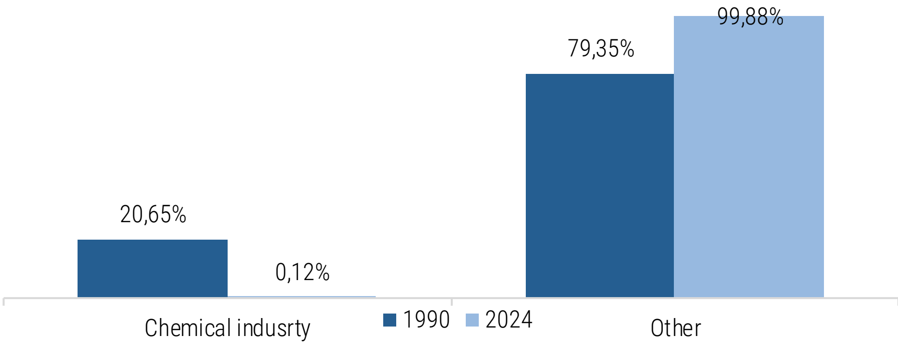

Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2024

Emissions from the chemical industry sector are presented in Table 4.8.

Table 4.8 Emissions from the chemical industry (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	0.940	NR	0.340
1995	0.070	3.532	NA	0.140	NR	NR	0.490	NR	0.030
2000	0.189	0.845	NA	0.044	0.089	0.1630	0.190	0.0027	0.340
2005	0.156	0.716	NA	0.132	0.146	0.2660	0.310	0.0044	0.300
2010	0.0000	0.071	0.0000	0.010	0.005	0.0140	0.042	0.0001	0.405
2015	0.0002	0.046	0.0000	0.007	0.0008	0.0023	0.007	0.00001	0.353
2020	NO	0.033	NO	0.016	0.0010	0.0031	0.0095	0.00002	0.573
2021	NO	0.037	NO	0.016	0.0011	0.0033	0.0095	0.00002	0.582
2022	NO	0.014	NO	0.004	0,001	0.0027	0.0088	0.00003	0.606
2023	NO	0.019	NO	0.00003	0.0022	0.0037	0.0040	0.00004	0.429
2024	NO	0.0245	NO	0.00010	0.0036	0.0059	0.0075	0.00006	0.533
Change 1990-2024, %		-99.82		-99.97			-99.20		56.89
Change 2023-2024, %		27.80		219.84	58.31	56.19	86.91	56.10	24.35

During 1990-2024 emissions of all substances were reduced considerably. 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. In 2024, a new operator was added, resulting in a slight increase in particulate matter and CO emissions. It is important to note that starting in 2022, due to the war and economic sanctions, liquid ammonia storage volumes and associated terminal operations, as well as ammonia emissions, were significantly reduced to a minimum.

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.

Table 4.9 Emissions from the metal production sector (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
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
2023	0.059	0.0001	0.002	0.038	0.011	0.030	0.077	0.00004	0.020
2024	0.059	0.0001	0.003	0.029	0.012	0.035	0.091	0.00004	0.020

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Change 2005-2024, %	378.52	-90.23	-76.21	-47.62	-47.15				
Change 2023-2024, %	0.002	9.81	14.52	-22.77	13.18	18.11	17.53	11.52	-0.72

Table 4.9 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
				t				
1990	0.012	0.0010	0.000	0.00007	0.0005	0.0004	0.003	0.0186
1995	0.005	0.0004	0.0001	0.00003	0.0002	0.0001	0.001	0.0071
2000	0.037	0.0002	0.0001	0.00002	0.018	0.014	0.015	0.0242
2005	0.009	0.0001	0.00002	0.00001	0.075	0.012	0.027	0.1116
2010	0.015	0.0001	0.00002	0.00001	0.129	0.009	0.013	0.0468
2015	0.010	0.00001	0.000003	0.000001	0.069	0.003	0.021	0.1817
2020	0.006	0.00001	0.000003	0.000001	0.033	0.009	0.014	0.1413
2021	0.006	0.00001	0.000003	0.000001	0.024	0.012	0.010	0.1426
2022	0.005	0.00000	0.000000	0.0000000	0.008	0.016	0.001	0.1458
2023	0.007	0.00000	0.000000	0.0000000	0.005	0.019	0.001	0.1508
2024	0.013	0.00000	0.000000	0.0000000	0.005	0.008	0.001	0.1447
Change 2005-2024, %								
Change 2023-2024, %	86.85		-28.93		-6.85	-57.03	-12.23	-4.02

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	0.0021	0.00005
2015	0.031	0.0017	0.00003
2020	0.033	0.0012	0.00003
2021	0.031	0.0015	0.00003
2022	0.029	0.0018	0.00003
2023	0.032	0.0018	0.00003
2024	0.034	0.0017	0.00003
Change 2005-2024, %			
Change 2023-2024, %	5.37	3.05	1.42

The share of this sector in total Estonian emission is insignificant. As well as in other sectors, in the 2C metal production sector, there was a noticeable decrease in production and as a result - a decrease in emissions for almost all substances.

The main sources of ammonia emission is rare-earth metals factory in Sillamäe. The decrease in ammonia emissions to the air compared to the previous year is due to the shutdown of the rare metals factory and the decrease in production volumes.

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.

The NFR 2C6 includes data from secondary zinc production and plating.

The NFR 2C5 includes emission from lead battery and accumulators recycling.

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 2C7c includes mainly emissions from welding, plasma and gas cutting, metal surface cleaning and some other activities of metal production or mechanical treatment. Emissions data are provided by operators.

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 (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
2020	0.979	0.064
2021	1.049	0.056
2022	1.034	0.000
2023	0.880	0.000
2024	0.640	0.000

Table 4.11 Pollutant EF for sector 2C1

Pollutant	Unit	Secondary steel production	Secondary iron production
		Tier 2, Electric furnace steel plant	Tier 2
		Table 3-15	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	
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.

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The Estonian Inventory Group confirms the use of the designation "NE" (not estimated) for HCB (hexachlorobenzene) emissions in category 2C1 (iron and steel production) for 2004, 2005, 2006, 2007, 2008, 2011, and 2012, as activities reported in sector 2C1 in Estonia during these years were limited to the production of components from recycled metal materials, heat treatment processes, and the casting of iron and steel parts from pre-treated metal raw materials. These technologies do not include high-temperature combustion processes typically associated with HCB emissions. Estimates of pollutant emissions from typical production processes in Estonia in category 2C1 for all previous years were calculated using the Tier 2 methodology with the emission factors provided in Tables 3.8 and 3.15 of the EMEP/EEA Guidebook.

The Estonian Inventory Group has reviewed the available activity data and considers the previous and future use of the designation "NE" (not estimated) for HCB (hexachlorobenzene) emissions in category 2C1 to be appropriate, taking into account the nature of production in this sector. 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 the sector NFR 2C3, there is only one operator involved in the production and processing of aluminium since 2017. The operator calculates and reports all emissions related to the casting and secondary processing of aluminium, except for HCB and PCDB/PCDF, which are calculated based on the 2023 emission factors of the NFR 2C3 EMEP/EEA guideline. The reduction of TSP, $PM_{2.5}$ and PM_{10} emissions since 2017 is related to the changes that have taken place in the company (installation of a new gas furnace, elimination of grinding machines and injection molding). All parts are ground and sawed, not drilled. Whereas previously, emissions from these processes were discharged to the outside air through a low ventilation opening, which created a high dust concentration, now the machines are equipped with bag filters and this ventilation is closed.

Based on available data, there are no companies in Estonia that are primarily engaged in zinc smelting from raw materials, and therefore no production processes with Hg, Cd, and Pb emission. There are only a few companies engaged in metal recycling and galvanization (i.e., secondary zinc production).

The Estonian inventory team does not consider it necessary to calculate and report these emissions. Therefore, the use of the designation "NA" (not applicable) for these emissions in NFR 2C6 is justified.

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 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
1990	0.0270	NR	NR	0.2567	NR
1995	0.0080	NR	NR	0.0713	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
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
2023	0.0180	0.0011	0.0225	0.1684	0.00006
2024	0.0156	0.0010	0.0195	0.1460	0.00006
Change 2005-2024, %	-18.02	-16.07			
Change 2023-2024, %	-13.30	-13.31	-13.30	-13.30	-13.29

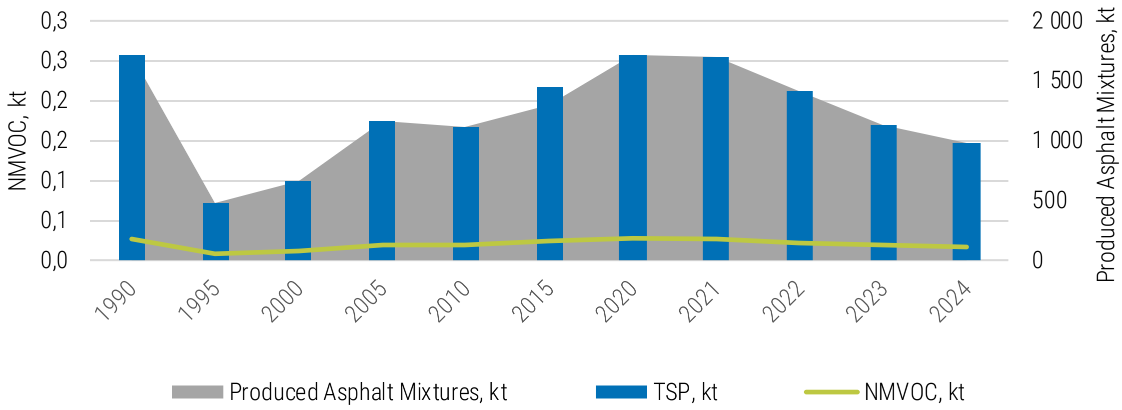

Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production

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).

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 $PM_{2.5}$	15 000

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 1990-2024 (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 (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
2020	1,715.151
2021	1,696.543
2022	1,420.305
2023	1,122.891
2024	973.546

4.1.6. Pulp, Paper and Food Industry (NFR 2H)

4.1.6.1. Source Category Description

This chapter includes the pollutant emissions from the pulp and paper, food and drink, wood and furniture industries, as well as from others industries, such as bulk storage and handling operations in the ports.

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. Horizon Tselluloosi ja Paberi AS manufactures only unbleached varieties.

Brief descriptions of the Horizon Tselluloosi ja Paberi AS and AS Estonian Cells technological processes are presented here.

The main air pollution-related processes at Horizon are: Post-combustion of exhaust gases from the cooking and evaporation section, Soda recovery boiler, Smelt tank of the soda recovery boiler (or smelt dissolving tank), Lime kiln, Boiler house and cogeneration plant.

In the cooking section, the digester is filled with wood chips, and the required amount of preheated cooking liquor is added before sealing the unit. Cooking takes place by increasing temperature and pressure (at 160°C, the pressure is 6 bar) and lasts approximately four hours. The resulting turpentine vapors are directed to a spiral condenser for cooling. After the cooking process is completed, the pulp is pumped into the collection tank. Sulfur gases released from this process are directed to the post-combustion unit. The black liquor generated in the cooking process is sent to the evaporation section, where water is removed from the liquor until the dry matter content reaches 70%. The secondary steam produced during evaporation is directed to a condenser, where some gases condense upon contact with water. The uncondensed secondary steam is sent to the post-combustion unit to burn malodorous compounds and reduce air pollution. Natural gas is used as an auxiliary fuel. During combustion, reduced sulfur compounds and volatile organic compounds decompose. The combustion process produces sulfur dioxide and, due to the addition of air in the post-combustion unit, nitrogen oxides.

After the evaporation process, the black liquor is burned in the soda recovery boiler (SRB, eesti keeles SRK). To compensate for alkali losses in the circulation, solid sodium sulfate is added to the black liquor before it enters the furnace.

The gases and dust generated during combustion pass through an electrostatic filter, where sodium sulfate dust is captured (with 99% efficiency) and returned to circulation.

The mineral residue from the black liquor combustion melts in the furnace and flows into the smelt tank, where it is dissolved with weak white liquor. The resulting green liquor is sent for causticizing. Gases from the smelt tank pass through a steam screen and a weak white liquor spray system, which helps reduce the release of hydrogen sulfide and sodium sulfate dust into the atmosphere.

As a by-product, lime sludge is used in the lime kiln to produce lime. The lime kiln operates using natural gas as fuel. The boiler house operates with natural gas and wood-fired boilers. In the cogeneration plant, the mill burns sawdust and bark generated at the facility, as well as purchased wood chips. An electrostatic filter is installed for exhaust gas purification.

The Estonian inventory team reports in sector 2H1 only the particulate emissions (TSP, $PM_{2.5}$ ja PM_{10}) from the from the smelt dissolving tank of the soda recovery boiler. All other technological emissions related to fuel combustion processes are reported in energy sector, emissions related to wastewater treatment are reported in waste sectors.

Estonian Cell AS, an aspen pulp factory in Kunda (established in 2006), is the largest pulp producer.

The plant produces high-quality chemi-thermo-mechanical aspen pulp (Aspen BCTMP). The produced aspen pulp is a raw material for various quality papers (raw material for the pulp industry). Pulp production consists of the following production stages: wood delivery and storage, wood peeling, chipping (shredding), chip washing, impregnation, boiling and grinding, pulp sorting, bleaching, dewatering, drying, pressing, storage and packaging of the finished product. The company's emissions of pollutants into the ambient air are related to combustion equipment, aspen pulp dryer, steam fan, emergency burner, aeration basin and composting saunas. The combustion equipment uses natural gas and biogas as fuel. The biogas produced by the company from industrial wastewater is directed to a biomethane plant, where the biogas is purified into biomethane for its own use. In cases where it is not possible to receive biogas produced at the biomethane plant due to technical problems, it is burned off in an emergency burner.

In 2024, as well as in 2023, the factory's production volumes were reduced due to high raw material and electricity prices.

The Estonian inventory team in this chapter presents particulate matter emissions from the production stages of sulphide-free chemical-mechanical pulp (impregnation, cooking and grinding), all others, such as fuel combustion activities and their emissions, presented in in energy sector, emissions related to wastewater treatment presented in waste sectors.

Also in sector 2H1 are presented the processes of lamination, hot pressing and drying in the production of plywood.

The emissions from sector NFR 2H are presented in Table 4.16.

Table 4.16 Pollutant emissions from the pulp, paper and food industries (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	0.150	0.002	0.140
2005	NA	0.769	0.130	0.127	0.171	0.220	0.003	0.020
2010	0.018	0.739	0.028	0.158	0.217	0.290	0.004	0.028
2015	0.015	0.706	0.002	0.057	0.085	0.134	0.001	0.004
2020	0.002	0.748	0.000	0.031	0.054	0.105	0.001	0.022
2021	0.002	0.767	0.000	0.031	0.053	0.099	0.001	0.030
2022	0.002	0.808	0.000	0.030	0.050	0.097	0.001	0.027
2023	0.001	0.772	0.00000	0.019	0.034	0.066	0.0003	0.013
2024	0.002	0.807	0.00001	0.014	0.024	0.054	0.0002	0,007
Change 2005-2024, %		5.05	-100.0	-89.01				
Change 2023-2024, %	110.66	4.58	324.33	-27.46	-28.95	-19.29	-14.52	-48.10

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 main source of NMVOC emissions is the food industry and the small decrease in emissions between 1990 and 2024 was due to small decrease in production volumes in this sector. Significant emissions reductions in the pulp and paper industry, as well as in the food industry in 2024 can be explained by the general economic crisis, rising prices for raw materials and energy, a noticeable change in sales markets due to sanctions and war.

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 emissions of NMVOC and particulates from the wood processing (NFR 2I) are presented in Table 4.17.

The wood processing industry also saw a decline in production volumes and emissions in 2024 for the same reasons.

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Table 4.17 NMVOC and PM emission from the wood processing (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
2010	0.014	0.027	0.082	0.248
2015	0.003	0.025	0.074	0.226
2020	0.057	0.056	0.166	0.509
2021	0.094	0.057	0.169	0.522
2022	0.115	0.067	0.197	0.509
2023	0.129	0.056	0.162	0.507
2024	0.119	0.057	0.168	0.521
Change 2023-2024, %	-8.10	3.5	4.1	2.85

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. Therefore, starting in 2018, they are reported in other NFRs, namely NFR 1A2d. In NFR 2H1, SO_x and NO_x emissions are designated as NA. Particulate matter is emitted from the melting boiler of the "Horizon" Pulp and Paper Joint-Stock Company and from the production of sulfite-free chemimechanical pulp at the Estonian Cell Mill, data for which are reported in 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 1990-2024 (see Table 4.19-4.20).

Table 4.19 Activity data for the food industries (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
2020	80.6	11.3	73.4	75.3	..	..	176.6
2021	83.6	11.6	72.3	73.1			180.3
2022	86.9	11.8	72.0	73.0			227.6
2023	85.7	12.4	70.9	89.8			126.7
2024	80.0	12.7	87.2	79.8			189.0

Table 4.20 Activity data for the drinks industries (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
2020	72.6	1,379.9		131.9
2021	84.56	1,453.3		139.7
2022	85.1	1,351.8		166.6
2023	32.9	1,075.0		163.1
2024	25.53	1, 096.3		137.0

4.1.7. Uncertainty

An uncertainty analysis was carried out to the year 2026 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 industrial sector are given in Table 4.21.

Table 4.21 Uncertainties in industrial processes sector

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NOx	0.07	kt	0.37	0.17	0.05
NMVOC	0.97	kt	4.35	1.73	3.38
SOx	0.0004	kt	0.005	0.001	0.00003
NH_3	0.04	kt	0.40	0.63	0.52
$PM_{2.5}$	0.21	kt	4.80	3.12	1.26
PM_{10}	1.53	kt	17.81	15.87	4.81
TSP	4.96	kt	33.73	30.67	1.74
BC	0.0004	kt	0.04	0.01	0.07
CO	0.59	kt	0.69	0.32	0.09
Pb	0.01	t	0.33	0.16	0.003
Cd	0.00	t	0.00	0.00	0.001
Hg	0.00000006	t	0.00003	0.00002	0.002
PCDD	0.03	g I-TEQ	0.76	0.68	0.28
HCB	0.002	kg	0.33	0.33	0.29

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

For more information on the recalculations and changes made in the 2026 submission, see Chapter 8.

4.1.10. Source-Specific Planned Improvements

Not planned for the next submission.

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.

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, 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	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
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 2024, the solvent and other product use sector was the largest source of NMVOC emissions in Estonia, accounting for 44.4% of national total NMVOC emissions. Cu emissions from the solvent and other product use sector accounted for 10.7% of the national total Cu emissions. The contribution of other pollutants from this sector was not as significant.

In the solvent and other product use sector, coating applications accounted for the largest share of NMVOC emissions (41.2%), followed by the use of domestic solvents (including fungicides) at 36.9%, use of other solvents (including adhesives) at 15.8%, printing at 2.8%, chemical products at 2.0%, degreasing at 0.6%, other product use at 0.5%, and dry cleaning at 0.1% (see Figure 4.9).

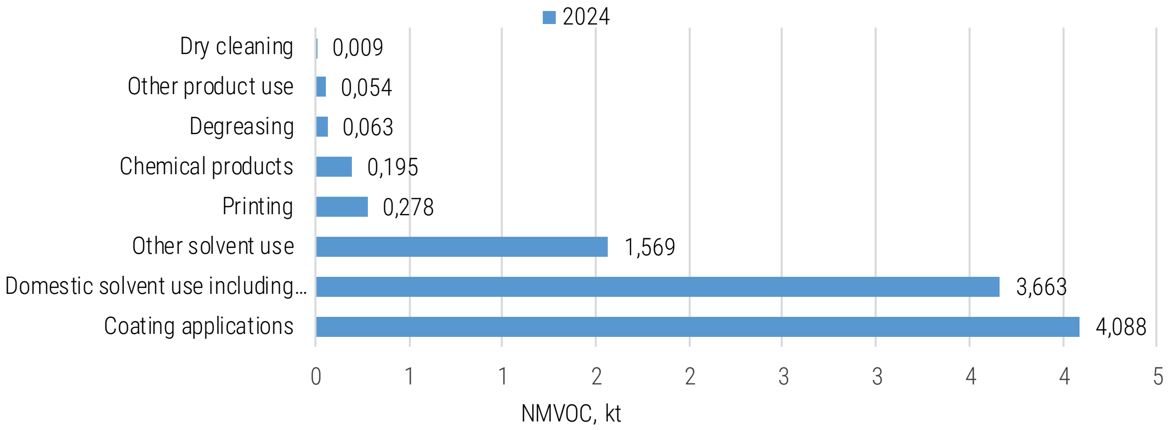

Figure 4.9 NMVOC emissions by sectors in 2024

There has been an increasing trend of NMVOC emissions from solvent and other product use. Compared to 1990, NMVOC emissions from the solvent and other product use sector have increased by 18.1%. In recent years, the largest increase in NMVOC emissions has been observed in the coating application category (NFR 2D3d), with emissions also rising in the printing (NFR 2D3h) and other solvent use (NFR 2D3i) categories.

Fluctuations in NMVOC emissions between 1990 and 2024 are largely due to the economic situation 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 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, indicating that the bottom of emissions had been reached in 2010, and henceforward, the emissions began to rise again. Estonia experienced a period of economic growth from 2011 to 2019. However, since 2020 there have been major fluctuations, including a short-term decline due to the pandemic, a rapid recovery in 2021. After 2021, economic growth slowed significantly and the economy fell into a broad-based recession in 2023 and 2024. The reason was the global increase in energy prices, geopolitical instability and increased inflation. NMVOC emissions have been on a downward trend in recent years and decreased further in 2024.

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 22% of the total solvent sector's 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 2024, NMVOC emissions from the use of solvents and other products decreased by 9.0% compared to 2023. The main reason for this decrease was the reduction in emissions from coating application consumption (20.2%). The decrease was due to a decrease in the amount of chemicals used.

However, despite the overall downward trend, some sectors experienced increases. In 2024, NMVOC emissions from domestic solvent use increased by 0.2% compared to 2023, emissions from other solvent use increased by 4.5%, and emissions from dry cleaning by 40.8%.

NMVOC emissions by NFRs are presented in Table and Figures below.

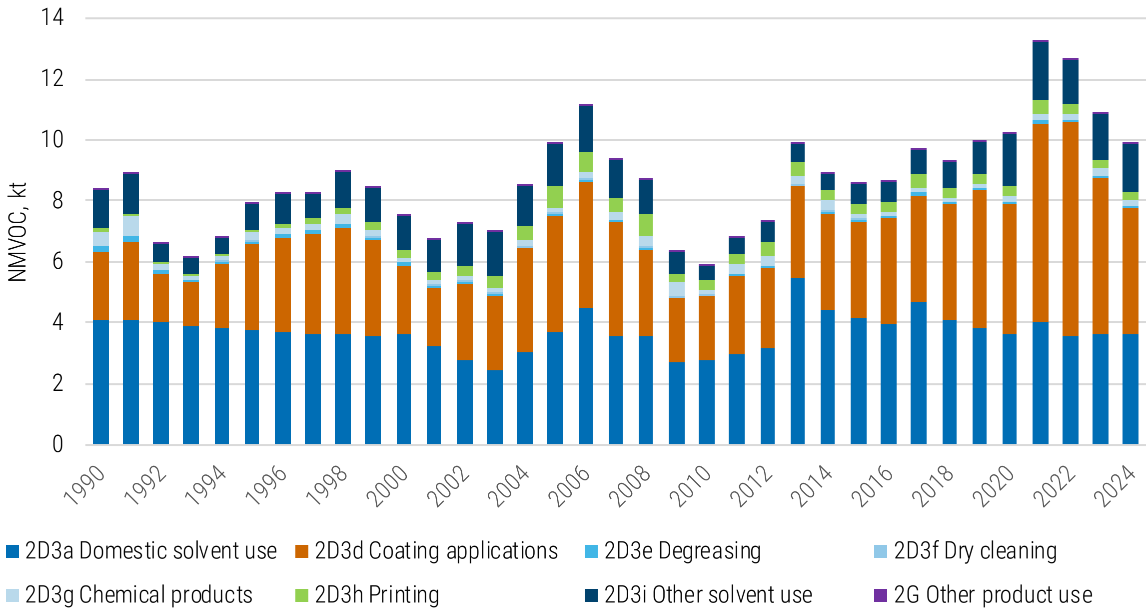

Figure 4.10 NMVOC emissions from the solvent and other product use sector

Table 4.23 NMVOC emissions from the solvent and other product use sector (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
2020	3.63	4.28	0.07	0.01	0.17	0.33	1.71	0.05
2021	3.99	6.56	0.08	0.01	0.21	0.45	1.95	0.05
2022	3.58	7.02	0.08	0.004	0.17	0.34	1.47	0.05
2023	3.65	5.12	0.07	0.01	0.21	0.28	1.50	0.06
2024	3.66	4.09	0.06	0.01	0.19	0.28	1.57	0.05
Change 1990-2024, %	-10.0	82.3	-65.0	-41.1	-60.7	248.4	24.1	1.4
Change 2023-2024, %	0.2	-20.2	-7.1	40.8	-6.6	-0.3	4.5	-2.7

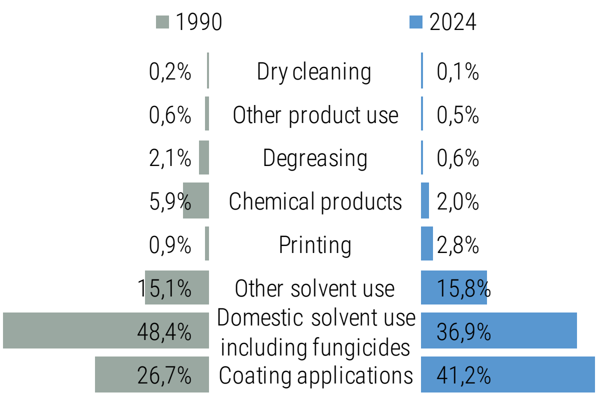

Figure 4.11 The share of NMVOC emissions in 1990 and 2024 by NFR solvent subcategory codes

4.2.2. Methods

NMVOC emission estimations from solvent and other product use are based on several data sources and methods.

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 and submit an annual air emissions report. The thresholds for NMVOC emissions, above which a permit is required, are relatively low: until the end of 2017, a permit was mandatory if emissions exceeded 0.1 tons per year, and from the end of 2017, the threshold increased to 0.5 tons per year. Consequently, facilities with a significant environmental impact are expected to hold a permit and provide annual emissions data.

The annual air emissions reports for solvent and other product use include detailed information on:

- 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.

Emissions from point sources are collected through the web-based air emissions data system, while emissions from diffuse sources are estimated using data primarily from Statistics Estonia, combined with international emission factors and expert assessments. Information sources for the NMVOC inventory by subcategory, along with emission sources not included in the inventory, are presented in Table 4.24.

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 (2004-2023, GB2023)
		060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: EF from Table 3-5 (2004-2023, GB2023)

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NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
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), 2007-2023 IEF from the PS; Table 3-7 in combination with Table 3-19 (1990-2007, GB2023, water based), 2008-2023 IEF from the PS; PS: facility specific
		060103	Construction and buildings	Statistics Estonia and expert estimate	DS: Tables 3-4 and 3-5 (1990-2023, GB2023, solvent based); Tables 3-4 and 3-5 in combination with Table 3-17 (1990-2023, GB2023, water based); 149.5 g/kg of paint applied (1990-2023, 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
		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

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		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
		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

Other pollutants emissions are obtained from the air emissions data system, except for emissions from fireworks and tobacco use, which are estimated using Tier 2 emission factors from the EMEP/EEA Guidebook 2023, and emissions from lubricant use, which are estimated using the COPERT 5 model.

4.2.3. Uncertainty

An uncertainty analysis was carried out to the year 2026 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, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024 %
NO_x	0.002	kt	0.01	0.01	0.00
NMVOC	9.92	kt	44.43	12.86	3.21
SO_x	0.001	kt	0.01	0.00	0.000
NH_3	0.01	kt	0.08	0.04	0.01
$PM_{2.5}$	0.05	kt	1.07	0.54	0.12
PM10	0.06	kt	0.71	0.36	0.08
TSP	0.07	kt	0.45	0.22	0.01
BC	0.02	kt	1.41	0.71	0.08

Pollutant	Emission, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024 %
CO	0.08	kt	0.09	0.04	0.004
Pb	0.21	t	5.67	2.85	0.05
Cd	0.02	t	3.67	1.84	0.14
Hg	0.00002	t	0.01	0.00	0.001
PCDD	0.0001	g I-TEQ	0.003	0.01	0.001
b(a)p	0.0001	t	0.01	0.03	0.002
b(b)f	0.0001	t	0.01	0.01	0.0003
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	0.004
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 category 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 2024, NMVOC emissions from the NFR category 2D3a had decreased by 10% compared to the year 1990. NMVOC emissions in 2024 increased by 0.2% compared to 2023, remaining effectively at the same level. This slight increase was mainly due to higher consumption of household products.

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. Therefore, the population-based approach was used instead the product-based approach.

NMVOC emissions and activity data are presented in the Table below.

Table 4.28 Activity data and NMVOC emissions from domestic solvent use (other than paint application) (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
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	2.82	6.94	3.02	1.91	26.57	2.77
2023	1.37	3.44	7.08	2.95	1.80	27.35	2.47
2024	1.37	3.27	21.79	3.02	1.74	23.29	2.23

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
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	0.36	0.11	0.54	0.40	0.13	1.20	0.27	0.09
2023	0.44	0.11	0.53	0.41	0.12	1.23	0.28	0.09
2024	0.41	0.35	0.54	0.42	0.11	1.05	0.28	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
2020	0.34	0.06	3.63
2021	0.44	0.06	3.99
2022	0.42	0.06	3.58
2023	0.37	0.07	3.65
2024	0.33	0.07	3.66

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 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 category 2D3h.

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.

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 2024, NMVOC emissions from this sector increased by 82.3% compared to 1990. Compared to 2023, NMVOC emissions decreased by 20.2%. The decrease in NMVOC emissions was mainly due to a decrease in the consumption of decorative coatings (SNAP activities 060103 and 060104). For example, in 2024, the consumption of decorative coatings decreased by 24.2% compared to 2023. According to Statistics Estonia, construction volumes in Estonia decreased in 2024 compared to 2023, mainly due to a decline in building construction, which may have contributed to reduced use of decorative coatings. Approximately 52% of the decorative coatings used in 2024 were solvent-based, indicating a decrease in their use compared to 2023.

In 2024, 66% of coatings were used for decorative coating and 34% for industrial coating. In 2024, an increase in the use of industrial coatings was noticed. The consumption of industrial coatings had increased by 4.7%.

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 28% in 2023. 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.

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SNAP	SNAP name	Chemical Type	Value	Unit	Tier	Source	Comment
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
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 2024. 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	2015	2020	2021	2022	2023	2024
WB	-	181	255	234	133	151	124	90	84	85
SB	569	443	448	341	449	431	411	401	402	389

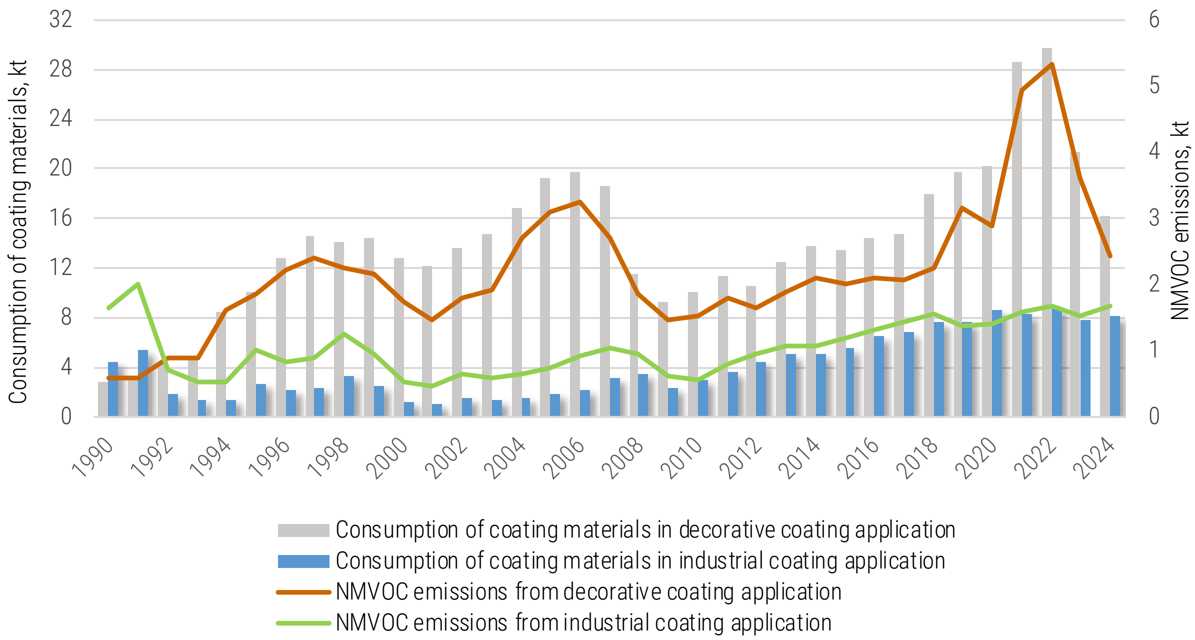

Figure 4.12 The consumption of coating materials and NMVOC emissions from decorative and industrial coating applications

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 (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
2020	1.73	12.13	1.15	8.08
2021	2.97	17.20	1.98	11.46
2022	3.20	17.83	2.13	11.89
2023	2.16	12.83	1.44	8.55
2024	1.45	9.72	0.97	6.48

Table 4.32 NMVOC emissions and consumption of coating materials from industrial paint (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
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	0.06	0.15	0.58	0.69	5.28	0.71	2.51

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
2023	--	--	NA	NA	0.13	0.33	0.01	0.05	0.12	0.43	0.64	4.73	0.63	2.27
2024	--	--	NA	NA	0.13	0.33	0.01	0.05	0.13	0.45	0.71	4.88	0.69	2.48

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.

In 2024, NMVOC emissions from this sector decreased by 65.0% compared to the year 1990. Compared to 2023, NMVOC emissions in 2024 decreased by 7.1%.

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.

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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	2023	2024
Open-top degreaser	25%	20%	15%	5%	0%	0%	0%	0%	0%	0%	0%
Semi open-top degreaser and good housekeeping	5%	10%	10%	10%	10%	5%	0%	0%	0%	0%	0%
Semi open-top degreaser and good housekeeping with activated carbon	0%	0%	5%	10%	15%	20%	25%	26%	27%	28%	29%
Sealed chamber system using chlorinated solvents	10%	10%	10%	10%	5%	5%	0%	0%	0%	0%	0%
Cold cleaner	60%	60%	60%	65%	70%	70%	75%	74%	73%	72%	71%

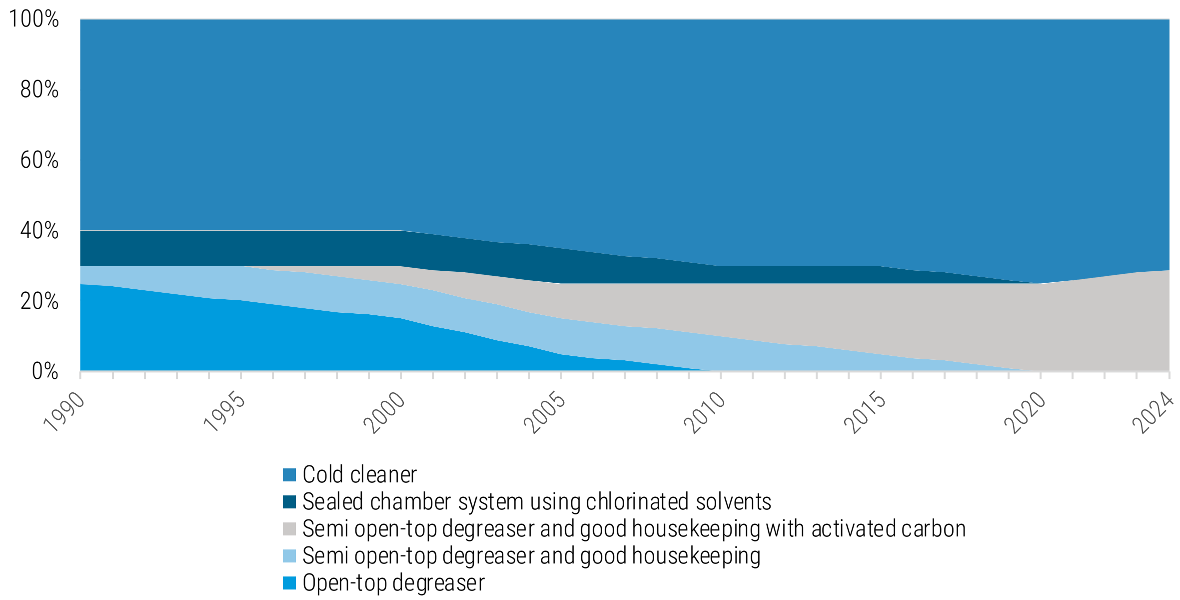

Figure 4.13 The shares of different technologies within the degreasing industry

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 1995-2024. 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 2024, the point sources database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2024, 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 are presented in the Table 4.35

Table 4.35 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes (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
2020	0.002	0.03	0.01	0.01	0.01	0.02	0.05	0.09
2021	0.003	0.03	0.01	0.01	0.01	0.02	0.07	0.11
2022	0.001	0.02	0.00	0.01	0.01	0.03	0.07	0.13
2023	0.001	0.01	0.01	0.01	0.01	0.03	0.05	0.13
2024	NA	NA	0.01	0.01	0.01	0.03	0.05	0.17

For the SNAP codes 060201, 060203 and 060204, emissions and solvent consumption are based only on the reported data from the point sources.

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 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 0.1% of the NMVOC emissions from the solvent and other product use sector in 2024. In 2024, NMVOC emissions from dry cleaning decreased by 41.1% compared to 1990. Compared to 2023, NMVOC emissions increased by 40.8% in 2024. The increase observed in 2024 was mainly driven by diffuse sources, where the use of tetrachloroethylene increased by 61%, while in facilities holding an environmental permit, the use of tetrachloroethylene remained at the same level.

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[9]; UBA, 1989[10]). Also, a significant amount of the solvent goes back to the producers and to the recyclers, along with the sludge.

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[11]) – 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, was carried out in 2010.

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[9] Passant N.R. (1993). Emissions of Volatile Organic Compounds from Stationary Sources in the United Kingdom: A Review of Emission Data by Process.
[10] UBA (1989). Luftreinhaltung '89 – Tendenzen – Probleme – Lösungen. Edited by the German Federal Protection Agency (Umweltbundesamt), Erich Schmidt Verlag GmbH, Berlin 1989.
[11] IIASA (2008). Greenhouse Gas and Air Pollution Integrations and Synergies (GAINS) model, www.iiasa.ac.at/rains/gains-online.html.

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
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

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.

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 (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
2020	0.01	0.01
2021	0.01	0.01
2022	0.004	0.01
2023	0.01	0.01
2024	0.01	0.02

For the dry cleaning sector in years 1990 to 2001, only statistical data is used, whereas for the period of 2002 to 2024, both statistical and reported data are used.

4.2.7.3. 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.

4.2.7.4. 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 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 0.9% to the total national NMVOC emissions in 2024 and 2.0% to the whole solvent and other product use sector.

By 2024, NMVOC emissions from the chemical products sector had decreased by 60.7% compared to 1990. Compared to 2023, NMVOC emissions in 2024 decreased by 6.6%.

4.2.8.2. Methodological Issues

All emission estimates 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.

Polyester resin plastic products fabrication (polyester processing) were reported under SNAP 060314 (other). Emissions from the production of adhesives and sealants were also reported under snap code 060314. The analysis of the annual ambient air reports for the years 2004-2024 revealed that facilities did not reported emissions under SNAP code 060311 (adhesive, magnetic tapes manufacturing). Additionally, it was found that some facilities producing plastic packaging and films made from polyethylene, polypropylene, and polystyrene granules have reported emissions from production under SNAP code 060412 (NFR 2D3i).

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 were 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.

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 2D3g, the activity data is unknown for the period of 2006-2024.

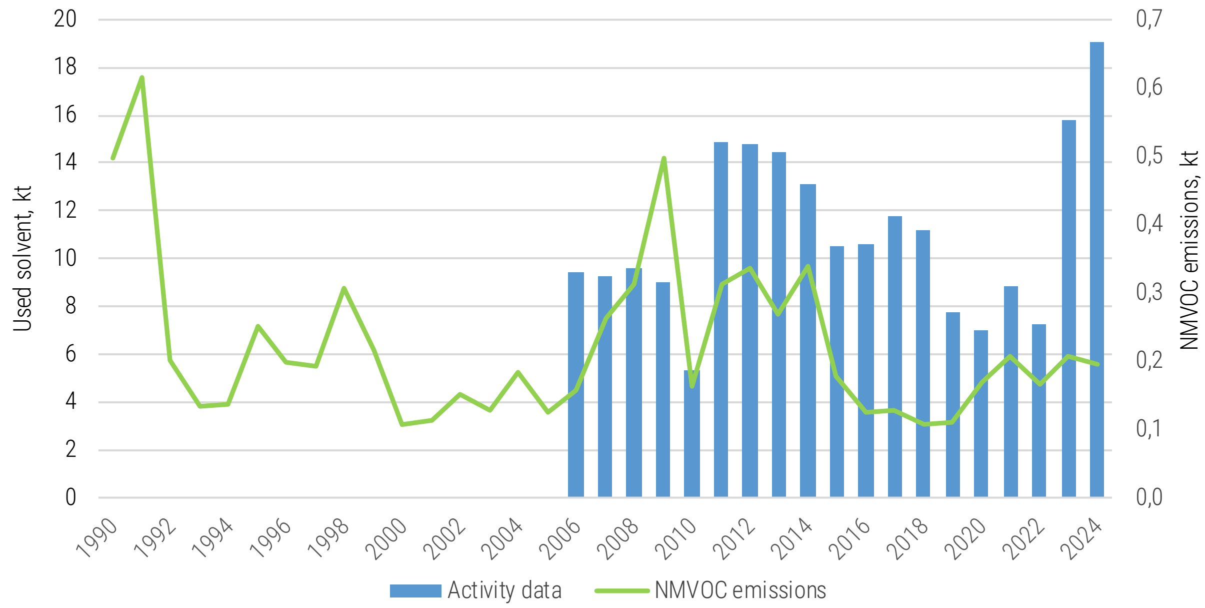

Figure 4.14 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing

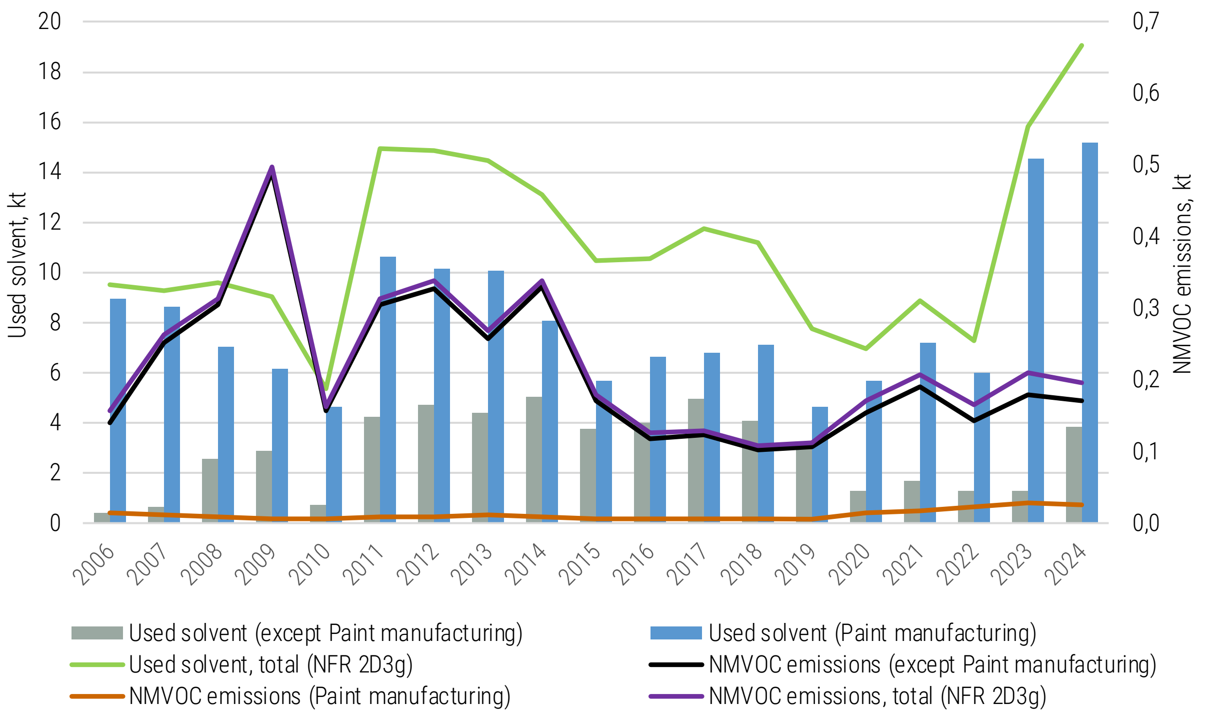

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing

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 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 (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	4.65
2015	--	--	0.01	3.02	0.06	0.10	0.02	0.01	0.01	5.71
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	0.02	5.97
2023	--	--	0.004	NA	0.07	0.001	0.004	0.004	0.03	14.55
2024	--	--	0.01	NA	0.08	2.649	0.003	0.003	0.03	15.18

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	NA	NA	NA	NA	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
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	0.24	0.00005	0.004	0.06	1.03
2023	NA	NA	NA	NA	0.002	0.32	0.00004	0.001	0.10	0.93
2024	NA	NA	NA	NA	0.001	0.32	0.00003	0.001	0.08	0.90

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 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

No major improvements are planned for the next submission.

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.

In 2024, the NMVOC emissions of the printing sector accounted for only 1.2% of the national total NMVOC emissions and 2.8% of the total NMVOC emissions of the solvent and other product use sector. NMVOC emissions from printing had increased by 248.4% compared to the year 1990. In 2024, NMVOC emissions from printing remained at the same level as in 2023. In recent years, several major print publications discontinued their paper editions in Estonia. This shift to digital formats may contribute to a reduction in emissions in the printing sector.

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[12], it can be concluded that the following techniques are applied (with relevant emission factors) for press and edition/ publication:

[12] Atmospheric Emission Inventory Guidebook. Second Edition. EEA 2000

- 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 (1995-2024). 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 2024, 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 (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
2020	0.33	1.37
2021	0.45	1.61
2022	0.34	1.41
2023	0.28	1.24
2024	0.28	1.26

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[13]).

In 2024, NMVOC emissions from the NFR 2D3i sector increased by 24.1% compared to 1990. In 2024, NMVOC emissions from the use of other solvents increased by 4.5% compared to 2023. The main reason for this increase was the higher consumption of adhesives.

In the NFR category 2D3i , the largest share was the use of adhesives (SNAP 060405) at 96%, followed by the use of other solvents (SNAP 060412) at 3.0%. Other activities are insignificant, as their share is less than 1.0%.

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.

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.

[13] 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.

Application of glues and adhesives (SNAP 060405)

The Tier 2 emission factor is used for calculations: 780 g/kg adhesive[14] for the period of 1990-2000, 522 g/kg adhesive[15] 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 2024, activity data regarding adhesives use in point sources are collected in the point sources database (SNAP 060405).

For the years 2006-2024, 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.

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.

[14] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[15] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023

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 2000-2024 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 (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
2020	--	--	NA	NA	NA	NA	1.67	4.20	0.001	0.01
2021	--	--	NA	NA	NA	NA	1.90	4.63	0.001	0.01
2022	--	--	NA	NA	NA	NA	1.42	3.80	0.001	0.002
2023	--	--	NA	NA	NA	NA	1.45	3.32	0.01	0.002
2024	--	--	NA	NA	NA	NA	1.51	3.62	0.01	0.003

Table 4.41 continues

SNAP code	060407		060412	
Year	NMVOC	Activity data, mln.inhab.	NMVOC	Activity data
1990	0.12	1.57	NA	NA
1995	0.18	1.45	NA	NA
2000	0.20	1.40	0.01	NA
2005	NO	--	0.003	NA
2010	NO	--	0.01	0.07
2015	NO	--	0.04	0.09
2020	NO	--	0.04	0.10
2021	NO	--	0.05	0.10
2022	NO	--	0.05	0.10
2023	NO	--	0.05	0.10
2024	NO	--	0.05	0.15

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 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.

The share of sector NFR 2G in national total emissions in 2024 was as follows: Cu – 10.7%, Pb – 5,7%, Cd – 3.7% and Ni – 4.3%. The share of other pollutants was not as significant.

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 2023, the use of fireworks increased by 21.5% in 2024. The amounts of fireworks used and the corresponding pollutant emissions are presented in the table below. The increase may reflect normal year-to-year variability in consumption. Although some municipalities have reduced public fireworks displays in recent years, this may not fully offset variations in private use.

Table 4.43 The use of fireworks and pollutant emissions

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	NR	NR
1995	0.02	0.0001	0.0002	0.00001	0.002	NR	NR
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
2020	0.11	0.0003	0.001	0.00003	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
2023	0.22	0.001	0.002	0.0001	0.02	0.02	0.01
2024	0.27	0.001	0.002	0.0001	0.03	0.03	0.01

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
2020	0.0001	0.0002	0.002	0.05	0.00001	0.003	0.08	0.03
2021	0.001	0.001	0.01	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
2023	0.0003	0.0003	0.004	0.10	0.00001	0.01	0.18	0.06
2024	0.0004	0.0004	0.004	0.12	0.00002	0.01	0.21	0.07

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 $PM_{1.8}$

Pollutant	Emission Factor	Unit
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

In recent years, a decrease in the smoking of conventional cigarettes has been observed in Estonia, while the use of new tobacco and nicotine products, such as e-cigarettes and nicotine pouches, has increased. In 2024, tobacco consumption decreased by 10.3% compared to 2023.

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

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
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	1.43	0.01	0.003	0.08	0.01	0.04	0.04	0.04	0.02
2023	1.44	0.01	0.003	0.08	0.01	0.04	0.04	0.04	0.02
2024	1.29	0.01	0.002	0.07	0.01	0.03	0.03	0.03	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
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
2023	0.0002	0.0001	0.0001	0.0001	0.01	0.004	0.004	0.01	0.0001
2024	0.0001	0.0001	0.0001	0.0001	0.01	0.003	0.003	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.

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

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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

Year	Lubricant consumed	NMVOC	Pb	Cd	Cr	Cu	Ni	Se	Zn
	kt	kt	t						
1990	1.19	0.03	0.00004	0.01	0.02	0.93	0.04	0.01	0.54
1995	0.76	0.02	0.00003	0.003	0.01	0.59	0.02	0.00	0.34
2000	0.80	0.02	0.00003	0.004	0.02	0.63	0.03	0.00	0.36
2005	1.11	0.03	0.00004	0.01	0.02	0.86	0.04	0.01	0.50
2010	1.23	0.03	0.00004	0.01	0.02	0.96	0.04	0.01	0.55
2015	1.46	0.04	0.00005	0.01	0.03	1.13	0.05	0.01	0.66
2020	1.64	0.05	0.0001	0.01	0.03	1.27	0.05	0.01	0.74
2021	1.69	0.05	0.0001	0.01	0.03	1.31	0.05	0.01	0.76
2022	1.71	0.05	0.0001	0.01	0.03	1.33	0.05	0.01	0.77
2023	1.74	0.05	0.0001	0.01	0.03	1.36	0.06	0.01	0.78
2024	1.71	0.05	0.0001	0.01	0.03	1.33	0.05	0.01	0.77

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.

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
3Da4	Crop residues applied to soils	Includes emissions from crop residues applied to soils	NH_3	Tier 2
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	Includes emission from use of pesticides	HCB	Tier 1
3F	Field burning of agricultural residues	The activity is not common practice in the region. Burning of crop residues has been prohibited since 2004.	NO	

The share of agricultural sources in total emissions in 2024 was as follows: NO_x – 13%, NH_3 – 97%, NMVOC – 21%, PM_{10} -20% and TSP – 15%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 52%, 42%, 60%, and 65% 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 was liquidated and after land and ownership reform the land was returned to former owners. Only half a hundred large-scale producers 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.[16]

After Estonia joined the EU in 2004, livestock numbers and the consumption of mineral N-fertilisers increased compared to mid-nineties due to the free market and EU support mechanisms. Over the past decade, the volume of emissions has also been affected by changes in livestock housing and manure holding systems, as well as the adoption of various other emission abatement techniques.

In 2024, NO_x, NH_3 and NMVOC emissions decreased by 7%, 3% and 1% respectively, compared to 2023.

Emissions from the agricultural sector decreased due to a 6% reduction in fertilizer use and a decline in the number of non-dairy cattle, sheep, goats, laying hens, other poultry and broilers, while TSP emissions remained largely unchanged compared to the previous year.

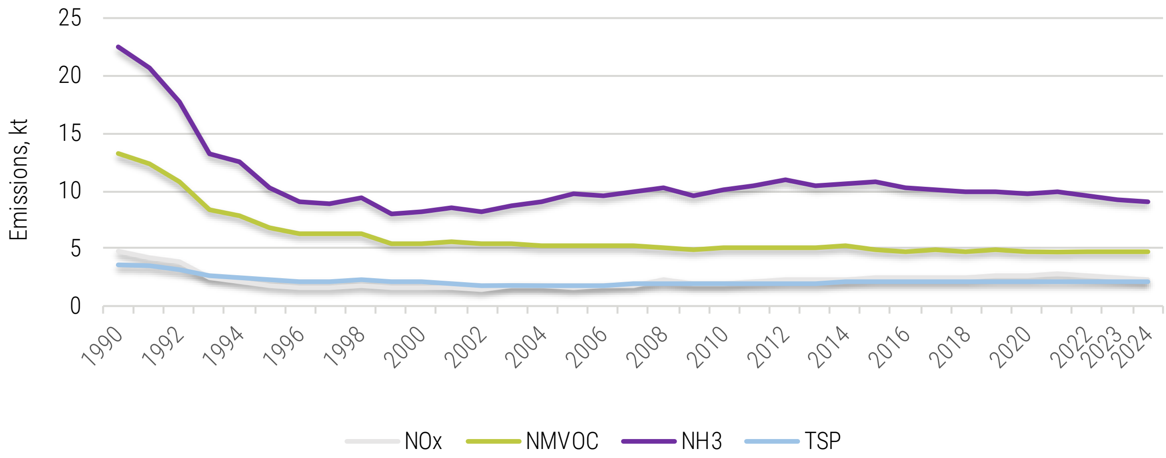

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector (kt)

[16] Estonian University of Life Sciences. (2011). Maaelu arengu aruanne.

Table 5.2 Total emissions from the agriculture sector (kt)

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
1990	4.77	13.24	22.50	3.58	NR	NR
1995	1.73	6.81	10.30	2.24	NR	NR
2000	1.64	5.38	8.27	2.06	0.19	1.64
2005	1.63	1.62	1.62	1.62	0.17	1.44
2010	2.01	2.01	2.01	2.01	2.01	2.01
2015	2.39	4.94	10.72	2.14	0.19	1.68
2020	2.39	4.75	10.32	2.12	0.19	1.71
2021	2.43	4.83	10.14	2.10	0.18	1.66
2022	2.48	4.76	9.89	2.12	0.19	1.72
2023	2.58	4.81	9.95	2.17	0.20	1.77
2024	2.57	4.76	9.75	2.20	0.20	1.80
Share in total 2024 emission, %	13.41	20.99	96.57	14.56	4.27	20.27
Change 2023-2024, %	-6.57	-1.12	-2.83	-0.71	-1.87	-1.52
Change 1990-2024, %	-52.05	-64.56	-60.11	-42.04	-0.28	5.31

More than half of NH_3 emissions come from 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 87% (see Figure 5.3).

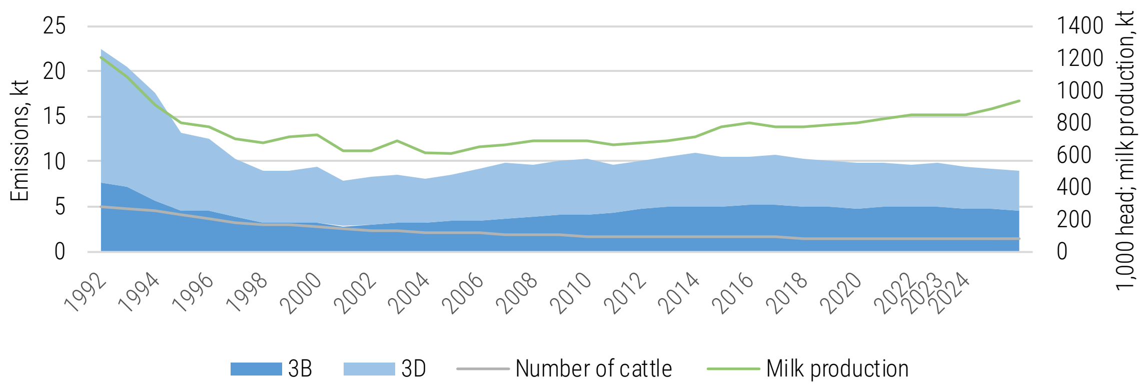

Figure 5.2 NH_3 emission distributions by the agriculture sector activities

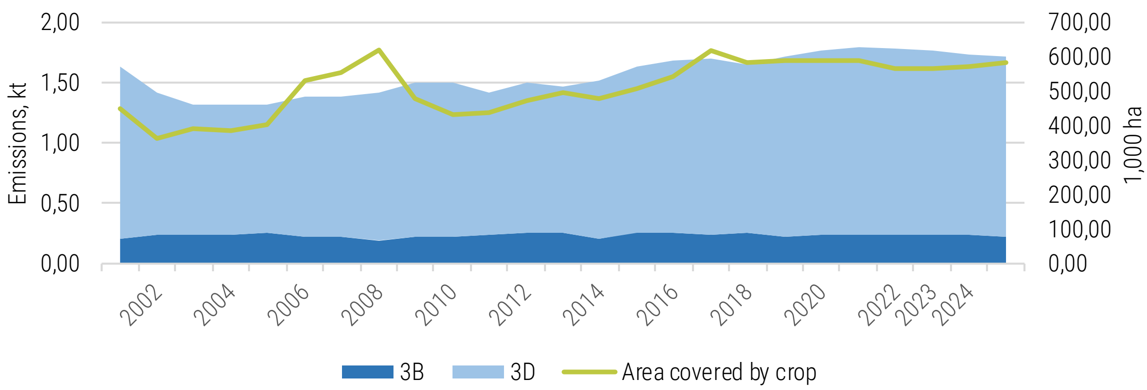

Figure 5.3 PM_{10} emissions from livestock (3B) and agricultural soils (3D)

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 emissions in 2024 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 updating the share of manure from grazing cattle. For more details, 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.

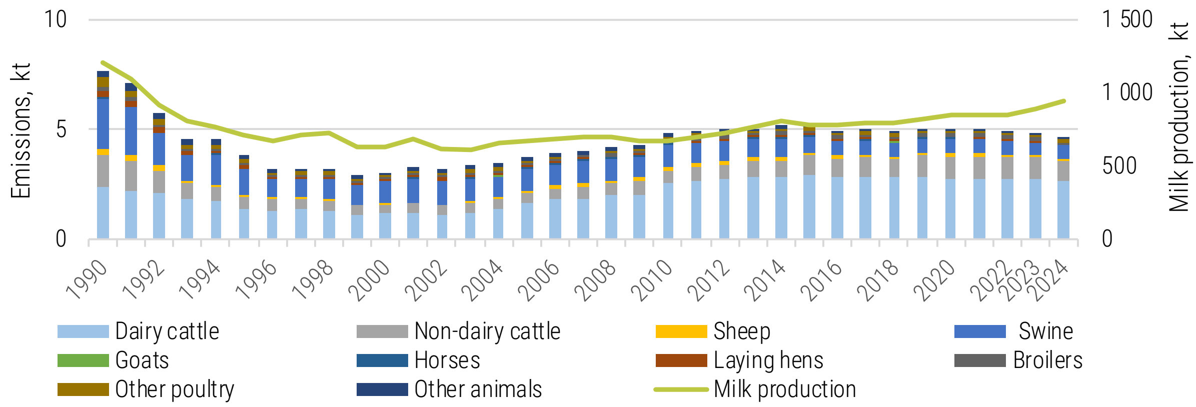

Figure 5.4 NH_3 emissions from manure management

During the period of 1990–2024, the emission of NH_3 decreased by 39% (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).[17] Changes in manure-handling technology have decreased the levels of ammonia emissions because liquid manure generates less ammonia than does solid manure.

[17] 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 1990-2024, the annual average nitrogen production per head of dairy cattle increased by 100%.

Table 5.3 Total emissions of NO_x from manure management (kt)

Year	Dairy cattle*	Non-dairy cattle*	Sheep*	Swine *	Goats*	Horses*	Laying hens*	Broilers*	Other poultry*	Other animals*
1990	0.057	0.03	0.006	0.004	0.0001	0.0012	0.007	0.003	0.007	0.008
1995	0.031	0.01	0.002	0.003	0.0001	0.0006	0.003	0.001	0.003	0.005
2000	0.028	0.01	0.001	0.003	0.0002	0.0006	0.002	0.001	0.002	0.003
2005	0.024	0.01	0.002	0.003	0.0002	0.0007	0.002	0.002	0.002	0.005
2010	0.021	0.01	0.004	0.003	0.0003	0.0009	0.002	0.002	0.002	0.004
2015	0.007	0.01	0.004	0.001	0.0003	0.0009	0.003	0.002	0.003	0.004
2020	0.005	0.01	0.003	0.001	0.0003	0.0007	0.001	0.003	0.002	0.001
2021	0.005	0.01	0.003	0.001	0.0002	0.0007	0.001	0.003	0.003	0.001
2022	0.004	0.01	0.003	0.001	0.0002	0.0007	0.001	0.003	0.002	0.001
2023	0.003	0.01	0.002	0.001	0.0002	0.0007	0.002	0.003	0.003	0.001
2024	0.004	0.01	0.002	0.001	0.0002	0.0007	0.001	0.002	0.004	0.001
Change 2023-2024, %	**1.4**	**-8.7**	**-20.0**	**-19.8**	**-13.4**	**3.6**	**-11.2**	**-28.7**	**34.7**	**0.0**
Change 1990-2024, %	**-93.8**	**-73.9**	**-70.7**	**-80.0**	**53.4**	**-36.0**	**-80.2**	**-41.4**	**-46.0**	**-93.7**

** NO_x emissions from animal manure applied to soils are reported under NFR 3D2a.*

Table 5.4 Total emissions of NMVOC from manure management (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1990	6.32	3.96	0.04	0.53	0.001	0.067	0.37	0.21	0.62	0.45
1995	3.82	1.56	0.02	0.27	0.001	0.036	0.14	0.09	0.27	0.26
2000	3.26	1.05	0.01	0.21	0.002	0.033	0.12	0.07	0.15	0.10
2005	2.91	1.10	0.02	0.23	0.002	0.037	0.12	0.11	0.14	0.25
2010	2.69	1.06	0.03	0.25	0.003	0.053	0.10	0.13	0.18	0.20
2015	2.46	1.12	0.02	0.20	0.003	0.049	0.14	0.15	0.23	0.23
2020	2.45	1.16	0.02	0.21	0.003	0.042	0.07	0.17	0.25	0.01
2021	2.43	1.15	0.02	0.20	0.003	0.040	0.09	0.18	0.23	0.00
2022	2.47	1.16	0.02	0.17	0.003	0.039	0.09	0.18	0.23	0.04
2023	2.51	1.07	0.02	0.18	0.002	0.041	0.11	0.17	0.25	0.00
2024	2.59	1.01	0.01	0.18	0.002	0.043	0.10	0.17	0.22	0.00
Change 2023-2024, %	**3.01**	**-5.66**	**-16.33**	**2.19**	**-13.42**	**4.06**	**-12.53**	**-1.38**	**-10.23**	**0.00**
Change 1990-2024, %	**-59.1**	**-74.4**	**-70.9**	**-65.3**	**52.7**	**-36.4**	**-73.9**	**-18.9**	**-64.0**	**-99.7**

Table 5.5 Total emissions of NH_3 from manure management (kt)

Year	Dairy cattle*	Non-dairy cattle *	Sheep*	Swine*	Goats*	Horses*	Laying hens*	Broilers*	Other poultry*	Other* animals
1990	2.41	1.39	0.27	2.32	0.00	0.06	0.30	0.20	0.41	0.32
1995	1.37	0.55	0.10	1.19	0.00	0.03	0.11	0.09	0.18	0.21
2000	1.20	0.40	0.06	0.96	0.01	0.03	0.10	0.06	0.10	0.11
2005	1.66	0.49	0.10	1.00	0.01	0.03	0.10	0.10	0.09	0.21
2010	2.60	0.56	0.16	0.97	0.01	0.05	0.08	0.12	0.12	0.14
2015	2.90	0.91	0.15	0.69	0.01	0.04	0.11	0.14	0.15	0.15
2020	2.78	1.00	0.11	0.69	0.01	0.04	0.04	0.15	0.15	0.02
2021	2.79	0.99	0.11	0.67	0.01	0.03	0.05	0.16	0.15	0.02
2022	2.78	0.99	0.10	0.58	0.01	0.03	0.06	0.16	0.14	0.02
2023	2.78	0.96	0.09	0.59	0.01	0.04	0.06	0.15	0.16	0.02
2024	2.67	0.91	0.07	0.61	0.01	0.04	0.05	0.14	0.14	0.02
Change 2023-2024, %	**-3.90**	**-5.38**	**-17.77**	**3.24**	**-13.75**	**3.73**	**-12.33**	**-10.23**	**-9.01**	**0.00**
Change 1990-2024, %	**15.33**	**-31.22**	**-66.43**	**-74.44**	**68.36**	**-41.74**	**-80.99**	**-22.24**	**-61.16**	**-93.76**

** NH_3 emissions from animal manure applied to soils and grazing are reported under NFR 3D2a and 3Da3.*

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Table 5.6 Total emissions of $PM_{2.5}$ from manure management (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	0.002	0.002	0.0001	0.001	0.002	0.003	0.01	0.0006
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
2023	0.03	0.02	0.001	0.001	0.0001	0.001	0.002	0.003	0.01	0.0001
2024	0.03	0.02	0.001	0.001	0.0001	0.001	0.002	0.003	0.01	0.0001
Change 2023-2024, %	0.21	-5.55	-16.33	5.15	-12.50	4.05	-12.53	-1.37	-10.23	0.00
Change 1990-2024, %	-23.6	36.6	37.6	-12.8	-12.5	30.5	-19.9	156.7	44.6	-81.8

Table 5.7 Total emissions of PM_{10} from manure management (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	0.02	0.006	0.04	0.0003	0.002	0.02	0.02	0.05	0.0011
2015	0.05	0.03	0.005	0.03	0.0003	0.001	0.03	0.03	0.07	0.0012
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	0.03	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
2023	0.05	0.03	0.003	0.03	0.0002	0.001	0.03	0.03	0.07	0.0002
2024	0.05	0.03	0.003	0.02	0.0002	0.001	0.02	0.03	0.06	0.0002
Change 2023-2024, %	-0.58	-5.56	-16.33	-19.06	-13.04	4.31	-12.53	-1.38	-10.23	0.00
Change 1990-2024, %	-24.17	35.75	38.30	-31.58	-13.04	30.11	-19.90	156.59	44.61	-81.82

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:

$$E = AAP_{animal} \times EF_{pollutant\_animal}$$

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:

$$E_{NMVOC\_i} = AAP_{animal\_i} \times (E_{NMVOC,silage\_store\_i} + E_{NMVOC,silage\_feeding\_i} + E_{NMVOC,building\_i} + E_{NMVOC,store\_i} + E_{NMVOC,appl.\ \_i} + E_{NMVOC,graz\_i})$$

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 2025[18] (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

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 the first time, when calculating NH_3

[18] Estonian GHG National Inventory Report 2025, Ch. 5 Agriculture (CFR 3)

emissions from manure, data on manure sent to digesters has been taken into account separately using the Tier 2 methodologies described in chapters 3B and 5B2 of the EMEP/EEA Guidebook 2023 along with the emission factors for pre-storage and storage of digestate outlined in chapter 5B2. For more detailed information about recalculations, see in Chapter 8.

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.

Due to various methodological innovations, the calculation files based on the previous EMEP/EEA Guidebook, Appendix B, Chapter 3B – Manure Management were abandoned, and the entire calculation was consolidated into one file. Previously, calculations for each animal category were kept in separate files. During this process, some errors were detected in the previous calculation files, and the rounding logic was harmonized. For more detailed information about recalculations, see Chapter 8.

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 2025.[19]

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)[20] 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 2015.21 For 2024, the data from the previous survey have been updated.22 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.

NH_3 emissions reductions in percentage terms were used from the United Nations Economic Commission for Europe's guidance document[23] on preventing and abating ammonia emissions from agricultural sources (see Table 5.14 and Table 5.15).

[19] Estonian GHG National Inventory Report 2025, Ch. 5 Agriculture (CFR 3)
[20] Regulation No 66 by the Minister of the Environment
[21] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf
[22] https://www.klab.ee/wp-content/uploads/2021/09/Laudatehnoloogiad_final.pdf
[23] https://unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_120_ENG.pdf

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock[24]

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
2020	140.1	134.130
2021	140.2	134.085
2022	142.0	134.080
2023	143.1	139.439
2024	149.1	145.297
Change 2023-2024, %	4.2	4.2
Change 1990-2024, %	100.8	62.5

Table 5.11 Nitrogen excretion rates of non-dairy cattle, kg N/head/year[25]

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
2020	74.1	74.1	50.5	16.0	2.9
2021	75.4	75.5	51.3	16.0	2.9
2022	75.0	73.2	51.0	16.0	2.9
2023	74.9	73.2	51.0	16.0	2.9
2024	74.2	73.3	51.0	16.0	2.9
Change 2023-2024, %	-0.9	0.1	0.1	0.0	0.0
Change 1990-2024, %	24.5	19.4	17.7	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

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.

[24] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)
[25] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

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, pasture/range and anaerobic digester). For the first time, digestate storage has been distinguished in the calculations. 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[26]. For further insight regarding leakage and N-excretion estimations, see the Estonian GHG National Inventory Report 2026.

Table 5.13 Manure management system usage for swine and cattle[27]

Livestock category	Year	Fattening pig	Shows	Young pig	Dairy cattle	Bowine animals	Calvess	Mature females	Mature males
Liquid/Slurry. %	1990	87.0	85.5	87.0	0.0	0.0	0.0	0.0	0.0
	1995	80.0	77.9	80.0	0.0	0.0	0.0	0.0	0.0
	2000	78.0	75.8	78.0	0.0	0.0	0.0	0.0	0.0
	2005	79.0	76.8	79.0	20.1	2.2	2.8	2.5	2.2
	2010	71.2	71.6	75.2	51.0	5.5	6.8	8.9	5.5
	2015	69.1	87.9	94.0	72.8	23.7	20.8	22.7	23.6
	2020	87.7	88.3	98.3	77.9	39.3	15.3	27.6	13.1
	2023	88.1	90.7	100	80.2	45.1	11	25.8	57.3
	2024	86.4	94.7	97.0	76.2	45.4	9.7	24.7	56.5
Solid Storage +deep litter. %	1990	13.0	14.5	13.0	82.7	67.1	85.7	67.8	67.1
	1995	20.0	22.1	20.0	80.5	67.1	85.7	67.8	67.1
	2000	22.0	24.3	22.0	82.7	67.1	85.7	67.8	67.1
	2005	21.0	23.2	21.0	63.0	66.3	82.9	43.5	66.3
	2010	20.0	22.1	20.0	45.0	73.5	83.8	46.3	73.5
	2015	13.6	0.0	0.0	13.5	40.3	58.5	42.0	42.4
	2020	7.4	7.3	0.0	7.4	39.5	63.0	32.4	66.7
	2023	11.9	9.3	0.0	5.0	35.1	68.2	31.5	31.8
	2024	9.4	1.8	0.0	5.3	31.2	66.6	3.6	33.9
Pasture/Range. %	1990	0.0	0.0	0.0	17.3	32.9	14.3	32.2	32.9
	1995	0.0	0.0	0.0	19.5	32.9	14.3	32.2	32.9
	2000	0.0	0.0	0.0	17.3	32.9	14.3	32.2	32.9
	2005	0.0	0.0	0.0	16.9	31.5	14.4	54.0	31.5
	2010	0.0	0.0	0.0	3.9	21.0	9.4	44.8	21.0
	2015	0.0	0.0	0.0	4.8	29.7	14.0	34.5	28.9
	2020	0.0	0.0	0.0	1.3	11.2	12.3	39.5	20.2
	2023	0.0	0.0	0.0	0.8	10.4	12.8	42.2	10.7
	2024	0.0	0.0	0.0	0,8	10.4	12.8	43.3	8.9
Anaerobic digester	1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[26] 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

[27] https://www.klab.ee/wp-content/uploads/2021/06/Arendus2020_aruanne_180221.pdf

Livestock category	Year	Fattening pig	Shows	Young pig	Dairy cattle	Bowine animals	Calvess	Mature females	Mature males
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2010	8.9	6.3	4.8	0.0	0.0	0.0	0.0	0.0
	2015	17.4	12.1	6.0	9.9	6.3	6.8	0.8	5.1
	2020	5.0	4.4	1.7	13.4	10.0	9.4	0.5	0.0
	2023	0.0	0.0	0.0	14.0	9.4	8	0.4	0.2
	2024	4.2	3.5	3	17,7	13	10.9	0.4	0,7

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
2024	Cattle	35	1.2	0.0	32
	Pigs	77.2	2.9	0.0	36
	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*

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Table 5.15 NH_3 emission abetment techniques for manure application to land

NH_3 abatement techniques	2005			2010			2015			2020			2024			NH_3 emission reduction coefficient, %
	Cattle	Swine	Other*	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	0.0	0.0	0.0	50
Incorporation within 4 hours (solid)										100	100	100	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	2.9	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	6.2	62	0.0	3.6	58.3	0.0	45
Injecting slurry (open slot)	0.0	0.0	0.0	0.0	0.0	0.0	13.2	2.9	0.0	25.3	15.2	0.0	16.7	17.1	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	12.3	4.9	0.0	19.6	9.8	0.0	80
Sod injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.0	4.1	0.0	55.1	5.4	0.0	70
Closed slot injection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	13.8	0.0	3.0	9.5	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 pre-storage digestate	NH_3 storage of digestate	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	0.0009	0.0266	0.550	0.680	0.140
Other cattle	0.240	0.080	0.250	0.320	0.000	0.008	0.0009	0.0266	0.550	0.680	0.140
Calves							0.0009	0.0266			
Fattening pigs	0.270	0.230	0.110	0.290	0.000	0.008	0.0009	0.0266	0.400	0.450	0.000
Weaners							0.0009	0.0266			
Sows	0.350	0.240	0.110	0.290	0.000	0.008	0.0009	0.0266	0.290	0.450	0.000
Laying hens		0.410		0.140			0.0009	0.0266		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
	2024	0.173	0.079	0.208	0.289	0.158	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

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
	2020	0.172	0.080	0.207	0.269	0.165	0.238
	2024	0.172	0.080	0.200	0.289	0.158	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	0.061	0.236	0.169	0.158
	2024	0.208	0.184	0.061	0.238	0.167	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	0.270	0.240	0.060	0.236	0.122	0.158
	2024	0.270	0.240	0.061	0.238	0.121	0.158

Activity data

Information regarding the numbers of livestock in agriculture is available from Statistics Estonia (www.stat.ee) for the years 1990-2024. 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
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
2023	83.3	158.0	55.1	3.7	5.2	250.7	24.3	662.5	1 604.5	505.0	19.9
2024	82.8	149.6	46.1	3.2	5.5	259.9	23.6	579.5	1 582.4	453.3	19.9
Change 2023-2024, %	-0.6	-5.6	-19.5	-15.6	4.8	3.5	-3.0	-14.3	-1.4	-11.4	0.0
Change 1990-2024, %	-70.5	-68.6	-70.9	52.4	-36.5	-68.0	-49.9	-73.9	-18.9	-64.0	-93.7

5.2.3. Uncertainty

An uncertainty analysis was carried out for the 2026 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, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	2.29	kt	12.91	9.07	1.14
NMVOC	4.69	kt	21.02	12.65	0.92
NH_3	8.98	kt	93.51	40.86	9.78
$PM_{2.5}$	0.19	kt	4.21	2.82	0.69
PM_{10}	1.72	kt	20.10	17.51	3.92
TSP	2.07	kt	14.11	10.33	0.53
HCB	0.04	kg	7.23	21.70	5.33

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.

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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 emissions 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 are reported under NFR 3Da3.

NO_x and NH_3 emissions from animal manure applied to soils, as well as urine and dung deposited by grazing animals, were recalculated for the years 2020–2023. The recalculations are associated with the share of manure from grazing cattle, which was estimated based on movement data for this cattle group obtained from the Agricultural Registers and Information Board (ARIB) database. For more details, see Chapter 8.

The share of agricultural soils in the total NH_3 emissions in 2024 was at 48%.

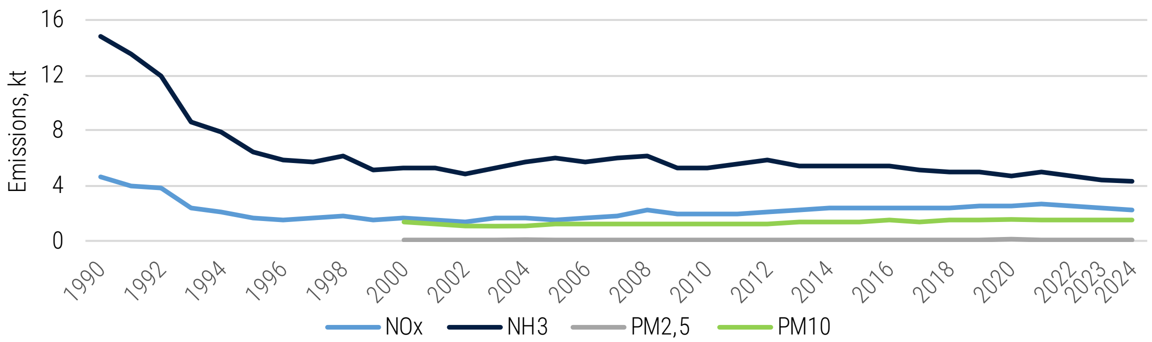

Figure 5.5 NO_x, NH_3, $PM_{2.5}$ and PM_{10} emissions from agricultural soils

During the period 1990-2024, emissions of NH_3 decreased to 70% (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 traditional methods of spreading manure 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.[28]

All the emission time series are presented in Tables 5.20-5.23. In 2024, NH_3 emissions decreased by 2% compared to 2023. Emissions from the land use sector declined due to a 5% reduction in fertilizer use.

Table 5.20 NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions from agricultural soils (kt)

Year	NMVOC	TSP	PM_{10}	$PM_{2.5}$
1990	0.68	NR	NR	1.72
1995	0.35	NR	NR	1.34
2000	0.37	0.12	1.42	1.42
2005	0.37	0.10	1.17	1.17
2010	0.31	0.10	1.19	1.19
2015	0.34	0.12	1.43	1.43
2020	0.38	0.13	1.55	1.55
2021	0.35	0.12	1.54	1.54
2022	0.35	0.12	1.52	1.52
2023	0.36	0.12	1.49	1.49

[28] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf

Year	NMVOC	TSP	PM_{10}	$PM_{2.5}$
2024	0.36	0.12	1.50	1.50
Change 2023-2024, %	1.50	-0.51	0.28	0.28
Change 1990-2024, %	-46.25	1.00	5.23	-13.00

Table 5.21 NH_3 emissions from agricultural soils (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	Crop residues applied to soils
1990	4.06	8.03	0.01	0.00	0.90	1.81
1995	1.14	3.89	0.01	0.01	0.47	0.95
2000	1.29	3.09	0.01	0.01	0.34	0.50
2005	1.35	3.66	0.01	0.05	0.41	0.56
2010	1.54	2.89	0.01	0.11	0.27	0.52
2015	1.88	2.82	0.01	0.11	0.35	0.28
2020	2.13	1.95	0.01	0.11	0.26	0.29
2021	2.39	1.86	0.01	0.10	0.28	0.28
2022	2.15	1.83	0.01	0.10	0.26	0.29
2023	1.97	1.80	0.01	0.09	0.25	0.28
2024	1.86	1.84	0.01	0.08	0.24	0.29
Change 2023-2024, %	-5.52	2.00	0.65	-11.46	-3.92	1.80
Change 1990-2024, %	-54.19	-77.07	-13.04	1 997.57	-73.84	-84.03

Table 5.22 NO_x emissions from agricultural soils (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	1.40	0.00	0.00	0.36
1995	0.76	0.72	0.00	0.00	0.18
2000	0.90	0.55	0.00	0.01	0.13
2005	0.80	0.59	0.00	0.03	0.16
2010	1.15	0.66	0.00	0.06	0.11
2015	1.45	0.71	0.00	0.06	0.14
2020	1.66	0.72	0.00	0.05	0.10
2021	1.87	0.71	0.00	0.05	0.11
2022	1.68	0.70	0.00	0.05	0.10
2023	1.54	0.69	0.00	0.05	0.09
2024	1.45	0.68	0.00	0.04	0.09
Change 2023-2024, %	-5.59	-1.45	0.66	-16.43	-5.74
Change 1990-2024, %	-49.43	-51.51	-12.48	1 838.98	-75.25

Table 5.23 HCB emissions from the use of pesticides (kg)

Year	HCB
1990	0.06
1995	0.06
2000	0.06
2005	0.06
2010	0.06
2015	0.06
2020	0.03
2021	0.03
2022	0.04
2023	0.04
2024	0.04
Change 2023-2024, %	0.85
Change 1990-2024, %	-32.20

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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. 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.

Emissions from the use of mineral fertilizers are conditionally based on the Tier 2 method. Statistics Estonia can only provide separate data on the use of urea fertilizers (a detailed description is included in the activity data chapter). There are no statistics available across the entire time series on the distribution of other fertilizer types. Therefore, two different emission factors were applied to calculate NH_3 emissions. For urea, an EF of 0.195 (kg kg^{-1} fertilizer-N applied) was used, and for all other fertilizers, an EF of 0.0539 (kg kg^{-1} fertilizer-N applied) was applied. This EF represents the arithmetic mean of Tier 2 emission factors (excluding urea) as shown in Table 3.2 of the crop production and agricultural soils (normal pH) of chapter of the EMEP/EEA Guidebook 2023. Due to the question raised during the review regarding the emission factor for other fertilizers, recalculations were carried out for the entire time series (see Chapter 8). Calculations assume that, according to expert judgement, approximately 16% of fertilizers were incorporated directly into the soil in 2012, reducing emissions by 35%[29]. This share reached 24.9% in 2021, with intermediate values interpolated. During the projection review, it was noted that these emission reduction measures do not apply to all types of fertilizers. Therefore, based on expert input, the category of "other fertilizers" was subdivided into ammonium-based fertilizers and remaining fertilizer types, using a 70:30 ratio.

Following the question raised in the review and after consulting various authorities including Statistics Estonia, the Agricultural Board, and the Environmental Research Centre, the main 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.[30] 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 manure 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).

The Tier 2 emission factor is calculated annually with the equation presented below.

[29] untitled
[30] https://www.klab.ee/wp-content/uploads/2021/06/Arendus2020_aruanne_180221.pdf

$$EFi = \sum(Ej.NMVOC * 24 * 365 * Fracemit.j) * mdmj * Fraci.j$$

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'.

The Tier 1 method uses readily available statistical data (see Table 5.27) and default emission factors (see Table 5.24).

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 5.26).

Emissions of particles from farm activities have been recalculated due to an error in the previous calculations (see Chapter 8).

Table 5.24 NO_x, NH_3, NMVOC and PM emission factors for agricultural soils

NFR Code	Pollutant	Unit	Value
3Da1	NO_x	kg kg^{-1} fertilizer-N applied	0.040
	NH_3	kg NH_3 kg^{-1} urea-N applied	0.195
	NH3	kg NH_3 kg-1 fertilizer-N applied	0.0539
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 5.25 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 5.26 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
		$kg ha^{-1} PM_{10}$				$kg ha^{-1} PM_{2.5}$			
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

For the calculation of NH_3 emissions from 3Da4 crop residues applied to soils, a Tier 2 methodology based on the EMEP/EEA Guidebook (EEA, 2023) was used first time. IPCC default parameters, which are consistent with those applied in the GHG inventory[31], were used. It is assumed that crop residues removed following harvest or other management activities are completed within 3 days. However, since no data are available on the incorporation of crop residues, the fraction of residues incorporated within 3 days is considered to be 0 for all crops. In addition, the burning of crop residues is prohibited.

In the GHG inventory[32], a detailed methodology was used to calculate the nitrogen (N) content of crop residues.

The calculations presented in this submission differ slightly from those provided to the review team during the summer review for the years 2021-2023, due to minor refinements in the underlying activity data, specifically the area of other grassland.

HCB emissions from the use of pesticides were estimated for the first time using the Tier 1 default approach. Activity data were based on statistics on the annual sales of active substances and the proposed maximum concentrations (impurity factors) from the EMEP/EEA Guidebook (EEA, 2023). In Estonia, three active substances containing HCB as an impurity are in use: picloram, clopyralid, and chlorothalonil, with maximum concentrations of 50, 2.5, and 40, respectively. Data are available from 2011 onwards (see Table 5.28); for earlier years, the average emissions for the period 2011–2024 were applied as a proxy.

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 1990-2024.

In 2015 the Statistics Estonia stopped gathering mineral fertilizer data on 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 2014-2024 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 was used.

[31] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)
[32] Estonian GHG National Inventory Report 2023, Ch. 5 Agriculture (CFR 3)

Table 5.27 Active data for agricultural soil sector

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
2020	41,486	181.2	591,933	20,700	168,038	78,807	172,300	1331,283	1.3
2021	46,767	181.2	567,4	11,900	179,948	78,807	172,300	1250,920	1.3
2022	42,053	181.2	564,1	13,318	180,971	86,448	172,300	1263,959	1.3
2023	38,404	181.2	569,5	16,903	173,565	76,486	172,300	1150,211	1.4
2024	36,257	181.2	584,4	18,235	173,320	60,247	172,300	961,231	1.4
Change 2023-2024, %	-5.6	0.0	2.6	7.9	-0.1	-21.2	0.0	-16.4	0.6
Change 1990-2024, %	-37.9	-86.7	-38.6	-72.3	566.6	-90.0	0.0	1 839.6	-12.5

Pesticide sales data (kg of active substance) by pesticide type, from Statistics Estonia, are available from 2011.

Table 5.28 Annual sales of pesticides by active substance, tons

Year	Picolarm	Chlorothalonil	Clopyralid
1990	...	...	...
1995	...	...	...
2000	...	...	...
2005	...	...	...
2010	...	...	...
2015	...	...	...
2020	0.5	0.0	3.1
2021	0.5	0.0	2.6
2022	0.6	0.0	4.1
2023	0.5	0.0	4.4
2024	0.6	0.0	2.8
Change 2023-2024, %	14.5		-37.3

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2024. 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. 4 of the Minister of Agriculture[33].

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.

[33] Maa heas põllumajandus- ja keskkonnaseisundis hoidmise nõuded–Riigi Teataja

Source: www.bioneer.ee

6. WASTE (NFR 5)

6.1. Overview of the Sector

Waste management in Estonia is based on EU and national legislation. The main purpose of the national waste policy has been to reduce the volume of waste deposited in landfills, increase the potential of recoverable waste, and minimise the hazardousness of waste to the limit.

Compared to 2023, total waste generation in 2024 decreased by 15.8%, and the generation of hazardous waste decreased by 1.3%. In 2024, the amount of waste deposited in landfills also decreased slightly.

This category includes emissions from solid waste disposal on land (landfills), waste incineration, cremation, wastewater treatment, dry toilets, composting, and other waste sources. Emissions from municipal waste incineration are reported under the energy sector, as municipal waste is not incinerated without energy recovery.

Emissions from the waste sector are based on point sources data (reported by operators and are facility-specific) and diffuse sources data. Emissions from point sources are taken from the point sources database. Emissions from diffuse sources are calculated using data from the Estonian Rescue Board, the waste data management system in ESTEA, and activity data collected through surveys.

For emission calculations, 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) are used. In addition, expert judgement is 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	-	--	NO
5C1bi	Industrial waste incineration	Includes point sources emissions from afterburners in industry	Tier 3	NOx, NMVOC, SOx, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, As, Cr,
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	--	--	NO
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

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NFR	Source	Description	Method	Emissions reported
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 emissions of PCBs, HCB, and dioxins. In 2024, PCB emissions accounted for 50.7% of the national total PCB emissions, dioxin emissions accounted for 23.5% of the national total dioxins emissions, and HCB emissions accounted for 23.4% of the national total HCB emissions.

The main sources of PCB and HCB emissions are the open burning of waste (NFR 5C2). In 2024, emissions of PCBs and HCB from the open burning of waste decreased by 79.8% compared to 1990. The main reason for the reduction in PCB and HCB emissions was the decrease in the amount of open burned waste.

The main source of dioxins emissions is car and house fires. In 2024, emissions of dioxins from car and house fires decreased slightly compared to 2023. The main reason for the reduction in dioxin emissions was the decrease in the number of fires.

In 2024, 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 waste sector

Year	NOx	NMVOC	SOx	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	0.02	0.15	0.004	0.37	NR	NR	0.07	NR	0.32
1995	0.03	0.24	0.01	0.32	NR	NR	0.09	NR	0.44
2000	0.04	0.27	0.01	0.28	0.29	0.29	0.30	0.000002	0.48
2005	0.02	0.18	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	0.0000005	0.14
2015	0.02	0.11	0.03	0.22	0.19	0.19	0.20	0.000001	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
2023	0.02	0.13	0.01	0.20	0.11	0.11	0.12	0.000001	0.07
2024	0.02	0.12	0.01	0.19	0.11	0.11	0.11	0.000001	0.07
Change 1990-2024, %	-24.8	-19.3	87.4	-48.5			74.1		-78.8
Change 2023-2024, %	-8.4	-1.9	-37.4	-3.8	-3.0	-1.8	-0.8	0.0	-4.7

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	0.01	0.0004	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
2023	0.003	0.001	0.04	0.001	0.001	0.002	0.0004	0.0002	0.002
2024	0.003	0.001	0.04	0.001	0.001	0.002	0.0005	0.0002	0.002
Change 1990-2024, %	556.3	2083.5	5514.4	96593.6	20974.2	2759.0	12624.0		
Change 2023-2024, %	1.3	-1.7	-1.1	-2.4	-2.4	-2.8	2.0	2.7	2.8

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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
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
2023	1.08	0.002	0.001	0.001	0.002	0.13	0.22
2024	1.05	0.002	0.001	0.001	0.002	0.12	0.21
Change 1990-2024, %	-1.3	-79.8	-79.8	-79.8	-79.8	-60.3	-78.2
Change 2023-2024, %	-3.3	-3.7	-3.7	-3.7	-3.7	-3.9	-3.6

6.1.1. Uncertainty

An uncertainty analysis was carried out to the year 2026 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, 2024	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2024, %
NO_x	0.017	kt	0.10	0.06	0.01
NMVOC	0.124	kt	0.56	0.25	0.08
SO_x	0.007	kt	0.08	0.03	0.00
NH3	0.193	kt	2.01	0.85	0.07
$PM_{2.5}$	0.105	kt	2.35	2.07	0.28
PM_{10}	0.109	kt	1.28	1.09	0.12
TSP	0.115	kt	0.78	0.64	0.04
BC	0.000001	kt	0.0001	0.0001	0.00002
CO	0.068	kt	0.08	0.04	0.01
Pb	0.003	t	0.07	0.03	0.00
Cd	0.001	t	0.19	0.13	0.01
Hg	0.036	t	19.37	6.74	1.04
PCDD	1.049	g I-TEQ	23.54	52.51	21.64
benzo(a) pyrene	0.002	t	0.21	0.42	0.12
benzo(b) fluoranthene	0.001	t	0.10	0.20	0.02
benzo(k) fluoranthene	0.001	t	0.16	0.33	0.10
Indeno	0.002	t	0.22	0.43	0.33
HCB	0.122	kg	23.38	31.45	85.27
PCB	0.210	kg	50.69	70.62	3.51

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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. NMVOCs and particulate matter are emitted from this sector.

In 2024, 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.[34]

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 the 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 deposited biodegradable solid waste at landfills has decreased by 87.3% compared to 1990 due to improved knowledge of recycling and waste reuse.

In 2024, NMVOC emissions from the disposal of solid waste at landfills decreased by 36.8% compared to 1990. Compared to 2023, emissions in 2024 decreased by 2.0%. In 2024, particulate matter emissions increased by 53.6% compared to 2023. This increase is primarily due to the increased recovery of mineral waste.

Table 6.4 Emissions from solid waste disposal on land (including mineral waste recovery)

Year	Amount of deposited and recovered mineral waste, kt	Amount of deposited biodegradable SW in landfills, kt	CH_4 emission into air, kt	NMVOC	$PM_{2.5}$	PM_{10}	TSP
				kt			
1990	10,435.5	356.86	9.78	0.04	NR	NR	0.005
1995	10,744.3	442.63	11.57	0.04	NR	NR	0.005
2000	9,016.3	487.41	19.90	0.07	0.0003	0.002	0.004
2005	13,247.3	280.21	17.52	0.06	0.0004	0.003	0.01
2010	15,005.0	142.83	15.37	0.06	0.0005	0.003	0.01
2015	18,593.0	19.91	8.80	0.03	0.001	0.004	0.01
2020	13,411.0	45.61	6.82	0.02	0.0004	0.003	0.01
2021	16,661.8	47.34	6.85	0.02	0.001	0.004	0.01
2022	19,006.9	29.49	6.59	0.02	0.001	0.004	0.01
2023	13,000.8	28.32	6.30	0.02	0.0004	0.003	0.01
2024	19,974.3	45.38	6.17	0.02	0.001	0.004	0.01

[34] „Greenhouse Gas Emissions in Estonia 1990-2023. National Inventory Report“, Estonia 2023, p 307.

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 amounts of mineral waste deposited in the landfill and 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 amount of CH_4 generated during the biodegradation process of this waste. NMVOC emissions were calculated based on the amount of CH_4 emitted. The amount of CH_4 emitted into 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 obtained from the EERC, which compiles the Estonian GHG inventory. Activity data are presented in Table 6.4.

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 6.5) and anaerobic digestion at biogas facilities (NFR source category 5B2, see Table 6.6).

Composting related activities are mainly reflected in the environmental permits of wastewater treatment plants and landfills. In recent years, the largest share of biodegradable waste generated in Estonia has been sewage sludge. Sewage sludge is mainly treated by composting. In larger wastewater treatment plants, the sludge undergoes an anaerobic digestion process before composting. In 2024, 70.9% of compostable biodegradable waste was sludge.

Compared to 2023, the amount of biodegradable waste increased in 2024. The amount of biodegradable waste composted decreased, while the amount of waste treated through anaerobic digestion increased. In 2024, emissions from composting decreased by 16.4% compared to 2023.

Table 6.5 The amount of organic waste composted and emissions from compost production

Year	Amount of biodegradable waste composted	NMVOC	NH_3
1990	28.28	0.004	0.01
1995	64.41	0.01	0.02
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
2020	181.99	0.03	0.04
2021	171.01	0.03	0.04
2022	172.79	0.03	0.04
2023	157.24	0.02	0.04
2024	131.41	0.02	0.03

Most biogas plants in Estonia are agricultural, where the main raw material for biogas is manure, to which plant substrate (low-quality silage, grain residues, etc.) is added. In 2023, a biogas plant began operating, producing biogas from separately collected biowaste.

In addition, there are industrial companies that produce biogas from production residues and sewage sludge. Larger wastewater treatment plants also produce biogas from sewage sludge. The digested sludge is dewatered and composted. Emissions from sewage sludge handling at wastewater treatment plants are reported under the composting category.

Emissions from biogas production are related to flaring in biogas and biomethane production facilities and to storage of additional substrates on the premises of the agricultural 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 2024, NH_3 emissions from biogas production increased by 169.4% compared to 2023. The increase in emissions was due to an increase in the amount of biodegradable waste used in biogas production. An overview of the types and quantities of waste used for biogas production is provided in Table 6.7.

Table 6.6 Emissions from anaerobic digestion at biogas facilities

Year	NO_x	NMVOC	SO_2	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	NE	NE	NE	NE
2005	NE	NE	NE	NE	NE	NE	NE	NE
2010	0.0004	0.00003	0.0002	NE	NE	NE	NE	0.0004
2015	0.008	0.001	0.005	0.00001	NE	NE	0.00002	0.008
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
2023	0.002	0.0002	0.009	0.0001	0.00002	0.00002	0.00002	0.001
2024	0.001	0.00004	0.004	0.0002	0.000003	0.000003	0.000003	0.0004

6.3.2. Methodological Issues

Data to calculate NH_3 emissions from composting (NFR 5B1) are 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 NH_3 emissions from biogas production (NFR 5B2) are 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 6.7 Anaerobically treated waste in 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
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
2023	0.24	3.74	47.87	NO	4.16	9.68	5.77
2024	0.02	5.97	72.28	0.31	25.15	100.01	NO

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. The calculation includes NH_3 emissions from the storage of feedstock on the premises of the biogas facility. A Tier 2 approach is used. An 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. Dry matter content values were derived from various literature sources—for example, the handbook "Biogaasi tootmine ja kasutamine" (Biogas Production and Use), published by the Estonian Farmers' Federation in 2009.

To avoid double counting of emissions, emissions from handling of digestate are included under the agricultural sector.

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 kinds 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 mixed MSW is incinerated to generate heat and electricity, all emissions occurring in the process are reported in the combustion sector (NFR source category 1A1a).

Industrial waste incineration

In Estonia, industrial waste was incinerated as fuel at the Kunda Nordic Cement plant from 1999 in the production of clinker, which was terminated in 2020. Waste was incinerated with energy recovery and these emissions were reported under the energy sector.

In Estonia, an environmental permit is required for incinerating industrial waste. Facilities that incinerate 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 2021 the amount was 1.12 tonnes. In 2024, industrial waste was not incinerated without energy recovery.

In the Estonian emission inventory, the incineration of industrial waste sector includes emissions from afterburners at facilities. Emissions from fuel combustion alone are not included in the industrial waste incineration sector, as these emissions are already accounted for in the energy sector. Emissions from afterburners are reported under the industrial waste incineration sector unless it can be clearly identified that they originate solely from the combustion of additional fuel. This applies, for example, to activities where emissions were obtained by measurement and it was not possible to distinguish the part of the emissions resulting from the combustion of the fuel from the part of the main production process. In addition, emissions from activities reported under SNAP code 090204 have also been reported in the industrial waste incineration sector. According to the EMEP 2019 guidebook, emissions reported under SNAP code 090204 were taken into account under the industrial waste incineration sector.

All pollutants reported under the industrial waste incineration sector are based on emission data submitted by the facilities to the point source database. Emissions from the industrial waste incineration sector are insignificant compared to national emissions.

Table 6.8 Emissions from industrial waste incineration

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	0.005	0.004	0.01	0.0002	0.000004	0.00001	0.00001	0.0000001	0.01
2015	0.0004	0.0002	0.02	0.0001	0.00002	0.00003	0.00005	0.000001	0.001

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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	0.001	0.0001	0.00004	0.0001	0.00001	0.00002	0.00003	0.000001	0.001
2022	0.001	0.0001	0.0001	0.00002	0.00001	0.00001	0.00002	0.0000002	0.0002
2023	0.001	0.00003	0.00002	0.00001	0.000002	0.000004	0.00001	0.0000001	0.0001
2024	0.001	0.00004	NA	0.00001	0.000003	0.00001	0.00001	0.0000001	0.0001

Hazardous waste and clinical waste incineration

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 at Epler & Lorenz, though between 1990 and 2007, clinical waste was also incinerated at facilities other than Epler & Lorenz. Table 6.9 will provide an overview of emissions from hazardous waste incineration, and Table 6.10 will provide an overview of emissions from clinical waste incineration.

Table 6. 9 Emissions from hazardous waste incineration

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	0.0001	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
2020	4.58	0.02	0.0003	0.01	0.0004	0.001	0.001	0.00001	0.01
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
2023	1.62	0.002	0.0001	0.0005	0.00003	0.0001	0.0001	0.000001	0.001
2024	1.65	0.002	0.0001	0.001	0.00003	0.0001	0.0001	0.000001	0.001

Table 6.9 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
2015	0.002	0.0002	0.0001	0.00003	NE	0.004	0.0003
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
2023	0.002	0.0002	0.0001	0.00003	0.000001	0.000001	0.0002
2024	0.002	0.0002	0.0001	0.00003	0.000001	NA*	0.0002

* Data from the facility (measured); emissions = 0

Table 6.9 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

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Year	PCDD/F	PAHs Total	HCB
	g I-TEQ	t	kg
2015	0.001	0.00004	0.004
2020	0.002	0.00003	0.009
2021	0.001	0.00003	0.003
2022	0.001	0.00004	0.004
2023	0.001	0.00003	0.003
2024	0.001	0.00003	0.003

Table 6.10 Emissions from clinical waste incineration

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	0.00003	NR	0.00002
1995	0.01	0.00002	0.00001	0.00001	NR	NR	0.00003	NR	0.00002
2000	0.02	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.0000004	0.00001
2005	0.02	0.00002	0.00001	0.00001	0.00001	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
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
2023	0.58	IE	IE	IE	IE	IE	IE	IE	IE
2024	0.55	IE	IE	IE	IE	IE	IE	IE	IE

Table 6.10 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni
	t						
1990	0.0004	0.00004	0.001	0.000001	0.000005	0.0001	0.000004
1995	0.0004	0.00003	0.001	0.000001	0.000004	0.0001	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	0.0001	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
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
2023	0.0001	0.00002	0.02	0.0001	0.00003	IE	0.00002
2024	0.00005	0.00002	0.02	0.0001	0.00003	IE	0.00002

Table 6.10 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
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
2023	0.001	0.00000002	0.06	0.01
2024	0.001	0.00000002	0.06	0.01

Cremation

The first crematorium was established in Estonia in 1993. By 2024, there were 9 crematoriums. In 1993, there were only 39 cremations. By 2024, the number of cremations had increased to over 11,500, accounting for approximately 73% of all deaths in that year. Calculated emissions from cremation are presented in Table 6.11.

Table 6.11 Pollutants emissions from cremation

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
2020	10034	0.01	0.0001	0.001	0.0003	0.0003	0.0004	0.001
2021	12028	0.01	0.0002	0.001	0.0004	0.0004	0.0005	0.002
2022	11660	0.01	0.0002	0.001	0.0004	0.0004	0.0005	0.002
2023	11281	0.01	0.0001	0.001	0.0004	0.0004	0.0004	0.002
2024	11592	0.01	0.0002	0.001	0.0004	0.0004	0.0004	0.002

Table 6.11 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
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	0.0004	0.0001	0.02	0.0002	0.0002	0.0001	0.0002	0.0002	0.002
2023	0.0003	0.0001	0.02	0.0002	0.0002	0.0001	0.0002	0.0002	0.002
2024	0.0003	0.0001	0.02	0.0002	0.0002	0.0001	0.0002	0.0002	0.002

Table 6.11 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	0.0000001	0.0000001	0.001	0.003
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
2023	0.0003	0.0000001	0.0000001	0.0000001	0.0000001	0.002	0.005
2024	0.0003	0.0000002	0.0000001	0.0000001	0.0000001	0.002	0.005

Open burning of waste

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. It is assumed that waste burned in piles, barrels or domestic fireplaces is not burned for disposal purposes but occurs as part of habitual household practices. 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 of 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. Table 6.12 provides an overview of emissions from domestic waste burning.

Table 6.12 Pollutants emissions from domestic waste burning

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	0.04	0.04	0.04	0.20
2010	0.01	0.04	0.001	0.02	0.02	0.02	0.12
2015	0.005	0.02	0.001	0.01	0.01	0.01	0.07
2020	0.01	0.03	0.001	0.01	0.01	0.01	0.07
2021	0.01	0.03	0.001	0.01	0.01	0.01	0.07
2022	0.005	0.02	0.001	0.01	0.01	0.01	0.07
2023	0.005	0.02	0.001	0.01	0.01	0.01	0.07
2024	0.005	0.02	0.001	0.01	0.01	0.01	0.06

Table 6.12 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
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
2023	0.12	0.002	0.001	0.001	0.002	0.06	0.20
2024	0.12	0.002	0.001	0.001	0.002	0.06	0.19

6.4.2. Methodological Issues

Industrial waste incineration

Emissions from industrial waste incineration are based on data from facilities. All pollutants reported under the industrial waste incineration sector are based on emission data submitted by the facilities to the point source database.

Hazardous waste and clinical waste incineration

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 6.13. 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 were not available. Therefore, the amount of incinerated waste was calculated on the basis of population data and the amount of waste per capita in 1996.

Table 6.13 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
$PM_{2.5}$	% 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 at 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 from 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, a 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 the emissions calculations.

Table 6.14 Emission factors for clinical 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

Pollutant	Unit	Value Tier 2 (Other)	Value Tier 1 (Epler & Lorenz)
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 the hazardous waste incineration facility was modernised and classified as class 4 according to the UNEP classification.

- Hazardous waste (Epler & Lorenz):

1991-2006 - 10 µg/Mg waste;
2007-2024 – 0.75 µg/Mg waste.

- Clinical waste (Epler & Lorenz)

1991-2006 - 525 µg/Mg waste;
2007-2024 - 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 were not available. Therefore, the amount of incinerated waste was calculated on the basis of population data and the amount of waste per capita in 1996.

Open burning of waste

The pollutant emissions from open domestic waste burning are calculated based on an expert judgement about the amount of burned waste. A 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 6.15 Amount of domestic waste burned (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
2020	337.91	1.69
2021	336.86	1.68
2022	332.49	1.66
2023	320.28	1.60
2024	308.29	1.54

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.

Table 6.16 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
I(1,2,3-cd)p	mg/Mg waste	1,27
HCB	g/Mg waste	0,04
PCB	mg/Mg waste	126

Cremation

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. The number of cremations is obtained through questionnaires sent to crematoriums. These questionnaires are not sent every year, but rather every three years. The questionnaire also requests clarification of cremation figures for previous years. In the years between questionnaires, the number of cremations is estimated based on the figures from the previous years, as well as the total number of deaths. The latest questionnaire was sent to crematoriums in 2025.

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

No major improvements are planned for the next submission.

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 and NH_3 occur from waste water treatment plants, but are largely insignificant in terms of total national emissions.

The share of the population connected to the public sewerage system has remained stable at over 80%. In 2024, the proportion of the population connected to the public sewerage system was 84%.

By 2024, NMVOC emissions from residential/commercial wastewater handling had decreased by 54% compared to 2005. Compared to 2023, NMVOC emissions decreased by 15.1%. This trend reflects the decrease in wastewater generation and water use in Estonia over the years.

The most common wastewater treatment method in Estonia is centralised aerobic wastewater treatment. Septic systems are also emptied into centralised 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 has decreased over time. Dry toilets are the main source of NH_3 in the residential/commercial wastewater handling sector. By 2024, NH_3 emissions from residential/commercial wastewater handling had decreased by 56.8% compared to 1990. Compared to 2023, NH_3 emissions decreased by 1%.

Table 6.17 Emissions from domestic wastewater handling

Year	Wastewater handled	Number of dry toilet user	NO_x	NMVOC	SO_x	NH_3
	thousand m^3	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	0.0001	0.18
2015	1 641 669	107	0.0001	0.02	0.0001	0.17
2020	923 137	100	0.0001	0.01	0.0001	0.16
2021	1 067 579	100	0.0001	0.02	0.0001	0.16
2022	1 261 337	98	NA	0.02	NA	0.16
2023	876 603	98	NA	0.01	NA	0.16
2024	744 682	97	NA	0.01	NA	0.16

Emissions from industrial wastewater treatment are reported by facilities in their annual ambient air reports. In 2024, 11 industrial facilities reported pollutant emissions from processes related to wastewater treatment.

Table 6.18 Emissions from industrial wastewater handling (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
2020	0.0003	0.01	0.0001	0.001
2021	0.0003	0.001	0.0001	0.001
2022	NA	0.004	NA	0.002
2023	NA	0.004	NA	0.002

Year	NO_x	NMVOC	SO_x	NH_3
2024	NA	0.01	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 are 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 were 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 number 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[35].

Table 6.19 Dry toilets in settlements, %

Year	Dry toiletsin in low population settlements %	Dry toilets in high population settlements %
1990	25.7	9.9
1995	24.4	8.6
2000	23.1	7.4
2005	21.4	5.7
2010	20.1	3.7
2015	19.4	3.4
2020	17.8	3.1
2021	17.5	3.2
2022	17.2	3.2
2023	16.9	3.0
2024	16.6	2.9

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 air emission reports. It is assumed that NMVOC emissions from diffuse sources related to 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.

[35] Greenhouse Gas Emissions in Estonia 1990-2023. National Inventory Report", Estonia 2025, p 327.

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 (5 operators in 2024). 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 pollutants, except for NMVOC, in this sector have decreased compared to 2023. The reduction in emissions is primarily due to a decrease in unwanted building and car fires in 2024. The slight increase in NMVOC emissions was primarily due to the treatment of hazardous waste at a waste management facility.

Pollutants emissions are presented in Table 6.20.

Table 6.20 Emissions from other waste

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	0.0005
2015	0.0004	0.003	NE	0.0002	0.18	0.18	0.18	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
2023	NE	0.04	NE	0.0003	0.10	0.10	0.10	NE
2024	NE	0.04	NE	0.0002	0.09	0.09	0.09	NE

Table 6.20 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
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
2023	0.0003	0.001	0.001	0.001	0.001	0.002
2024	0.0003	0.001	0.001	0.001	0.001	0.002

Table 6.20 continues

Year	PCDD/F
	g I-TEQ
1990	NE
1995	NE
2000	2.01
2005	1.71
2010	1.00

Year	PCDD/F
	g I-TEQ
2015	1.77
2020	1.08
2021	1.07
2022	1.06
2023	0.96
2024	0.93

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 air emission 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 6.21). 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. This allows building fires to be more accurately grouped into the correct categories. Since 2015, the building fire statistics include all building fires.

Table 6.21 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

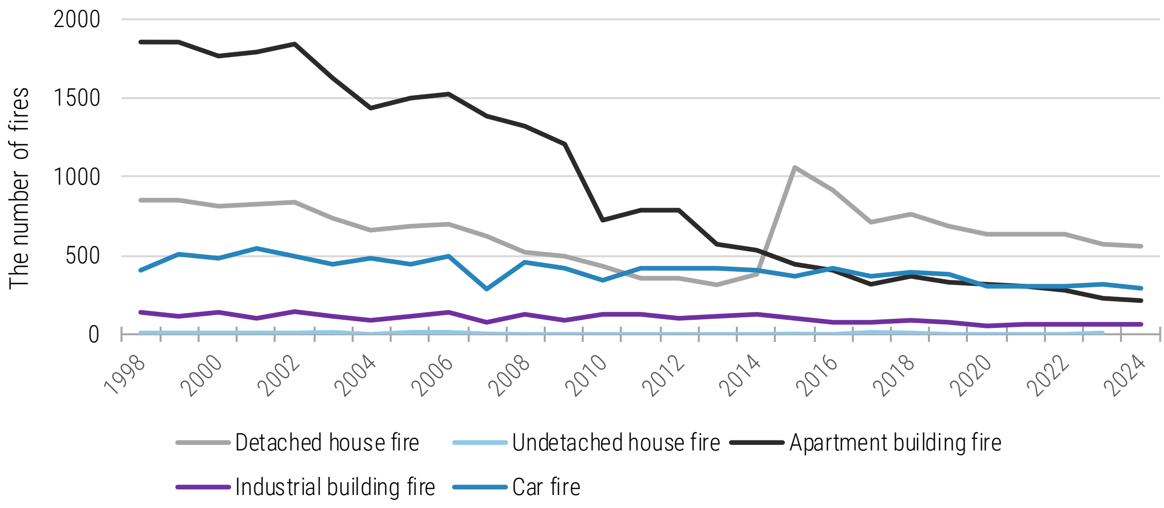

Figure 6.1 The number of fires according to the Estonian Rescue Board in the period of 1998-2024

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)

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 show that there is a tendency for forest fires to occur depending on weather conditions - in years with the highest air temperatures and the least amount of precipitation, the greatest number of fires are observed.

Table 7.2 Pollutant emissions from forest fires

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	NR	NR	0.409	NR	0.582
1995	0.019	0.056	0.004	0.004	NR	NR	0.401	NR	0.558
2000	0.068	0.205	0.014	0.014	0.830	1.015	1.568	0.075	2.051
2005	0.009	0.026	0.002	0.002	0.106	0.130	0.200	0.010	0.260
2010	0.002	0.007	0.000	0.000	0.032	0.040	0.061	0.003	0.074
2015	0.008	0.025	0.002	0.002	0.114	0.139	0.215	0.010	0.249
2020	0.012	0.036	0.002	0.002	0.160	0.195	0.302	0.014	0.357
2021	0.003	0.010	0.001	0.001	0.043	0.052	0.081	0.004	0.098
2022	0.002	0.005	0.000	0.000	0.023	0.028	0.043	0.002	0.053
2023	0.009	0.028	0.002	0.002	0.122	0.149	0.231	0.011	0.282
2024	0.002	0.005	0.0003	0.0003	0.021	0.025	0.039	0.002	0.049
Trend 1990-2024, %	-91.6	-91.6	-91.6	-91.6			-90.37		-91.6
Change 2023-2024, %	-82.7	-82.7	-82.7	-82.7	-82.9	-82.9	-82.9	-82.9	-82.9

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Table 7.2 continues

Year	PCDD/F, g	PCB, kg
1990	0.024	0.003
1995	0.024	0.002
2000	0.092	0.009
2005	0.012	0.001
2010	0.004	0.0004
2015	0.013	0.001
2020	0.018	0.0018
2021	0.005	0.0005
2022	0.003	0.0003
2023	0.014	0.001
2024	0.002	0.0002
Change 1990-2024, %	-90.4	-90.4
Change 2023-2024, %	-82.9	-82.9

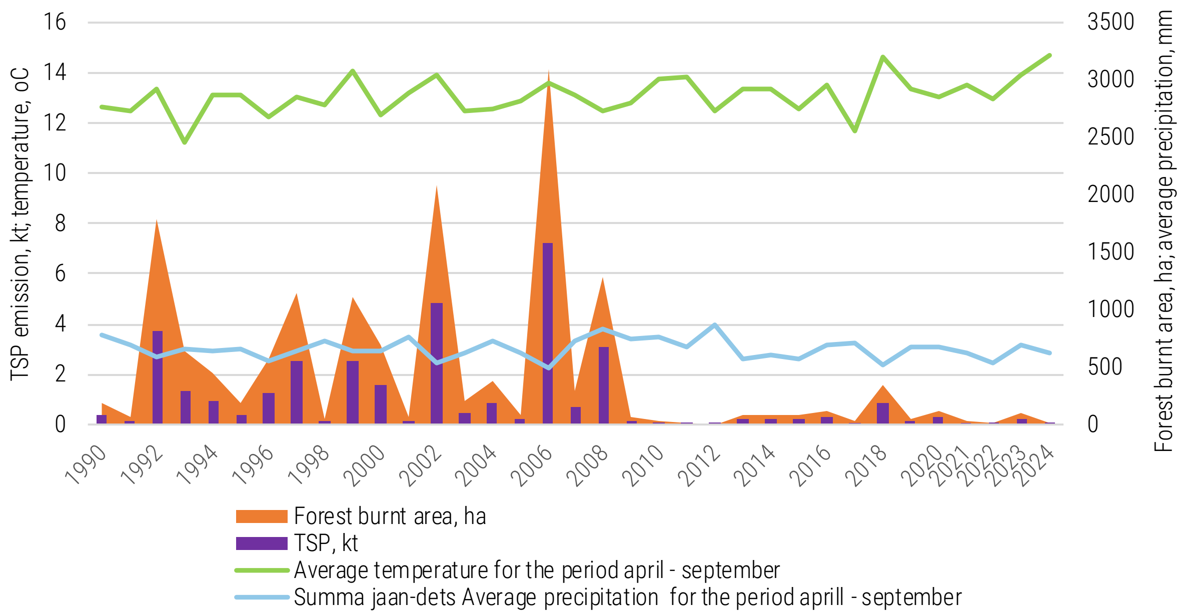

Figure 7.1 Forest burnt area, particulates emission, average temperature and precipitation

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 1999–2024, 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.). 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.

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.

Compared to 2023, the area of burned forest i decreased by about 6 times in 2024, which was accompanied by a decrease in emissions (Table 7.2).

Emissions of NO_x, NMVOC, SO_x, NH_3 and CO are calculated using EMEP/EEA 2023 Guidance Level 1 emission factors (see Table 7.3) and data on forest burning area from the Forestry Department of the Environment Agency. Emissions of particulate matter are calculated using EMEP/EEA 2023 Guidance Level 1 emission factors and biomass burned.

The 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

Year	Forest burnt area	Burnt biomass
	ha	t
1990	194.0	24,064.8
1995	185.9	23,560.8
2000	683.8	92,261.4
2005	86.5	11,784.2
2010	24.8	3,601.4
2015	83.1	12,622.7
2020	119.1	17,772.0
2021	32.5	4,770.9
2022	17.62	2,554.5
2023	94.2	13,581.2
2024	16.33	2,317.9

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.

Table 7.5 NMVOC emission from other natural sources (kt)

Year	NMVOC
1990	35.438
1995	34.730
2000	39.621
2005	38.348
2010	37.313
2015	39.859
2020	41.185
2021	40.730
2022	40.522
2023	40.522
2024	40.522
Change 2023-2024, %	-0.5
Change 1990-2024, %	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[36] per vegetation type;

[36] Emission potential at 30 °C and PAR (photosynthetically active radiation) = 1,000 μmol.$m^{-2}.s^{-1}$

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).

Statistics on agricultural lands obtained from Statistics Estonia contain information on crop fields and cereal field area for the years 1990-2023. These data were used for calculating the total emission. Information on permanent grasslands is available for the years 2005-2024. There is no information in the statistical database for the years 1990-2000.

Table 7.7 Activity data used for NMVOC emission calculation, 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
2020	668.5	376.2	629.5	133.5	84.4	195.7	32.7

Year	Pine-woods	Spruce-woods	Birch-woods	Aspen-woods	Alder-woods	Grey alder-woods	Other stands
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
2023	658.3	361.5	627.9	132.8	86	211.6	33.1
2024	658.3	361.5	627.9	132.8	86	211.6	33.1

Table 7.8 Activity data used for NMVOC emission calculation, 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
2023	350.38	192.30
2024	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

8.1. Recalculations

The latest recalculations in the emission inventory were done for the time period from 1990 to 2023. The main objective of recalculation is to improve the emissions inventory and the quality of reports.

The differences in emissions between the 2025 and 2026 submissions are presented in Annex IV.

8.1.1. Energy Sector (NFR 1)

8.1.1.1. Energy industries

The 2026 submission include the following corrections to previously reported data for the Energy sector.

1A1c Manufacture of solid fuels and other energy industries

Emissions of NO_x, NMVOC, TSP and CO for 2023 were revised due to the erroneous inclusion of emissions not related to this sector in the 2025 submission. At the same time, emissions of these substances were already included in NFR 1A2gviii.

1A4bi Residential: Stationary

Minor changes to 2023 emissions due to corrections in data on the use of liquid and solid fuels.

8.1.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2025 and 2026 are made by using exact calculation numbers, but it is not relevant this year due to the fact that diesel amount in the 2026 submission was same as in 2025 submission.

1A3b Road transport (1A3bi-vii)

All emissions from the road transport have been recalculated for the period between 1990-2023. Recalculations entailed the adopting of a new and improved edition (version 5.9.2) of the COPERT 5 programme for emissions calculations.

1A3c Railway sector

An expert mistake was found and corrected in railways sector. The error concerned the coefficient used; the fuel amount was not changed and the resulting differences were marginal.

8.1.1.3. Fugitive emissions

1B1c Other fugitive emissions from solid fuels

Minor changes to 2023 emissions due to corrections in oil shale mining data.

8.1.2. Industry Sector (NFR 2)

8.1.2.1. Industrial Processes

The 2026 submission include the following corrections to previously reported data for the industry sector.

2H2 Food and beverages industry

Corrections were made to the 2023 data on SO_2 and NH_3 emissions due to a typographical error made during data entry in the 2025 submission.

2C1 Iron and steel production

The typographical error in the 2020 data related to PCDD emissions has been corrected.

2C3 Aluminium production

Corrections were made to the 2023 data on $PM_{2.5}$, PM_{10}, TSP, PCDD and HCB emissions and activity data due to a typographical error made during data entry in the 2025 submission.

8.1.2.2. Solvent and Other Product Use

There were no recalculations in the solvent and other product use sector due to methodological changes in the 2026 submission. The recalculations were mainly due to corrections in the statistical activity data and to the correction of inaccuracies in the expert calculations.

2D3a Domestic solvent use including fungicides

NMVOC emissions for 2022 and 2023 were recalculated due to corrections in statistical activity data; the impact on emissions was negligible (up to 0.07%).

2D3d Coating applications

Recalculations for NFR 2D3d for the years 2020–2023 were mainly due to an expert calculation error. Some of the chemicals used under SNAP code 060105 had inadvertently not been included in the emission estimates. In addition, corrections were made for the years 2022 and 2023 to the classification of chemicals reported by companies in their annual reports. Despite these adjustments, the impact on NMVOC emissions was negligible, remaining below 0.15%.

2D3g Chemical products

Recalculations were made because NMVOC emissions from one company under SNAP code 060304 were not included in the 2023 emissions. The emissions were missing from the company’s annual air emissions report. During a review of the company’s annual reports, the error was identified, and the missing emissions were included in the 2026 submission.

As a result, NMVOC emissions in NFR category 2D3g changed by 31.7% compared to the 2025 submission. Since NFR 2D3g represents only a minor share of total national NMVOC emissions, the impact of this correction on the total national emissions is negligible.

2G Other product use

In NFR 2G, recalculations of NMVOC and heavy metal emissions were carried out due to updated data from the transport sector, which affected lubricant consumption and the related emissions. Compared to the

2025 submission, the revisions resulted in changes of up to 10.6%. CO emissions were also corrected due to rounding adjustments.

8.1.3. Agriculture Sector (NFR 4)

8.1.3.1. Manure Management

3B1b Cattle non-dairy

Compared to the previous submission, only the share of manure from grazing cattle, calculated based on movement data for this cattle group from the Agricultural Registers and Information Board (ARIB) database, was updated. For the remaining cattle categories, these improvements had already been implemented in the previous year; however, as the data were received very late, it was not possible to update the entire dataset at that time.

8.1.3.2. Agricultural Soils

3Da1 Synthetic N-fertilizers

Recalculations were carried out in response to questions raised during the review process, incorporating the following methodological changes, which are described in more detail in Chapter 5.3.2:

- Revision of the emission factor for other fertilisers (0.0539 kgNH_3/kg N for other fertiliser instead of 0.07 kgNH_3/kg N for other fertiliser);
- The abatement efficiency of fertiliser ploughing has also been updated based on additional analysis carried out in response to review questions;
- Differentiation of ammonium-based fertilisers in the calculation of the impact of emission reduction measures.

3Da2a Animal manure applied to soils and urine and dung deposited by grazing animals

Compared to the previous submission, NO_x and NH_3 emissions from animal manure applied to soils, as well as from urine and dung deposited by grazing animals, have been recalculated for the reasons described in the previous chapter.

3Da2c Other organic fertilisers applied to soils

Emissions for 2022–2023 have been recalculated due to updated input data.

3Dc Farm-level agricultural operations including storage, handling and transport of agricultural products

Emissions of particles from farm activities have been recalculated due to an error in the previous calculations.

3De Cultivated crops

The 2004 emission value has been corrected due to a data entry error.

8.1.4. Waste Sector (NFR 5)

There were no recalculations in the waste sector due to methodological changes in the 2026 submission. The recalculations were mainly due to corrections in the activity data.

5A Solid waste disposal on land

Compared to the previous submission, recalculations were carried out in sector 5A due to the implementation of the refinement of the waste model used in the compilation of the greenhouse gas inventory. The update introduced revised default values for parameters used in the calculations. As a result of corrections, CH_4 emissions were revised, which consequently affected NMVOC emissions. These changes impacted the entire time series.

5C1a Municipal waste incineration

During the 2025 Review, the TERT recommended that the notification key should be NO when waste is incinerated with energy recovery. As municipal waste is incinerated with energy recovery, the notation key for all pollutants was changed from IE to NO for the years 2013–2023.

5C1biv Sewage sludge incineration

During the 2025 Review, the TERT recommended that the notation key should be NO when waste is incinerated with energy recovery. Based on the available information, sewage sludge has not been incinerated without energy recovery. This conclusion is based on an analysis of the annual environmental reports submitted by operators. Therefore, the notation key for all pollutants was changed from NA to NO for the years 1990–2023.

5C1bv Cremation

Recalculations of pollutant emissions were carried out due to corrections in statistical activity data. In 2025, crematoria in Estonia were contacted and asked to provide data on cremations for the years 2021–2024. Based on the data received, recalculations of pollutant emissions were carried out for the years 2021–2023. Compared to the 2025 submission, the revisions resulted in changes of up to 7.0%.

In addition, emissions of Ni for the year 2003, Zn for the year 2008, and BaP and total PAHs for the year 2017 were corrected due to an expert calculation error. The impact on emissions was negligible.

8.2. Planned improvements

All planned changes are described in the sectorial chapters.

8.3. Status of implementation of ERTs in-depth review recommendations

Source: http://lofciam.pl

9.PROJECTIONS

9.1. Description of general methods, data sources and assumptions

Ministry of Climate (MoC) 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[37], 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. One projection scenario 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 2022 used in projections is consistent with Estonia's 2024 submission to the CLRTAP on 15th of March 2024 (Estonian Informative Inventory Report 1990–2022).

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

The following chapter includes policies and measures for electricity supply, heat supply, energy consumption – commercial/institutional and residential sectors and energy consumption – and manufacturing industries. In the energy sector air pollutants are mainly reduced through policies and measures that support achieving higher energy efficiency as well as shifting to zero or low emission alternative fuel use (including technology).

The Government of Estonia approved the **Estonian Energy Development Plan until 2030** (ENMAK 2030) in 2017.[38] The current ENMAK 2030 aims to consume renewable energy in a volume that would be at least 50% of the final energy consumption by 2030 (~16 TWh).

[37] 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)

[38] Estonian Energy Development Plan until 2030 (2017). [www] https://kliimaministeerium.ee/sites/default/files/documents/2023-07/Energiamajanduse%20arengukava%20aastani%202030.pdf (09.12.2024)

Since the European Union is increasing its renewable energy targets, Estonia has taken a major step towards more ambitious targets in 2022 with an amendment to the **Energy Sector Organisation Act (2016)**[39], according to which by 2030 renewable energy must be at least 100% of gross final consumption of electricity. Thus, the production of electricity from oil shale will gradually decrease at the same time as ensuring that there is a certain degree of controllable generation capacity. Also, by 2030, renewable energy must account for at least 65% (~20.4 TWh) of national gross final energy consumption.

The objectives of the sectors set out in the Energy Sector Organisation Act by 2030 are as follows:

- **electricity**: at least 100% renewable energy in gross final consumption of electricity;
- **transport:** renewable energy used in road and rail transport accounts for at least 14% of total energy consumed in transport;
- **heat**: at least 63% renewable energy in gross final consumption of heat.

The Government of Estonia is currently updating the ENMAK 2030. The renewed **Energy Development Plan until 2035**[40] aims to update the trends, goals and activities of the energy economy included in the ENMAK 2030. It will also include the development vision, goals, bottlenecks and policy instruments of the Estonian energy economy in moving towards climate-neutral energy production and consumption and ensuring energy security. The planned approval of the renewed Energy Development Plan until 2035 is set for the year 2025.

9.2.1.1. Electricity supply

The Electricity Market Act (2005)[41] governs the generation, storage, 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, meets environmental requirements and the needs of consumers, and the utilization of energy sources in a balanced manner, in an environmentally clean way and with a long-term perspective. The act states that electricity undertakings shall always facilitate activities performed by consumers for the purpose of conserving electricity. Pursuant to §59 of the Electricity Market Act, support is paid to the electricity producer in order to meet the 2030 goal of electricity production from renewable energy sources (100%).

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 that affect the reduction of air pollutants the most are connected to the Electricity Market Act. From its support more renewable and efficient CHP-based electricity production have been introduced. In addition, the act helps to increase the share of solar and wind power in electricity production.

[39] Energy Sector Organisation Act (2016). [www] https://www.riigiteataja.ee/en/eli/517112024001/consolide (09.12.2024)
[40] Ministry of Climate. Energiamajanduse arengukava (ENMAK). [www] https://kliimaministeerium.ee/energiamajanduse_arengukava (09.12.2024)
[41] Electricity Market Act (2005). [www] https://www.riigiteataja.ee/en/eli/ee/528082014005/consolide/current (09.12.2024)

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In addition to the WEM scenario measures, there are measures, which directly or indirectly help implement the WEM scenario measures. To support achieving those goals, measures like investment in a compensation measure in Northeast Estonia, acquisition of air surveillance radars, preliminary development of offshore wind farm, green procurements and reinforcement of the electricity grid will help more renewable energy to be introduced to the Estonian electricity system.

9.2.1.2. Renewable energy

Estonia's renewable energy trajectory derives from national renewable energy targets that are more ambitious than the targets set in the Directives ((EU) 2018/2001 and (EU) 2018/1999) agreed at European Union level, with an overall EU target of 42.5% + a possible 2.5% and a domestic target of 65%, including Estonia's renewable energy trajectory in line with milestones (at least 18% of the overall target in 2022, at least 43% of the overall target by 2025 and at least 65% of the overall target by 2027).

To support achieving this goal, measures like encouraging biomethane production, deployment of hydrogen technologies, accelerating the introduction of renewable electricity and a green fond are being implemented.

9.2.1.3. Heat supply

The District Heating Act (2003)[42] governs activities related to the production, distribution and sale of heat by way of district heating networks and connection to district heating networks.

In the past few years, a continuous transition to renewable sources has been happening in the heating sector. More and more boiler houses and cogeneration plants have switched to renewable fuels, and according to 2023 data, the share of renewable energy and waste heat in district heating was about 75%[43], of which 93% have received the label of efficient district heating.

Heat supply WEM scenario measures, which have the largest effect on air pollutant reduction, are connected to renovation of depreciated and inefficient heat pipelines, renovation of district heating boilers and fuel change and fuel oil boiler replacement with heating system renovation in households.

9.2.1.4. Energy use in buildings

The housing and energy sector are very closely related, as the energy demand of buildings is an important part of Estonia's energy balance. In 2022, the energy consumption of buildings in Estonia made up 53%[44] of the total energy balance and therefore improvement of energy efficiency in the residential and tertiary sectors has an important role from the emissions reduction aspect.

In Estonia, policies implemented to improve energy efficiency increasingly lead to the adoption of energy-efficient buildings and the renovation of buildings to be more energy-efficient to reduce energy dependence and air pollutant emissions of the housing sector. Renewable energy (including heat pumps) solutions must be applied in making buildings more energy efficient, where possible and be based on the aspect of cost effectiveness.

[42] District Heating Act (2003). [www] https://www.riigiteataja.ee/en/eli/ee/520062017016/consolide/current (09.12.2024)
[43] Energiatalgud. Eesti üleminek süsinikuneutraalsele soojus- ning jahutusmajandusele aastaks 2050. [www] https://energiatalgud.ee/node/8931 (09.12.2024)
[44] Riigikantselei. Hoone indikatiivse energiatõhususe klassi reaalajas määramine ning energiatõhususearvu järelevalve automatiseerimine. [www] https://riigikantselei.ee/hoone-indikatiivse-energiatohususe-klassi-reaalajas-maaramine-ning-energiatohususearvu-jarelevalve (13.12.2024)

Here, the impact of EU Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (EPBD)[45] should be highlighted as these set minimum energy efficiency requirements for buildings, which set total energy consumption limits for the building. 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. The **Building Code (2015)**[46] promotes sustainable development and ensures the safety, purposeful functionality and usability of the built environment, which is supported by the **Minimum building energy efficiency requirements regulation (2019)**[47].

In 2020, the government approved a **long-term reconstruction strategy (REKS)**[48], the main goal of which is to completely renovate all buildings built before 2000 in Estonia by 2050. The strategy presents a long-term vision for the reconstruction of buildings and describes the activities and their scope necessary to achieve the goal. Based on this, Estonia is planning and developing necessary support measures for the building sector.

9.2.1.5. Energy efficency

Energy Sector Organisation Act (2017)[39] provides 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.

The Product Conformity Act (2010)[49] 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, energy performance labels and ecological design requirements.

Energy efficiency WEM scenario measures (additionally to the ones concentrating on building reconstruction presented in previous sections), which have the largest effect on air pollutants reduction, are connected to decreasing energy consumption in industries, exchanging old lighting for LED lighting in street lighting and public spaces.

In addition, there are measures and programmes, which directly or indirectly help implement the WEM scenario measures. These measures for example are support for energy- and resource audits in industries, energy storage pilot program, adoption of resource-efficient green technologies, energy taxes to support the continuity of local production and the change of business models, so that the products of Estonian production companies meet the goals of environmental and climate neutrality and are competitive in export markets.

[45] Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings. [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275&pk_keyword=Energy&pk_content=Directive (09.12.2024)
[46] Building Code (2015). [www] https://www.riigiteataja.ee/en/eli/ee/510102024002/consolide/current (09.12.2024)
[47] Minimum building energy efficiency requirements regulation (2019). [www] https://www.riigiteataja.ee/akt/105072023309?leiaKehtiv (09.12.2024)
[48] Ministry of Climate (2020). Long-term reconstruction strategy. [www] https://kliimaministeerium.ee/sites/default/files/documents/2023-06/Hoonete%20rekonstrueerimise%20pikaajaline%20strateegia.pdf (09.12.2024)
[49] Product Conformity Act (2010). [www] https://www.riigiteataja.ee/en/eli/ee/515042021005/consolide/current (09.12.2024)

9.2.1.6. Methodolody

The scenario projecting air pollutant emissions in the Energy sector (without Transport) is mainly based on the measures of the Ministry of Climate, which are funded through, Environmental Investment Centre and the State Shared Service Center (e.g. funding from the Recovery and Resilience Facility as well as revenues from the EU ETS). In addition, the scenario was updated based on certain inputs on parameters received from the Ministry of Climate and industries (incl. planned renewable energy capacities, use of various fuels etc.). Also, future EU ETS allowance price and GDP growth were considered. The air pollution reduction impact of the measures are mainly calculated through their energy saving or fuel exchange that they initiate.

The main assumption for electricity supply in the WEM scenario is that step-by-step, the use of oil shale shall decrease to produce electricity and increase to produce shale oil. The retort gas that occurs as a side product during the production of shale oil is used for electricity production. Information about the amounts of oil shale used in the shale oil industry and the amounts of retort gas produced is an input from the oil shale industry.

Electricity generation from wind and solar also substantially increases based on the input from the MoC. The projected future usage of fuels through the impact of the measures is applied for the calculations while using the emission calculations of the EMEP/EEA 2023 Guidebook.

The projections for heat supply in the WEM scenario are based on the renovation rate of buildings, boilers and heat pipes. The projections also consider the building rate of new and dropout rate of old buildings.

9.2.1.7. AP emissions projections

The Energy sector (excluding transport) includes air pollutant 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 and construction; Other sectors, including Commercial/institutional (buildings), Residential (buildings), Agriculture/Forestry/Fishing/Fish farms (excluding mobile machinery, e.g. tractors, harvesters etc.) and Fugitive emissions from natural gas/oil 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 53.1%, SO_2 by 72.6%, NMVOC by 63.2%, $PM_{2.5}$ by 69.2% and NH_3 by 66.9% 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) 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.

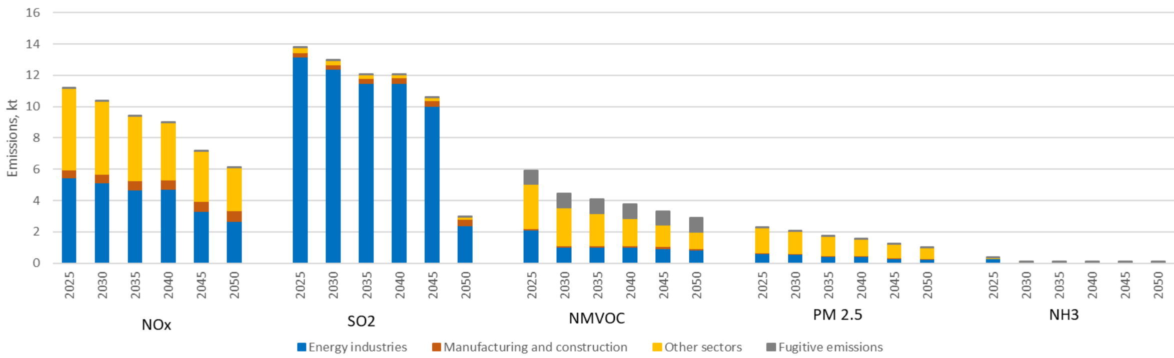

Figure 9.1 Total projected WEM scenario air pollutant emissions from Energy sector, kt

9.2.2. Transport

The main strategic development document for the transport sector in Estonia is the Transport and Mobility Development Plan 2021–2035[50] , which focus is to reduce the environmental footprint of the transport means and system to contribute to the achievement of climate and air pollutant goals. 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 (now the Ministry of Climate) also commissioned a report from the International Transport Forum (ITF) "The Future of Passenger Mobility and Goods Transport in Estonia" (2020)[51], 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 air pollutant emissions are mainly reduced through policies and measures that can be divided widely in four by supporting: 1) reduction of forced movements and transport needs; 2) the availability of sustainable modes of movement; 3) increase in the share of energy efficient vehicles and; 4) increase in the proportion of fuels with lower emissions.

The Liquid Fuel Act (2003)[52] provides the principles 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. According to §21 of the Act 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, by the seller of fuel or by a person holding an authorization for the import of fuel, must include, as a total energy content of biofuels – or of biomethane, hydrogen 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.

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[50] Ministry of Climate (2021). Transport and mobility development plan 2021–2035. [www] https://kliimaministeerium.ee/sites/default/files/documents/2023-09/Transpordi%20ja%20liikuvuse%20arengukava%202021-2035_EN%20%281%29.pdf (09.12.2024)

[51] International Transport Forum (2020). The Future of Passenger Mobility and Goods Transport in Estonia. [www] https://www.oecd.org/en/publications/the-future-of-passenger-mobility-and-goods-transport-in-estonia_9db7333e-en.html (09.12.2024)

[52] Liquid Fuel Act (2003). [www] https://www.riigiteataja.ee/en/eli/ee/531032014004/consolide/current (09.12.2024)

As road transport emits the biggest share of air pollutants in the Transport sector, a lot of measures focus on decreasing the air pollutant impact from road transport. The transport sector WEM scenario measures, which have the largest effect on air pollutant reduction, are connected to increasing the share of biofuels (including electricity) in private and public transport, increasing the number of departures of the public transport, modal shift but also decreasing travel time to decrease the usage of personal cars.

Although a lot of measures focus on decreasing the air pollutant impact from road transport, there are also measures being implemented that are directed towards railroad and domestic navigation. The focus in railroad is electrification and in domestic navigation replacing ferries, which run on diesel for alternative fuel (electricity/hydrogen) ferries.

9.2.2.1.Methodology

Projections of air pollutants emissions have been calculated for the period of 2023–2050. The reference year 2022 used in projections is consistent with Estonia's 2024 submission to the CLRTAP on 15th of March 2024 (Estonian Informative Inventory Report 1990–2022). One projection scenario is presented – the WEM scenario evaluates future air pollutant emission trends under the current policies and measures.

Sybil baseline model[53] is used for the air pollutant projections in the road transport sector. The model uses a bottom-up approach requiring data about the vehicle fleet, technology (EURO class) and road activity. The biggest strength of the model is that it is compatible with COPERT model[54], which is used for the compilation of road transport emission estimates in the national inventory report and kept up to date by EMISIA, the same team as for COPERT. 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 and parameters from the ITF report "The Future of Passenger Mobility and Goods Transport in Estonia", the TalTech report "Traffic survey manual and the business as usual forecast"[55] and the Ministry of Climate.

For instance, rail diesel projected consumption is based on five-year historical values (2018–2022). Changes in national aviation traffic are derived from the EUROCONTROL Aviation Outlook 2050[56], while maritime traffic adjustments are referenced from the 2024 IIR report. CO_2 emission metrics, such as those for new passenger vehicles (in gCO_2/km) and heavy trucks (as a percentage compared to 2019), are sourced from EU regulations. Additionally, data on vehicle purchases, categorized into new and used cars or trucks, is provided by AMTEL (Association of Estonian Car Sales and Service Companies)[57]. This comprehensive parameter selection ensures a robust foundation for the evaluation, leveraging reliable and diverse sources to guide the projections.

To estimate air pollutant emissions, emission factor data from EMEP/EEA 2023 Guidebook along with country-specific emission factors are used.

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[53] Sybil baseline model. [www] https://copert.emisia.com/sibyl-baseline/ (06.12.2024)
[54] COPERT model. [www] https://copert.emisia.com/ (06.12.2024)
[55] Kaal, L.; Metsvahi, T.; Kendra, A. (2020). Liiklusuuringu juhendi ja baasprognoosi koostamine. Tallinna Tehnikaülikool. [www] https://transpordiamet.ee/sites/default/files/documents/2021-11/bp-2050_aruanne.pdf (06.12.2024)
[56] EUROCONTROL Aviation Outlook 2050 (2022). [www] https://www.eurocontrol.int/archive_download/all/node/13448 (06.12.2024)
[57] Autode müügi- ja teenindusettevõtete Eesti Liit. [www]https://amtel.ee/ (06.12.2024)

The projections for the WEM scenario are also in line with Regulation (EC) No 2019/631 of the European Parliament and of the Council. 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.

9.2.2.2. 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 the WEM 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. 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 9.2).

The Transport sector's projected emissions in the WEM scenario are presented in Figure 9.2. In the WEM scenario, the NO_x emissions are projected to decrease by 58.8%, NMVOC by 76.3%, $PM_{2.5}$ by 77.8%, NH_3 by 81.2% and SO_2 by 49.9% from 2020 to 2050.

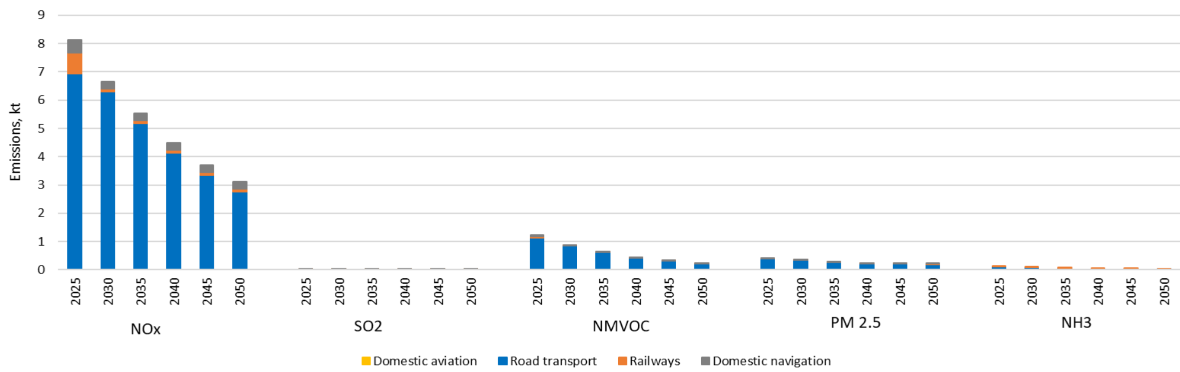

Figure 9.2 Total projected WEM scenario air pollutant emissions from Transport sector, kt

9.2.3. Industrial processes

Emissions from the industrial processes and solvent use sector are regulated by the obligation for manufacturing industries above certain thresholds 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 2023–2050 under current policies and measures. The reference year 2022 used in projections is consistent with Estonia’s 2024 submission to the CLRTAP on 15th of March 2024 (Estonian Informative Inventory Report 1990–2022). As there are no additional measures currently planned, then the ‘With Additional Measures’ (WAM) scenario equals to WEM.

The following emission sources are reflected in the Industrial processes subsector:

- 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 2022 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.

In 2022, the share of industry sources (without Solvent use) in total emissions constituted 0.3% of NO_x emissions, 6.1 % of $PM_{2.5}$ emissions, 3.7 % of NMVOC 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[58] and population[59]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2023 Guidelines. 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 (IEA). Given that the industrial processes sector is governed by the IEA, and according to current reference documents for BATs (BREFs) all production plants above environmentally sound threshold 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

[58] 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 (03.12.24)
[59] Statistics Estonia, RV086: Population Projection Until 2080 by Sex and Age (based on the population figure as at 1 January 2024) [www] https://andmed.stat.ee/et/stat/rahvastik__rahvastikunaitajad-ja-koosseis__rahvaarv-ja-rahvastiku-koosseis/RV083 (03.12.24)

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 46.1% of national emissions in 2022 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 based on the activity data of Statistics Estonia and Eurostat, historical emission trends, coupled with projections of Estonia´s GDP[60] and population[61]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2023 Guidelines[62].

In 2022 ca 83 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)[63] and Directive 2004/42/CE[64] 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[65] on detergents (requirements on biodegradability, and ingredient lists), Regulation (EC) No 1223/2009[66] on cosmetic products (requirement of safety assessment and bans of certain hazardous components) and Regulation (EU) No 528/2012[67] concerning the making available on the market and use of biocidal products (imposing bans of certain hazardous components).

The paints directive has set NMVOC limits until the year 2010. Other beforementioned regulations do not impose specific further restrictions that could lead to certain reduction in emissions.. In the future additional

[60] 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 (03.12.24)
Long-term GDP projection of the Ministry of Finance of Estonia [www] 03.03.23)
[62] EMEP/EEA air pollutant emission inventory guidebook 2023. [www] https://www.eea.europa.eu//publications/emep-eea-guidebook-2023 (03.12.23)
[63] 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 (03.12.24)
[64] 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%3A02004L0042-20210716 (03.12.24)
[65] 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)
[66] 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/TXT/?uri=CELEX%3A02004R0648-20150601(03.12.24)
[67] 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%3A02012R0528-20240611 (03.12.24)

legislative measures are needed for the further decrease of emission factors. The European Commission published a chemicals strategy for sustainability on 14 October 2020[68]. 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 (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 2023–2050.

NO_x emissions are at a low level until 2050 amounting 0.067 kt.

Approximately 41% 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 14% until 2050.

NMVOC emissions arise largely from Food and Beverages industry. Emissions are projected to decrease *ca* 5% 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* 18% higher than as in 2022.

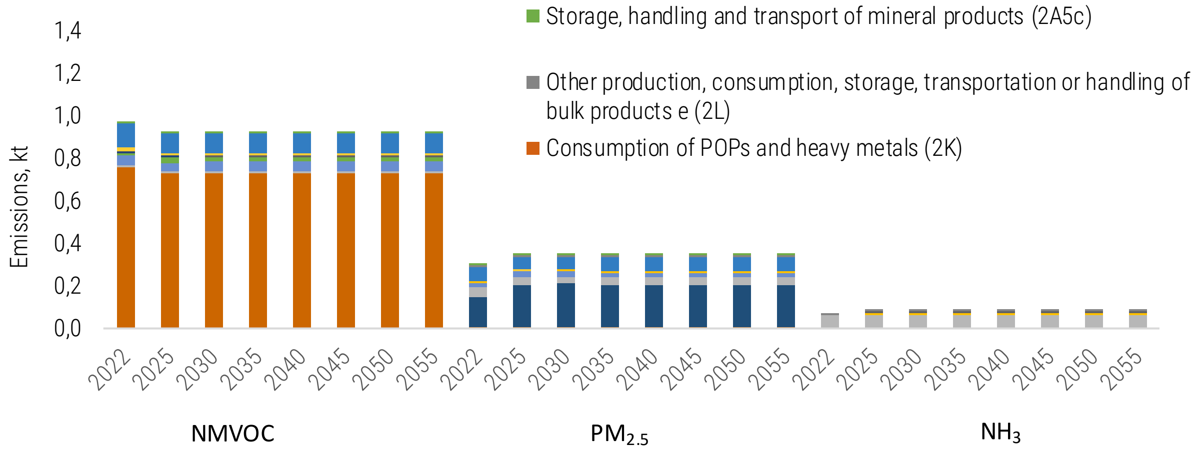

Figure 9.3 WEM=WAM projections from Industrial processes (including road paving with asphalt), kt

[68] 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 (03.12.24)

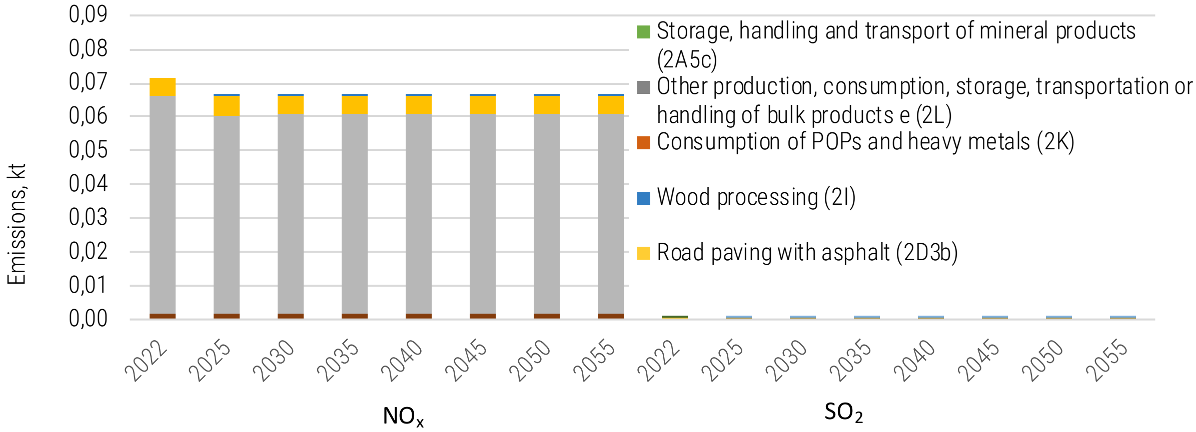

Figure 9. 4 WEM=WAM projections from Industrial processes (including road paving with asphalt), kt

Solvent use

Although emission factors are projected to decrease until 2050 the demand for solvent based chemicalsis rising. In 2050 the NMVOC emissions are projected to be 7% smaller than in 2022. In Degreasing (2.D.3.e) subcategory emissions are slightly decreasing and in the subcategory Printing (2.D.3.h) emissions are slightly rising.

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. The emissions from this subcategory show slight increase until 2050.

NMVOC emissions from Dry cleaning are increasing 25 until 2050 considering historical trends.

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 close to the 2022year´s level.

Concerning 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.

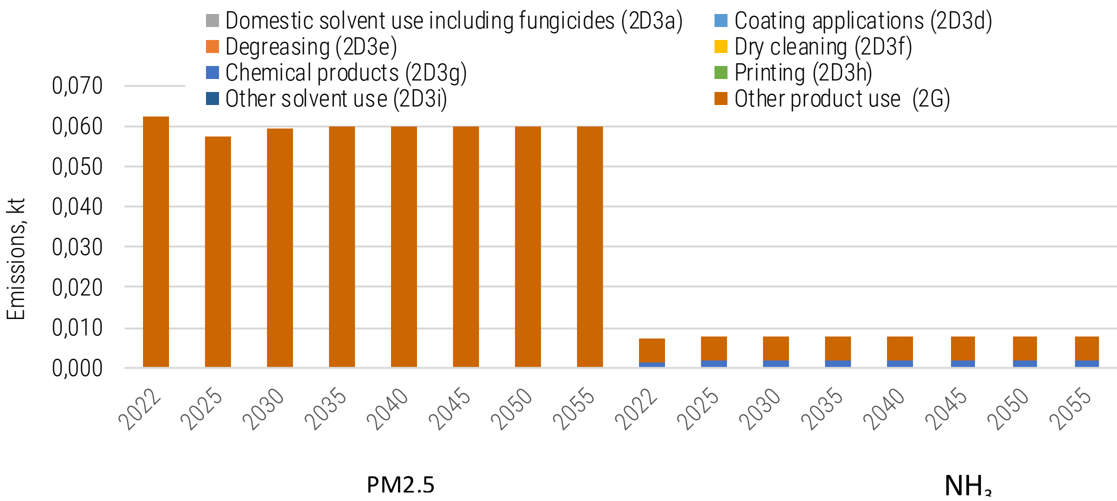

Figure 9.5 WEM=WAM projections from Solvent use, $PM_{2.5}$ and NH_3 emissions

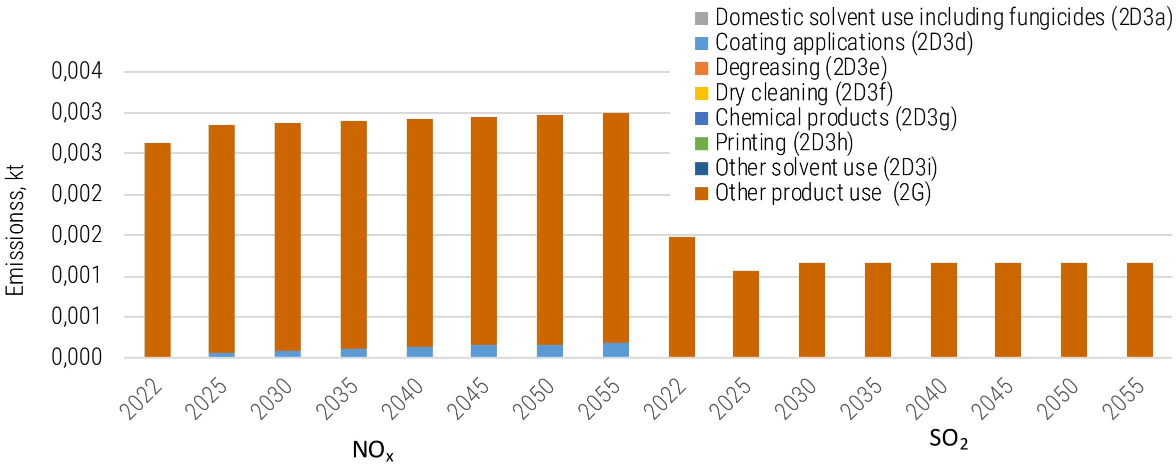

Figure 9.6 WEM=WAM projections from Solvent use, NO_x and SO_2 emissions

Emissions in the years 2022–2050 according WEM=WAM scenario are depicted in the Figures 9.5 - 9.6.

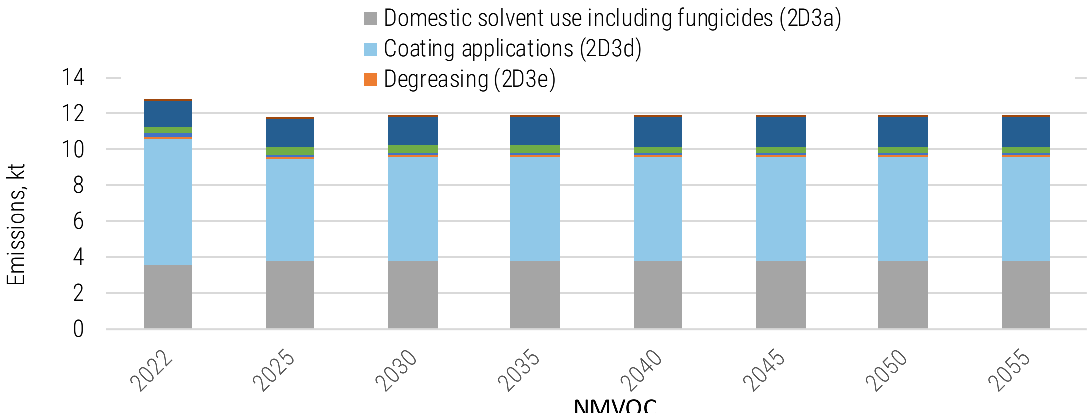

Figure 9.7 WEM=WAM projections from Solvent use, NMVOC emissions

[69] 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).

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. 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.

9.2.4.1.Methodology

The projections scenario of air pollutant emissions has been calculated for the period 2022 –2055. The reference year 2022 used in projections is consistent with Estonia's 2024 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.

The Tier 1 and Tier 2 methods of the EMEP/EEA Guidebook 2023[70] 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.

The projected numbers of animals have been mostly received from the expert judgements of the officials of the Ministry of Regional Affairs and Agriculture. Also, projected amounts of mineral fertilizers used have been received from the Ministry of Regional Affairs and Agriculture. The use of synthetic fertilizers in Estonia is projected to decrease until 2030 compared to 2022 and then to stay at stable level. Global demand for meat- and dairy products along with 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 number of fur animals will be marginal in 2025. By 2030, it will decrease to zero, due to the ban on fur farming in Estonia. It is expected that the number of pigs will increase slightly and will remain at the same level starting from 2030. The number of poultry production is expected to decrease until 2030 compared to 2022 and then to stay at stable 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 WEM scenario (see figure below). According to the WEM scenario NH_3 emissions in Agriculture sector are projected to decrease 1.47%, i.e from 9.49 kt to 9.35 kt between 2022 and 2055. $PM_{2.5}$ emissions are projected to decrease from 0.195 kt in 2022 to 0.190 kt by 2055 (2.57%) in

[70] 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).

Agriculture sector according WEM scenarios. NMVOC emissions are projected to increase from 4.78 kt in 2022 to 4.88 kt by 2055 (1.85%) in Agriculture sector according to 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 decrease from 2.58 kt to 2.46 kt (4.50 %) between 2022 and 2055 according to WEM scenarios.

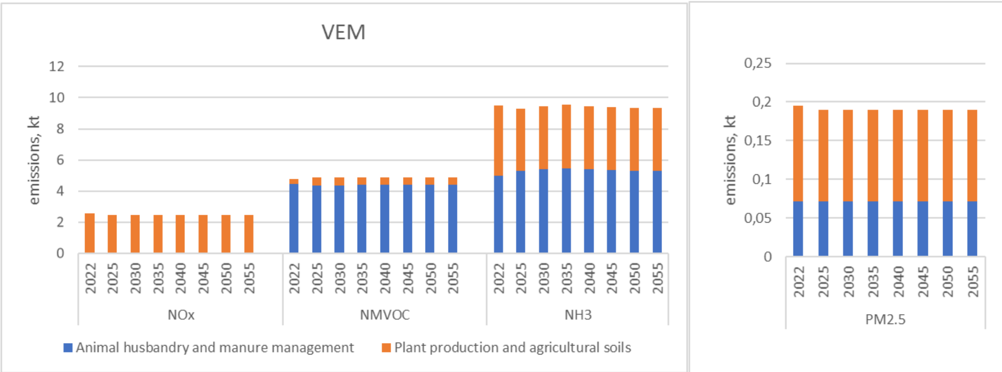

Figure 9.8 AP emissions from Agriculture sector according to WEM scenario, kt

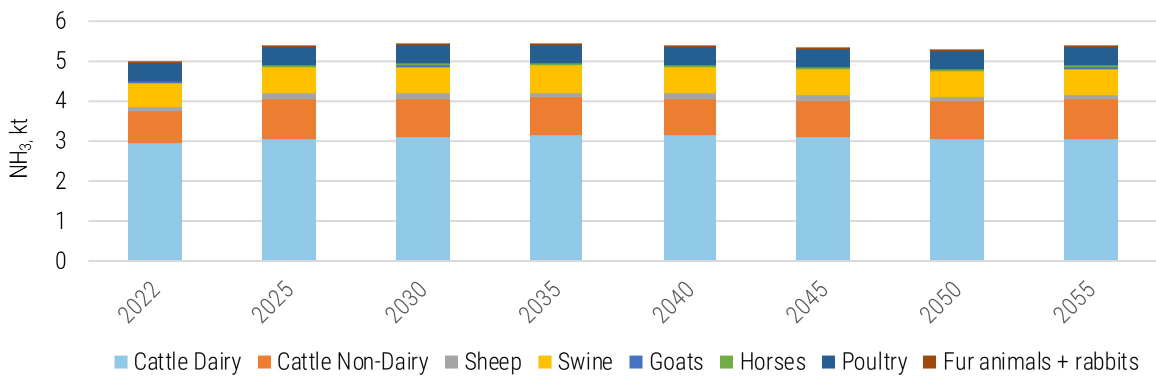

Figure 9.9 AP emissions from Agriculture sector according to WAM scenario, kt

The NH_3 reduction measures of the UNECE Guidance document on preventing and abating ammonia emissions from agricultural sources 2014[71] (table 12 p41; table 13 p.44 and table 15 p.59) have been used in the agriculture projection estimates.

Since 2019, a national database has been available in Estonia, based on which it is possible to find the distribution of the technologies used in terms of housing-, manure storage- and spreading technologies.

During the NAPCP projection compilation, an agriculture expert working group including relevant Estonian stakeholders was asked to give additional input for the assumptions made for the uptake of ammonia abatement measures. The expert group concluded that two main areas most suitable for curbing NH_3 emissions (to meet the emission ceiling levels set for Estonia in the NEC directive) are:

1) the use of technologies enabling fast incorporation of manure and synthetic fertilizers to soils; and

2) covering and further upgrading manure storage facilities.

[71][www] https://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_120_ENG.pdf

The expected trends of distribution and proportions of implementation level of the measures are presented in the following tables.

Table 9.2 Share of technologies in use

Technologies	Share of technologies %	
Cattle	2025	2030
Incorporation of surface applied slurry within 24h	0.00	0.00
Band spreading slurry with trailing shoe	5.00	5.00
Injecting slurry (open slot)	81.00	79.00
Injecting slurry (closed slot)	14.00	16.00
Pigs		
Band spreading slurry with trailing shoe	55.00	52.00
Injecting slurry (open slot)	34.00	35.00
Injecting slurry (closed slot)	11.00	13.00

Table 9.3 Storages covering in agricultural sector

Cattle	2025	2030
Lagoon natural crust	61.00	59.00
Open tank, natural crust	38.00	39.00
Tight lid storage	1.00	2.00
Pigs	2025	2030
Lagoon low tech floating cover	16.00	13.00
Open tank, low tech floating cover	80.00	82.00
Tight lid storage	4.00	5.00

Table 9.4 NH_3 abatement measures

NH_3 abatement measure	2015	2022	2025	2030
Closed-slot injection of mineral fertilizers during seeding operations	16.0%	24.5%	40.0%	40.0%

Table 9.5 Projected nitrogen excretion per head of livestock per year for each livestock type

Livestock type	Nitrogen excretion per head; Nex, kg/yr	
	2025	2030
Dairy cows	150.0	157.2
Mature males (2 year and over)	74.8	74.8
Mature females (2 year and over)	74.8	74.8
Bovine animals (1-2 year)	56.1	56.1
Calves (<1 year)	16.0	16.0
Fattening pigs	10.6	10.6
Young pigs	8.7	8.7
Piglets	4.5	4.5
Sows	25.1	25.1
Sheep	15.5	15.5
Goats	18.7	18.7
Horses	60.2	60.2
Laying hens	0.69	0.69
Broilers	0.36	0.36
Other hens and roosters	1.26	1.26
Other poultry	1.26	1.26
Livestock type	Gross energy intake per head; MJ/day	
	2025	2030
Dairy cows	380.1	391.4
Mature males (2 year and over)	176.7	176.7
Mature females (2 year and over)	135.5	135.5
Bovine animals (1-2 year)	147.2	147.2
Calves (<1 year)	88.1	88.1

For NMVOC tier 2 method is used (Guidebook 2023, Table 3.11, EF NMVOC_silage_feeding).

Table 9.6 The projected shares of different manure management systems for each livestock type including the fraction of the year animals are housed*

Technologies	Abatement, NH_3* %	Share of technologies % 2025	2030
Dairy cattle (3B1a)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, manure removal with a mobile device 2-3 times a day, little bedding		8.56	6.42
Free range, scraper, manure removal >3 times a day, little bedding	30	87.17	89.30
Free range, manure channels, little bedding		4.28	4.28
Free range, deep litter		46.15	46.15
Tethered keeping, manure removal with a mobile device 2-3 times a day, plenty of litter (open system)		46.15	46.15
Tethered keeping, scraper, manure removal >3 times a day, plenty of litter (closed system)	19	0.00	0.00
Tethered keeping, scraper, manure removal 2-3 times a day, plenty of litter (closed system)		7.69	7.69
Tethered keeping, scraper conveyors, manure removal >3 times a day, plenty of litter (open system)		0.00	0.00
Mature males (3B1b)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, manure removal with a mobile device 2-3 times a day, little bedding	28	100	100
Free range, deep litter		100	100
Mature females (3B1b)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, manure removal with a mobile device 2-3 times a day, little bedding		7.38	5.74
Free range, scraper, manure removal >3 times a day, little bedding	30	92.62	94.26
Free range, manure channels, little bedding		0.00	0.00
Free range, deep litter		98.50	98.85
Tethered keeping, manure removal with a mobile device 2-3 times a day, plenty of litter (open system)		1.50	1.15
Tethered keeping, scraper, manure removal >3 times a day, plenty of litter (closed system)		0.00	0.00
Tethered keeping, scraper, manure removal 2-3 times a day, plenty of litter (closed system)		0.00	0.00
Tethered keeping, scraper conveyors, manure removal >3 times a day, plenty of litter (open system)		0.00	0.00
Bovine animals, 1-2 years (3B1b)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, manure removal with a mobile device 2-3 times a day, little bedding		10.20	8.16
Free range, scraper, manure removal >3 times a day, little bedding	30	89.80	91.84
Free range, manure channels, little bedding		0.00	0.00
Free range, deep litter		92.16	94.12
Tethered keeping, manure removal with a mobile device 2-3 times a day, plenty of litter (open system)		7.84	5.88
Tethered keeping, scraper, manure removal >3 times a day, plenty of litter (closed system)	19	0.00	0.00
Tethered keeping, scraper conveyors, manure removal >3 times a day, plenty of litter (open system)		0.00	0.00
Calves, <1 year (3B1b)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, deep litter		100	100
Free range, little bedding		100	100
Fattening pigs (3B3)			
Group pens, fully slatted floor (concrete slats), vacuum system, cooling of the bottom layer of manure	50	15.79	16.67
Group pens, fully slatted floor (concrete slats), vacuum system, without bedding		12.63	11.46
Group pens, fully slatted floor, manure cellar, without bedding		0.00	0.00
Group pens, partially slatted floor (concrete slats), vacuum system, without bedding	17	54.74	54.17
Group pens, partially slatted floor (concrete slats), vacuum system, cooling of the bottom layer of manure	50	6.32	7.29
Group pens, partially slatted floor (concrete slats), curved lying area, manure chutes or channels, manure flushing	30	3.16	2.08
Group pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding	40	2.11	2.08
Group pens, partially slatted floor, scraper, little bedding	30	4.21	4.17
Group pens, partially slatted floor, manure channel with sloped walls	50	1.05	2.08

Technologies	Abatement, NH_3* %	Share of technologies % 2025	2030
Group pens, monolithic floor, deep litter	20	100	100
Young pigs (3B3)			
Group pens, fully slatted floor (concrete slats), vacuum system, cooling of the bottom layer of manure	29	15.79	16.67
Group pens, fully slatted floor (concrete slats), vacuum system, without bedding		12.63	11.46
Group pens, fully slatted floor, manure cellar, without bedding		0.00	0.00
Group pens, partially slatted floor (concrete slats), vacuum system, without bedding	17	52.53	53.06
Group pens, partially slatted floor (concrete slats), vacuum system, cooling of the bottom layer of manure	50	6.32	7.29
Group pens, partially slatted floor (concrete slats), curved lying area, manure chutes or channels, manure flushing	30	3.16	2.08
Group pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding	40	2.11	2.08
Group pens, partially slatted floor, scraper, little litter	30	4.21	4.17
Group pens, partially slatted floor, manure channel with sloped walls	50	1.05	2.08
Group pens, monolithic floor, deep litter	20	100	100
Piglets (3B3)			
Group pens, fully slatted floor, vacuum system, without bedding		3.00	2.00
Group pens, partially slatted floor (concrete slats), curved lying area, manure chutes or channels, manure flushing	30	1.00	1.00
Group pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding	40	48.00	46.00
Group pens, partially slatted floor, scraper, little litter	30	0.00	0.00
Group pens, partially slatted floor (metal or plastic slats), self-flowing manure removal, without bedding, dual climate	30	4.00	5.00
Group pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding, dual climate	30	31.00	32.00
Group pens, partially slatted floor (metal slats), vacuum system, cooling of the bottom layer of manure, without bedding, dual climate	60	13.00	14.00
Sows (3B3)			
Group pens, fully slatted floor, vacuum system, without bedding		4.26	3.16
Group pens, partially slatted floor (concrete slats), vacuum system, without bedding	9	27.72	26.32
Group pens, partially slatted floor (concrete slats), vacuum system, cooling of the bottom layer of manure	40	10.64	12.63
Group pens, partially slatted floor (concrete slats), collection channels, without bedding	20	4.26	3.16
Group pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding	20	15.96	15.79
Group pens, partially slatted floor, scraper, little litter		7.45	7.37
Individual pens, partially slatted floor (metal or plastic slats), vacuum system, without bedding	30	23.40	24.21
Individual pens, partially slatted floor (metal or plastic slats), vacuum system, cooling of the bottom layer of manure, without bedding	60	5.32	7.37
Individual pens, partially slatted floor, scraper, plenty of litter	30	100	100
Sheep (3B2)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, deep litter		100	100
Goats (3B4d)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, deep litter		100	100
Horses (3B4e)			
Insulation of the roof of an uninsulated (partially insulated) barn	10	90	90
Automatically adjustable natural ventilation in an uninsulated (partially insulated) barn	20	20	20
Free range, deep litter		100	100
Laying hens (3B4gi)			
Cages, removing manure with conveyor belts to a closed storage (without drying) at least 2 times a week		15.00	13.00
Cages, removing manure with conveyor belts to a closed storage (without drying) at least 2 times a day	50	70.00	65.00
Keeping on several levels, conveyor belt system, deep bedding in the littered area		10.00	15.00
Keeping on the floor, deep litter, without drying the manure		5.00	7.00
Broilers (3B4gii)			
Keeping on the floor, deep litter, without drying the manure	14	100	100

Technologies	Abatement, NH_3* %	Share of technologies %	
		2025	2030
Other hens and roosters			
Cages, removing manure with conveyor belts to a closed storage (without drying) at least 2 times a week		100	100
Other poultry			
Keeping on the floor, deep litter, without drying the manure	14	100	100

* Abatement techniques for reducing NH_3 emissions, UNECE, 2014, p.27-39

Table 9. 7 The projected share of different manure/digestate application methods and the assumptions about NH_3 abatement for each method

Technologies	Abatement, NH_3* %	Share of technologies %	
Cattle		2025	2030
Incorporation of surface applied slurry within 24h	30	0.00	0.00
Band spreading slurry with trailing shoe	50	5.00	5.00
Injecting slurry (open slot)	70	81.00	79.00
Injecting slurry (closed slot)	80	14.00	16.00
Pigs			
Band spreading slurry with trailing shoe	50	55.00	52.00
Injecting slurry (open slot)	70	34.00	35.00
Injecting slurry (closed slot)	80	11.0	13.00

*Abatement techniques for slurry and reducing NH_3 emissions from mineral fertilizers Table 15 p.59 (UNECE, 2014)
https://www.unece.org/fileadmin/DAM/env/documents/2012/EB/ECE_EB.AIR_120_ENG.pdf

9.2.5. Waste

The **Waste Act** (2004) provides waste management requirements for preventing waste generation and for minimizing waste related health and environmental hazards. It includes 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 **National Waste Plan 2023– 2028** (NWP 2023-2028) (MoC, 2022b), adopted at the end of 2023, is a guiding document used to organize and set objectives for waste management in Estonia for the country as a whole, as well as for local authorities, businesses, producers and the general public. It describes the most important principles for the development of the sector and states the most important actions to be taken to achieve the waste policy objectives set out in the Waste Act and other related documents.

NWP 2023–2028 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 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, the adoption of sustainable production and consumption models is promoted. 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.

Some of the themes from The Circular Economy White Paper affecting the AP emissions include minimizing waste production and improving the division of waste by type in the collection to enable higher rates of recycling.

The **Urban Wastewater Treatment Directive** aims to protect human health and the environment through regulating the wastewater treatment in the Member States. It sets a minimum standard for the quality of wastewater treatment from settlements of over 2000 and 10 000 inhabitants, guides the Member States to identify and protect sensitive areas according to stricter standards, and calls Member States to monitor the performance of treatment plants and receiving waters. As of 3 July 2023, Estonia had 56 wastewater collection areas with over 2000 population equivalent (p.e) and 474 smaller wastewater collection areas.

The AP emissions are mostly affected by the energy neutrality goal coming from the renewed directive that requires bigger wastewater treatment plants to send their sludge to biogas production instead of composting or direct field applications.

9.2.5.1.Methodology

The 'With Existing Measures' (WEM) projections scenario includes air pollutant emission projections for the period 2023–2055 under current policies and measures. The reference year 2022 used in projections is consistent with Estonia's 2024 submission to the CLRTAP on 15th of March 2024 (Estonian Informative Inventory Report 1990–2022). There are no additional measures currently planned so 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, a MoC expert judgement indicated 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 the activity is expected to stop by 2030. 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.

NO_x emission projections are connected to industrial waste incineration, anaerobic digestion, and cremation. Incineration of waste without energy recovery is predicted to stop by 2030 according to an expert opinion from MoE, cremation is predicted to stay on the current level, and anaerobic digestion category is expected to increase significantly by 2055 due to the increased focus on biogas production in the country.

SO_2 emission projections are mostly affected by the anaerobic digestion category and the increased focus on biogas production.

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. AP emissions from domestic wastewater category are predicted to stay on a similar level to the base year. The AP emissions from composting are expected to increase slightly by 2055 due to less biodegradable waste being landfilled and more being treated biologically.

$PM_{2.5}$ emission projections are driven by open burning of waste and other waste handling categories. Open burning of waste is expected to end by 2030, affecting somewhat the AP emissions. There are no projections done for the other waste handling category as it is mostly affected by unexpected fires and reported company data, so the related AP emissions are expected to stay on a similar level as on the base year.

NH_3 emission projections are mostly affected by domestic wastewater handling and compost category. The AP emissions from composting are expected to increase slightly due to more biodegradable waste being composted and the AP emissions related to domestic wastewater handling are expected to decrease slightly compared to the base year levels.

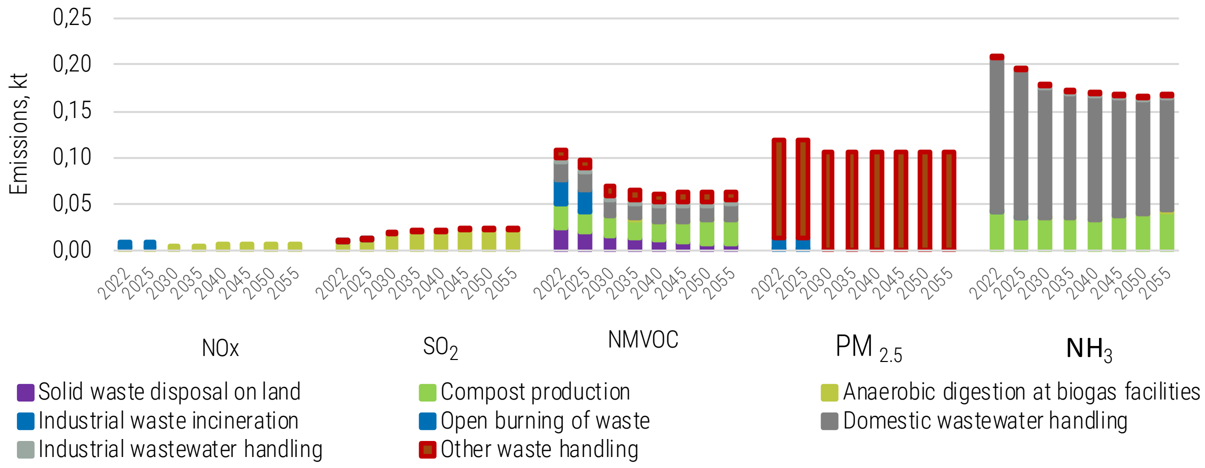

Figure 9.10 WEM = WAM emission projections in Waste sector, kt

9.3. Total projected AP emissions

Estonia's total projected emissions of air pollutants (excluding informative projections of NO_x and VOC emissions in the Agriculture sector) are presented in figure below. The overall main driver for decrease of emissions 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 55% in WEM scenarios. This estimate takes into account NO_x emissions form Agriculture sector.
- NMVOC – in 2020–2050, emissions are projected to decrease by 25% in WEM scenario. This estimate takes into account NMVOC emissions form Agriculture sector.
- SO_2 – in 2020–2050, emissions are projected to decrease by 72% in WEM scenario .
- NH_3 – in 2020–2050, emissions are projected to decrease by 6% in WEM scenario.
- $PM_{2.5}$ – in 2020–2050, emissions are projected to decrease by 60% in WEM scenario.

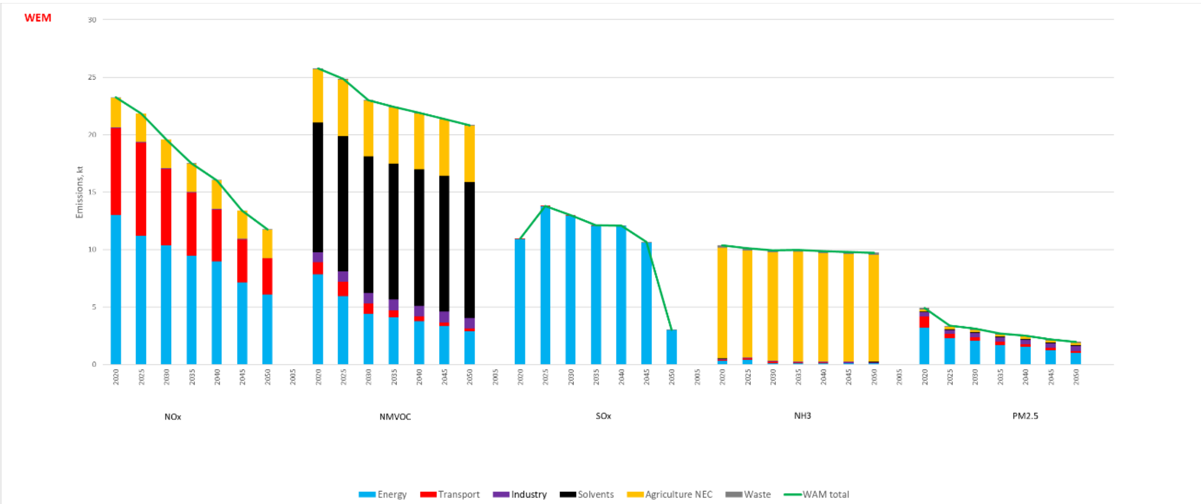

Figure 9.11 Sectoral projections of air pollutant emissions (excluding NOx emissions projections from Agriculture sector) 2020–2050, kt

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[72] requires all Member States to reduce atmospheric pollutant emissions by 2020 and 2030 compared to base year 2005 (Table 9.8). As the 2020 commitments have already been met, then the comparison is done only for 2030.

Estonia's total emission projections (i.e excluding NO_x and NMVOC emissions from Agriculture sector) and % change compared to 2005 according are presented inTable 9.8.

Table 9.8 Commitments to reduce emissions of certain atmospheric pollutants established by the NEC Directive for Estonia and % change compared to 2005

Pollutant	WEM	
	Reduction target 2030	% change in 2030
NO_x	-30%	-58%
NMVOC	-28%	-38%
SO_2	-68%	-83%
NH_3	-1%	-7%
$PM_{2.5}$	-41%	-62%

According to current projections, in WEM scenario, all commitments will be achieved.

[72] 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 2023 for each GNFR (aggregated sectors) were submitted on 24 April 2025. Emissions data are disaggregated to the extended EMEP grid with a with the resolution of 0.1° x 0.1° long-lat.

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.

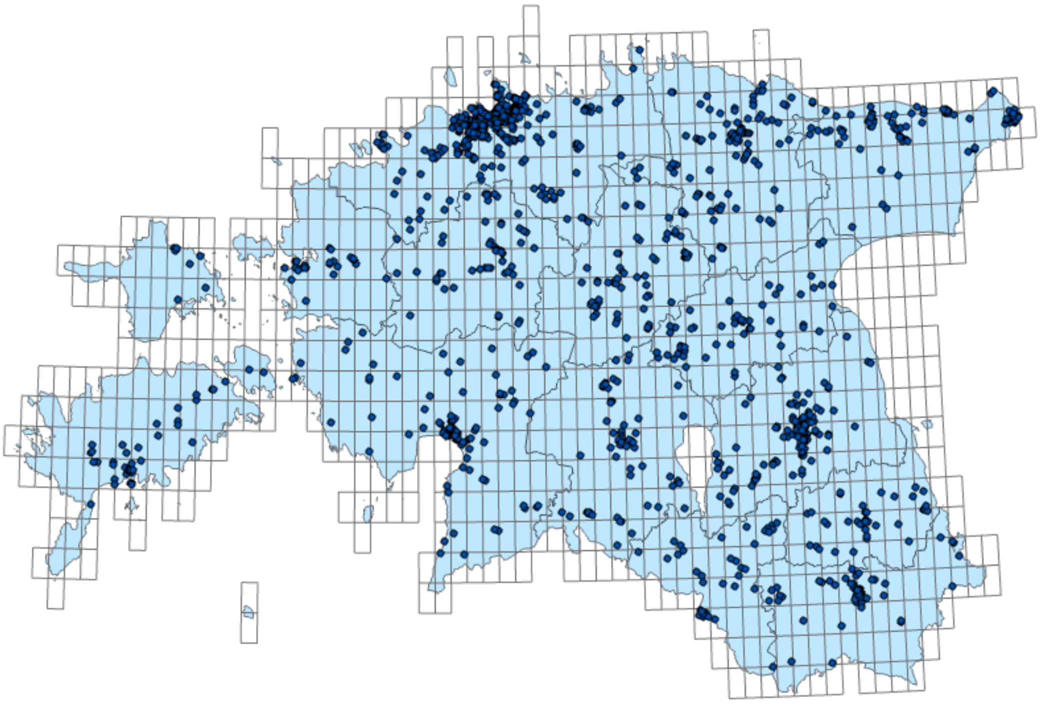

Figure 10.1 Point Sources distribution used for gridded emissions in 2019

The NFR toolbox in the ArcGIS program was used to distribute national emissions spatially on a 0.1 × 0.1 degree grid. The NFR toolbox is developed by the Estonian Environmental Research Centre to automate the territorial distribution of Estonian ambient air pollutant emissions using the "one button press" method, on the condition that the standardized base files have been prepared beforehand.

LPS data for 1990, 1995, 2000, 2005, 2010, 2015, 2019 and 2023 and point source data for 2023 were allocated directly to the grid by using their X and Y coordinates. Diffuse data were distributed using different statistical and geographical data (e.g. road maps, maps on the 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; heat production data; 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 and heat production data, 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 and heat productiob 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.

NFR	Description	
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

No major improvements are planned for the next submission.

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, 2019 and 2023 by GNFR (aggregated sectors) codes in NFR 2014-1 format and were submitted to EIONET's Central Data Repository on 24 April 2025.

For the identification of LPS for the period from 2005 to 2023, the principles of E-PRTR activities and pollutant emission thresholds in accordance with the requirements of Annexes I and II of the E-PRTR Regulation have been used. This was the main reason for the difference in the number of facilities and emissions. The reasons for the data differences and recalculations are given in Chapter 10.2.3.

All E-PRTR facilities are required to submit annual reports on ambient air pollution. The reports contain information on the parameters of each source of pollution, the amount of emissions by source and by the facility as a whole. They also provide data on combustion plants, including capacities, the amount of fuel used, electricity and heat production; data on solvent use, liquid fuel distribution, livestock and other relevant information.

A more detailed description of the data collection system from facilities is presented in Chapter 1.3 "The Process of Inventory Preparation" of the Estonian Informative Inventory Report 1990–2023.

Table 10.3 presents the number of LPS in 2023 by GNFR sectors and reported pollutants. Each LPS emission has been aggregated by GNFR sectors and stack height classes. If the total emission of a facility exceeded the applicable threshold value and the facility had different activities or stack height classes, the data were submitted separately for each activity or stack height class, regardless of the threshold.

Figure 10.2 and Table 10.4 shows the number of LPS for the period 1990-2023.

Table 10.3 Activities and pollutants under LPS in 2023

GNFR	Emissions reported	Number of LPS facilities	Height class
A_PublicPower	NO_x, SO_x, PM_{10}, $PM_{2.5}$, CO, Cd, Hg, PCDD/PCDF	10	1,2,3,4,5
B_Industry	NO_x, SO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, CO, Pb	6	1,2,3,4
D_Fugitive	NO_x, SO_x, NMVOC, NH_3, CO	4	1, 2
K_AgriLivestock	NH_3	23	1
L_AgriOther	NH_3	17	1
J_Waste	NH_3	1	1

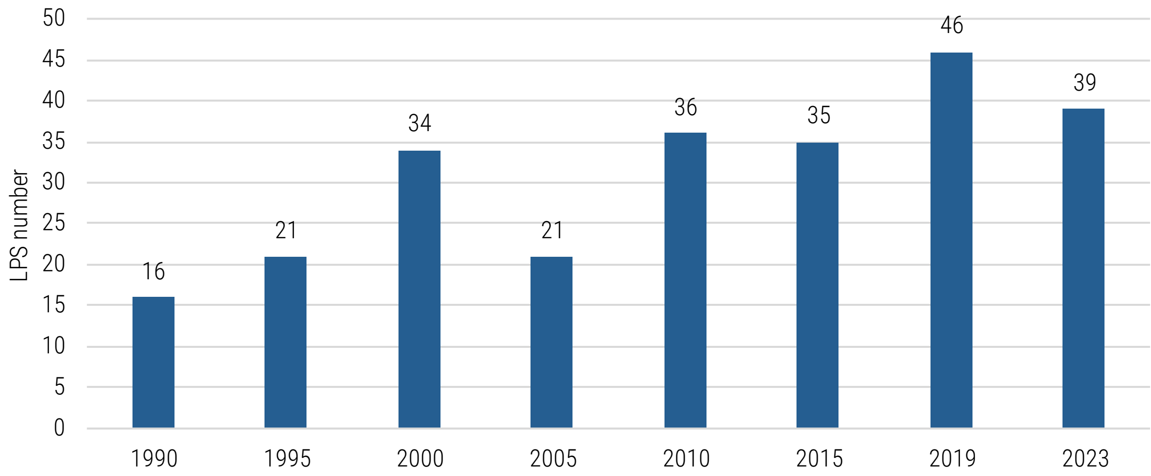

Figure 10.2 The number of large point sources

Table 10.4 The number of LPSs by GNFR sectors

GNFR	1990	1995	2000	2005	2010	2015	2019	2023
A_PublicPower	6	7	9	7	8	9	10	10
B_Industry	10	11	17	9	6	8	8	6
C_OtherStationaryComb			2				1	
D_Fugitive		1	6	4	5	3	4	4
E_Solvents		2	2	2				
K_AgriLivestock				1	17	17	26	23
L_AgriOther					9	15	7	17
J_Waste			1				1	1

During the period of 1990-2023, the number of LPS facilities increased from 16 to 39 (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 2023, out of 39 facilities, 23 are agricultural (Table 10.4). This also explains the growth of ammonia emissions from LPS (Table 10.5).

As can be seen from Figure 10.3 and Table 10.5, the contribution of large point sources to total emissions in 2023 is significant only for three pollutants: SO_2 - 52%, CO - 49%, and Hg - 33.5%. The main sources of SO_2 emissions are plants burning oil shale or by-products of oil shale processing (generator or coke oven gases); the main source of CO emissions is shale oil production plants, and the source of mercury is a municipal waste incinerator. The main contributors to particulate emissions are oil shale mining and oil shale power plants; PCDD/PCDF – plants burning biomass; and NO_x emissions – oil shale power plants. The share of other substances from LPS is not significant.

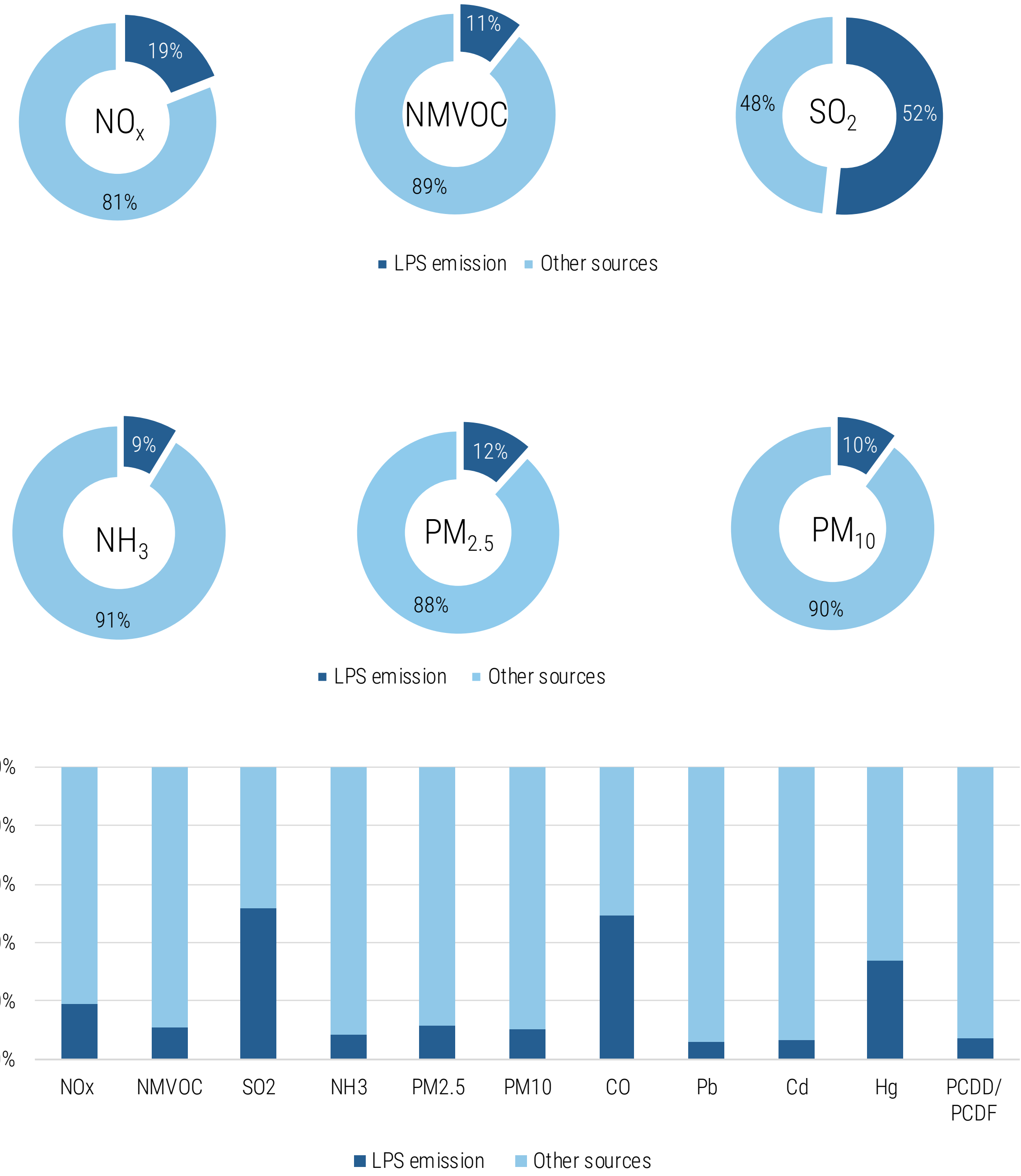

Figure 10.3 The contribution of LPS emissions in 2023 total emission

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.

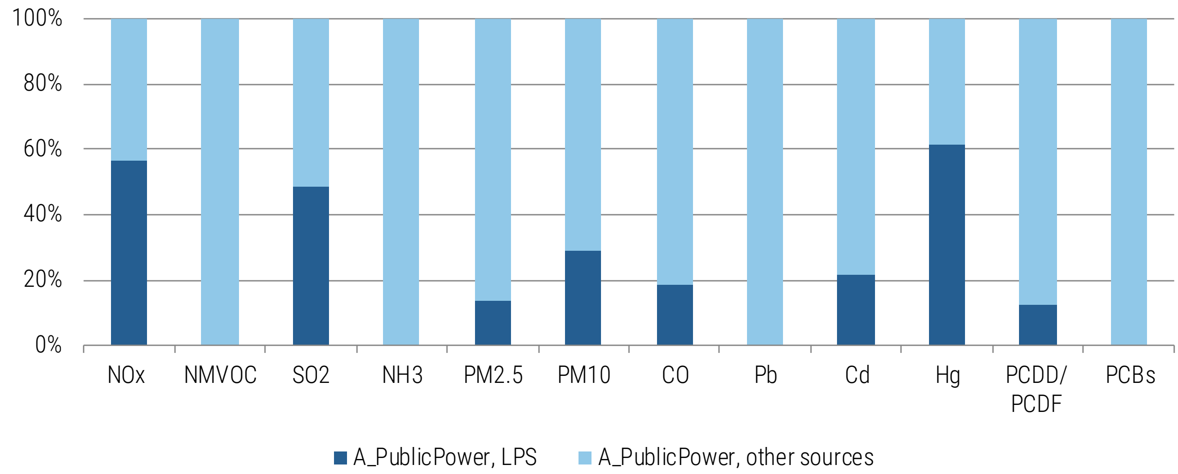

Figure 10.4 The contribution of LPS emissions in 2023 into A_PublicPower sector

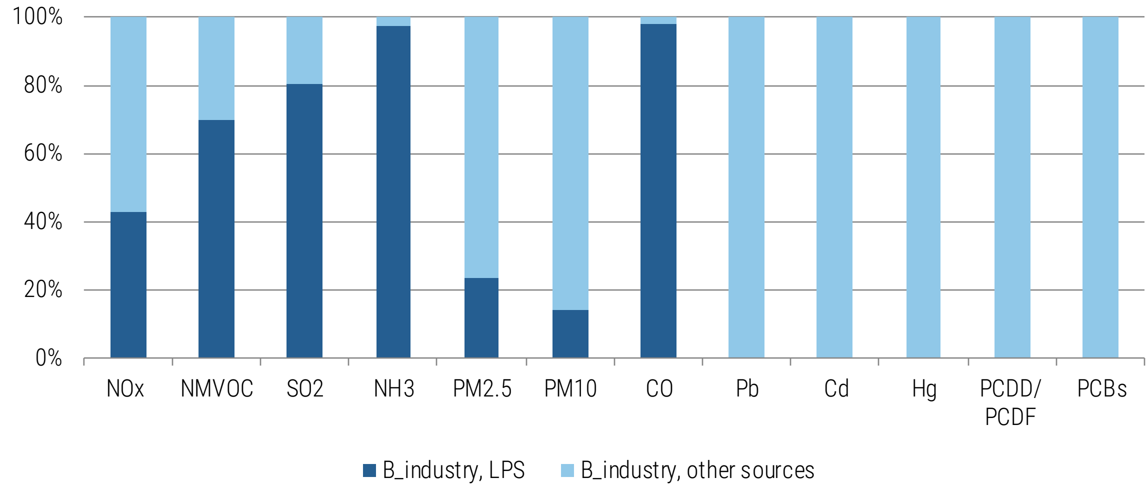

Figure 10.5 The contribution of LPS emissions in 2023 into B_IndustrialCombustion sector

It should be noted that during the period 1990-2023, the main large point sources, such as oil shale power plants, shale oil, cement, and pulp and paper production factories, continued their operations (cement production has been discontinued since 2020, which was one of the reasons for the reduction in NOx, SO_2 and dioxin emissions). Emissions of all substances (except NH_3 and CO) dropped significantly (Table 10.5, Figures 10.6–8), mainly due to the reduction in energy production and the introduction of new technologies at oil shale power plants, as well as the renovation of cleaning installations in cement production. A detailed description can be found in the Pollutant Emission Trends and Energy Sector chapters of the IIR.

While the energy sector has consistently remained the primary source of SO_2 emissions throughout the entire period, the profile of ammonia emissions has shifted over time. In the 1990s and early 2000s, the main contributors were facilities producing mineral fertilizers (with production discontinued since 2013) and rare earth metals. In more recent decades, however, shale oil production and agriculture have emerged as the dominant sources. Within the agricultural sector, emissions from pig and poultry farming remain relatively minor compared to those from cattle farming and the use of fertilizers. The increase in ammonia emissions is due to the addition of agricultural enterprises to the list of LPS since 2010. Another reason is the increase in the production of shale oil using Enefit-140 technology, which has also affected the increase in CO emissions.

Table 10.5 Pollutant emissions from LPSs

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF (dioxins/ furans)	PCBs
	kt							t			g I-Teq	kg
1990	19.000	14.802	202.713	0.577			11.185	120.960	4.194	1.054	0.716	0.933
1995	11.348	5.312	94.52	0.163			11.546	56.164	1.818	0.547	0.251	0.490
2000	12.510	4.750	87.447	0.180	5.460	19.756	14.297	22.538	0.4	0.364	0.000	0.436
2005	11.073	2.193	61.886	0.373	2.787	6.826	19.742	4.068	0.127	0.074	0.000	0.480
2010	14.318	2.220	73.622	0.766	6.055	12.659	32.771	4.725	0.159	0.094	0.221	0.597
2015	8.377	1.956	25.792	0.875	2.718	4.863	33.915	1.625	0.148	0.096	0.229	0.337
2019	5.468	2.090	14.116	1.005	1.069	1.692	46.593	0.758	0.104	0.068	0.624	0.166
2023	3.557	2.472	5.660	0.847	0.546	0.883	43.913	0.000	0.027	0.065	0.330	0.000
Trend 1990-2023, %	-81.3	-83.3	-97.2	46.7	-90.0	-95.5	292.6	-100.0	-99.4	-93.8	-53.9	-100.0
Nationl total 2023 emission	18.692	23.105	10.955	9.736	4.661	8.760	89.452	3.592	0.417	0.194	4.510	0.439
LPS Share in total 2023 emission, %	19.0	10.7	51.7	8.7	11.7	10.1	49.1	0.0	6.4	33.5	7.3	0.0

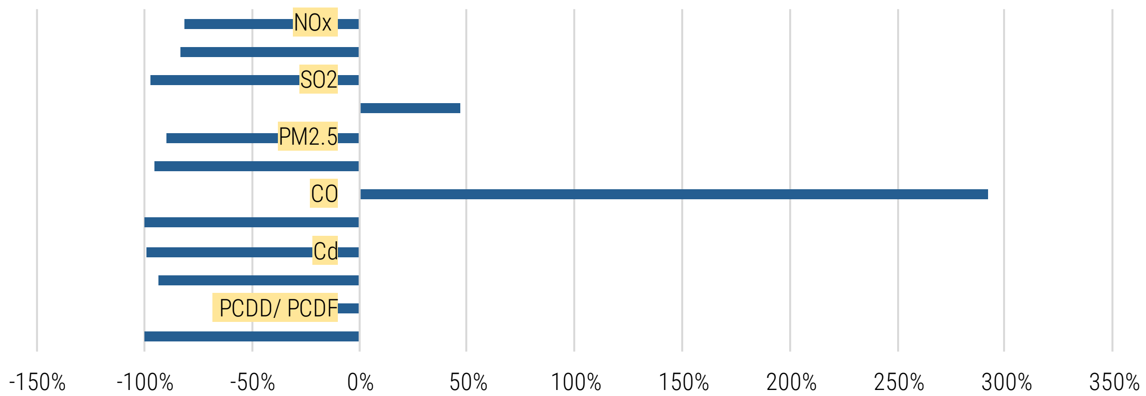

Figure 10.6 Change in pollutants emissions from LPS in the period 1990-2023

Table 10.6 LPS emissions from GNFR A_PublicPower

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		187.265				1.211	59.218	0.985	0.985	0.153	0.933
1995	10.606	0.111	83.233				1.039	31.044	0.518	0.517		0.490
2000	10.438		76.136		3.968	16.992		22.055	0.375	0.364		0.436
2005	10.232		59.088		1.838	5.505		4.068	0.127	0.074		0.480
2010	13.238		72.011		5.127	11.353		4.706	0.159	0.094	0.115	0.597
2015	7.848	0.103	24.395		1.844	3.961		1.625	0.148	0.096	0.229	0.337
2019	4.598	0.119	11.152		0.379	0.780	0.558	0.758	0.104	0.068	0.484	0.166
2023	3.115		4.308		0.072	0.226	0.531		0.027	0.065	0.330	
Trend 1990-2023, (PM 2000-2023), %	-82.2		-97.7		-98.2	-98.7	-56.2	-100.0	-97.3	-93.4	115.5	-100.0
Total 2023 A_PublicPower sector emission	5.536	0.594	8.877	0.007	0.528	0.775	2.866	0.676	0.124	0.106	2.612	0.181
Share in 2023 total A_PublicPower sector emission, %	56.3	0.0	48.5	0.0	13.5	29.2	18.5	0.0	21.4	61.6	12.6	0.0
Total 2023 emission	18.692	23.105	10.955	9.736	4.661	8.760	89.452	3.592	0.417	0.194	4.510	0.439
Share in total 2023 emission, %	16.7	0.0	39.3	0.0	1.5	2.6	0.6	0.0	6.4	33.5	7.3	0.0

Table 10.7 LPS emissions from GNFR B_Industry

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	14.802	15.448	0.577			9.974	61.742	3.209	0.069	0.563	
1995	0.742	4.369	11.287	0.163			10.507	25.120	1.3	0.030	0.251	
2000	1.962	1.384	10.531	0.180	1.203	2.389	13.441	0.483	0.025			
2005	0.841	1.300	2.798	0.305	0.553	0.915	19.742					
2010	1.080	1.770	1.610	0.272	0.402	0.767	32.771					
2015	0.529	1.733	1.397	0.264	0.152	0.160	33.903					
2019	0.869	1.872	2.714	0.304	0.124	0.326	46.030				0.140	
2023	0.443	2.454	1.352	0.314	0.105	0.274	43.326					
Trend 1990-2023, (PM 2000-2023), %	-69.6	-83.4	-91.2	-45.7	-91.3	-88.5	334.4	-100.0	-100.0	-100.0	-100.0	
Total 2023 B_Industry sector emission	1.033	3.520	1.689	0.322	0.452	1.941	44.301	0.089	0.016	0.009	0.261	0.034
Share in 2023 total B_Industry sector emission, %	42.9	69.7	80.0	97.3	23.3	14.1	97.8	0.0	0.0	0.0	0.0	0.0
Total 2023 emission	18.692	23.105	10.955	9.736	4.661	8.760	89.452	3.592	0.417	0.194	4.510	0.439
Share in total 2023 emission, %	2.4	10.6	12.3	3.2	2.3	3.1	48.4	0.0	0.0	0.0	0.0	0.0

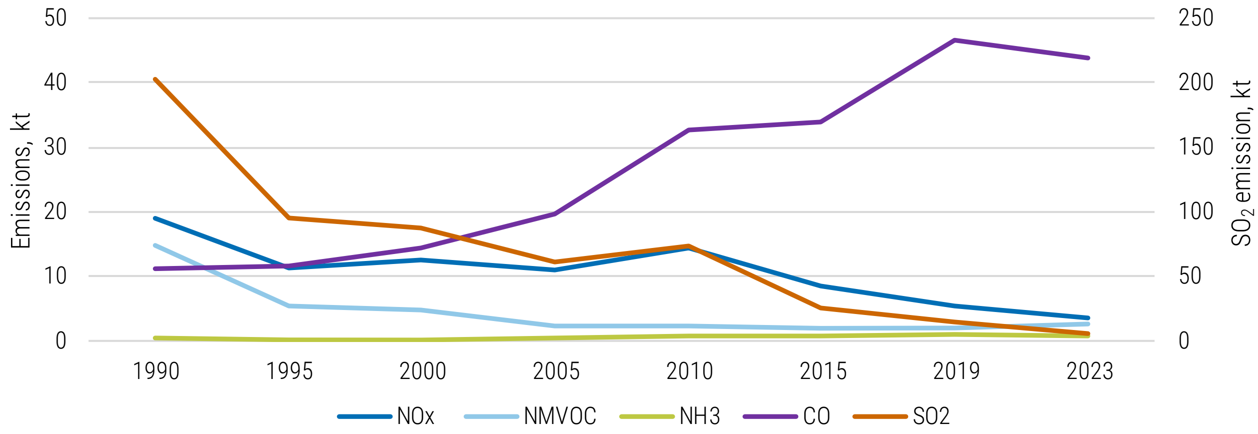

Figure 10.7 Main pollutant emissions from LPS

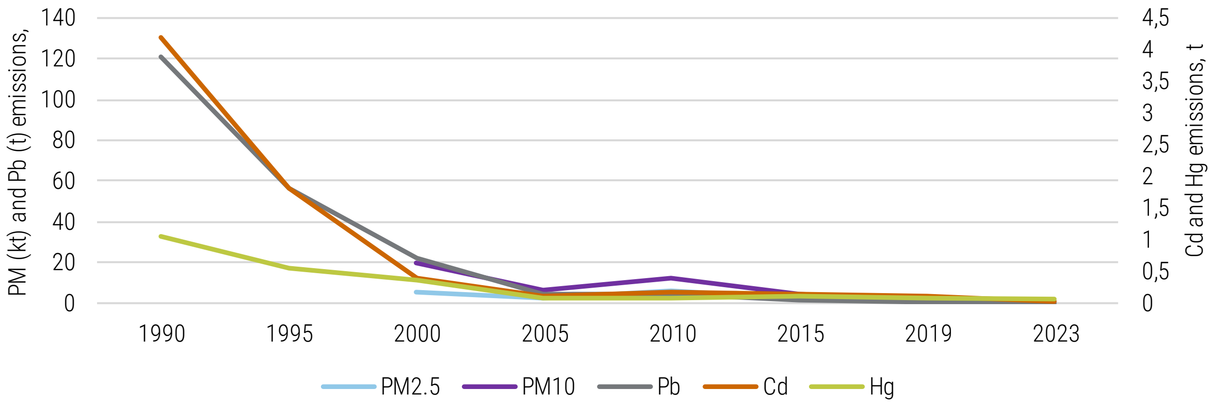

Figure 10.8 Pollutant emissions from LPS

10.2.2. Methodological Issues

The methods for emission 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 and national methodologies. The operator can also calculate emissions using 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 HM and POPs from energy activities, which have been calculated on the basis of fuel combustion and national or Guidebook 2023 emission factors. The emission factors used for the calculations are given in the IIR Energy chapter. Only dioxin emissions from a cement production facility are presented by the operator on the basis of measurements. 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

The number of facilities for the period from 1990 to 2005 is identical in both the 2021 and 2025 submissions (Figure 10.9). Between 2010 and 2019, one hazardous and hospital waste incineration plant (Epler & Lorenz AS), for which dioxin emissions were recalculated and the adjusted emissions do not exceed the pollutant emission thresholds identified by the E-PRTR Regulation, was removed from the list. The reason and more detailed information are given in Chapter 8.4 of "Estonia IIR 2022".

In the 2025 submission, the following recalculations were carried out:

GNFR B_Industry

Recalculated emissions of NMVOC and CO for Enefit Energiatootmine AS, Auvere põlevkiviõlitehas for the period 1990–2019. The reason for this is a new permit and a change in the methodology for calculating emissions from shale oil production at the Enefit 140 installation (NFR 1A1c). A detailed description is given in Chapter 8.1.1 of "Estonia IIR 2024".

For the same facility, ammonia emissions for 2000–2010 were also recalculated and emissions for 1990–1999 were additionally estimated. The reason for the recalculation was a new method for determining ammonia emissions in shale oil production using Enefit 140 technology. A detailed description is given in Chapter 8.1.1 of "Estonia IIR 2022".

GNFR A_PublicPower

Heavy metal emissions from oil shale power plants (Enefit Energiatootmine AS, Eesti, Balti and Auvere PP) were recalculated 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 2019, improve data quality and reduce uncertainty. When making the calculations, the time of introduction of new technologies or more modern treatment equipment was taken into account. See Chapter 8.1.1 of the IIR, submission 2022.

Small correction of PCB emissions was made for Enefit Energiatootmine AS, Eesti elektrijaam.

GNFR D_Fugitive

Emissions from Estonia põlevkivikaevandus, Enefit Power (NFR 1B1c) have been recalculated for the period between 1990–2020 mainly due to the correction of emission factors for particulates. Operator 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. A detailed description is given in Chapter 8.1.3. of "Estonia IIR 2024".

The differences in the large point sources emissions data between the 2021 and 2025 submissions are presented in Tables 10.8-10.10.

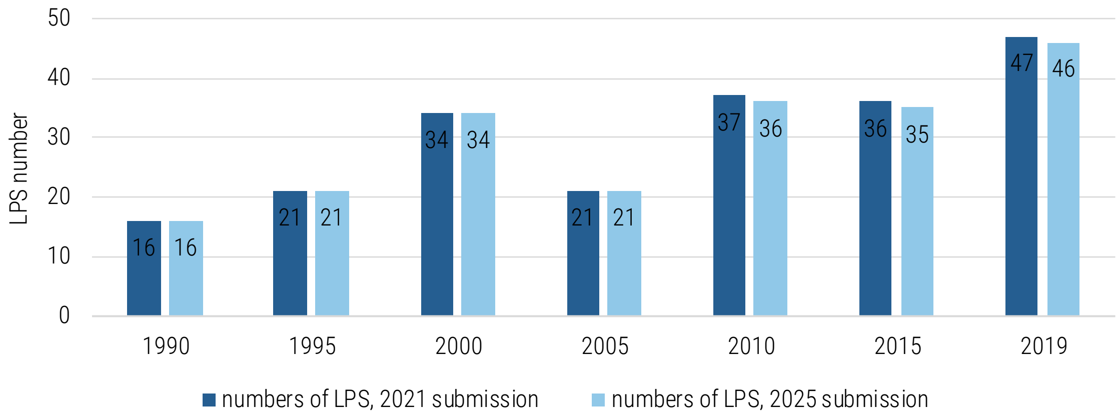

Figure 10.9 The differents in number of LPS in 2021 and 2025 submission

Table 10.8 The differences in the LPS main pollutants emissions (kt) for 1990-2019 between 2021 and 2025 submissions

Year	NO_x			NMVOC			SO_x			NH_3			CO		
	2021	2025	%	2021	2025	%	2021	2025	%	2021	2025	%	2021	2025	%
1990	19.000	19.000	0.0	14.412	14.802	**2.7**	202.713	202.713	0.0	0.529	0.577	**9.2**	10.570	11.185	**5.8**
1995	11.348	11.348	0.0	4.794	5.312	**10.8**	94.520	94.520	0.0	0.099	0.163	**65.1**	10.705	11.546	**7.9**
2000	12.510	12.510	0.0	4.046	4.750	**17.4**	87.447	87.447	0.0	0.092	0.180	**95.2**	9.668	14.297	**47.9**
2005	11.073	11.073	0.0	1.128	2.193	**94.4**	61.886	61.886	0.0	0.240	0.373	**55.2**	12.874	19.742	**53.3**
2010	14.318	14.318	0.0	0.450	2.220	**393.1**	73.622	73.622	0.0	0.560	0.766	**36.9**	20.878	32.771	**57.0**
2015	8.377	8.377	0.0	0.965	1.956	**102.8**	25.792	25.792	0.0	0.896	0.875	**-2.3**	28.637	33.915	**18.4**
2019	5.468	5.468	0.0	0.814	2.090	**156.6**	14.116	14.116	0.0	1.016	1.005	**-1.0**	37.300	46.593	**24.9**

Table 10.9 The differences in the LPS particulates (kt) and heavy metals (t) emissions for 1990-2019 between 2021 and 2025 submissions

Year	$PM_{2.5}$			PM_{10}			Pb			Cd			Hg		
	2021	2025	%	2021	2025	%	2021	2025	%	2021	2025	%	2021	2025	%
1990	NR	NR		NR	NR		120.977	120.960	**-0.01**	4.194	4.194	0.0	1.054	1.054	0.0
1995	NR	NR		NR	NR		56.162	56.164	**0.004**	1.817	1.818	**0.1**	0.547	0.547	0.0
2000	5.229	5.460	**4.4**	19.704	19.756	**0.3**	28.436	22.538	**-20.7**	0.482	0.400	**-17.0**	0.457	0.364	**-20.4**
2005	2.391	2.787	**16.5**	6.420	6.826	**6.3**	29.770	4.068	**-86.3**	0.484	0.127	**-73.8**	0.484	0.074	**-84.7**
2010	5.530	6.055	**9.5**	12.120	12.659	**4.4**	35.977	4.725	**-86.9**	0.592	0.159	**-73.2**	0.592	0.094	**-84.1**
2015	1.996	2.718	**36.2**	4.122	4.863	**18.0**	25.690	1.625	**-93.7**	0.478	0.148	**-69.0**	0.478	0.096	**-79.9**
2019	0.503	1.069	**112.6**	1.110	1.692	**52.4**	6.500	0.758	**-88.3**	0.201	0.104	**-48.1**	0.199	0.068	**-65.8**

Table 10.10 The differences in the LPS POPs emissions for 1990-2019 between 2021 and 2025 submissions

Year	PCDD/ PCDF, g I-Teq			PCB, kg		
	2021	2025	%	2021	2025	%
1990	0.716	0.716	0.0	0.930	0.933	**0.4**
1995	0.251	0.251	0.0	0.486	0.490	**0.9**
2000	NA	NA	NA	0.431	0.436	**1.2**
2005	0.122	0.000	**-100.0**	0.472	0.480	**1.5**
2010	0.542	0.115	**-78.7**	0.594	0.597	**0.6**
2015	0.952	0.229	**-76.0**	0.317	0.337	**6.4**
2019	1.069	0.624	**-41.7**	0.142	0.166	**16.3**

10.2.4. Planned Improvements

No major improvements are planned for the next submission.