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Data sheet

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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

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

Notation keys

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

Like Snow (photo by Margus Muts)

EXECUTIVE SUMMARY

Estonia, as a party to the Convention on Long-range Transboundary Air Pollution (CLRTAP) is required to report annual emission data, projections of main pollutants, activity data and to provide an Informative Inventory Report. The emissions data of all pollutants for the period 1990-2019 was submitted on 9th February 2021. The first IIR was submitted in 2010.

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 2018. The reasons for the recalculations are specified in the The status of recalculations in the 2021 submission Table 0.1.

Table 0.1 The status of recalculations in the 2021 submission

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1a	Public electricity and heat production	Correction of emissions data by using on Tier 2 emission factor from GB 2019	PCDD/F, PAHs, HCB, PCBs	1990-2018
1A1c	Manufacture of solid fuels and other energy industries	Correction of emissions data by using on Tier 2 emission factor from GB 2019	PCDD/F, PAHs, HCB, PCBs	1990-2018
		Additionally calculated emission	SO2, CO, TSP	1990-1993
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Additionally calculated emission	Cd, Hg	2010, 2016
			As	2010
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Additionally calculated emission	Cd, Hg, Cr, Cu, Ni, Zn	2010-2012; 2015-2018
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Additionally calculated emission	Cd, Hg	2012, 2014-2018
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Additionally calculated emission	Hg	2004-2005
			As	2005
1A2gvii	Mobile combustion in manufacturing industries and construction	Correction of emission factors	NO_x, NMVOC, NH_3, TSP, CO	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Emissions reallocated from 2A6 and 2B10a	SO_x	2001, 2003-2004
		Correction of emissions data by using on Tier 2 emission factor from GB 2019	PCCD, PAHs, HCB, PCB	1990-2018
1A3bi	Road transport: Passenger cars	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, HMs, PCDD/F, PAHs, HCB, PCBs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A3bii	Road transport: Light duty vehicles	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, HMs, PCDD/F, PAHs, HCB, PCBs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A3biii	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, HMs, PCDD/F, PAHs, HCB, PCBs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A3biv	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, HMs, PCDD/F, PAHs, HCB, PCBs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018

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NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A3bv	Road transport: Gasoline evaporation	Correction of activity data and emission factors	NMVOC	1990-2018
1A3bvi	Road transport: Automobile tyre and brake wear	Correction of activity data and emission factors	TSP, HMs, PAHs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A3bvii	Road transport: Automobile road abrasion	Correction of activity data and emission factors	TSP	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A3c	Railways	Corrections of statistical data (fuel consumption)	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs	2012-2014, 2018
1A3di(i)	International maritime navigation	Corrections of statistical data (fuel consumption) and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, HMs, PCDD/F, PAHs, HCB, PCBs	1990-1992, 2018
			As, Cu, Se, PAHs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2018
1A3dii	National navigation (shipping)	Corrections of statistical data (fuel consumption) and emission factors	NO_x, NMVOC, SO_x, TSP, CO, HMs, PCDD/F, HCB, PCBs	1991, 1999, 2012-2016, 2018
			Cu, Se, PAHs	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2012-2016, 2018
1A4ai	Commercial/institutional: Stationary	Correction of emissions data by using on Tier 2 emission factor from GB 2019	PCDD/F, PAHs, HCB, PCBs	1990-2018
1A4aii	Commercial/Institutional: Mobile	Correction of emission factors	NO_x, NMVOC, NH_3, TSP, CO	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A4bi	Residential: Stationary	Correction of activity data Correction of emission data	All pollutants	1990-2018
1A4bii	Residential: Household and gardening (mobile)	Correction of emission factors	NO_x, NMVOC, NH_3, TSP, CO	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A4ci	Agriculture/Forestry/Fishing: Stationary	Correction of emissions data by using on Tier 2 emission factor from GB 2019	PCDD/F, PAHs, HCB, PCBs	1990-2018
1A4cii	Agriculture/Forestry/Fishing: National fishing	Correction of emission factors	NO_x, NMVOC, NH_3, TSP, CO	1990-2018
			$PM_{2.5}$, PM_{10}, BC	2000-2018
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Correction of emission factors	Cu, Se, PAHs	1990-2018
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Additionally calculated emission;	Cd, Hg	2013-2017; 2018
		Correction of emission	SO2, NOx, CO, NMVOC, $PM_{2.5}$, PM_{10}, BC, TSP, HM	2018
1B2aiv	Fugitive emissions oil: Refining and storage	Additionally calculated emission	$PM_{2.5}$, PM_{10}, TSP	2002-2007
			NOx	2010, 2015-2018
			CO	2007
1B2av	Distribution of oil products	Corrections of statistical data (gasoline consumption) from Statistics Estonia	NMVOC	2018
2A6	Other mineral products	Emissions reallocated to NFR 2L	NH_3	2000-2003
		Emissions reallocated to NFR 1A2gviii	SO_2	2001
2B1	Ammonia production	Additionally calculated emission	CO	2002-2003; 2005-2006
2B10a	Chemical industry: Other	Emissions reallocated to NFR 1A2gviii	SO_2	2003-2004
		Additionally calculated emission	NOx	2010; 2013-2014
			CO	2009-2010; 2013
2B10b	Storage, handling and transport of chemical products	Additionally calculated emission	BC	2018
2C1	Iron and steel production	Additionally calculated emission	Cd	2000-2018
		Emissions reallocated from NFR 2C7ai	$PM_{2.5}$, PM_{10}, TSP, BC	2009-2018

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NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
2C3	Aluminium production	Additionally calculated emission	PCDD/F, HCB	2007-2018
2C5	Lead production	Additionally calculated emission	PCDD/F, PCB	2000-2018
2C7a	Copper production	Emissions reallocated to NFR 2C1	$PM_{2.5}$, PM_{10}, TSP, BC	2009-2018
2C7c	Other metal production	Correction of emissions data.	Zn	2010-2018
2D3a	Domestic solvent use including fungicides	Corrections of statistical activity data from Statistics Estonia	NMVOC	2017-2018
2D3d	Coating application	Corrections of statistical activity data from Statistics Estonia	NMVOC	2018
2D3h	Printing	Corrections of statistical activity data from Statistics Estonia	NMVOC	2018
2G	Other product use	Correction of emission factors (use of tobacco)	$PM_{2.5}$, TSP	2000-2018
			TSP, Cd, Hg, As, Cu	1990-2018
		Emissions were relocated from NFR 1A3bi, 1A3bii, 1A3biii and 1A3biv	Pb, Cd, Cr, Cu, Ni, Se, Zn	1990-2018
		Tier 2 methodology were used for emissions calculations from lubricant use	NMVOC	1990-2018
2H2	Food and beverages industry	Additionally calculated emission	PM2.5, PM10, TSP	2007
2L	Other production, consumption, storage, transportation or handling of bulk products	Emission reallocated from NFR 2A6	NH3	2000-2003
		Additionally calculated emission	NH3	1990-1999
3B1a	Manure management - Dairy cattle	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3B1b	Manure management - Non-dairy cattle	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3B2	Manure management - Sheep	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3B3	Manure management - swine	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3B4d	Manure management - Goats	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
		Corrected emission.	PM_{10}	2005
3B4e	Manure management - horses	Renewed emission factor from GB2019	NOx, NH3	1990-2018
3B4gi	Manure management - Laying hens	Renewed emission factor from GB2019	NOx, NH3	1990-2018
3B4gii	Manure management – Broilers	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3B4h	Manure management - Other animals	Renewed emission factor from GB2019	NO_x	1990-2018
		Corrected emission.	NMVOC	2017
3Da2a	Animal manure applied to soils	Renewed emission factor from GB2019	NO_x, NH_3	1990-2018
3Da2c	Other organic fertilisers applied to soils	Corrections of statistical activity data	NO_x, NH_3	1990-2018
3Da3	Urine and dung deposited by grazing animals	Renewed emission factor from GB2019	NH3	1990-2018
3De	Cultivated crops	Corrections of statistical activity data from Statistics Estonia	NMVOC	2018
5B2	Biological treatment of waste – Anaerobic digestion at biogas facilities	Corrections of activity data	NH_3	1996-1998, 2004-2018
5C1bi	Industrial waste incineration	Corrected emissions data form the OSIS point sources database	NO_x, NMVOC, SO_2, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, As, Cr, Cu, Ni	2018
5C1bv	Cremation	Corrections of activity data	NOx, NMVOC, SOx, PM2.5, PM10, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PAHs, HCB, PCBs	2018
5E	Other waste	Corrections of activity data	$PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Cu, PCDD/F	2018

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

The differences in total emissions between the 2010 and 2021 submissions are presented in the Table 0.2.

Table 0.2 Difference between the 2020 and 2021 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
1990	0.23	4.42	0.87	-2.84	NR	NR	0.69	0.00	7.64	0.19	0.12	1.36
1991	0.89	4.48	0.88	-2.90	NR	NR	0.68	0.00	8.17	0.19	0.20	1.40
1992	2.33	5.36	0.90	-3.96	NR	NR	0.61	0.00	14.35	0.24	0.45	1.30
1993	2.62	5.33	0.87	-3.90	NR	NR	0.63	0.00	11.92	0.23	0.55	1.38
1994	1.46	3.12	0.69	-3.19	NR	NR	0.47	0.00	4.80	0.14	0.14	1.03
1995	1.04	2.63	1.08	-3.67	NR	NR	0.60	0.00	4.15	0.24	0.10	1.10
1996	1.32	2.84	1.09	-4.05	NR	NR	0.73	0.00	3.92	0.33	0.18	1.21
1997	1.19	1.62	0.60	-3.83	NR	NR	0.51	0.00	2.03	0.24	0.08	0.61
1998	1.23	1.12	0.33	-3.71	NR	NR	0.34	0.00	1.26	0.14	0.05	0.34
1999	0.70	0.37	0.00	-3.91	NR	NR	0.07	0.00	0.27	0.00	0.00	0.01
2000	0.87	0.39	0.02	-4.25	0.40	0.19	0.09	0.14	0.21	0.01	0.31	0.02
2001	0.83	0.36	0.05	-4.55	0.28	0.14	0.07	-0.12	0.14	0.00	0.32	0.00
2002	0.67	-0.33	-0.01	-4.63	-0.48	-0.26	-0.15	-1.87	-2.48	-0.05	-0.87	-0.07
2003	1.28	0.46	0.00	-4.21	0.43	0.30	0.19	-0.06	0.18	0.00	0.32	0.00
2004	0.68	0.11	-0.01	-3.03	-0.02	0.03	0.04	-0.87	-0.70	-0.02	0.06	0.99
2005	0.47	0.23	0.00	-3.27	0.09	0.12	0.09	-0.87	0.12	0.00	0.32	0.70
2006	0.20	0.20	0.00	-2.51	0.06	0.09	0.09	-1.25	0.11	0.00	0.26	-0.01
2007	-0.41	0.07	0.00	-3.17	-0.11	-0.02	0.02	-1.40	0.05	0.00	0.27	-0.01
2008	-0.90	-0.04	0.00	-1.98	-0.27	-0.17	-0.11	-1.54	0.02	-0.03	0.32	-0.01
2009	-1.38	-0.53	-0.01	-1.95	-0.44	-0.27	-0.18	-1.86	0.03	0.00	0.26	-0.02
2010	-1.97	-0.83	0.00	-1.04	-0.43	-0.25	-0.19	-1.85	0.09	0.00	0.29	-0.02
2011	-2.22	-1.30	-0.02	0.19	-0.43	-0.23	-0.19	-1.94	-0.29	-0.01	0.07	-0.02
2012	-2.74	-1.55	0.01	0.45	-1.08	-0.65	-0.44	-3.66	0.01	0.00	0.26	0.00
2013	-3.09	-1.41	0.00	0.80	-0.86	-0.51	-0.39	-3.36	-0.30	0.00	0.11	-0.02
2014	-4.68	-1.96	-0.03	2.13	-1.68	-0.96	-0.67	-5.24	-0.07	0.00	0.39	-0.02
2015	-6.79	-2.22	-0.03	2.25	-1.76	-1.16	-0.86	-4.74	-0.17	0.00	0.47	-0.01
2016	-6.22	-2.29	-0.01	0.87	-1.85	-1.18	-0.84	-5.02	0.05	0.01	0.65	-0.01
2017	-6.62	-2.25	-0.03	1.02	-1.70	-1.11	-0.81	-4.58	-0.04	0.00	2.01	-0.02
2018	-7.18	-1.78	0.04	1.14	-2.42	-1.44	-0.95	-6.54	0.90	0.03	1.56	0.13

Table 0.2 continues

Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
1990	0.07	0.16	0.57	0.14	-8.70	0.55	21.82	11.39	28.33	-59.33
1991	0.07	0.22	0.58	0.14	-8.14	0.72	21.93	10.84	25.58	-61.48
1992	0.06	0.31	0.71	0.18	5.92	1.12	26.71	17.15	36.12	-56.15
1993	0.07	0.33	0.69	0.17	-3.51	1.17	24.84	13.95	39.58	-66.57
1994	0.06	0.15	0.46	0.13	-16.95	0.48	17.05	-2.91	14.75	-69.90
1995	0.06	0.19	0.67	0.20	-8.33	0.60	19.51	-1.58	8.20	-58.44
1996	0.06	0.21	0.70	0.21	-7.75	0.68	17.39	-2.15	7.10	-60.97
1997	0.04	0.11	0.32	0.12	-16.58	0.35	7.14	-7.47	5.62	-62.87
1998	0.03	0.06	0.13	0.07	-23.54	0.20	3.36	-14.19	2.64	-69.95
1999	0.02	0.00	-0.04	0.00	-25.76	0.01	-0.21	-16.00	2.43	-67.29
2000	0.02	0.00	-0.05	0.01	-27.14	0.01	2.37	-16.15	2.34	-57.93
2001	0.03	0.00	-0.08	0.00	-32.73	0.00	4.01	-20.02	-2.36	-73.79
2002	0.03	-0.22	-0.23	-0.02	-34.83	-0.83	1.87	-24.40	0.74	-70.59
2003	0.02	0.00	-0.12	0.00	-32.61	0.00	-4.37	-23.98	7.52	-76.44
2004	0.02	-0.06	-0.09	-0.01	-32.36	-0.22	7.24	-27.62	-6.41	-63.68

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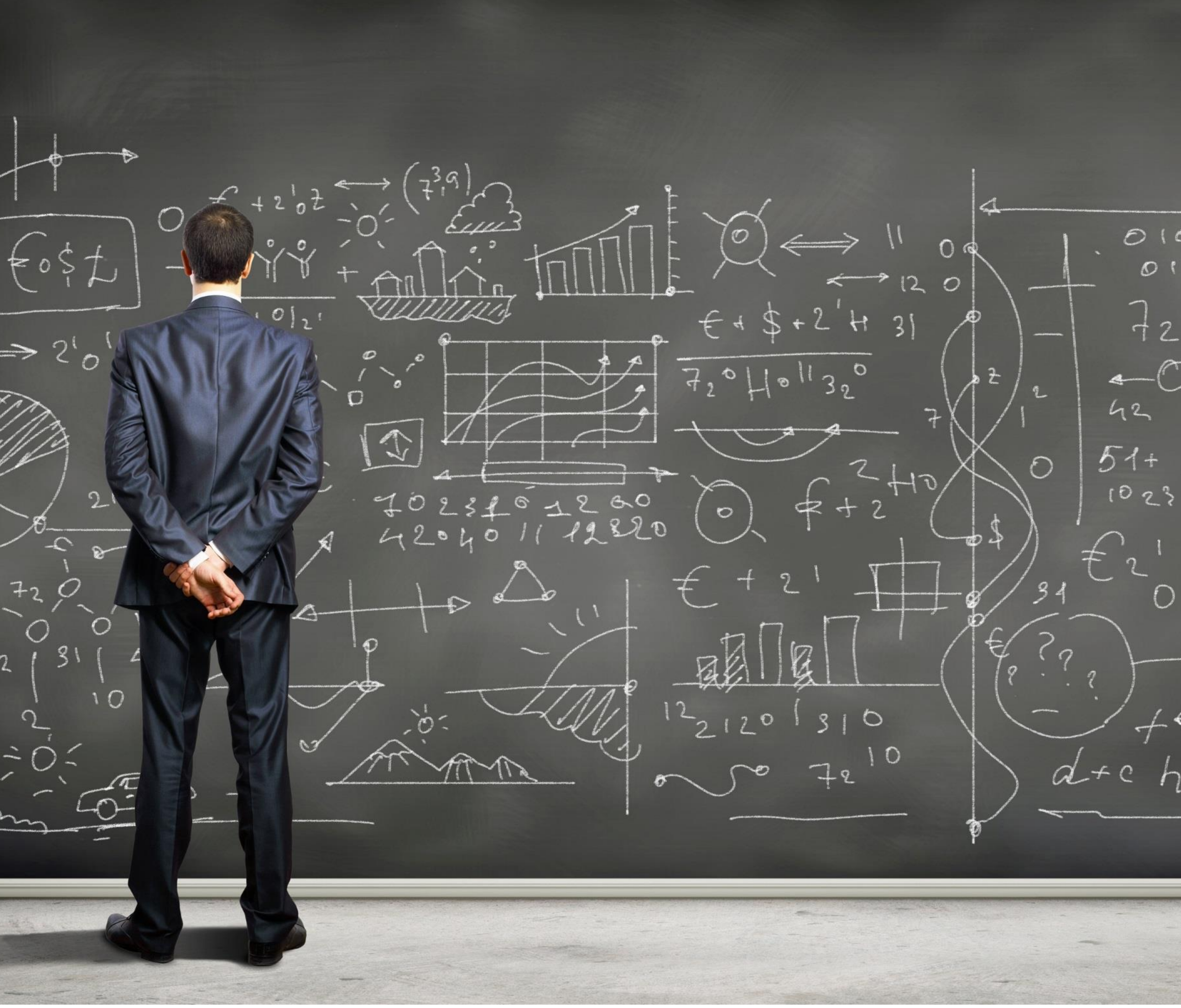
Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
2005	0.07	0.00	-0.04	0.00	-34.41	0.01	12.54	-29.86	3.23	-63.93
2006	0.03	0.00	-0.01	0.00	-37.08	0.01	6.87	-27.58	5.25	-59.23
2007	0.02	0.00	-0.10	0.00	-37.12	0.01	-21.32	-20.51	2.84	-36.23
2008	0.03	0.00	-0.11	0.00	-36.17	0.01	0.96	-24.65	-1.88	-64.73
2009	0.03	0.00	0.02	0.00	-34.03	0.01	7.59	-30.07	6.44	-71.56
2010	0.02	0.01	0.04	0.01	-31.25	0.04	-5.03	-37.54	9.97	-77.78
2011	0.02	-0.01	0.11	0.00	-33.39	-0.04	10.87	-38.97	15.13	-74.77
2012	0.03	0.01	0.19	0.00	-32.60	0.17	12.73	-39.38	9.36	-75.57
2013	0.02	-0.02	0.24	0.00	-33.70	0.12	16.22	-43.42	6.38	-77.89
2014	0.03	0.01	0.33	0.00	-33.68	0.23	13.98	-46.17	24.18	-79.35
2015	0.03	0.01	0.51	0.00	-18.58	0.31	14.91	-49.17	17.70	-84.81
2016	0.03	0.02	0.63	0.01	-19.41	0.27	20.38	-49.07	23.98	-83.25
2017	0.03	0.00	0.21	0.00	-37.27	0.23	23.86	-53.19	21.81	-84.24
2018	0.04	0.16	0.57	0.14	-8.70	0.55	21.82	11.39	28.33	-59.33

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

Priorities for future inventory improvement:

- Check the activity data and emission factors in energy industries. The main problem appears to be a discrepancy in the data regarding fuel consumption between statistical energy balance and the reports of the facilities;
- Comprehensive check of activity data and emissions in waste sector.



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1. INTRODUCTION

1.1. National Inventory Background

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

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

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

Estonia's Informative Inventory Report is due by March 2020. The report contains information on Estonian emission inventory from 1990 to 2019. The inventory detail the anthropogenic emissions of the main pollutants (SO_x, NO_x, NMVOC, NH_3 and CO), particulate matter (TSP, PM_{10}, $PM_{2.5}$), heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn) and persistent organic pollutants (dioxins, HCB, PAHs, PCB). Projected emissions for sulphur dioxide, nitrogen oxides, ammonia, $PM_{2.5}$ and NMVOCs are reported for the years 2020, 2025 and 2030.

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

1.2. Institutional Arrangements for Inventory Preparation

The Atmospheric Air Protection Act regulates data collection and reporting. Methods for the calculation of emissions are laid down in several regulations of the Minister of the Environment. The Air Pollution Database consists of data on point sources (about 1,950 reports for the year 2018) and diffuse sources. Structure and emission calculations from small point sources and area sources are mainly based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019.

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 the Environment. 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

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

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

1.3. The Process of Inventory Preparation

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

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

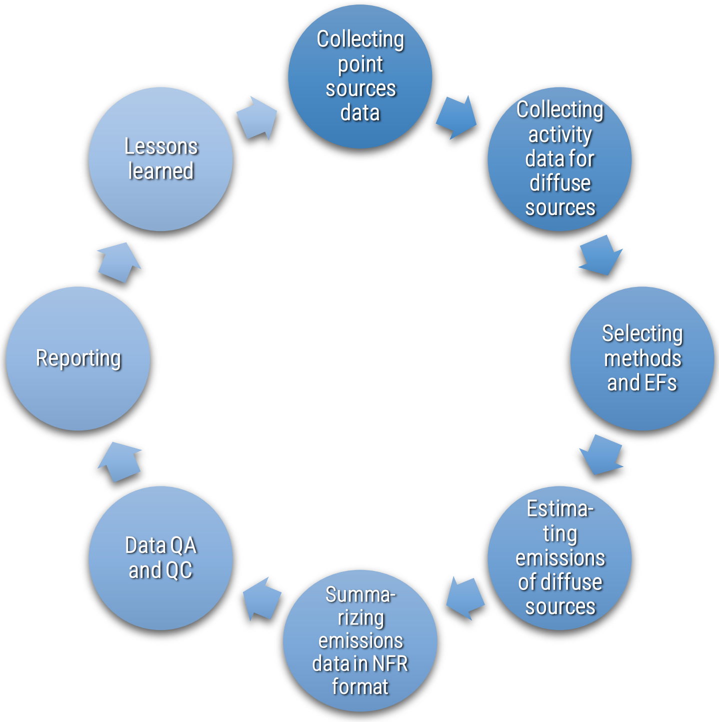

Figure 1.1 The main activities of inventory preparation

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

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

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

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

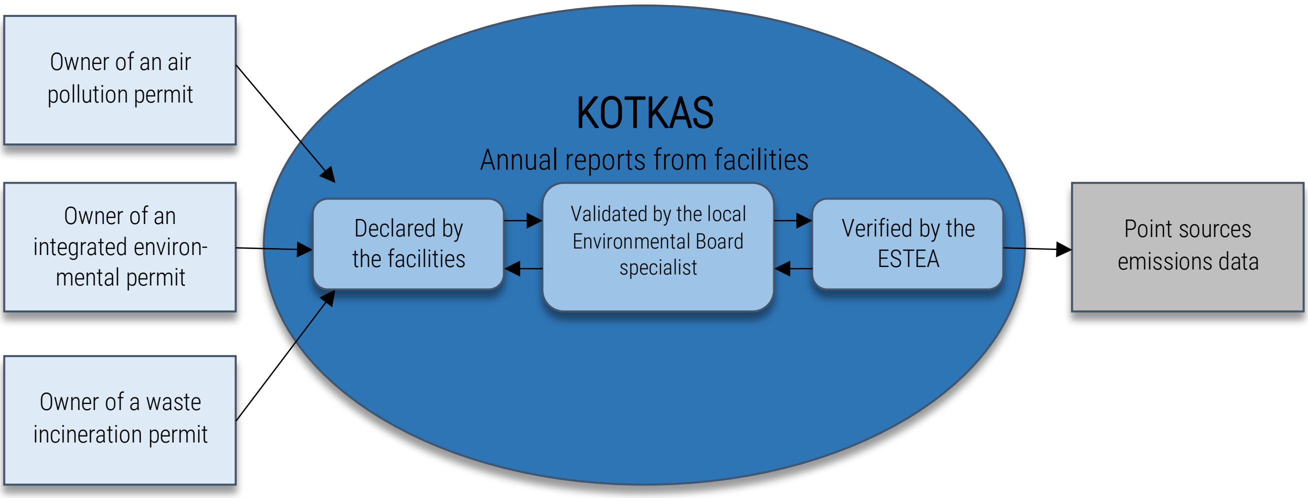

Figure 1.2 Validation of Estonian point sources data

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

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

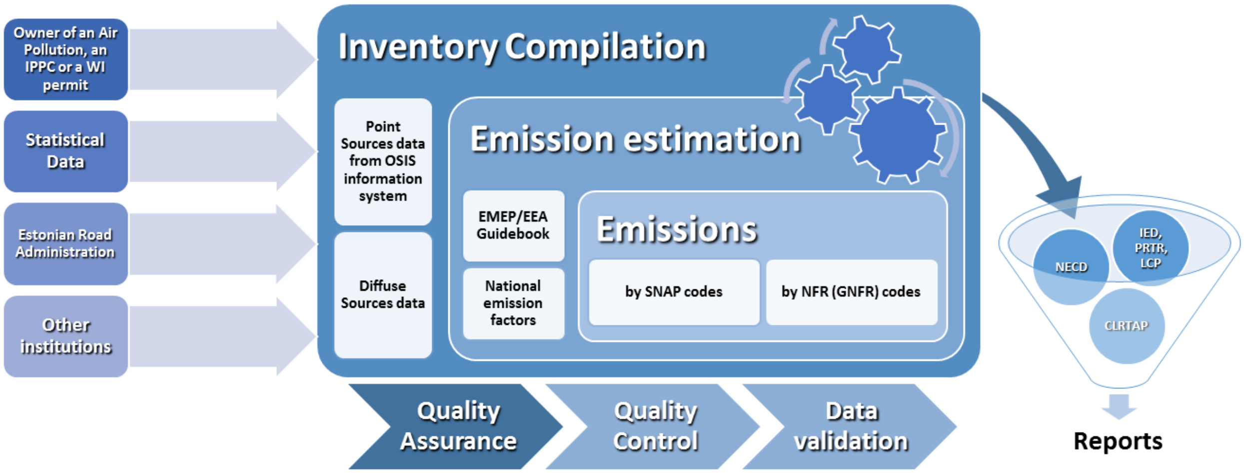

Figure 1.3 Air pollution inventory structure

1.4. Methods and Data Sources

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

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

Diffuse sources Fuel = EB fuel – PS fuel

With regard to the calculation of emissions from road transport, the COPERT 5 program (ver. 5.4.36) and emission factors are used. Total emissions are calculated on the basis of the combination of firm technical data (e.g. emission factors) and activity data (e.g. number of vehicles, annual mileage per vehicle, average trip, speed, fuel consumption, monthly temperatures). ESTEA has obtained vehicle data (passenger cars, light and duty vehicles, buses, motorcycles) and annual mileage per vehicle from the Estonian Road Administration. Meteorological data are provided by the ESTEA's Meteorological Observation Department and data pertaining to fuel consumption by Statistics Estonia.

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

1.5. Key Categories

This chapter presents the results of Estonian key sources analyses.

Key sources analysis is based on methods described in the EMEP/EEA Guidebook 2019.

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

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

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

Decorative coating application (2D3d) is a main source of NMVOC (20.0%). Additionally, road transport (1A3bi) domestic solvent use (2D3a), combustion in residential plants (1A4bi), manure management (dairy cattle, non-dairy cattle and swine), distribution of oil products (1B2av) and road transport (1A3bi) constitute key sources.

According to level assessment SO_2 emissions from the energy sector are responsible for 59.6% of SO_2 emissions in 2019. The majority of these emissions come from two oil shale power plants in east Estonia (Eesti and Balti power plants).

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

Combustion in residential plants (1A4bi) is a key source for particles. In addition, the public electricity and heat productions (1A1a) is a key source for TSP, PM_{10}, $PM_{2.5}$, BC and heavy metals. The influence of combustion in manufacturing industries and construction: (1A2gviii) is also significant for them.

According to level assessment, 48.9% of CO emissions come from residential combustion plants (1A4bi). In addition, road transport (1A3bi) and the oil-shale industry (1A1c) are the main polluters of CO. Combustion in the residential sector is also a key source for HCB and PAHs also.

Table 1.1 Results of key sources analysis

Pollutant	Key categories (Sorted from high to low from left to right)										Total (%)
SO_x	1A1a	1A2gviii	1A1c								92.5
	59.6%	20.2%	12.7%								
NO_x	1A1a	1A4bi	1A3bi	1A3biii	3Da1	1A3bii	1A4cii	1A2gvii			81.6
	22.9%	18.2%	12.0%	10.5%	6.6%	4.6%	3.9%	3.0%			
NH_3	3B1a	3Da2a	3Da1	3B1b	3B3	3Da3					82.4
	26.5%	20.9%	17.1%	7.3%	7.0%	3.5%					
NMVOC	2D3d	2D3a	1A4bi	3B1a	3B1b	2D3i	1A3bi	2H2	1B2av	2D3h	80.7
	20.0%	13.7%	13.5%	6.9%	6.6%	4.6%	3.9%	3.2%	3.1%	2.3%	
CO	1A4bi	1A1c	1A3bi								82.7
	48.9%	26.9%	6.9%								
TSP	2A5b	1A4bi	1A1a	1A2gviii	3Dc	2I	1A1c	1A3bvi			80.6
	24.3%	17.1%	14.6%	9.4%	6.6%	3.5%	3.1%	1.9%			
PM_{10}	1A4bi	1A1a	1A2gviii	2A5b	3Dc	1A1c	1A3bvi				81.5
	23.7%	17.5%	13.1%	11.1%	9.9%	4.1%	2.2%				
$PM_{2.5}$	1A4bi	1A1a	1A2gviii	1A1c	1A3bi	1A3bvi					81.7
	35.8%	19.6%	19.1%	3.0%	2.3%	1.9%					
Pb	1A1a	1A4bi									83.8
	60.3%	23.6%									
Hg	1A1a	1A4bi									82.9
	62.0%	23.6%									
Cd	1A4bi	1A1a	1A2gviii								93.7
	44.5%	35.0%	14.2%								
DIOX	1A1a	1A2gviii	1A4bi	5E	5C1bi						85.0
	27.6%	21.7%	16.1%	12.2%	7.5%						
PAH	1A4bi	1A2gviii									88.3
	78.8%	9.5%									
HCB	1A4bi	1A1a									82.5
	45.3%	37.2%									

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1.6. QA/QC and Verification Methods

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

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

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

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

- **Stakeholder engagement (stakeholders = e.g. suppliers of data, reviewers, recipients, other inventory compiling institutes):** The Estonian inventory was reviewed under the stage 3 review in 2016 summer by the EMEP emission centre CEIP acting as the review secretariat. The results are available at CEIP home page (http://www.ceip.at/review-process/centralised-review-stage-3/).
  In 2017-2020 the Estonian inventory has been a subject for the comprehensive technical review of national emission inventories pursuant to the Directive on the Reduction of National Emissions of Certain Atmospehric Pollutants (Directive (EU) 2016/2284). The recommendations from TERT and improvements made in the inventory are included in the Annex II of the IIR.
- **Data collection:** Data collection includes both point sources emissions and diffuse sources activity. Prior to using activity data, common statistical quality checking related to the assessment of trends is carried out.
  ESTEA uses only point sources data, which are checked and validated by local environmental departments.
- **Data manipulation:** Common statistical quality checking is carried out.
- **Inventory compilation:** Before submitting data to CEIP/EEA NFR, formats have to be checked with RepDab.
- **Reporting**
- **Archiving**

1.7. General Uncertainty Evaluation

Uncertainty analysis has been carried out for the 2020 submission under the terms and conditions of the LRTAP Convention as part of the Estonian IIR 2020.

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 2019. Tier 1 methodology calculations are based on the emissions for the base year and what is known as the reference year, and on activity rate uncertainties and emissions factors for every NFR sector. Firstly, the uncertainty level was calculated on a pollutant-by-pollutant basis for every subcategory, and then the uncertainty levels for all subcategories were added together, thereby producing the overall uncertainty level for the inventory data. Uncertainty levels were also evaluated for aggregated sectors such as stationary combustion, aviation, road transport, other forms of transportation, industrial processes, solvent use, and agriculture and waste management; the results are presented under each IIR chapter. The base year for all pollutants was 1990, except for the PM_{10} and $PM_{2.5}$ figures, in which case the appointed base year was 2000. The reference year is 2019.

The uncertainty values for emissions factors were for the most part based on the figures that are included in the EMEP/EEA guidance document. If the default figures for uncertainty values of specific pollutant emissions were not set out in the guidance document, then expert evaluations were also used. The recommended range of error that is listed in the EMEP/EEA Guidebook 2019 for source data and emissions factors is given in Table 1.3. The margins of error for source data and emissions factors in this document are shown respectively by sectors in Table 1.2 and Table 1.4.

Table 1.2 Activity data uncertainty and sources

NFR sector	Uncertainty, %	Data source
1A1	2	National energy statistics; operators data
1A2	2	National energy statistics; operators data
1A3	2	National energy statistics; operators data
1A4 (liquid fuels)	3	National energy statistics; operators data
1A4 (solid fuels)	2	National energy statistics; operators data
1A4 (natural gas)	2	National energy statistics; operators data
1A4 (biomass)	5	National energy statistics; operators data
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					
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.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)				

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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
2.D.3.b		D			D	D	D						
2.D.3.d		C											
2.D.3.e		B											
2.D.3.f		B											
2.D.3.g		B		D									
2.D.3.h		C											
2.D.3.i		C				B							
2.G	C	C	C	C	C	C	C	C	C	D	D		
2.H.1	C	C			D	D	D	C					
2.H.2		C			D	D	D						
2.L				E									
3.B.1.a	D	D		D	D	D	D						
3.B.1.b	D	D		D	D	D	D						
3.B.2	D	D		D	D	D	D						
3.B.3	D	D		D	D	D	D						
3.B.4.e	D	D		D	D	D	D						
3.B.4.gi	D	D		D	D	D	D						
3.B.4.gii	D	D		D	D	D	D						
3.B.4.giv	D	D		D	D	D	D						
3.B.4.h	D	D		D	D	D	D						
3.D.a.1	D	D		D	D	D	D						
5A		C		C	C	C	C						
5.B.1		C		C									
5.B.2	C	C	C	C			C	C					
5.C.1.bi	C	C		C	C	C	C	C		D			
5.C.1.biii										D			
5.C.1.bv	C	C	C	C	C	C	C	C	C	C	C	C	C
5.C.2	C	C	C		D	D	D	C	D	D	D	D	D
5.D.1		C											
5.D.2	C	C	C	C									
5.E		D			D	D	D		D				

1.7.2. Results of Uncertainty Evaluation

Table 1.5 shows the results of the uncertainty evaluation, which include the estimated emissions by pollutants for both 1990 and 2019, the uncertainties for trends in 1990-2019, and the full uncertainty figures for 2019's national emissions.

Table 1.5 Uncertainty evaluation

Pollutant	Total emission, 1990	Total emission, 2019	Unit	Trend in 1990-2019, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	80.060	25.164	kt	-68.57	13.07	2.59
NMVOC	66.555	22.694	kt	-65.90	18.78	5.44
SO_x	274.744	18.884	kt	-93.13	6.69	0.22
NH_3	21.558	10.594	kt	-50.86	39.52	10.14
$PM_{2.5}$	15.385	5.880	kt	-61.78	9.96	3.40
PM_{10}	32.134	9.237	kt	-71.25	16.61	4.70
TSP	281.008	13.936	kt	-95.04	26.20	1.30
CO	254.286	130.800	kt	-48.56	11.53	6.20
Pb	207.500	11.374	t	-94.52	93.41	3.09
Cd	4.566	0.552	t	-87.92	72.18	9.81
Hg	1.217	0.327	t	-73.11	97.66	9.61
PCDD/F	9.898	4.584	g I-TEQ	-53.69	81.81	57.12
B(a)p	2.603	0.900	t	-65.43	80.61	38.57

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Pollutant	Total emission, 1990	Total emission, 2019	Unit	Trend in 1990-2019, %	Uncertainty, %	Trend uncertainty 1990-2019, %
B(b)f	3.197	0.893	t	-72.07	76.38	34.62
B(k)f	1.635	0.575	t	-64.81	83.17	38.77
I(1,2,3-cd)p	1.693	0.846	t	-50.03	90.29	44.17
HCB	0.252	0.345	kg	36.64	106.87	67.02
PCB	3.406	0.438	kg	-87.14	156.71	9.23

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

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

1.8. General Assessment of Completeness

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

Table 1.6 Sources not estimated (NE)

NFR19 code	Substance(s)	Reason for not estimated
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, PCBs	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, PAHs	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, PAHs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
1A3di(i)	NH_3, PAHs	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 2019
1B2c	NH_3, Se	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2A1	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2A2	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019

NFR19 code	Substance(s)	Reason for not estimated
2A3	NH_3	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2A5a	BC	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 2019
2D3e	$PM_{2.5}$, PM_{10}	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3f	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2019
2D3g	NO_x, SO_2, $PM_{2.5}$, BC, HMs (exc. Cr, Zn), PCDD/F, PAHs, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3h	$PM_{2.5}$, PM_{10}, BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2D3i	NO_x, SO_2, $PM_{2.5}$, BC, CO, HMs (exc. Cr), PCDD/F, PAHs, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2G	Se, HCB, PCBs	Emission have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
2L	BC	Emission have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
3Fd	HCB	Emissions have not been estimated due to lack of activity data for the previous years
5A	CO, Hg	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
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 2019
5B2	NH_3, $PM_{2.5}$, PM_{10}, BC	Emissions have not been estimated due to lack of activity data
5C1bi	Se, Zn, PAHs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5C1biii	NO_x, NMVOC, SO_2, NH_3, PMs, CO, HMs, PAHs, HCB, PCBs	As this is a minor source of pollution, emissions have not been estimated
5C1bv	BC	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2019
5C2	NH_3, Se, I(1,2,3-cd)p	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5D1	NO_x, SO_2, NH_3, PMs, HMs	For NO_x and SO_2 emissions have not been estimated due to the lack of activity data. For PMs and HMs emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5D2	PMs, HMs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019
5E	NO_x, SO_2, NH_3, BC, CO, Ni, Se, Zn, POPs (exc. PCDD/F)	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2019

Table 1.7 Sources included elsewhere (IE)

NFR19 code	Substance(s)	Included under NFR code
1A2a	NH_3, all POPs	1A2gviii
1A2b	NH_3, all POPs	1A2gviii
1A2c	NH_3, all POPs	1A2gviii
1A2d	All POPs	1A2gviii
1A2e	All POPs	1A2gviii
1A2f	All POPs	1A2gviii
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
5C1a	All (2013-2019)	1A1a
5D2	NMVOC (1994-2007)	5D1

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Source: 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: 1990–2019;
- PM_{10}, $PM_{2.5}$ and BC: 2000–2019;
- All Heavy Metals: 1990–2019;
- POPs: 1990–2019.

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 2019. Emissions of all substances decreased significantly over the entire period (table 2.1, figures 2.1-2.3). Information for each substance separately, as well as key sources and the reasons for the decrease are described below

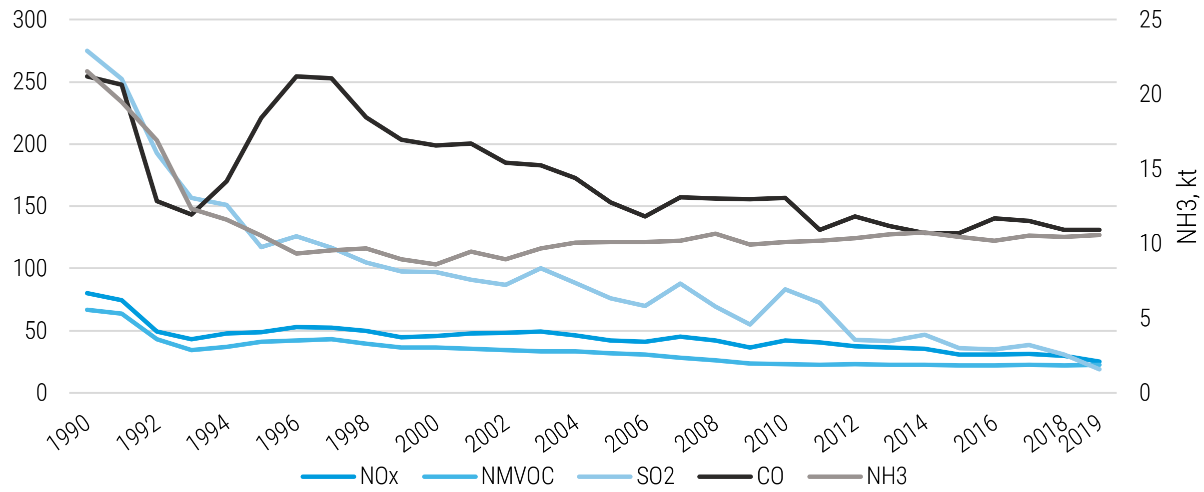

Figure 2.1 Main pollutants emissions trends in the period 1990-2019, kt

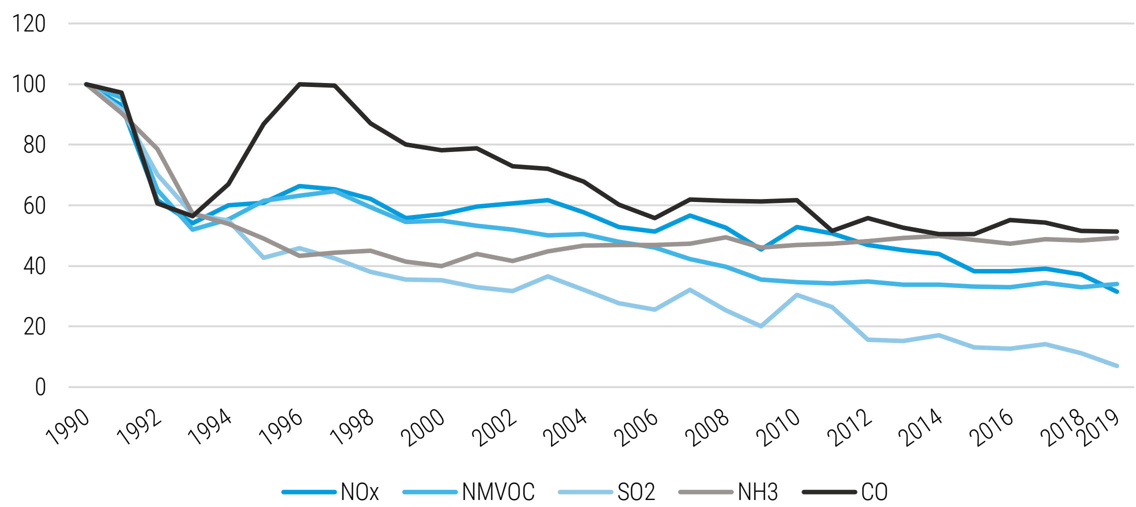

Figure 2.2 Indexed of main pollutants emissions (1990=100) in the period 1990-2019

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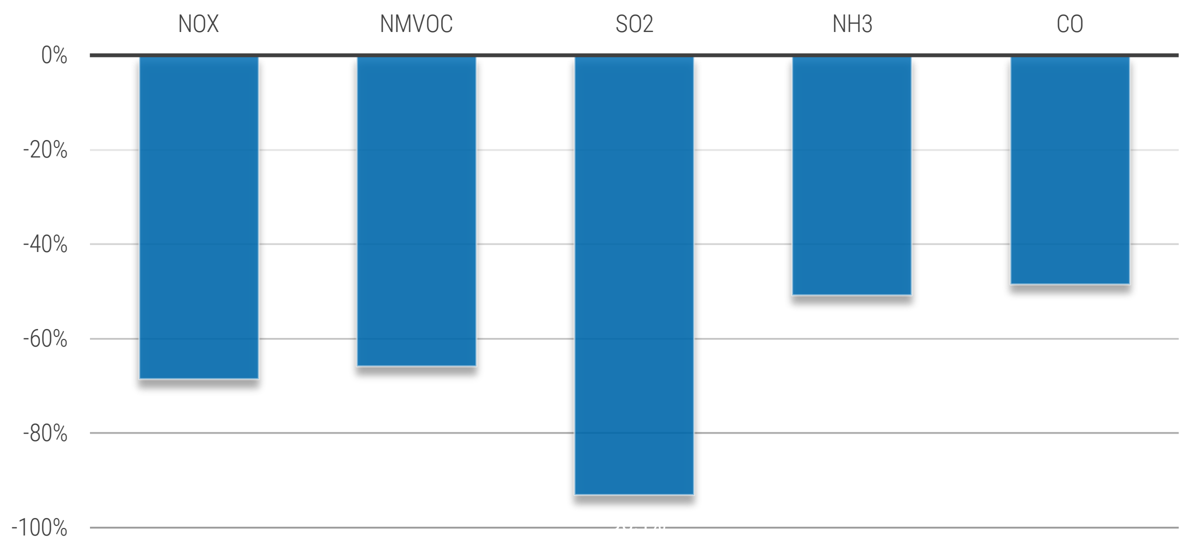

Figure 2.3 Reduction of main pollutants emissions in the period 1990-2019

Table 2.1 Main pollutant emissions in the period of 1990–2019 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	CO
1990	80.060	66.555	274.744	21.558	254.286
1991	74.390	63.568	252.299	19.494	247.473
1992	49.344	43.359	192.718	16.929	154.164
1993	43.374	34.605	156.565	12.342	143.579
1994	47.996	36.804	151.077	11.606	170.323
1995	48.764	40.983	116.984	10.546	220.964
1996	53.080	42.034	126.065	9.348	254.403
1997	52.259	43.091	116.621	9.545	252.877
1998	49.689	39.566	104.640	9.680	221.481
1999	44.639	36.284	97.783	8.935	203.528
2000	45.663	36.618	97.129	8.602	198.949
2001	47.761	35.492	90.765	9.453	200.674
2002	48.500	34.585	87.045	8.958	185.147
2003	49.408	33.334	100.324	9.665	183.027
2004	46.106	33.612	88.180	10.060	172.508
2005	42.286	31.857	76.299	10.094	152.901
2006	41.080	30.668	69.919	10.101	141.685
2007	45.373	28.088	88.059	10.214	157.476
2008	42.074	26.372	69.497	10.672	156.358
2009	36.330	23.595	54.887	9.938	155.873
2010	42.342	23.013	83.294	10.093	156.809
2011	40.651	22.836	72.708	10.213	131.126
2012	37.496	23.160	42.907	10.368	141.635
2013	36.256	22.535	41.695	10.618	133.888
2014	35.266	22.453	46.816	10.737	128.673
2015	30.676	22.054	36.058	10.454	128.636
2016	30.576	21.873	34.934	10.206	140.094
2017	31.268	22.861	38.636	10.529	138.143
2018	29.830	21.987	30.872	10.428	130.968
2019	25.164	22.694	18.884	10.594	130.800
Change 1990-2019, %	-68.6	-65.9	-93.1	-50.9	-48.5
Change 2005-2019, %	-40.5	-28.8	-75.3	4.9	-14.5
Change 2018-2019, %	-15.6	3.2	-38.8	1.6	-0.1

2.1.1. Sulphur Dioxide

During the period of 1990–2019, the emissions of sulphur dioxide had decreased by about 93.1%, which was largely influenced by a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 232 PJ in 1990 to 123 PJ in 2019) (see Figure 2.3 and 2.4, Tables 2.1 and 2.2). The latter, in turn, was the result of a restructuring of the economy. Likewise, the export possibilities regarding electricity have also decreased noticeably.

The use of local fuels (including wood, oil shale oil) and natural gas has been constantly increasing since 1993, while the relevance of heavy fuel oil in the production of thermal energy has reduced.
The use of fuel with lower sulphur content was also the reason for a decrease in SO_2 emissions (with regard to fuel for road transport and heating). Other reasons for the decrease in emissions are given below.

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

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	5 Waste	Total
1990	220.88	38.51	8.45	3.21	3.68	NE/NA/NO	0.000	0.01	274.74
1995	90.27	19.51	3.55	2.59	1.05	NE/NA/NO	0.000	0.02	116.98
2000	81.11	10.10	2.71	2.55	0.59	NE/NA/NO	0.042	0.02	97.13
2005	62.15	12.17	1.46	0.06	0.32	NE/NA/NO	0.132	0.01	76.30
2010	78.21	4.14	0.75	0.01	0.12	0.02	0.032	0.02	83.29
2015	30.58	4.92	0.47	0.01	0.02	0.03	0.003	0.03	36.06
2016	29.23	5.09	0.51	0.01	0.02	0.02	0.002	0.05	34.93
2017	32.47	5.68	0.42	0.01	0.03	0.03	0.002	0.01	38.64
2018	25.34	4.79	0.59	0.01	0.03	0.03	0.002	0.08	30.87
2019	13.65	4.52	0.58	0.01	0.02	0.03	0.002	0.08	18.88
Share in total 1990 emission, %	80.39	14.02	3.08	1.17	1.34		0.000	0.005	
Share in total 2019 emission, %	72.26	23.92	3.08	0.04	0.12	0.13	0.01	0.43	
Change 1990-2019, %	**-93.8**	**-88.3**	**-93.1**	**-99.8**	**-99.4**		**21,275.0**	**523.3**	**-93.1**
Change 2018-2019, %	**-46.2**	**-15.6**	**41.8**	**0.9**	**-3.3**	**1.18**	**19.9**	**840**	**-20.1**

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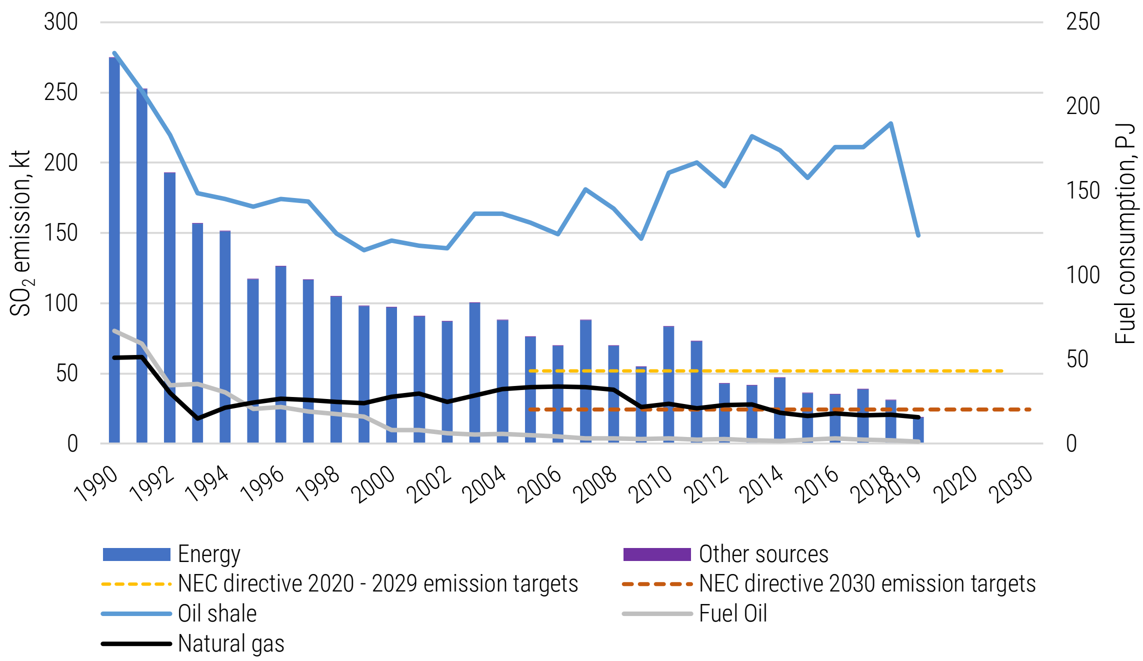

Figure 2.4 SO_2 emissions in the period of 1990–2019 and NEC directive 2016/2284 targets

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

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

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

In 2019, SO_2 emissions had decreased by about 20% when compared to 2018's figures. The main reason for the reduction of emissions was caused by a decrease in electricity production in oil shale power plants (by about 50%) and a higher proportion of cleaner and more efficient units.

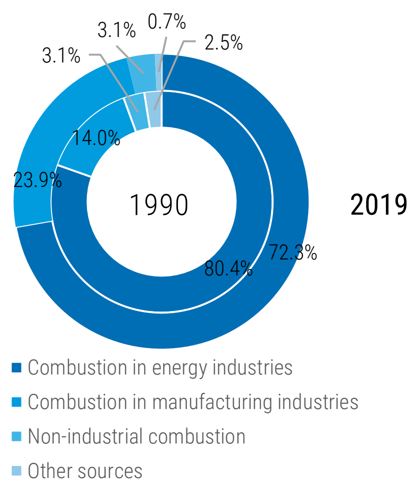

Figure 2.5 SO_2 emissions by sources of pollution in 1990 and 2019

The share of energy sector, including mobile sources, in total SO_2 emission is 99.6%; the combustion in energy industry (NFRs 1A1a-c) is responsible for about 72.3% of total emissions in 2019 (see Table 2.2 and Figure 2.5). The share of SO_2 emissions from the two large oil shale plants – Narva PP (Eesti and Balti PPs) – accounts for approximately 45% of total SO_2 emissions.

The second key SO_2 source is combustion in manufacturing industries (about 24%), and the largest contribution is made by Kiviõli Keemiatööstuse AS (82% from total NFR 1A2), in the boilers of which generator gas is burned (secondary fuel in the production of shale oil).

In 1990 the main polluters of SO_2 were combustion in energy industries (80%) and combustion in manufacturing industries (14%). In 2019, the dominant sources was the same – energy industries, but share of industrial combustion has increased to 24% (Figure 2.5).

According to the new NEC directive 2016/2284, the Member States should comply with the emission reduction commitments set out in this directive. Estonia fulfilled the requirements of the directive and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of sulphur dioxide emissions by 32% relative to 2005 baseline emissions by 2020, already in 2012. SO_2 emissions decreased by 75.3% in 2019 compared to 2005.

2.1.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 68.6% compared to 1990 (see Figure 2.6 and Tables 2.1 and 2.3). The reduction is mainly due to the decrease in energy production and the transport sector during the period of 1990–1993 (the consumption of petrol by road transport dropped 58% at this time and diesel by 45%). The increasing share of catalyst cars in more recent years was also a contributing factor to the reduction of NO_x emissions. Also, one of Eesti Energia's major achievements over the past years is the desulphurisation and denitrification systems that were added to the older energy production units of the Narva Power Plants that use pulverised combustion technology, owing to which the sulphur and nitrogen emissions have decreased by three and almost two times, respectively.

The energy industry and road transport sector are the main sources of nitrogen oxide emissions – 24.4% and 27.1% respectively, the share of other mobile sources was 11.4% and non-industrial combustion – 20.1% in 2019 (see Table 2.3 and Figure 2.7)

Table 2.3 NO_x emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agri-culture	5 Waste	Total
1990	25.69	5.60	5.02	25.11	13.66	NO	0.20	4.77	0.01	80.06
1995	14.08	2.34	10.21	15.61	4.68	NO	0.07	1.76	0.02	48.76
2000	12.78	2.47	8.45	15.15	4.92	0.01	0.20	1.64	0.02	45.66
2005	12.44	1.99	6.15	13.23	6.67	0.01	0.18	1.59	0.01	42.29
2010	15.28	1.62	7.44	9.68	6.30	0.04	0.04	1.91	0.03	42.34
2015	9.23	1.40	5.28	8.26	4.18	0.03	0.05	2.22	0.03	30.68
2016	10.12	1.48	5.43	7.86	3.37	0.02	0.05	2.22	0.03	30.58
2017	10.55	2.11	5.36	7.45	3.42	0.03	0.06	2.26	0.03	31.27
2018	9.44	2.21	5.25	7.11	3.39	0.03	0.06	2.32	0.02	29.83

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 Agri-culture	5 Waste	Total
2019	6.14	1.75	5.05	6.82	2.87	0.02	0.07	2.43	0.03	25.16
Share in total 1990 emission, %	32.09	6.99	6.26	31.36	17.06		0.25	5.96	0.02	
Share in total 2019 emission, %	24.41	6.94	20.06	27.08	11.39	0.09	0.28	9.65	0.10	
Change 1990-2019, %	-76.1	-68.8	0.7	-72.9	-79.0		-64.6	-49.1	91.1	-68.6
Change 2018-2019, %	-35.0	-20.8	-3.9	-4.2	-15.4	-14.9	22.4	4.5	11.1	-15.6

In 2019, NO_x emissions decreased by 15.6% in comparison to 2018's figures. The primary reason for reducing emissions is a decrease in electricity and heat production (emission from energy industries has decreased by 35%).

At the same period the NO_x emission from road transport decreased by 4.2%, mainly by the stricter emission standards for new vehicles categories. This means that new technologies have been introduced gradually and the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage).

Emissions from other mobile sources decreased by 15.4%. The significant decrease in NO_x emissions was due to the gradual penetration of new engine technologies that are used by non-road working machinery which have significantly smaller emission factors compared to older machinery. A decrease in NO_x emissions has occurred also due to a decrease in fuel consumption during that period.

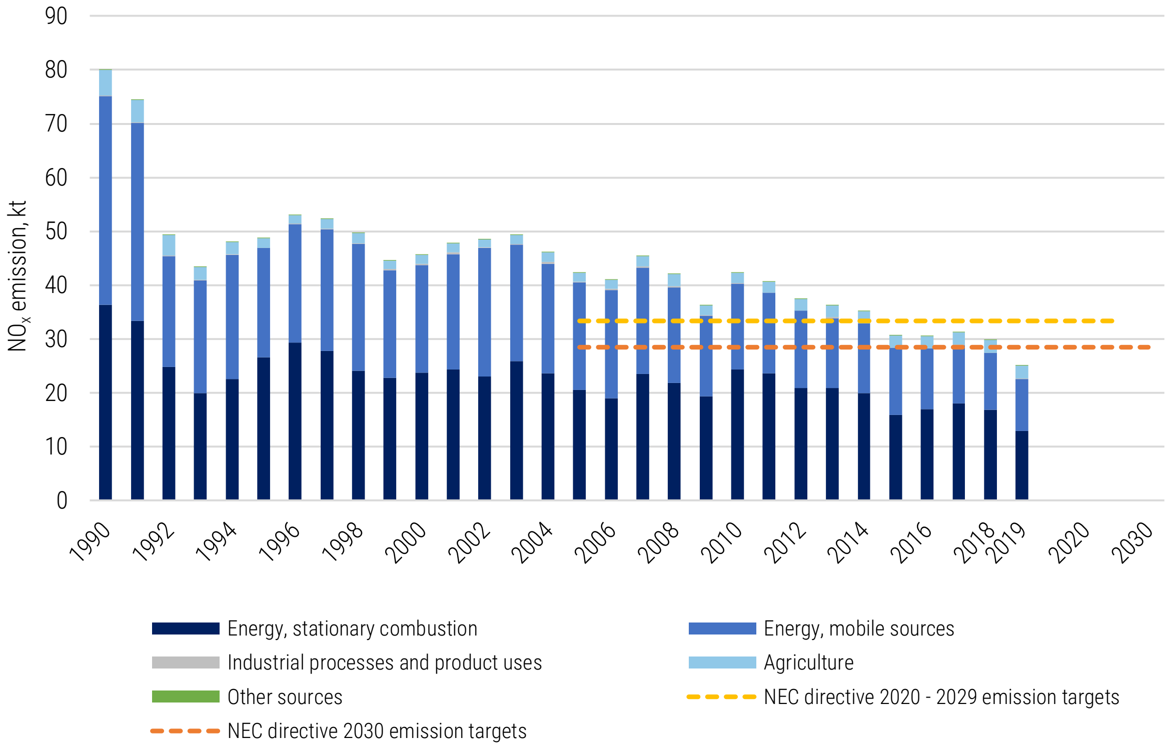

Figure 2.6 NO_x emissions in the period of 1990–2019 and NEC directive 2016/2284 targets

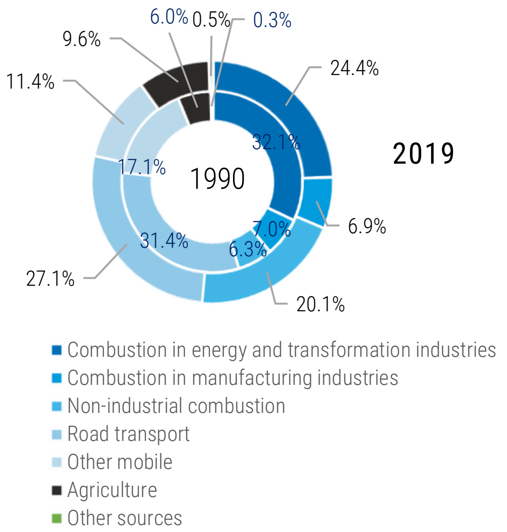

Figure 2.7 NO_x emissions by sources of pollution in the period of 1990 and 2019

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of nitrogen oxides emissions by 18% relative to 2005 baseline emissions by 2020, already in 2015. NOx emissions decreased by 40,5% in 2019 compared to 2005.

2.1.3. Non-Methane Volatile Organic Compounds

The total emissions of non-methane volatile organic compounds decreased by 65.9% between 1990 and 2019 (see Table 2.1 and 2.4, Figure 2.8).

Table 2.4 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	1.76	0.62	5.90	17.50	3.83	2.47	23.74	10.60	0.13	66.55
1995	1.57	0.23	8.12	10.78	1.10	1.63	12.30	5.06	0.19	40.98
2000	1.06	0.13	6.19	10.17	1.12	4.33	9.61	3.72	0.30	36.62
2005	1.74	0.65	4.41	5.28	1.08	4.28	9.99	4.15	0.27	31.86
2010	1.13	0.66	5.06	3.10	0.88	1.82	6.03	4.06	0.28	23.01
2015	1.23	0.86	3.45	1.69	0.65	1.19	8.15	4.65	0.19	22.05
2016	1.15	0.62	3.52	1.67	0.68	1.22	8.45	4.38	0.18	21.87
2017	1.08	0.81	3.46	1.46	0.70	1.15	9.27	4.76	0.18	22.86
2018	0.77	0.57	3.32	1.38	0.57	1.11	9.20	4.91	0.17	21.99
2019	0.92	0.75	3.16	1.35	0.56	0.86	10.31	4.60	0.17	22.69
Share in total 1990 emission, %	2.6	0.9	8.9	26.3	5.8	3.7	35.7	15.9	0.2	
Share in total 2019 emission, %	4.1	3.3	13.9	6.0	2.5	3.8	45.5	20.3	0.7	
Change 1990-2019, %	-47.7	20.7	-46.5	-92.3	-85.3	-65.2	-56.5	-56.6	26.2	-65.9
Change 2018-2019, %	19.5	32.1	-5.0	-1.9	-1.0	-22.2	12.2	-6.2	2.7	3.2

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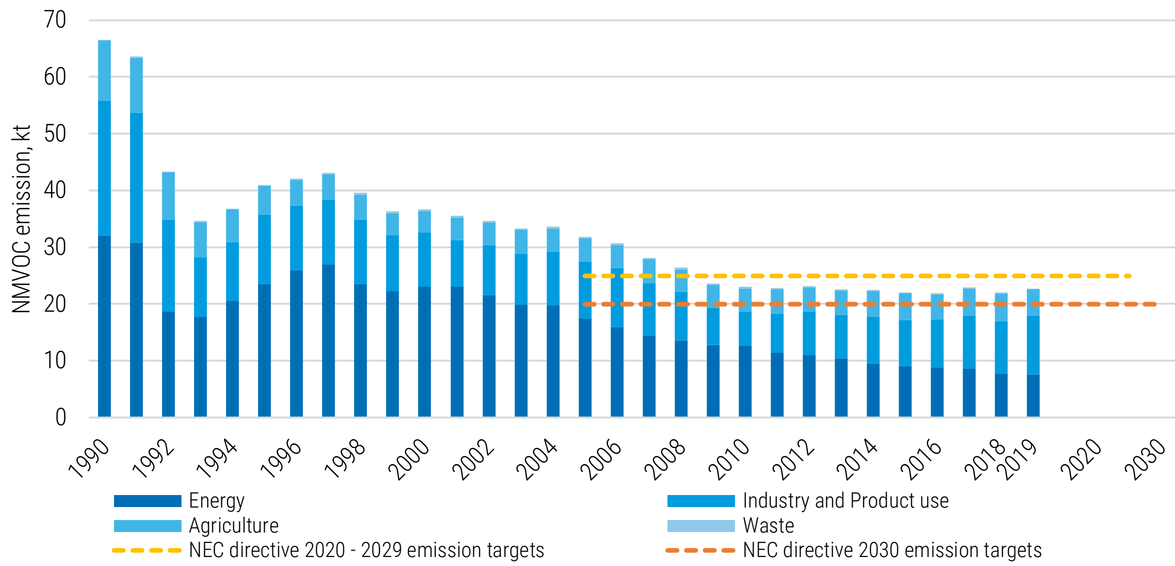

Figure 2.8 NMVOC emissions in the period of 1990–2019 and NEC directive 2016/2284 targets

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

Secondly, during the period of 1990–2019, the production of chemical products fell. Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. These are the results of the increasing tendency towards wood and wood waste combustion (the NMVOC emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion).

In 1990, the main polluters of NMVOC were industrial processes and product uses (35.7%) and mobile sources (32%, of which road transport - 26.3%). In 2019, the dominant source was the same – industrial processes and product uses sector (45.5%), but share of non-industrial combustion has increased from 8.9% to 14% and share of road transport has decreased from 26.3% to 6% (see Table 2.4 and Figure 2.9).

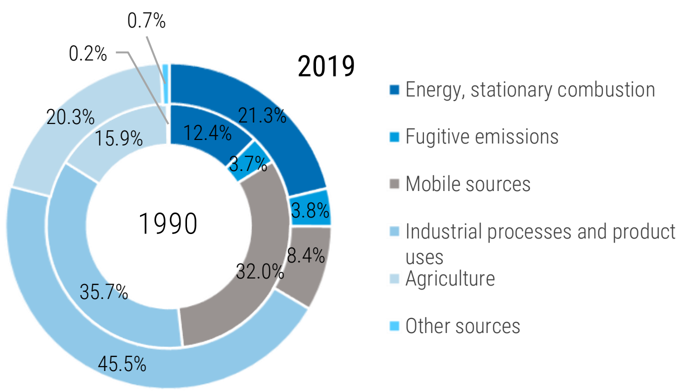

Figure 2.9 NMVOC emission by sources of pollution in 1990 and 2019

Emissions of NMVOC in 2019 increased by 3.2% compared to 2018 (see Table 2.4).

The main reason for the increase in emissions by almost 1,000 tons is the increased consumption of solvent-based paints for decorative coatings and the increased consumption of adhesives.

The increase in the amount of wood being burned resulted in an increase in emissions from the combustion processes in manufacturing industries, as well as in the energy industry sector. It should be noted that an increase in the amount of wood burned in the energy sector has not led to a significant increase in emissions, as large amount of biomass are used by large combustion plants, which have a significantly smaller emission factors compared to small boiler plants.

In 2019, NMVOC emissions from non-industrial combustion sector decreased by about 5% when compared to 2018's figures, mainly due to a decrease in solid biomass combustion.

During the same period NMVOC emissions from road transport decreased by 1.9%, mainly due to stricter emission standards for new vehicle categories. This means that new technologies have been introduced gradually and that older vehicles are used less compared to new vehicles (they have a lower annual mileage).

A small decrease (1.0%) in NMVOC emissions from other mobile sources took place due to the gradual penetration of new engine technologies which have significantly smaller emission factors compared to older non-road working machinery and also due to a decrease in fuel consumption during that period.

During this period, emissions from agriculture sectors decreased by 6.2%, mainly due to an decrease in the number of dairy cattle and swine.

Reduced emissions from terminals have contributed to a reduction in emissions in the Fugitive emissions sector.

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of non-methane volatile organic compounds emissions by 10% relative to 2005 baseline emissions by 2020, already in 2009. NMVOC emissions decreased by 28.8% in 2019 compared to 2005.

2.1.4. Ammonia

Total NH_3 emissions decreased by 50.9% between the years 1990 to 2019 due to a reduction in the number of animals and the use of fertilisers (see Table 2.5 and Figure 2.10). Livestock manure management and use of mineral fertiliser are the main sources of pollution regarding ammonia (about 88.7% in 2019).

The stationary fuel combustion activity is responsible for 7.6% of total emissions. Between 1990 and 2019, the amount of solid biomass burned in the energy sector increased, leading to an increase in ammonia emissions from this sector by almost 490%.

Transport emissions of NH_3 have increased approximately eight times during the period between 1990-2019. In detail, the majority of NH_3 emissions is emitted from road transport. Ammonia is not created in significant quantities during typical combustion in a gasoline powered vehicle, but is an undesirable by-product of NO reduction on the catalyst surface which leads to ammonia in motor vehicle exhaust. Consequently, NH_3 emissions are low for older gasoline-powered vehicles and have since increased following the widespread use of three-way catalytic converters.

Fugitive emissions from solid fuels (oil shale open cast mining, mainly explosive works) account for approximately 1% of emissions, mobile sources makes up 1.3%. All other sectors (industry and product use, waste) account for approximately 1.4% of total ammonia emissions (see Figure 2.11).

In 2019, NH_3 emissions increased by about 1.6% when compared to 2018's figures, due mainly to an increase in the use of fertilizers and wood and wood waste combustion in energy sector.

Table 2.5 NH_3 emissions by sector (kt), change in emissions and share in total emission

Year	Energy, stationary combustion	Mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	0.14	0.02	NO	0.68	20.72	0.002	21.56
1995	0.25	0.03	NO	0.30	9.97	0.002	10.55
2000	0.30	0.10	0.01	0.14	8.04	0.005	8.60
2005	0.47	0.20	0.05	0.22	9.13	0.02	10.09
2010	0.36	0.20	0.12	0.08	9.29	0.05	10.09
2015	0.63	0.15	0.20	0.08	9.35	0.05	10.45
2016	0.64	0.15	0.14	0.08	9.12	0.06	10.21
2017	0.79	0.15	0.17	0.09	9.27	0.06	10.53
2018	0.73	0.14	0.16	0.11	9.23	0.06	10.43
2019	0.80	0.14	0.10	0.10	9.40	0.05	10.59
Share in total 1990 emission, %	0.6	0.1		3.2	96.1	0.01	
Share in total 2019 emission, %	7.6	1.3	0.9	0.9	88.7	0.5	
Change 1990-2019, %	**488.4**	**660.6**		**-85.8**	**-54.6**	**3,276.6**	**-50.9**
Change 2018-2019, %	**9.3**	**2.1**	**-38.2**	**-7.6**	**1.8**	**-8.9**	**1.6**

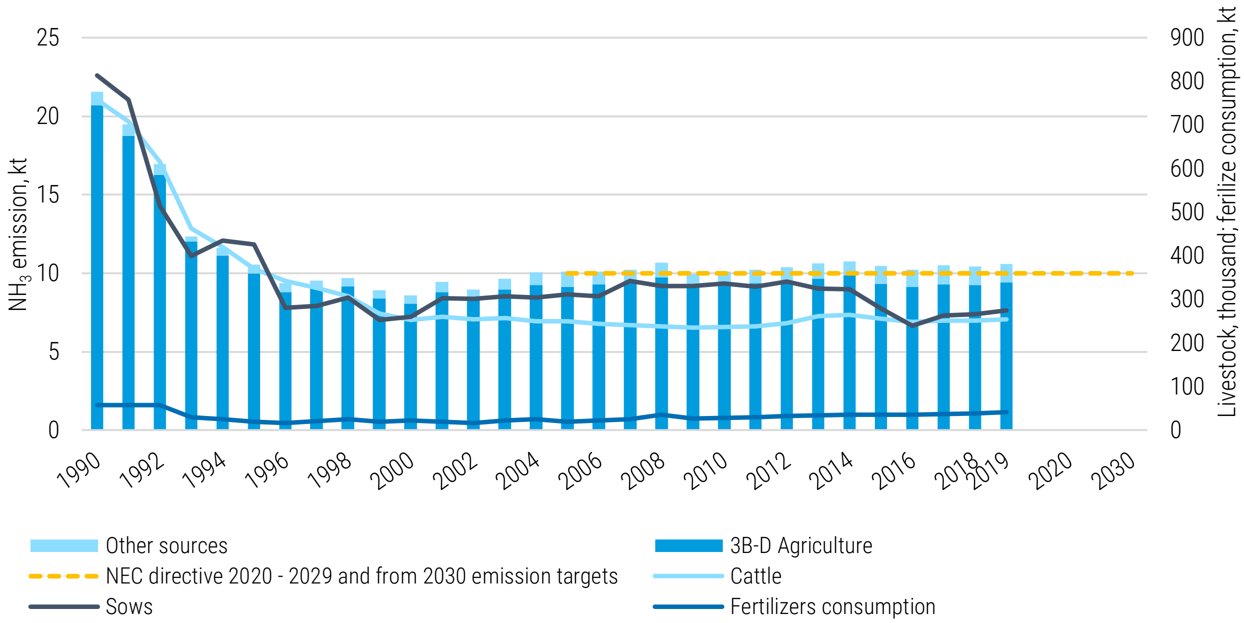

Figure 2.10 NH_3 emissions in the period of 1990–2019 and NEC directive 2016/2284 targets

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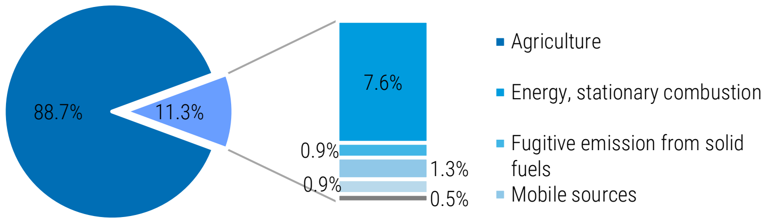

Figure 2.11 NH_3 emissions by sources of pollution in 2019

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

In 2019, ammonia emissions increased by 4.9% at the 2005 level. Although technological innovations in the agricultural sector as well as in environmental protection measures (e.g. duration and time of manure spreading) as had impact on agricultural emissions in recent years in 2019, ammonia emissions increased at the 2005 level manly due the increase of dairy cattle productivity and also liquid manure technology has been used in place of solid manure technology.

2.1.5. Carbon Monoxide

In the period of 1990–2019, the emissions of carbon monoxide decreased by 48.6%. That was, among other things, caused by the reduction in the use of vehicle fuels (especially from 1990 to 1992), and in recent years, by a decrease in the number of cars driving on petrol. The increase in emissions from 1994 to 1996 is caused by a growth in the burning of wood in the household sector (see Table 2.6 and Figure 2.12).

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

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	5 Waste	Total
1990	18.02	6.18	75.90	120.40	33.21	NO	0.57	0.01	254.29
1995	20.87	2.72	130.38	61.65	5.19	NO	0.15	0.01	220.96
2000	17.79	4.05	104.06	66.40	5.80	0.20	0.64	0.01	198.95
2005	22.66	7.87	77.22	39.33	5.12	0.17	0.51	0.00	152.90
2010	26.47	6.57	94.44	23.15	5.43	0.19	0.53	0.02	156.81
2015	34.13	7.42	68.26	12.95	5.18	0.18	0.51	0.01	140.09
2016	41.98	5.51	70.47	13.08	8.42	0.14	0.49	0.01	138.14
2017	37.37	9.44	70.15	11.73	8.72	0.17	0.56	0.01	138.14
2018	38.40	6.91	68.67	10.95	5.21	0.17	0.65	0.01	130.97
2019	41.53	6.57	64.95	10.74	6.15	0.13	0.72	0.01	130.80
Share in total 1990 emission, %	7.1	2.4	29.8	47.3	13.1		0.2	0.002	
Share in total 2019 emission, %	31.8	5.0	49.7	8.2	4.7	0.1	0.5	0.01	
Change 1990-2019, %	**130.5**	**6.3**	**-14.4**	**-91.1**	**-81.5**		**25.9**	**40.8**	**-48.6**
Change 2018-2019, %	**8.2**	**-5.0**	**-5.4**	**-1.9**	**18.0**	**-21.7**	**10.3**	**9.1**	**-0.1**

CO emissions from transport have declined over the past two decades. The introduction of catalytic converters and progressively stricter Euro emission standards are the main factors behind these reductions. However, the reductions have been accompanied by a shift from petrol to diesel-powered cars and the fact that older vehicles are used less when compared to new vehicles (they have a lower annual mileage). These serve as additional reasons for CO emissions declining by 1.9% in the road transport sector in 2019 when compared to the previous year.

Carbon monoxide emissions in the other mobile sector have decreased by 81.5% between 1990 and 2019 due to a significant decrease in petrol consumption (80.4%).

In 1990, the main polluters of carbon monoxide were road transport (47%), while in 2019, the dominant source was non-industrial combustion (50%) (see Figure 2.13). Emissions from non-industrial fuel combustion (mainly in households) have increased since 1995. These are the results of the increasing tendency towards wood and wood waste combustion (the CO emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion). The share of the energy industries sector increased at the same period from 7.1% to 31.8%, mainly due to an increase in shale oil production in Enefit Energiatootmine AS (Eesti Energia Oil Industry plant). This was the main reason for the 131% increase of CO emissions from the energy industries sector in the period 1990–2019.

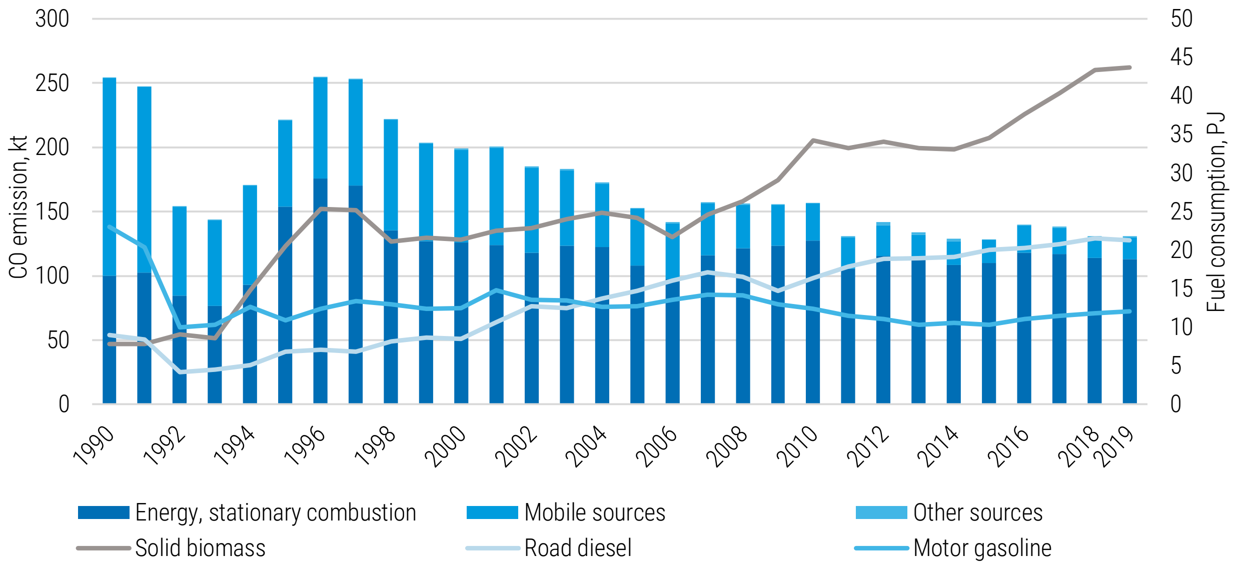

Figure 2.12 CO emissions in the period of 1990–2019

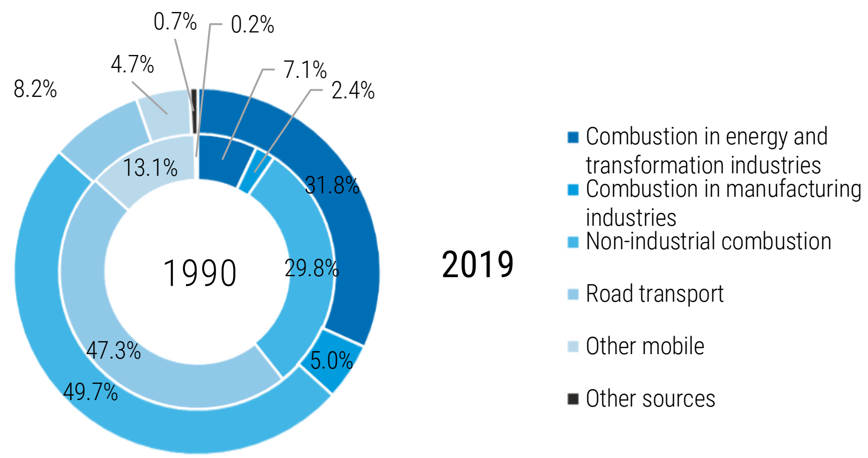

Figure 2.13 CO emissions by sources of pollution in 1990 and 2019

In 2019, carbon emissions decreased by 0.1% in comparison to 2018. During this period an decrease or increase was observed in emissions in all combustion-related sectors. For example, carbon monoxide emissions have increased in the manufacture of solid fuels and other energy industries by 8.2% due to the increase of oil shale consumption on the two shale oil production facilities.

In 2019, CO emissions from other mobile sources increased by 18.0% compared to 2018, mainly due to an increase in petrol consumption during that period. In general, emissions factors for CO have a great deal of difference when a comparison is made between diesel and petrol fuels and therefore total CO emissions are mostly influenced by the amount of petrol consumed.

In 2019, the biggest polluters of CO were combustion in the non-industrial sector (about 49.7%, from which a large part is wood combustion in the domestic sector), combustion in the energy industry (31.8%, mainly from shale oil production industry) and road transport – 8.2% (see Figure 2.13).

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

This chapter describes the changes in emissions of TSP from 1990 to 2019 and $PM_{2.5}$, PM_{10} and BC from 2000 to 2019. Emissions of all substances decreased significantly over the entire period (table 2.7, figures 2.14 - 2.16). The information for each substance separately, as well as key sources and the reasons for the decrease, are described below.

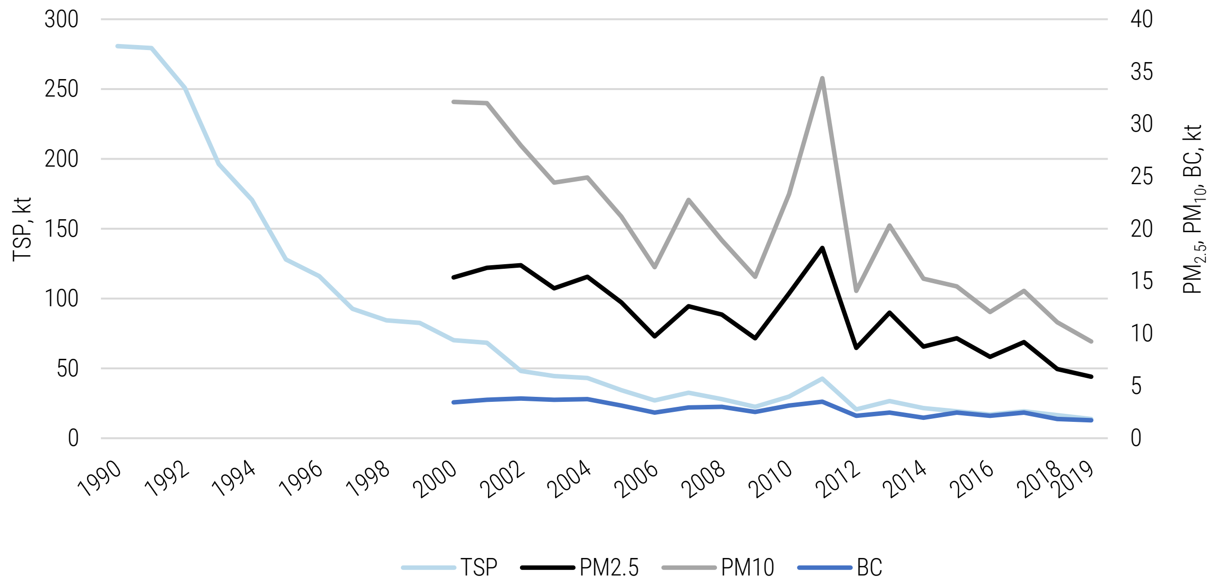

Figure 2.14 Particulates emissions trends in the period 1990-2019, kt

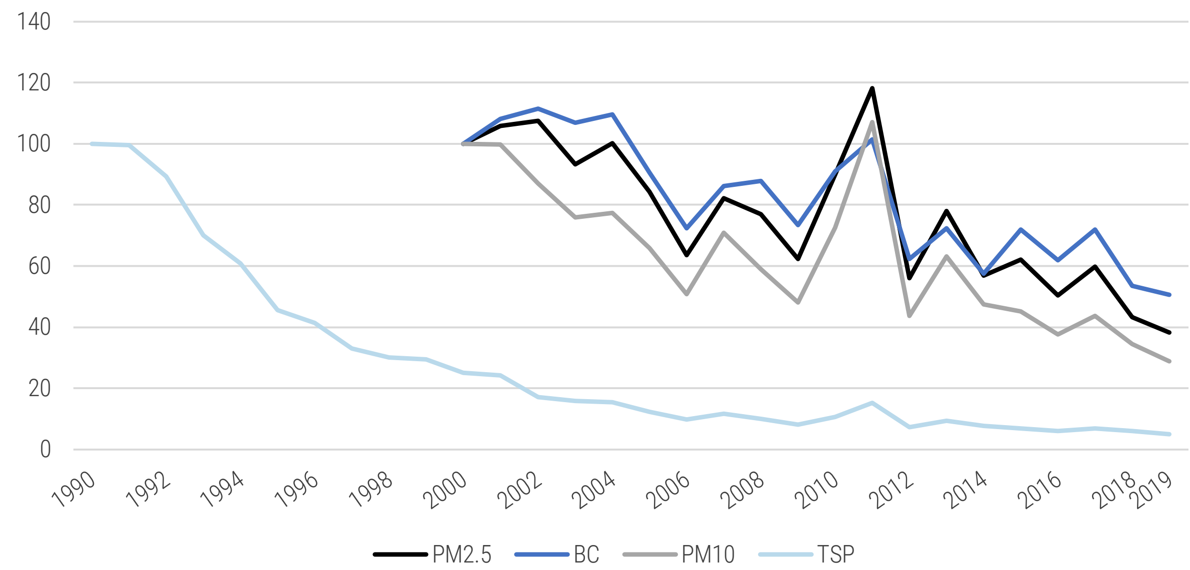

Figure 2.15 Indexed of particulates emissions (1990=100) in the period 1990-2019

Table 2.7 Particulates emissions in the period 1990–2019 (kt)

Year	$PM_{2.5}$	PM_{10}	BC	TSP
1990	NR	NR	NR	281.008
1991	NR	NR	NR	279.657
1992	NR	NR	NR	250.844
1993	NR	NR	NR	196.601
1994	NR	NR	NR	170.760
1995	NR	NR	NR	128.163
1996	NR	NR	NR	116.139
1997	NR	NR	NR	92.716
1998	NR	NR	NR	84.452
1999	NR	NR	NR	82.579

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Year	$PM_{2.5}$	PM_{10}	BC	TSP
2000	15.385	32.134	3.441	70.199
2001	16.292	32.028	3.721	68.386
2002	16.538	27.967	3.837	48.385
2003	14.341	24.400	3.680	44.539
2004	15.417	24.889	3.774	43.132
2005	12.976	21.199	3.113	34.395
2006	9.771	16.326	2.488	27.248
2007	12.645	22.750	2.969	32.820
2008	11.836	18.938	3.023	28.343
2009	9.573	15.451	2.525	22.560
2010	13.845	23.310	3.132	30.092
2011	18.183	34.402	3.489	42.677
2012	8.637	14.069	2.148	20.757
2013	12.010	20.299	2.487	26.560
2014	8.749	15.226	1.976	21.878
2015	9.557	14.492	2.477	19.539
2016	7.762	12.089	2.133	16.908
2017	9.197	14.071	2.477	19.513
2018	6.643	11.108	1.843	16.767
2019	5.880	9.237	1.743	13.936
Change 1990-2019, %	-56.8	-65.4	-46.5	-94.0
Change 2005-2019, %	-54.7	-56.4	-44.0	-59.5
Change 2018-2019, %	-11.5	-16.8	-5.4	-16.9

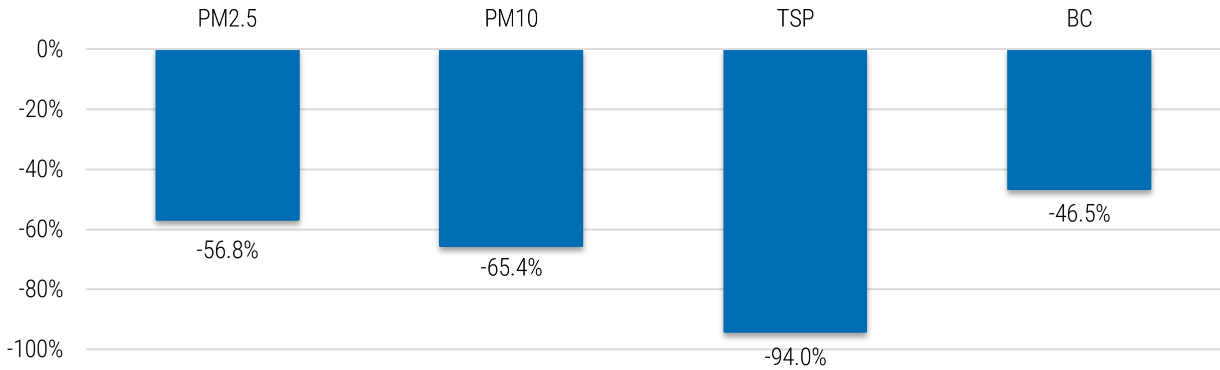

Figure 2.16 Reduction of TSP emissions in the period 1990-2019, $PM_{2.5}$, PM_{10} and BC in the period 2000-2019

2.2.1. Total suspended particulate matter (TSP)

In 1990–2019, TSP emissions dropped significantly – by 95% (see Table 2.8 and Figure 2.17). This is due to the increase in the efficiency of combustion devices and cleaning installations (especially in oil shale power plants and the cement factory – from 1990 to 1998) as well as the decrease in electricity production. Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. The growth of TSP and fine particulates emission in 2010 resulted from the growth in electricity production at the same period. The significant growth of particulates emission in 2011 was due to the increase in electricity production by 34% in Balti PP (Enefit Power AS) and it is a result of bad operation of electric precipitators on two power units of this power plant.

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

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	1B Fugitive emissions	2A-L Industry and Product use	3B-D Agriculture	5 Waste	Total
1990	173.29	89.79	5.81	1.00	1.46	NO	6.31	3.21	0.14	281.01
1995	84.21	33.61	5.97	0.80	0.31	NO	1.45	1.62	0.19	128.16
2000	54.70	4.51	5.12	0.90	0.23	0.11	2.84	1.39	0.41	70.20
2005	15.66	4.34	4.61	0.90	0.28	0.21	6.59	1.54	0.26	34.40
2010	15.91	3.16	4.15	0.73	0.24	0.31	4.05	1.40	0.15	30.09
2015	6.20	3.40	3.03	0.69	0.16	0.18	4.15	1.61	0.12	16.91
2016	4.57	1.90	3.44	0.69	0.13	0.13	4.25	1.66	0.13	19.51
2017	4.92	3.47	3.28	0.69	0.13	0.15	5.15	1.61	0.12	19.51
2018	3.70	1.62	2.91	0.69	0.13	0.14	5.88	1.58	0.13	16.77
2019	2.48	1.50	2.69	0.69	0.11	0.09	4.68	1.58	0.12	13.94
Share in total 1990 emission, %	61.7	32.0	2.1	0.4	0.5		2.2	1.1	0.050	
Share in total 2019 emission, %	17.8	10.8	19.3	5.0	0.8	0.6	33.6	11.3	0.86	
Change 1990-2019, %	-98.6	-98.3	-53.7	-31.0	-92.7		-25.8	-50.9	-14.2	-95.0
Change 2018-2019, %	-33.0	-7.5	-7.3	0.2	-16.1	-34.5	-20.4	0.0	-4.5	-16.9

The main source of particulates in 2019 is the energy sector (including mobile sources), which accounts for 54.2% of the total. The emissions of TSP by sectors of pollution are shown in Table 2.8 and Figure 2.17 -2.18.

In 2019, particulate emissions decreased by about 17% in comparison to 2018, due mainly to a decrease in electricity production at oil shale power plants and also due to a decrease in the use of solid biomass in the non-industrial combustion sector. The main reason for the decrease in TSP emissions in the industry sector by about 34% is associated with a decrease in construction volumes. The decrease of emissions from other mobile sources took place due to the gradual penetration of new engine technologies which have significantly smaller emission factors compared to older non-road working machinery and also due to a decrease in fuel consumption during that period.

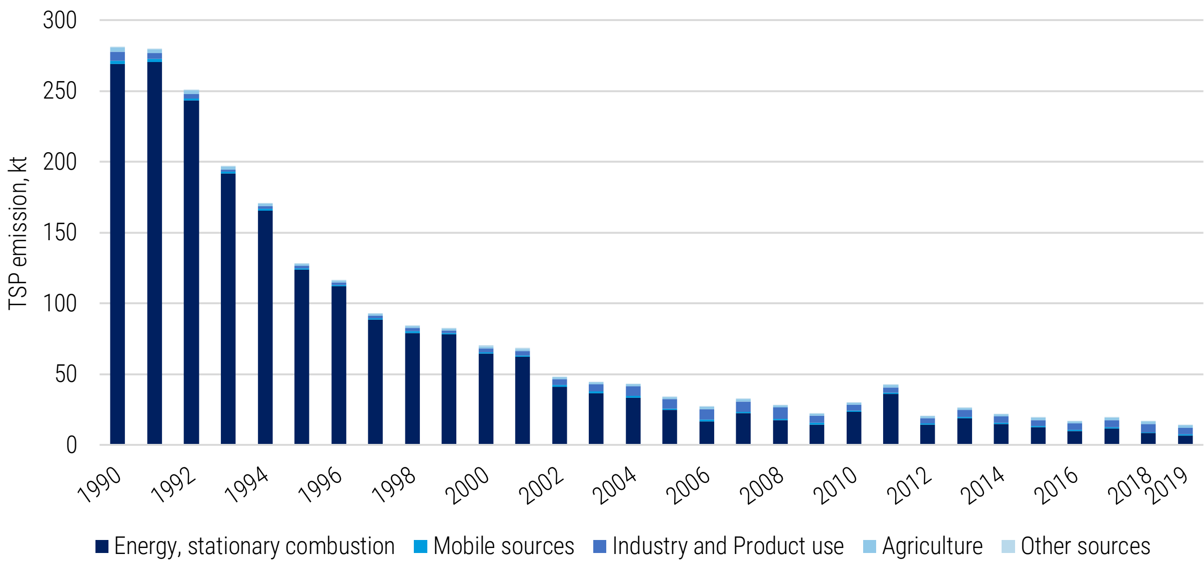

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Figure 2.17 TSP emissions in the period of 1990–2019

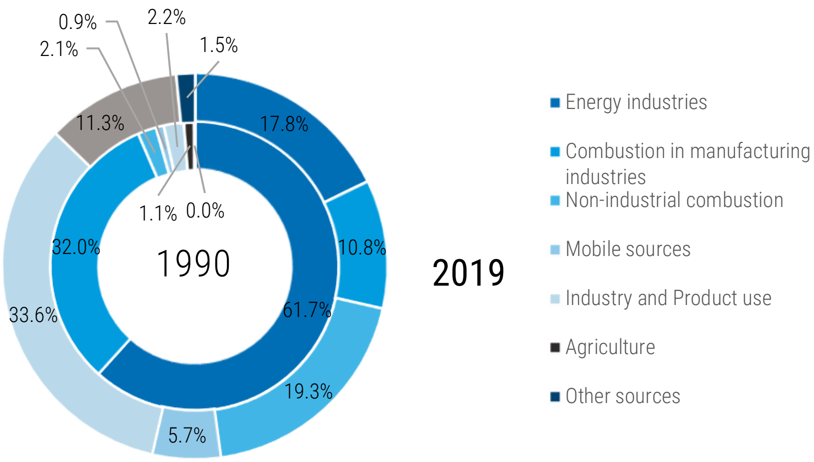

Figure 2.18 TSP emissions by sources of pollution in 1990 and 2019

In 1990, the main polluters of TSP were the energy industry (61.7%) and combustion in manufacturing industries (32%). In 2019, the share of combustion in energy industries dropped to 17.8% and dominant source was industrial processes and product uses (more precisely, construction and demolition) (33.6%). If the share of energy and transformation sector and combustion in manufacturing industries have decreased by 44% and 21% respectively, the share of non-industrial combustion, agriculture, and mobile sources has increased by 17.3%, 10.2% and 4.8% respectively compared to 1990 (see Figure 2.18). The main reasons for such changes are the following: an increase in the share of wood combustion in the domestic sector (high emission factor of particulates), modernisation of cleaning equipment at the cement plant and oil shale power plants, and a decrease in electricity production. Other sources (waste, fugitive emissions) contribute to 1.5% of the total emissions.

2.2.2. Particulate matter (PM_{10})

In 2000–2019, PM_{10} emissions dropped significantly – by 71.3% (see Table 2.9 and Figure 2.19). This is due to the increase in the efficiency of combustion devices and cleaning installations (especially in oil shale power plants) as well as the decrease in electricity production and heat production at the same period by 10.5% and 18.5% respectively. Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. It should be noted that emissions from the non-industrial combustion sector decreased between 2000 and 2019, despite an increase in the biomass burned in the residential sector. The reason for this is the growth of the last year's share of new high-efficiency technologies. The increase in particulates emissions from agriculture sector was mainly due to an increase in the area covered by crops.

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

Table 2.9 PM_{10} emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	3B-D Agriculture	Other sources	Total
2000	21.40	2.68	4.59	0.80	0.23	1.10	0.94	0.41	32.13
2005	9.08	3.47	3.81	0.77	0.28	2.39	1.06	0.34	21.20
2010	13.60	2.51	3.68	0.59	0.24	1.46	0.93	0.31	23.31
2015	5.46	2.91	2.72	0.54	0.15	1.39	1.12	0.20	14.49
2016	3.97	1.67	2.97	0.54	0.12	1.41	1.23	0.18	12.09
2017	4.32	3.09	2.95	0.52	0.13	1.72	1.17	0.18	14.07
2018	3.22	1.42	2.58	0.52	0.13	1.90	1.16	0.18	11.11
2019	1.99	1.36	2.40	0.52	0.11	1.55	1.16	0.15	9.24
Share in total 2000 emission, %	66.6	8.3	14.3	2.5	0.7	3.4	2.9	1.3	
Share in total 2019 emission, %	21.5	14.7	26.0	5.6	1.1	16.7	12.6	1.6	
Change 2000-2019, %	**-90.7**	**-49.2**	**-47.6**	**-34.4**	**-54.2**	**40.9**	**23.8**	**-63.4**	**-71.3**
Change 2018-2019, %	**-38.2**	**-4.0**	**-7.0**	**-0.1**	**-16.0**	**-18.8**	**0.2**	**-15.9**	**-16.8**

In 2019, PM_{10} emissions decreased by 16.8% in comparison to 2018, mainly due to decreased in electricity production at oil shale power plants and due to a decrease in the area of construction activities. The other reason is a decrease in solid biomass consumption in the non-industrial combustion sector. The decrease of emissions from other mobile sources took place due to the gradual penetration of new engine technologies which have significantly smaller emission factors compared to older non-road working machinery and also due to a decrease in fuel consumption during that period.

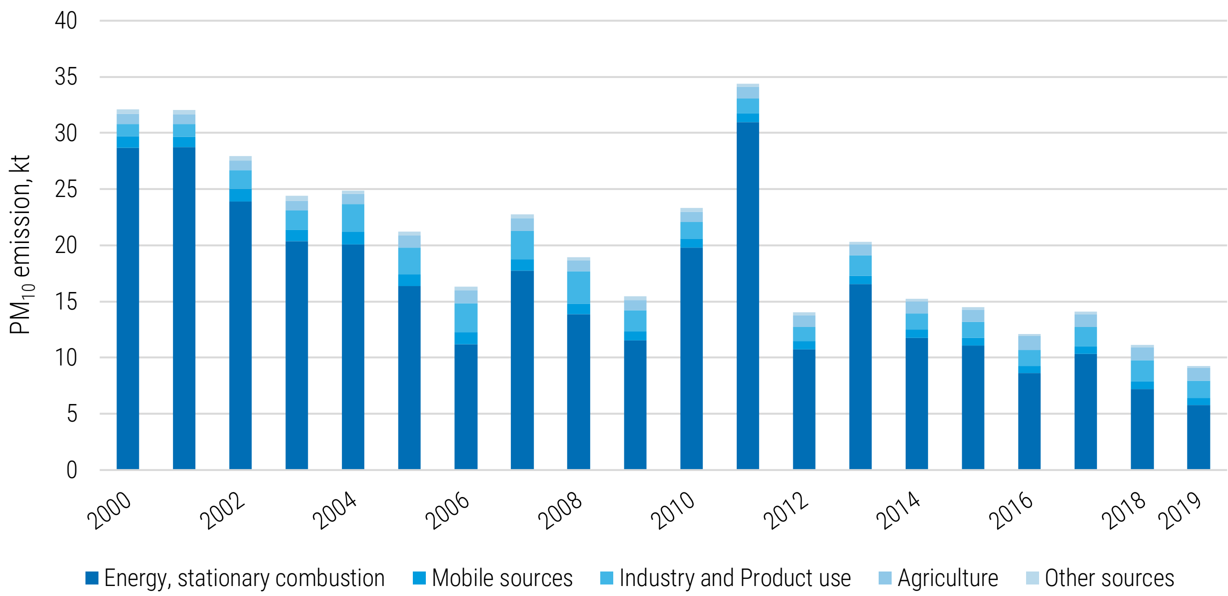

Figure 2.19 PM_{10} emissions in the period of 2000–2019

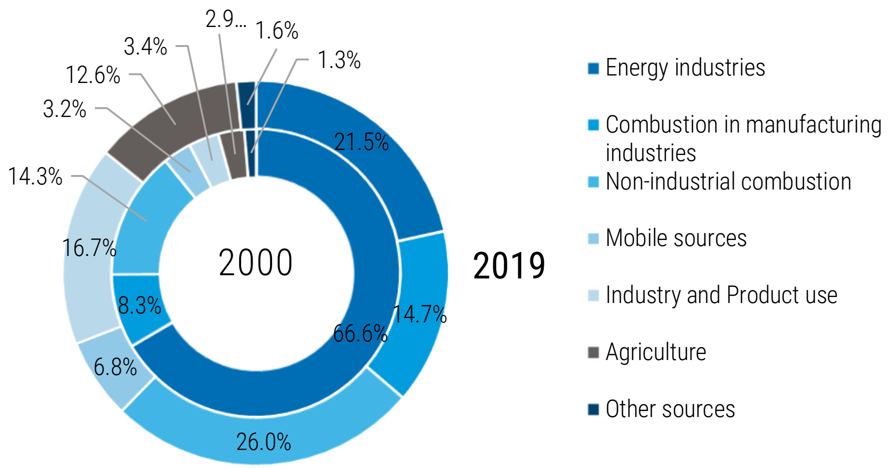

Figure 2.20 PM_{10} emissions by sources of pollution in 2000 and 2019

In 2000, the main polluters of PM_{10} were the energy industry (66.6%) and non-industrial combustion (14.3%). In 2019, the share of combustion in energy industries dropped to 21.5% and dominant source was non-industrial combustion (26%) (mainly solid biomass combustion in residential sector); the share of industrial processes and product uses (more precisely, construction and demolition) has increased from 3.4% to about 17%. (see Figure 2.20). The main reasons for such changes are the following: an increase in the share of wood combustion in the domestic sector (high emission factor of fine particulates), modernisation of cleaning equipment at oil shale power plants, and a decrease in electricity production. The contribution of other sources in total PM_{10} emission is shown in the Table 2.9 and Figure 2.20.

2.2.3. Particulate matter ($PM_{2.5}$)

In 2000–2019, $PM_{2.5}$ emissions decreased by 61.8% (see Table 2.10 and Figure 2.21). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants, as well as the decrease in electricity and heat production at the same period by 10.5% and 18.5% respectively.

Emissions have also been considerably reduced by shutting down the old blocks on the oil shale PP. It should be noted that emissions from non-industrial combustion sector decreased between 2000 and 2019, despite the increase in biomass burned in the residential sector. The reason for this is the growing in the last year's share of new high-efficiency technologies.

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

Table 2.10 $PM_{2.5}$ emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	3B-D Agriculture	Other sources	Total
2000	7.67	1.66	4.32	0.71	0.23	0.38	0.11	0.31	15.39
2005	4.60	2.96	3.46	0.66	0.28	0.68	0.11	0.23	12.98
2010	6.85	2.14	3.50	0.47	0.24	0.39	0.10	0.16	13.84
2015	3.15	2.72	2.59	0.41	0.15	0.30	0.12	0.11	9.56
2016	2.46	1.46	2.78	0.41	0.12	0.30	0.12	0.11	7.76
2017	2.45	2.83	2.80	0.39	0.12	0.40	0.11	0.10	9.20
2018	1.93	1.18	2.45	0.38	0.12	0.36	0.11	0.11	6.64
2019	1.33	1.26	2.28	0.38	0.10	0.32	0.11	0.10	5.88
Share in total 2000 emission, %	49.8	10.8	28.1	4.6	1.5	2.5	0.7	2.0	
Share in total 2019 emission, %	22.6	21.4	38.8	6.5	1.8	5.4	1.9	1.7	
Change 2000-2019, %	-82.7	-24.3	-47.2	-46.4	-54.0	-16.2	1.5	-69.1	-61.8
Change 2018-2019, %	-31.2	7.0	-6.9	-0.8	-15.9	-12.1	0.8	-8.7	-11.5

In 2019, $PM_{2.5}$ emissions decreased by 11.5% in comparison to 2018, due mainly to a decrease in electricity production at oil shale power plants and also to a decrease of area in construction activities. The other reason is decrease of solid biomass consumption in the non-industrial combustion sector. The reason for the decrease in emissions from other mobile sources is described in the TSP and PM_{10} chapters.

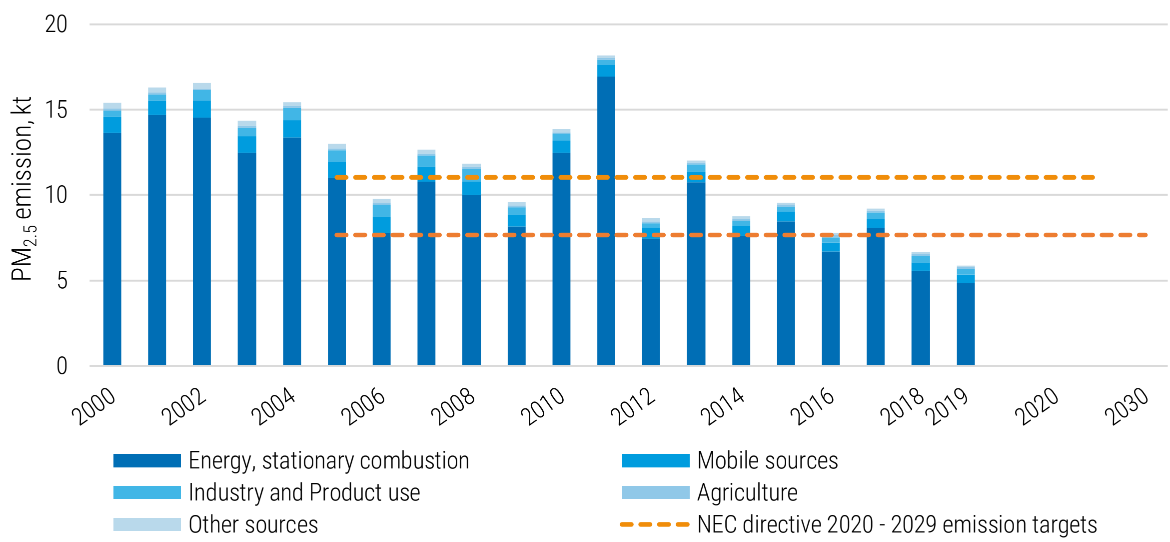

Figure 2.21 $PM_{2.5}$ emissions in the period of 2000–2019 and NEC Directive 2016/2284 $PM_{2.5}$ targets

In 2000, the main polluters of $PM_{2.5}$ were the energy industry (49.8%) and non-industrial combustion (28.1%). In 2019, the share of combustion in energy industries dropped to 22.6% and dominant source was non-industrial combustion (38.8%) (mainly solid biomass combustion in residential sector); the share of the combustion in manufacturing industries has increased from 10.8% to 21.4% (see Figure 2.22). The main reasons for such changes are the following: an increase in the share of wood combustion in the domestic and industrial combustion sectors (high emission factor of fine particulates), modernisation of cleaning equipment at oil shale power plants, and a decrease in electricity production. The contribution of other sources in total $PM_{2.5}$ emission is shown on the Table 2.10 and Figure 2.22.

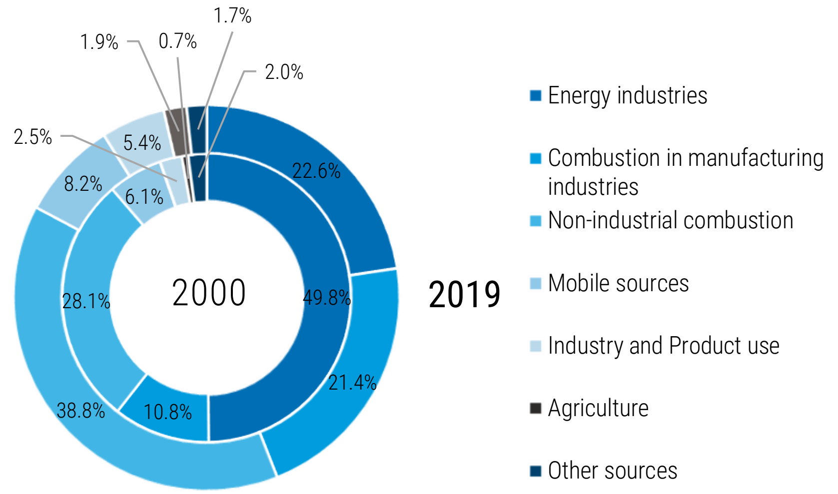

Figure 2.22 $PM_{2.5}$ emissions by sources of pollution in 2000 and 2019

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of fine particulate matter emissions by 15% relative to 2005 baseline emissions by 2020, in 2014. $PM_{2.5}$ emissions decreased by 54.7% in 2019 compared to 2005.

2.2.4. Black carbon (BC)

In the period between 2000-2019, emissions of BC decreased by 49.3% (Table 2.11). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants, as well as the decrease in electricity and heat production at the same period by 10.5% and 18.5% respectively.

Table 2.11 BC emissions by sector (kt), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	3B-D Agriculture	Other sources	Total
2000	0.90	0.43	1.62	0.34	0.12	0.03	NA	0.004	3.44
2005	0.56	0.79	1.24	0.33	0.16	0.04	NA	0.001	3.11
2010	0.78	0.58	1.36	0.25	0.14	0.02	NA	0.001	3.13
2015	0.39	0.77	0.98	0.21	0.09	0.02	NA	0.001	2.48
2016	0.39	0.39	1.05	0.20	0.07	0.02	NA	0.001	2.13
2017	0.33	0.79	1.07	0.19	0.07	0.02	NA	0.001	2.48
2018	0.29	0.31	0.97	0.18	0.08	0.02	NA	0.001	1.84
2019	0.25	0.34	0.89	0.17	0.06	0.02	NA	0.001	1.74

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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	3B-D Agriculture	Other sources	Total
Share in total 2000 emission, %	26.0	12.4	47.2	9.9	3.6	0.8		0.1	
Share in total 2019 emission, %	14.1	19.8	51.3	10.0	3.6	1.2		0.1	
Change 2000-2019, %	**-72.5**	**-19.1**	**-45.0**	**-48.8**	**-49.5**	**-27.0**		**-69.4**	**-49.3**
Change 2018-2019, %	**-13.8**	**11.2**	**-7.9**	**-2.1**	**-18.6**	**0.1**		**-0.7**	**-5.4**

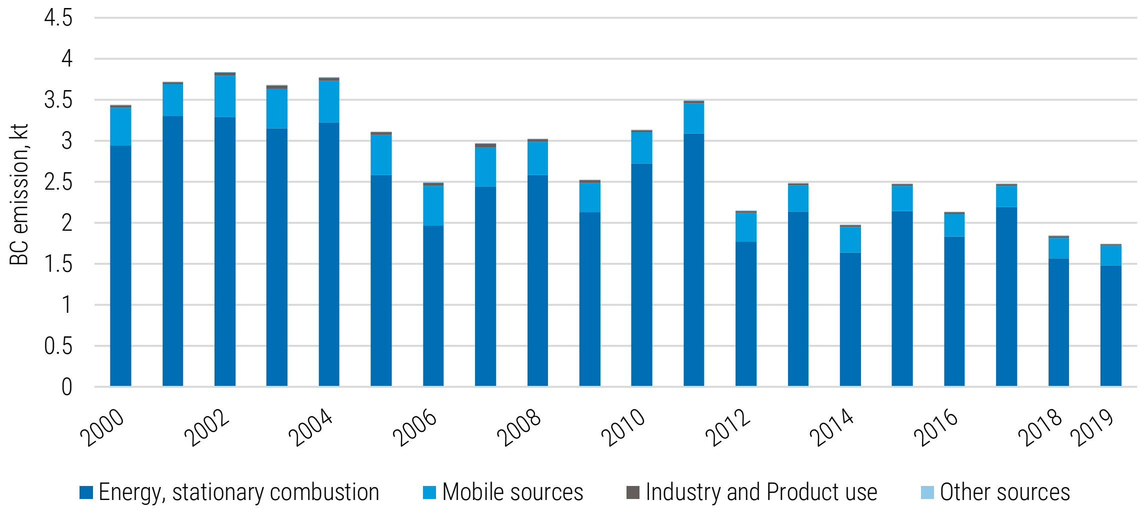

Figure 2.23 BC emissions in the period of 2000–2019

In 2019, BC emissions decreased by 5.4% in comparison to 2018. The reasons of decrease in emissions in 2019 in comparison with 2018 the same as well as for other particulates.

Emission of black carbon for all activities was calculated in this submission for 2000–2019. In the process of making the calculations in 2019 year submission, the new EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 methodology was applied.

The primary sources of BC emission in 2019 were non-industrial combustion (51.3%, mainly wood combustion), combustion in manufacturing industries (19.8%) and combustion in energy and transformation industries (14.1%, mainly oil shale combustion) (see Figure 2.24). Other sources are mainly industrial processes.

The distribution of BC emissions by sources of pollution is also visible in Table 2.11 and Figure 2.24. It is interesting to note that if the share of non-industrial combustion (generally wood combustion in domestic sector) in TSP emissions makes up 19% of the total emissions, then share in emissions of BC is significantly higher and makes up 51%.

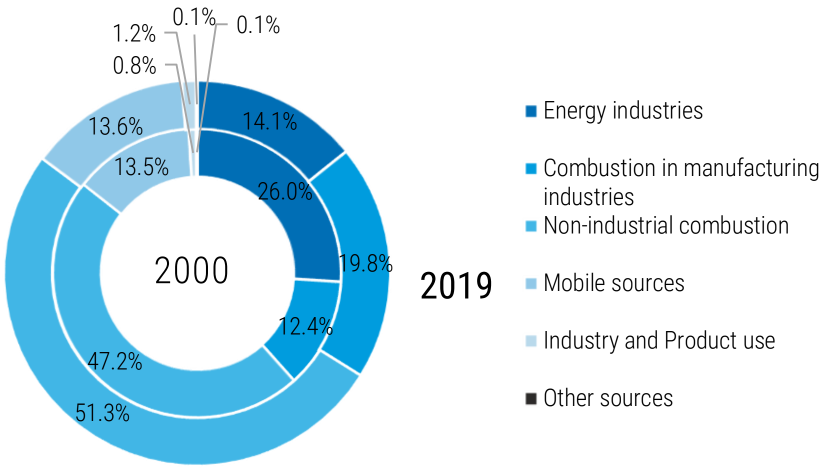

Figure 2.24 BC emissions by sources of pollution in 1990 and 2019

2.3. Heavy Metals

This chapter describes the changes in emissions of heavy metals from 1990 to 2019. Emissions of all substances decreased significantly over the entire period (table 2.12, figures 2.25 - 2.27). Heavy metals are mainly released by combustion in energy and transformation industries and from mobile sources. The energy industry (mainly oil shale power plants) is a big heavy metals polluter in Estonia.

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

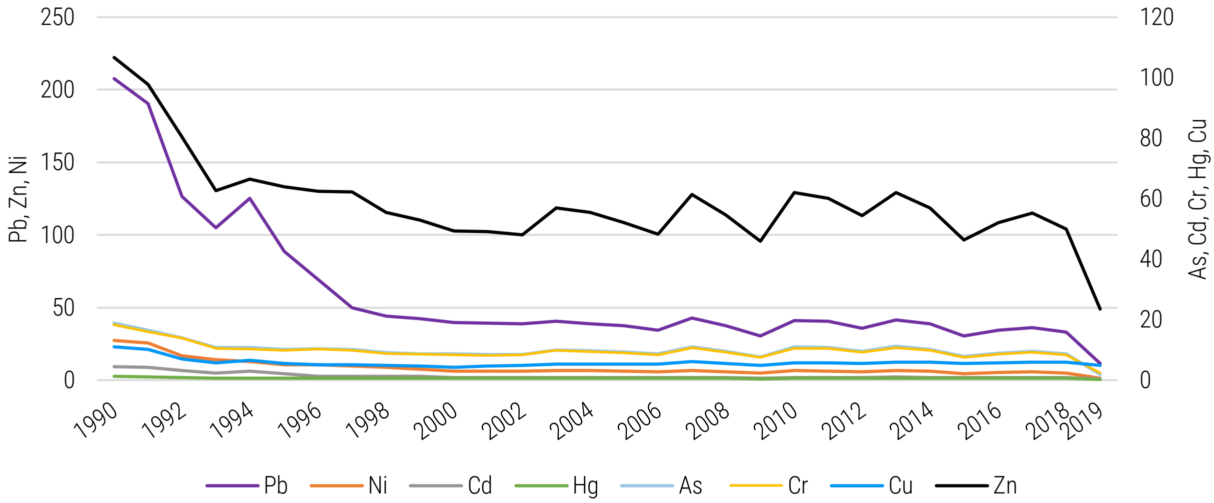

Figure 2.25 Heavy metals emissions in the period 1990 - 2019 (t)

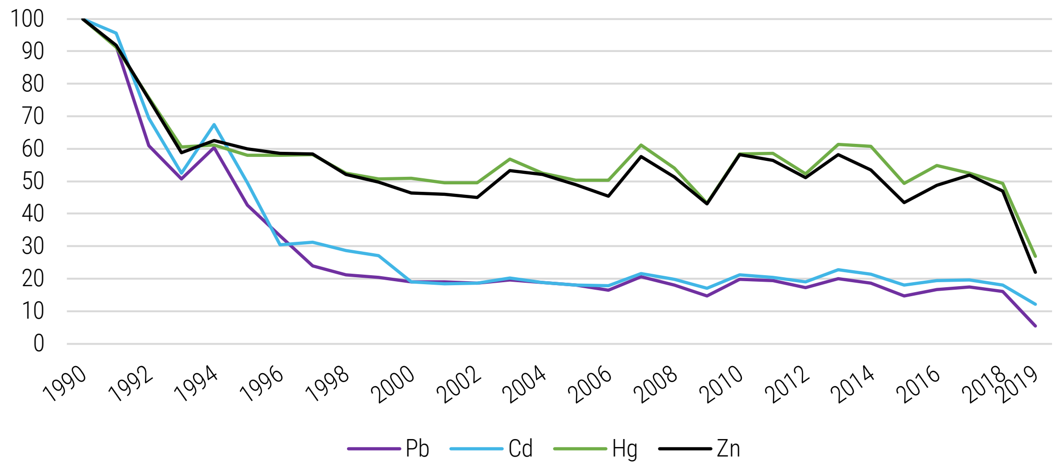

Figure 2.26 Indexed of heavy metals emissions (1990=100) in the period 1990-2019

Table 2.12 Heavy metals emissions in the period 1990–2019 (t)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
1990	207.500	4.566	1.217	18.932	18.452	11.043	27.450	106.599
1991	190.355	4.367	1.109	16.533	16.087	10.254	25.664	97.844
1992	126.544	3.170	0.921	14.111	13.860	7.112	17.048	80.335
1993	105.058	2.395	0.738	10.920	10.544	5.856	14.364	62.708
1994	125.336	3.084	0.744	10.764	10.403	6.558	12.887	66.556
1995	88.482	2.260	0.706	10.160	9.986	5.640	10.510	63.881
1996	69.104	1.388	0.705	10.444	10.256	5.176	10.880	62.399
1997	49.872	1.426	0.708	10.287	9.991	5.234	9.763	62.160
1998	44.151	1.306	0.640	9.233	8.932	4.983	8.806	55.469
1999	42.563	1.241	0.617	8.804	8.514	4.647	7.511	53.030
2000	39.556	0.867	0.619	8.663	8.378	4.331	6.497	49.349
2001	39.511	0.839	0.603	8.462	8.244	4.763	6.442	49.068
2002	38.711	0.847	0.603	8.433	8.343	4.912	6.200	48.038
2003	40.742	0.924	0.691	10.057	9.900	5.257	6.843	56.895
2004	38.930	0.857	0.639	9.749	9.566	5.268	6.757	55.449
2005	37.414	0.823	0.613	9.291	9.058	5.409	6.417	52.105
2006	34.261	0.812	0.613	8.663	8.482	5.438	5.791	48.325
2007	42.887	0.983	0.744	11.137	10.816	6.194	6.783	61.386
2008	37.486	0.903	0.657	9.468	9.342	5.604	5.956	54.613
2009	30.635	0.782	0.525	7.661	7.559	4.910	4.871	45.930
2010	40.954	0.969	0.710	11.021	10.609	5.831	6.628	62.072
2011	40.471	0.931	0.714	10.939	10.434	5.853	6.455	60.071
2012	36.002	0.867	0.637	9.656	9.193	5.653	5.677	54.452
2013	41.559	1.039	0.748	11.295	10.695	5.965	6.540	62.043
2014	38.771	0.974	0.739	10.304	9.871	6.023	6.068	56.952
2015	30.675	0.823	0.600	7.803	7.617	5.483	4.693	46.367
2016	34.651	0.888	0.668	9.039	8.697	5.832	5.360	52.073
2017	36.423	0.894	0.640	9.549	9.173	5.946	5.714	55.272
2018	33.217	0.825	0.600	8.659	8.317	5.920	5.089	50.050
2019	11.374	0.552	0.327	2.012	2.479	4.926	1.587	23.442
Change 1990-2019, %	-94.5	-87.9	-73.1	-89.4	-86.6	-55.4	-94.2	-78.0
Change 2018-2019, %	-65.8	-33.2	-45.5	-76.8	-70.2	-16.8	-68.8	-53.2

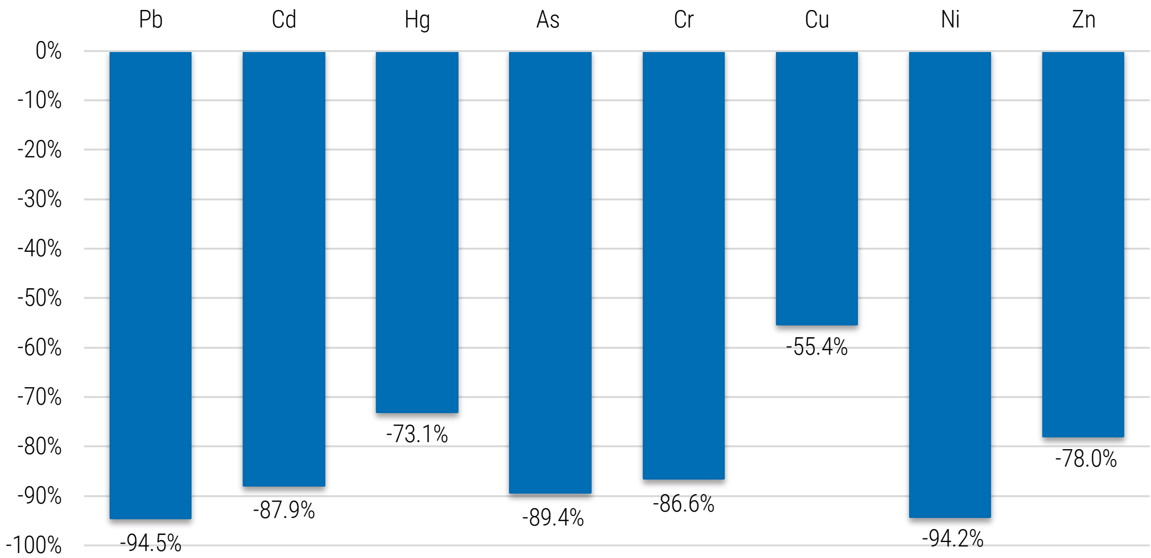

Figure 2.27 Reduction of heavy metals emissions in the period 1990-2019

2.3.1. Priority heavy metals (Pb, Cd and Hg)

2.3.1.1. Lead (Pb)

In the period between 1990-2019, the emissions of lead decreased by 94.5% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production. (Table 2.13 and Figure 2.28). A further reason is the discontinued use of leaded petrol in Estonia since 2000 (see Figure 2.29), what was the reason for the decrease in lead emissions from road transport by 99.6%.

Table 2.13 Pb emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	63.14	62.46	3.03	73.24	4.83	0.002	0.79	207.50
1995	34.47	25.34	3.15	23.65	0.76	0.02	1.09	88.48
2000	29.19	0.80	3.30	4.90	0.08	0.09	1.19	39.56
2005	30.77	0.92	2.84	2.10	0.03	0.27	0.48	37.41
2010	36.42	0.85	2.87	0.26	0.03	0.23	0.30	40.95
2015	26.14	0.81	2.78	0.24	0.03	0.35	0.33	30.67
2016	30.27	0.52	2.88	0.25	0.05	0.34	0.34	34.65
2017	31.71	0.88	2.83	0.26	0.05	0.35	0.34	36.42
2018	28.69	0.65	2.80	0.27	0.03	0.42	0.36	33.22
2019	6.87	0.67	2.78	0.27	0.03	0.39	0.36	11.37
Share in total 1990 emission, %	30.4	30.1	1.5	35.3	2.3	0.0	0.4	
Share in total 2019 emission, %	60.4	5.9	24.4	2.4	0.3	3.4	3.2	
Change 1990-2019, %	**-89.1**	**-98.9**	**-8.2**	**-99.6**	**-99.3**	**19,215.0**	**-54.3**	**-94.5**
Change 2018-2019, %	**-76.1**	**2.7**	**-0.8**	**1.9**	**24.8**	**-7.1**	**1.1**	**-65.8**

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The emissions of lead by sources of pollution in 1990 and 2019 are shown in Table 2.13 and Figure 2.30.

The distribution of emissions by sector has considerably changed over the last 29 years. While in 1990 the main sources of lead pollution were almost equally road transport (35.3%), energy industries (30.4%) and industrial combustion (30.1%, mainly cement manufacturing), in 2019 the main source of pollution by lead was the energy industry (60.4%, mainly oil shale power plants); the second largest source of lead emission – non-industrial combustion (24.4%) (Figure 2.30). The main sources of Pb emission in IPPU sector is fireworks use.

The main reason for the decrease in lead emissions in 2019 compared to 2018 is a decrease in electricity production, as well as a change in the methodology for calculating heavy metals at oil shale power plants.

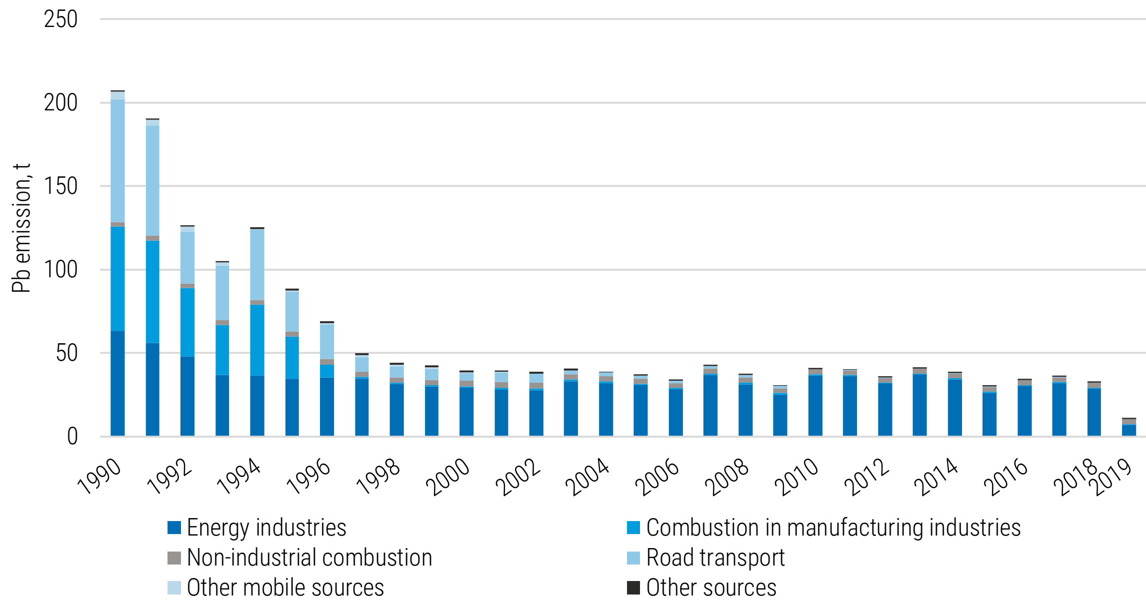

Figure 2.28 Pb emissions in the period of 1990–2019

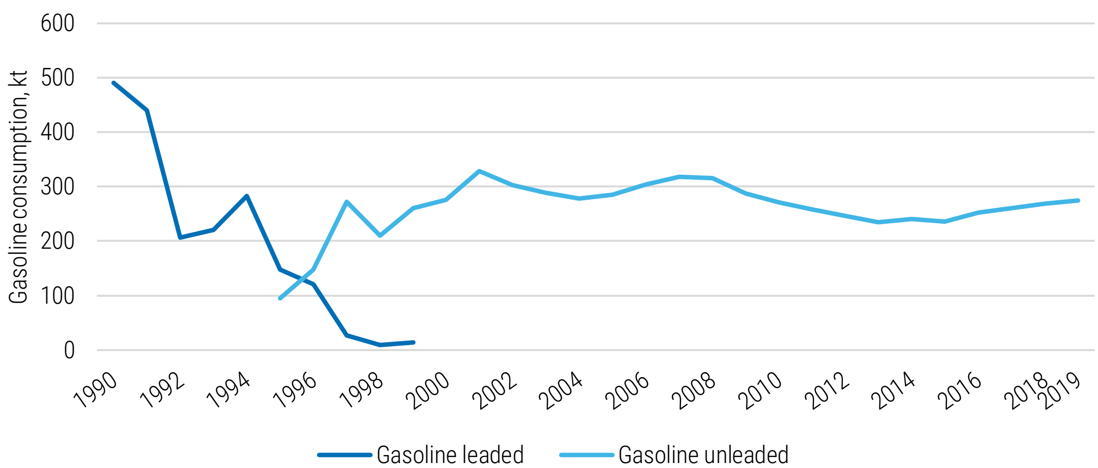

Figure 2.29 Gasoline consumption in 1990–2019

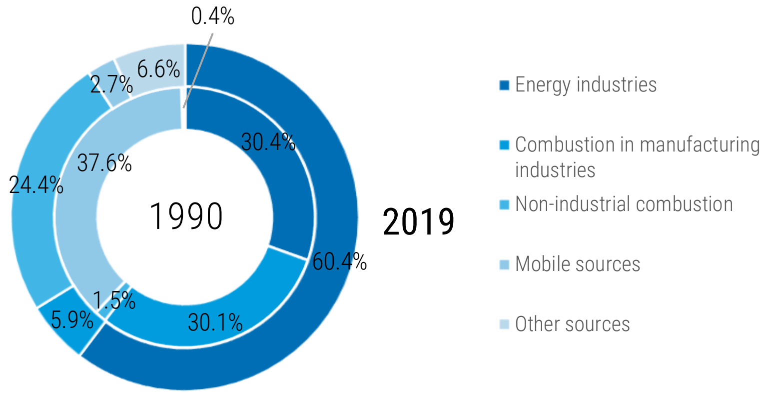

Figure 2.30 Pb emission by sources of pollution in the period of 1990 and 2019

2.3.1.2. Cadmium (Cd)

In the period between 1990-2019, the emissions of cadmium decreased by 86.2% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production (Table 2.14 and Figure 2.31).

Table 2.14 Cd emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.13	3.23	0.14	0.00	0.00	0.032	0.03	4.57
1995	0.62	1.31	0.28	0.00	0.00	0.02	0.04	2.26
2000	0.51	0.03	0.27	0.00	0.00	0.02	0.04	0.87
2005	0.53	0.01	0.24	0.00	0.00	0.02	0.02	0.82
2010	0.61	0.02	0.31	0.00	0.00	0.01	0.01	0.97
2015	0.49	0.02	0.27	0.00	0.00	0.02	0.01	0.82
2016	0.55	0.01	0.29	0.00	0.00	0.02	0.01	0.89
2017	0.53	0.02	0.29	0.00	0.00	0.03	0.01	0.89
2018	0.48	0.01	0.29	0.00	0.00	0.02	0.01	0.83
2019	0.22	0.02	0.28	0.00	0.00	0.02	0.01	0.63
Share in total 1990 emission, %	24.8	70.7	3.1	0.0	0.1	0.7	0.6	
Share in total 2019 emission, %	35.1	2.4	44.8	0.2	0.2	3.2	1.9	
Change 1990-2019, %	**-80.5**	**-99.5**	**98.4**	**4.7**	**-62.0**	**-38.6**	**-53.0**	**-86.2**
Change 2018-2019, %	**-54.5**	**3.4**	**-3.4**	**1.8**	**-5.2**	**-2.5**	**0.9**	**-23.9**

The emissions of cadmium by sources of pollution in 1990 and 2019 are shown in Table 2.14 and Figure 2.32.

The distribution of emissions by sector has changed during this period. While in 1990 the main sources of cadmium pollution were combustion in manufacturing industries (70.7%,

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mainly cement production industry) and energy industries (24.8%), in 2019, the main sources of pollution by Cd were non-industrial combustion (44.8%) and energy industry (35.1%, mainly oil shale power plants). The contribution of other sources (IPPU, waste and mobile sources) in 2019 is 17.8%, of which the use of fireworks makes up half.

The main reason for the decrease in cadmium emissions in 2019 compared to 2018 is a decrease in electricity production, as well as a change in the methodology for calculating heavy metals at oil shale power plants.

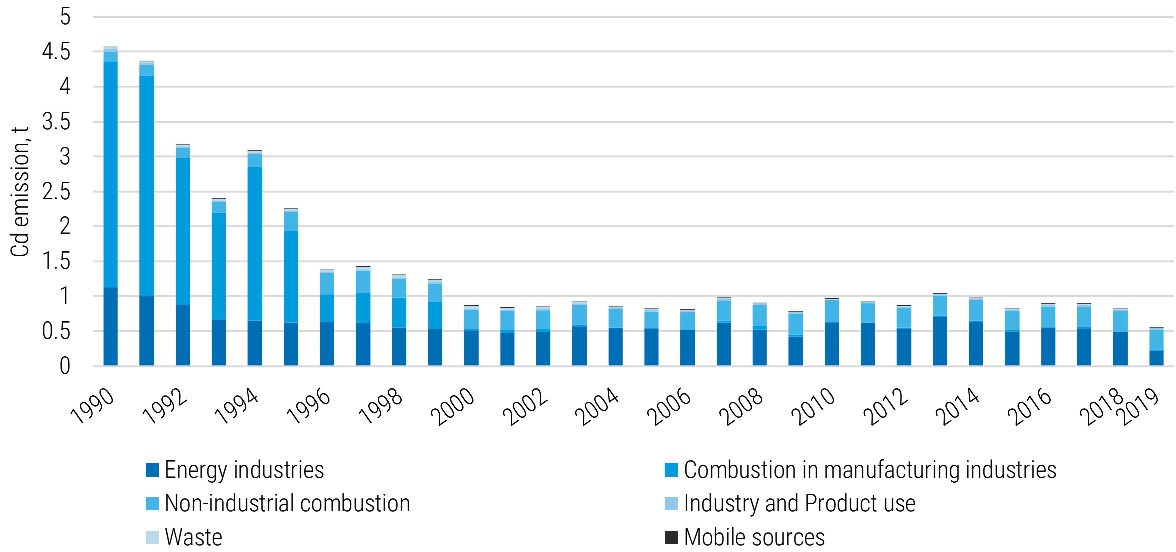

Figure 2.31 Cd emissions in the period of 1990–2019

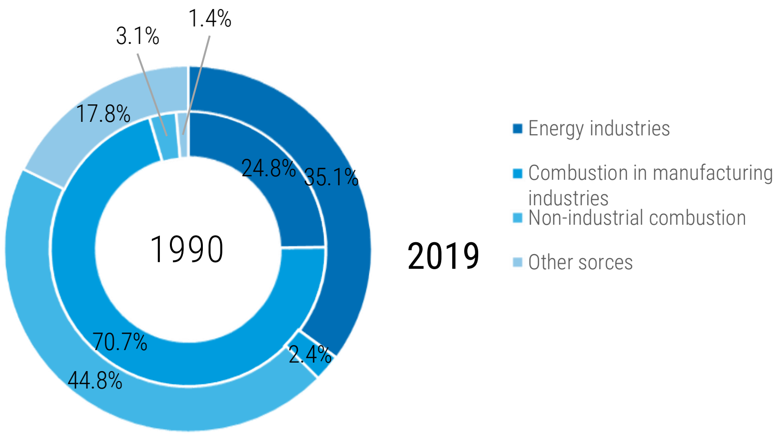

Figure 2.32 Cd emission by sources of pollution in the period of 1990 and 2019

2.3.1.3. Mercury (Hg)

In the period between 1990-2019, the emissions of mercury decreased by 72.5% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production (Table 2.15 and Figure 2.33).

Table 2.15 Hg emissions by sector (t), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.01	0.08	0.08	0.005	0.0015	0.013	0.02	1.22
1995	0.55	0.03	0.08	0.003	0.0005	0.006	0.03	0.71
2000	0.48	0.01	0.08	0.003	0.0003	0.005	0.04	0.62
2005	0.51	0.01	0.07	0.004	0.0004	0.007	0.02	0.61
2010	0.61	0.00	0.07	0.004	0.0003	0.003	0.02	0.71
2015	0.49	0.00	0.07	0.004	0.0002	0.005	0.02	0.60
2016	0.56	0.00	0.07	0.005	0.0002	0.005	0.02	0.67
2017	0.53	0.01	0.07	0.005	0.0002	0.005	0.02	0.64
2018	0.48	0.02	0.07	0.005	0.0002	0.004	0.02	0.60
2019	0.21	0.02	0.07	0.005	0.0002	0.004	0.02	0.33
Share in total 1990 emission, %	83.4	6.6	6.6	0.4	0.1	1.1	1.8	
Share in total 2019 emission, %	62.5	4.5	21.2	1.4	0.1	1.3	6.8	
Change 1990-2019, %	**-79.4**	**-81.2**	**-11.9**	**-14.6**	**-87.8**	**-67.4**	**6.8**	**-72.5**
Change 2018-2019, %	**-56.6**	**0.1**	**-0.4**	**-0.9**	**-15.1**	**-0.5**	**-0.8**	**-44.2**

The emissions of mercury by sources of pollution in 1990 and 2019 are shown in Table 2.15 and Figure 2.33, 2.34.

The distribution of emissions by sector has changed during this period. While in 1990 the energy industries was the main source of mercury pollution (83.4%, mainly oil shale power plants), in 2019 its share decreased and the non-industrial sector became the other key source (21.2%, mainly residential combustion). The share of combustion in manufacturing industries is about 4.5%. The contribution of other sources (IPPU, waste and mobile sources) in 2019 is 11.9% and more than half is from fireworks use.

The main reason for the decrease in mercury emissions in 2019 compared to 2018 is a decrease in electricity production, as well as a change in the methodology for calculating heavy metals at oil shale power plants.

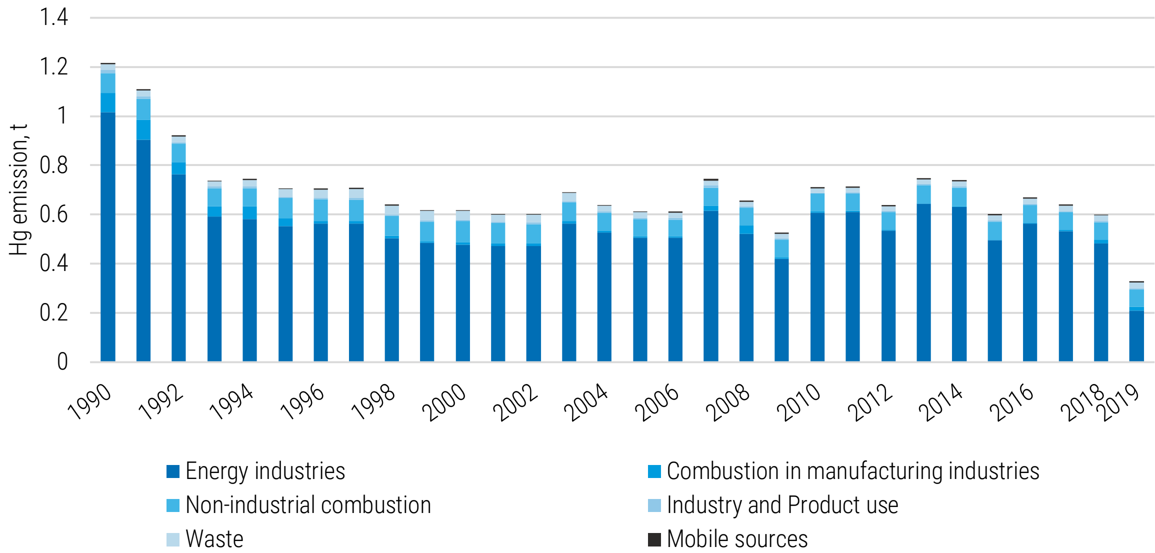

Figure 2.33 Hg emissions in the period of 1990–2019

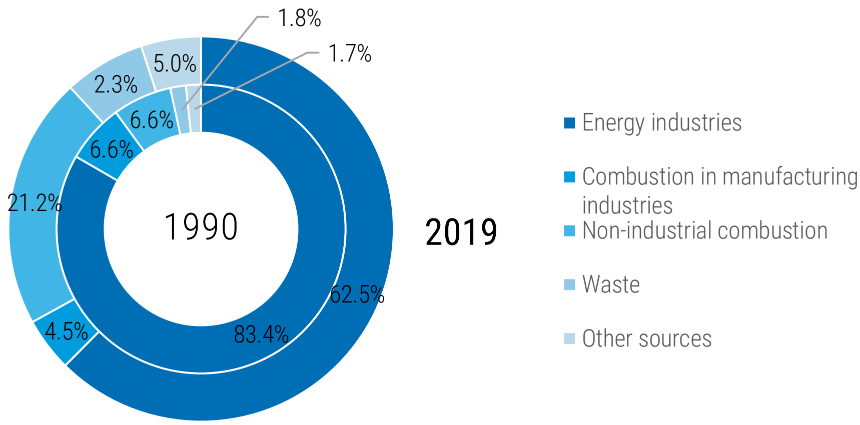

Figure 2.34 Hg emission by sources of pollution in the period of 1990 and 2019

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

In the period between 1990-2019, the emissions of As, Cr, Cu, Ni and Zn decreased by 89.4%, 86.6%, 55.4%, 94.2 and 78% respectively due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production (Table 2.12 and Figure 2.25, 2.27).

The emissions of all other heavy metals by sources of pollution in 1990 and 2019 are shown in Figures 2.35 - 2.39.

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

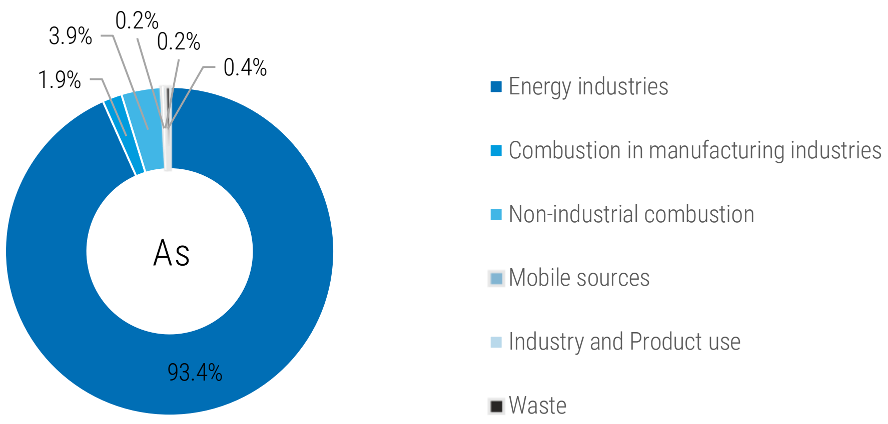

Figure 2.35 As emission by sources of pollution in 2019

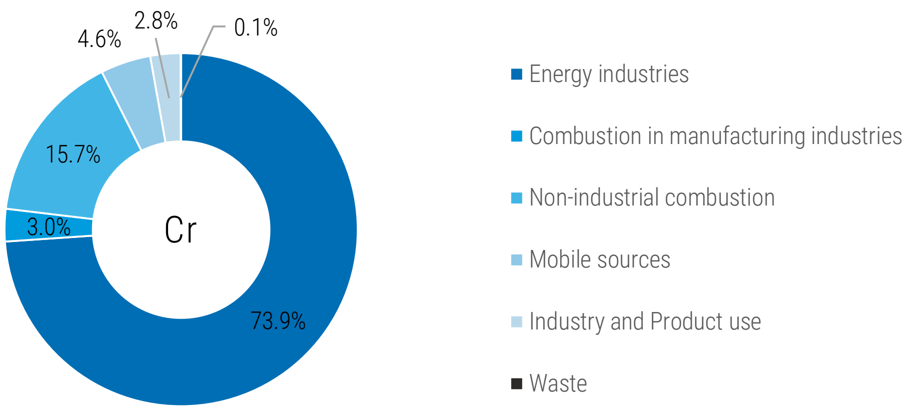

Figure 2.36 Cr emission by sources of pollution in 2019

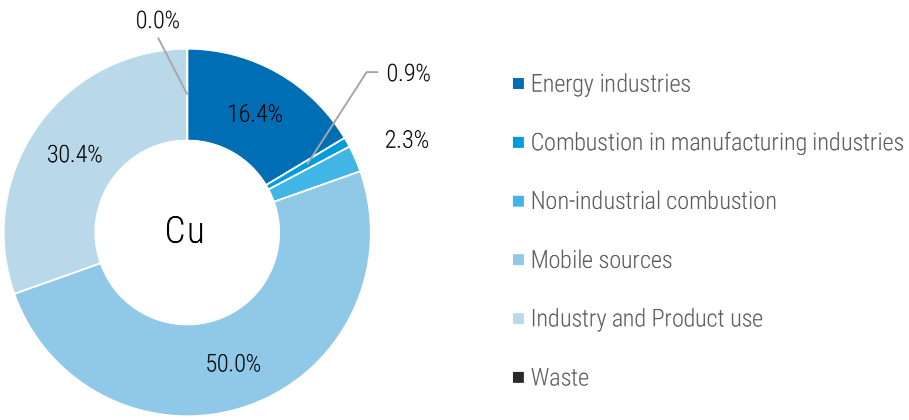

Figure 2.37 Cu emission by sources of pollution in 2019

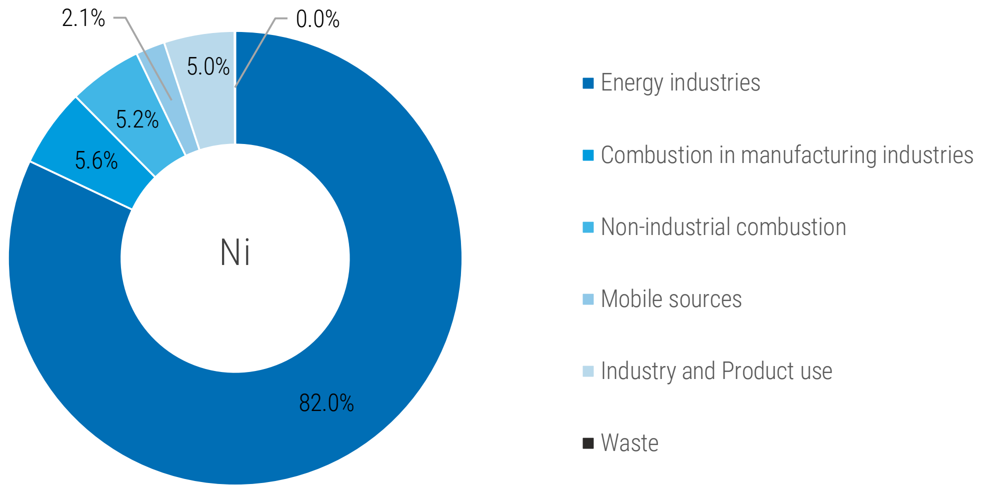

Figure 2.38 Ni emission by sources of pollution in 2019

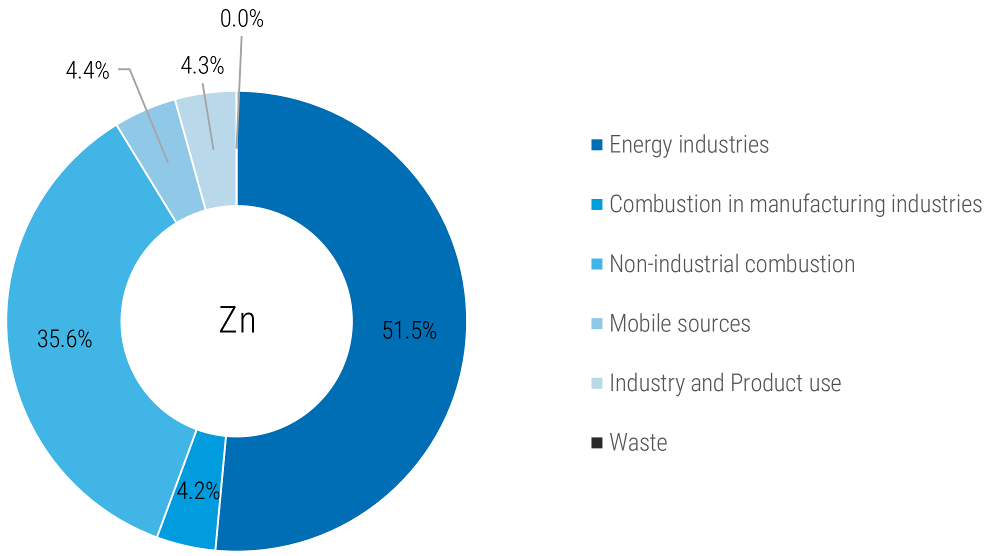

Figure 2.39 Zn emission by sources of pollution in 2019

The main reason for the decrease in emissions in 2019 compared to 2018 is a decrease in electricity production, as well as a change in the methodology for calculating heavy metals at oil shale power plants.

2.4. Persistent Organic Pollutants (POPs)

This chapter describes the changes in emissions of persistent organic pollutants from 1990 to 2019.

In this period, dioxin, PAHs total and PCB emissions decreased by approximately 53.7%, 64.8% and 87.1% respectively. Only HCB emissions increased for the same period by 36.6% (the main reason is the increase in the share of wood burning), but decreased from 1995 to 2019 by 4.8% (Table 2.16, figures 2.40 - 2.42).

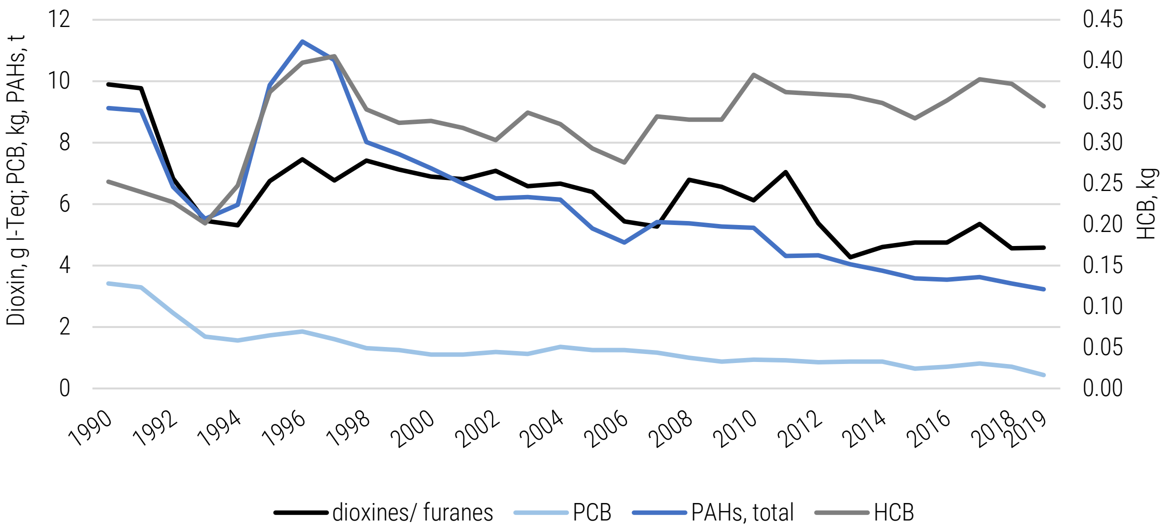

Figure 2.40 Persistent organic pollutants emissions in the period 1990 – 2019

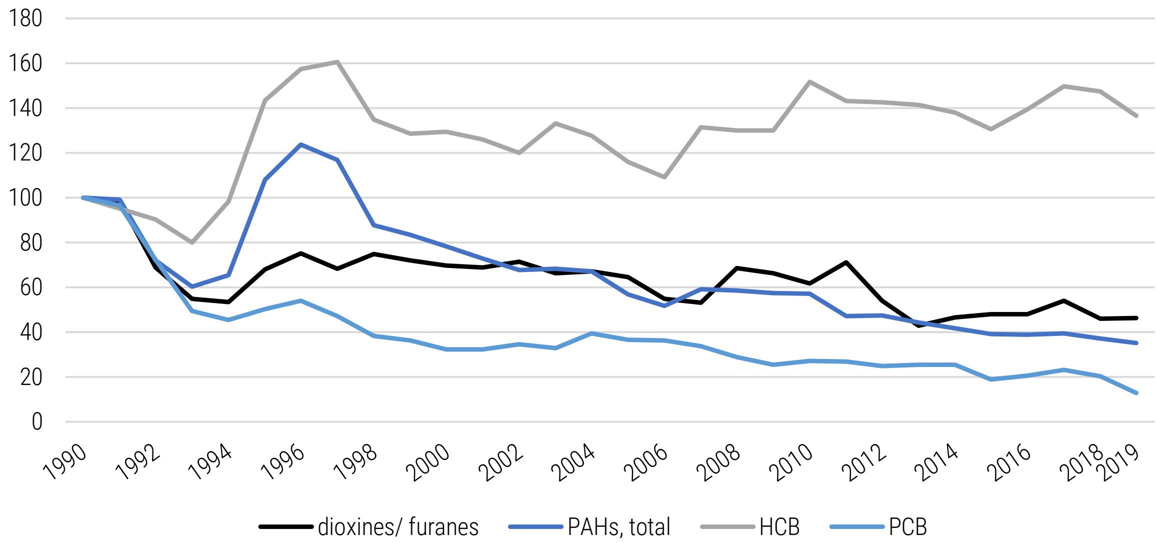

Figure 2.41 Indexed of persistent organic pollutants emissions (1990=100) in the period 1990-2019

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

In 2021 submission POPs emission from combustion activities were recalculated by using of Tier 2 methodology.

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

The emissions of POPs are shown in Table 2.16 and Figures 2.40.

Table 2.16 POPs emission in the period of 1990–2019

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	9.898	2.603	3.197	1.635	1.693	9.128	0.252	3.406
1991	9.773	2.576	3.168	1.619	1.679	9.043	0.240	3.289
1992	6.825	1.863	2.160	1.183	1.361	6.566	0.227	2.460
1993	5.447	1.556	1.728	1.000	1.220	5.504	0.202	1.688
1994	5.296	1.670	1.728	1.094	1.474	5.966	0.248	1.550
1995	6.742	2.739	2.721	1.811	2.592	9.864	0.362	1.713
1996	7.448	3.136	3.127	2.072	2.953	11.288	0.397	1.844
1997	6.763	2.960	2.871	1.968	2.881	10.680	0.405	1.603
1998	7.409	2.220	2.152	1.478	2.159	8.009	0.340	1.307
1999	7.119	2.116	2.069	1.405	2.033	7.623	0.324	1.234
2000	6.891	1.982	1.909	1.317	1.946	7.154	0.327	1.103
2001	6.814	1.841	1.775	1.224	1.812	6.651	0.318	1.100
2002	7.067	1.714	1.675	1.135	1.652	6.176	0.303	1.177
2003	6.572	1.725	1.662	1.143	1.694	6.225	0.336	1.120
2004	6.654	1.710	1.690	1.125	1.620	6.145	0.322	1.347
2005	6.399	1.451	1.453	0.950	1.350	5.203	0.292	1.247
2006	5.425	1.317	1.299	0.867	1.250	4.733	0.275	1.242
2007	5.270	1.496	1.414	0.995	1.503	5.409	0.332	1.152
2008	6.789	1.485	1.412	0.985	1.482	5.364	0.328	0.988
2009	6.565	1.456	1.359	0.968	1.476	5.259	0.328	0.869
2010	6.114	1.446	1.360	0.957	1.449	5.212	0.382	0.928
2011	7.046	1.201	1.145	0.789	1.176	4.311	0.361	0.913
2012	5.358	1.205	1.132	0.794	1.194	4.325	0.359	0.850
2013	4.260	1.126	1.088	0.737	1.089	4.039	0.357	0.871
2014	4.607	1.067	1.034	0.695	1.027	3.823	0.348	0.872
2015	4.752	0.995	0.967	0.648	0.960	3.570	0.329	0.643
2016	4.751	0.986	0.953	0.642	0.961	3.542	0.352	0.702
2017	5.354	1.009	1.006	0.649	0.953	3.616	0.377	0.795
2018	4.553	0.951	0.931	0.613	0.910	3.404	0.372	0.694
2019	4.584	0.900	0.893	0.575	0.846	3.214	0.345	0.438
Change 1990-2019, %	-53.7	-65.4	-72.1	-64.8	-50.0	-64.8	36.6	-87.1
Change 2018-2019, %	0.7	-5.3	-4.1	-6.1	-7.0	-5.6	-7.3	-36.9

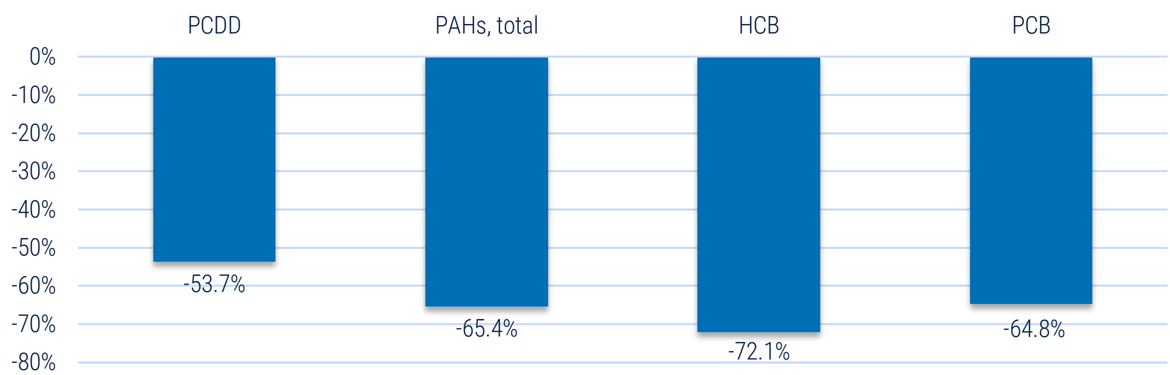

Figure 2.42 Reduction of persistent organic pollutants emissions in the period 1990-2019

2.4.1. Dioxins/Furans (PCDD/PCDF)

In the period between 1990 and 2019, the emissions of dioxin decreased by 53.4% due to decreased production of energy and mineral products. One of the reasons for the significant decrease in emissions from 1990 to 1994 was the decrease of coal and peat consumption in the residential sector (the dioxin emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion). Growth in wood consumption in the same sector is the reason for an increase in emissions since 1995. The increase in dioxin emissions from 2008 to 2011 is also due to an increased share of burning solid biomass in the energy industries sector (Table 2.17 and Figure 2.43).

Table 2.17 PCDD/PCDF emissions by sector (g I-TEQ), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.58	1.77	5.41	0.28	0.03	0.0004	0.83	9.90
1995	1.20	0.99	3.48	0.16	0.01	0.0002	0.90	6.74
2000	0.77	0.67	2.36	0.19	0.00	0.02	2.86	6.89
2005	0.85	0.94	1.76	0.27	0.00	0.04	2.54	6.40
2010	2.34	0.54	1.44	0.31	0.00	0.05	1.44	6.11
2015	1.22	0.74	0.94	0.31	0.00	0.03	1.51	4.75
2016	1.36	0.63	0.98	0.29	0.00	0.03	1.46	4.75
2017	1.44	1.02	0.98	0.28	0.00	0.03	1.61	5.35
2018	1.20	0.91	0.92	0.27	0.00	0.03	1.23	4.55
2019	1.27	0.99	0.86	0.27	0.00	0.03	1.16	4.58
Share in total 1990 emission, %	15.9	17.9	54.6	2.9	0.3	0.0	8.4	
Share in total 2019 emission, %	27.8	21.7	18.9	5.8	0.02	0.7	25.2	
Change 1990-2019, %	-19.4	-43.9	-84.0	-6.3	-97.1	7156.8	39.3	-53.7
Change 2018-2019, %	6.1	9.4	-6.2	0.0	-15.0	1.1	-5.8	0.7

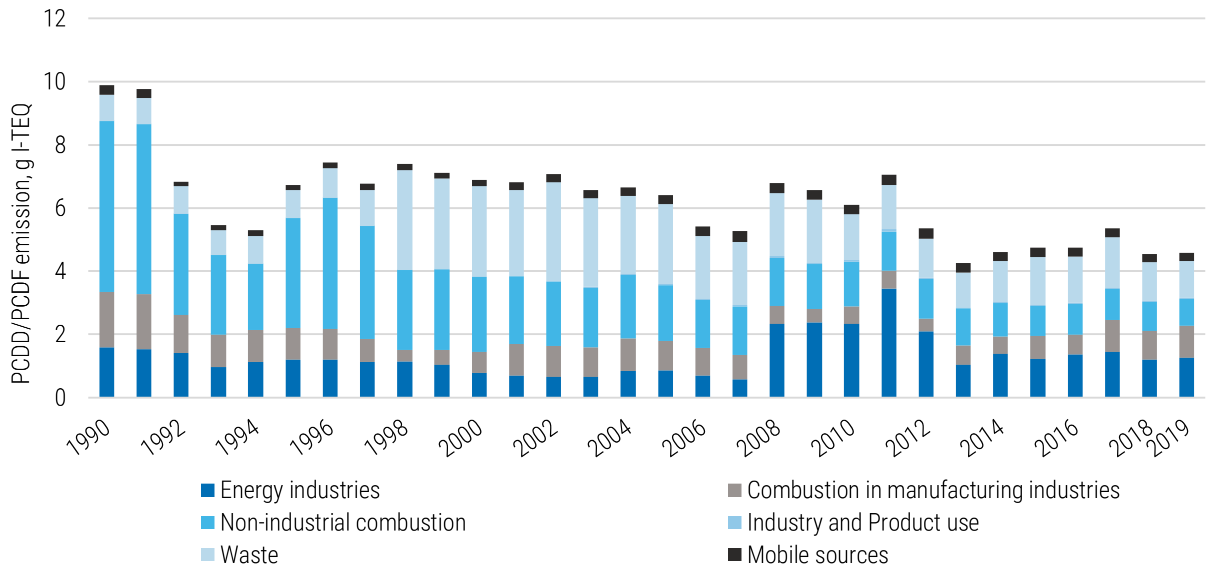

Figure 2.43 PCDD/PCDF emissions in the period of 1990–2019

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

The main sources of dioxins emission in 2019 are combustion in energy industries (27.8%, includes also waste combustion as fuel), the waste sector (25.2%, mainly industrial and clinical waste incineration), combustion in the manufacturing industry (21.7%, includes also waste combustion as fuel, mainly in the cement manufacturing industry), non-industrial combustion sector (18.9%), and other sources (6.5%, includes IPPU sector and mobile sources) (see Figure 2.44).

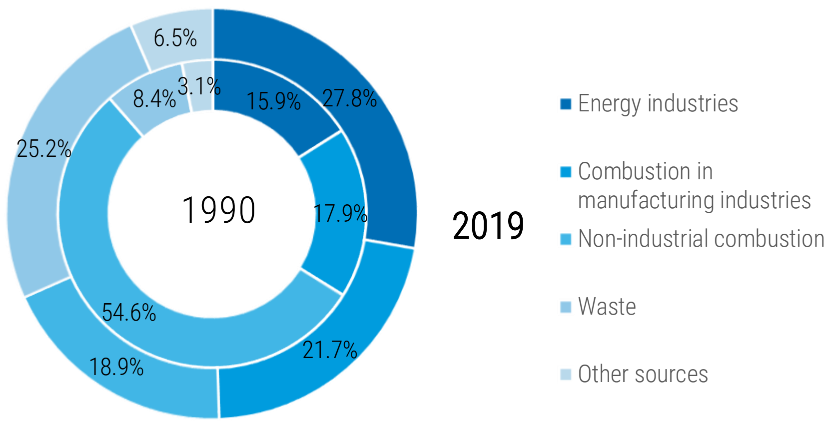

Figure 2.44 PCDD/PCDF emission by sources of pollution in the period of 1990 and 2019

2.4.2. Polycyclic Aromatic Hydrocarbons (PAHs)

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

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

Emissions for each substance in the period 1900 – 2019 are shown in the table 2.16.

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

In the period between 1990-2019, the emissions of PAHs decreased by 64.8% due to the decrease in energy production. One of the reasons of the significant decrease in emission from 1990 to 1994 the decrease of coal and peat consumption by residential sector (the PAHs emission factor for these fuels is much higher for the domestic stoves and higher than for other fuels combustion). Growth in wood consumption by the same sector the reason of increase in emissions since 1995. It should be noted that emissions from non-industrial combustion sector decreased between 2000 and 2019, despite the increase in biomass burned in the residential sector. The reason for this is the growing in the last year's share of new high-efficiency technologies (Figure 2.45).

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

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.32	0.41	7.31	0.04	0.05	0.0010	0.0001	9.13
1995	0.71	0.08	9.03	0.03	0.02	0.0005	0.0001	9.86
2000	0.34	0.11	6.67	0.03	0.01	0.0005	0.0001	7.15
2005	0.35	0.24	4.57	0.04	0.01	0.0006	0.0000	5.20
2010	0.22	0.21	4.73	0.04	0.02	0.0003	0.0000	5.21
2015	0.19	0.26	3.05	0.05	0.01	0.0005	0.0000	3.57
2016	0.24	0.22	3.01	0.05	0.01	0.0005	0.0000	3.54
2017	0.32	0.31	2.93	0.05	0.01	0.0004	0.0000	3.62
2018	0.24	0.28	2.82	0.05	0.01	0.0004	0.0000	3.40
2019	0.24	0.30	2.60	0.05	0.01	0.0004	0.0000	3.21
Share in total 1990 emission, %	14.5	4.4	80.0	0.5	0.5	0.01	0.001	
Share in total 2019 emission, %	7.5	9.5	80.9	1.7	0.4	0.01	0.001	
Change 1990-2019, %	**-81.7**	**-24.9**	**-64.4**	**24.8**	**-74.7**	**-64.6**	**-53.4**	**-64.8**
Change 2018-2019, %	**2.5**	**8.5**	**-7.8**	**1.2**	**-5.9**	**-11.5**	**2.3**	**-5.6**

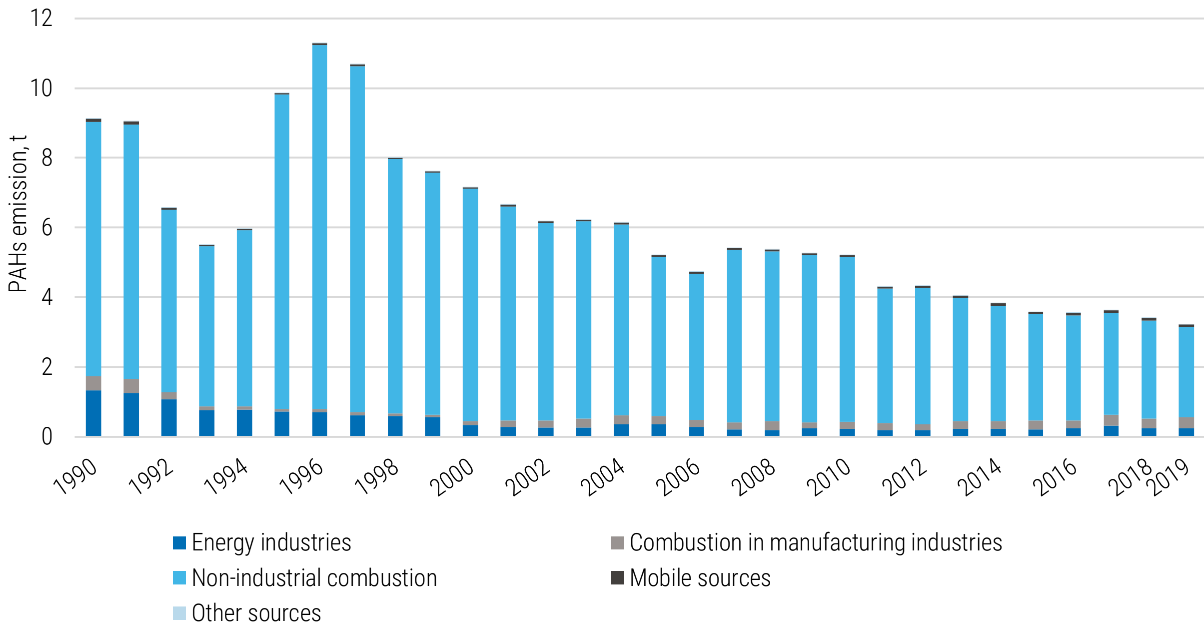

Figure 2.45 PAHs emissions in the period of 1990–2019

The main contributors to the total PAHs emissions in 2019 is non-industrial combustion (80.9%), mainly solid biomass combustion in residential sector. The share of energy industries and combustion in manufacturing industries sectors are 7.5% and 9.5% respectively. The contribution of other sources is insignificant, only 2.1% (Table 2.18 and Figure 2.46)

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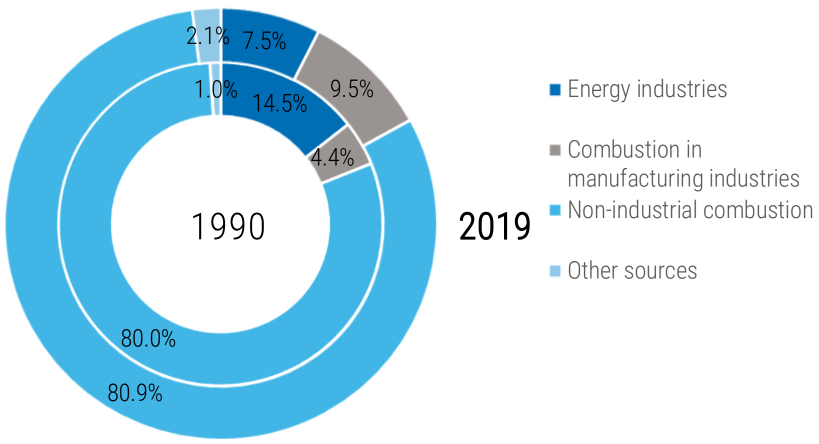

Figure 2.46 PAHs emission by sources of pollution in the period of 1990 and 2019

2.4.3. Hexachlorobenzene (HCB)

During the period of 1990–2019, the emissions of HCB had increased by about 36.6%, which was largely influenced by a growth of solid biomass consumption in energy production since 1995. Emission reduction between 1990 and 1994 was observed as a result of decrease coal and peat consumption in energy sector.

Table 2.19 HCB emissions by sector (kg), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	0.13	0.01	0.09	0.0002	0.002	NO	0.015	0.25
1995	0.10	0.01	0.24	0.0001	0.001	NO	0.021	0.36
2000	0.08	0.01	0.21	0.0002	0.001	NO	0.023	0.33
2005	0.09	0.03	0.16	0.0003	0.001	NO	0.010	0.29
2010	0.14	0.03	0.21	0.0003	0.001	0.002	0.007	0.38
2015	0.12	0.04	0.16	0.0003	0.001	0.002	0.008	0.33
2016	0.14	0.03	0.17	0.0003	0.001	0.003	0.008	0.35
2017	0.15	0.04	0.17	0.0003	0.001	0.002	0.008	0.38
2018	0.15	0.04	0.17	0.0003	0.001	0.002	0.008	0.37
2019	0.13	0.04	0.16	0.0003	0.0005	0.001	0.008	0.34
Share in total 1990 emission. %	52.9	2.8	37.6	0.1	0.6		6.061	
Share in total 2019 emission. %	37.2	12.9	46.9	0.1	0.1	0.43	2.4	
Change 1990-2019. %	-4.0	533.1	70.4	28.9	-68.1		-46.0	36.6
Change 2018-2019. %	-15.2	8.8	-4.4	0.0	-15.1	-6.9	0.8	-7.3

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The main sources of HCB emission in 2019 are the non-industrial combustion, energy industries and combustion in manufacturing industry sectors (46.9%, 37.2% and 12.9% respectively). The other sources (mobile, waste and industry) contribute only 3% in total emission. The share of waste sector (open burning of waste) is 2.4%. Emission from industry (the secondary aluminium production) were only 0.43% of total HCB emission (see Table 2.19 and Figures 2.47 - 2.48).

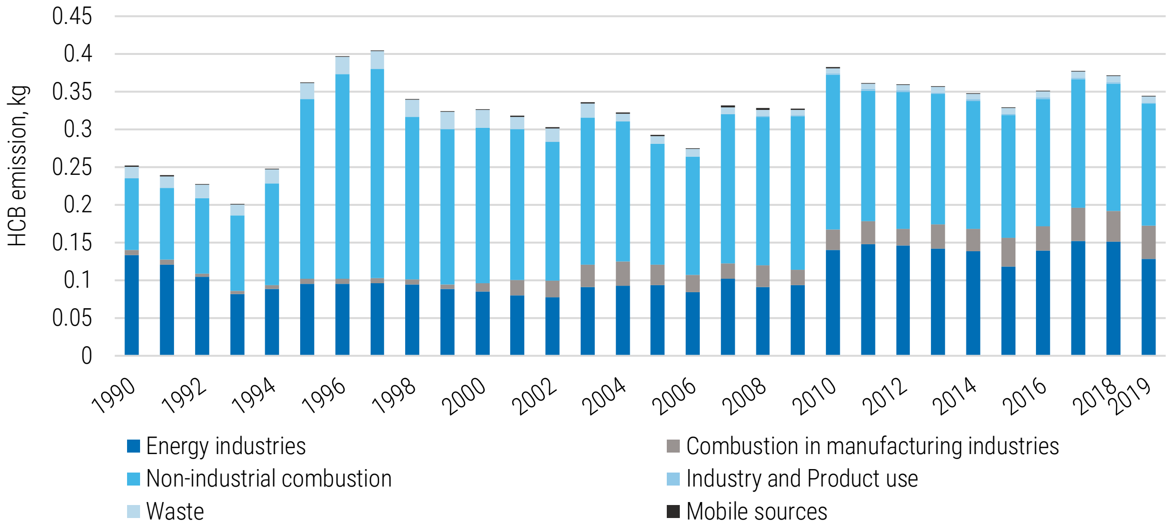

Figure 2.47 HCB emissions in the period of 1990–2019

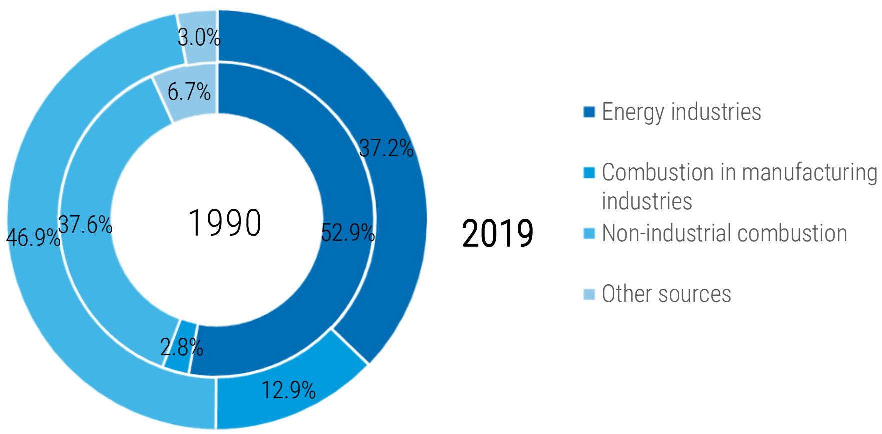

Figure 2.48 HCB emission by sources of pollution in the period of 1990 and 2019

2.4.4. Polychlorinated biphenyls (PCB)

During the period of 1990–2019, the emissions of PCB had decreased by about 87.1% due to the decrease in energy production. Emission reduction between 1990 and 1994 was observed as a result of decrease coal and peat consumption in energy sector (Figure 2.49).

Table 2.20 PCB emissions by sector (kg), change in emissions and share in total emission

Year	1A1 Energy industries	1A2 Combustion in manufacturing industries	1A4 Non-industrial combustion	1A3b Road transport	Other mobile sources	2A-L Industry and Product use	5 Waste	Total
1990	1.79	0.37	1.18	0.0001	0.021	NO	0.041	3.41
1995	1.17	0.07	0.40	0.0000	0.007	NO	0.056	1.71
2000	0.69	0.11	0.24	0.0000	0.001	0.0000	0.062	1.10
2005	0.83	0.15	0.24	0.0001	0.000	0.0000	0.027	1.25
2010	0.72	0.11	0.08	0.0001	0.000	0.000	0.018	0.93
2015	0.52	0.06	0.05	0.0001	0.000	0.000	0.020	0.64
2016	0.59	0.05	0.04	0.0001	0.000	0.000	0.020	0.70
2017	0.68	0.06	0.03	0.0001	0.000	0.000	0.021	0.79
2018	0.58	0.06	0.02	0.0001	0.000	0.000	0.022	0.69
2019	0.34	0.06	0.02	0.0001	0.0002	0.000	0.022	0.44
Share in total 1990 emission, %	52.6	10.9	34.7	0.0	0.6		1.189	
Share in total 2019 emission, %	77.0	13.8	4.1	0.0	0.1	0.01	5.023	
Change 1990-2019, %	**-81.2**	**-83.7**	**-98.5**	**-26.4**	**-98.9**		**-45.7**	**-87.1**
Change 2018-2019, %	**-42.3**	**-6.8**	**-20.5**	**0.0**	**-14.9**	**0.0**	**0.8**	**-36.9**

The main sources of PCB emission in 2019 are energy industries sectors (77%, mainly oil shale power plants) and combustion in manufacturing industries – 13.8% (mainly cement production). The share of waste sector is 5% (open burning of waste and cremation). Emission from industry (the secondary lead and zinc production) were only 0,01% of total PCB emission. The other sources (non-industrial combustion and mobile sources) contribute 4.2% in total PCB emission (see Table 2.20 and Figure 2.50).

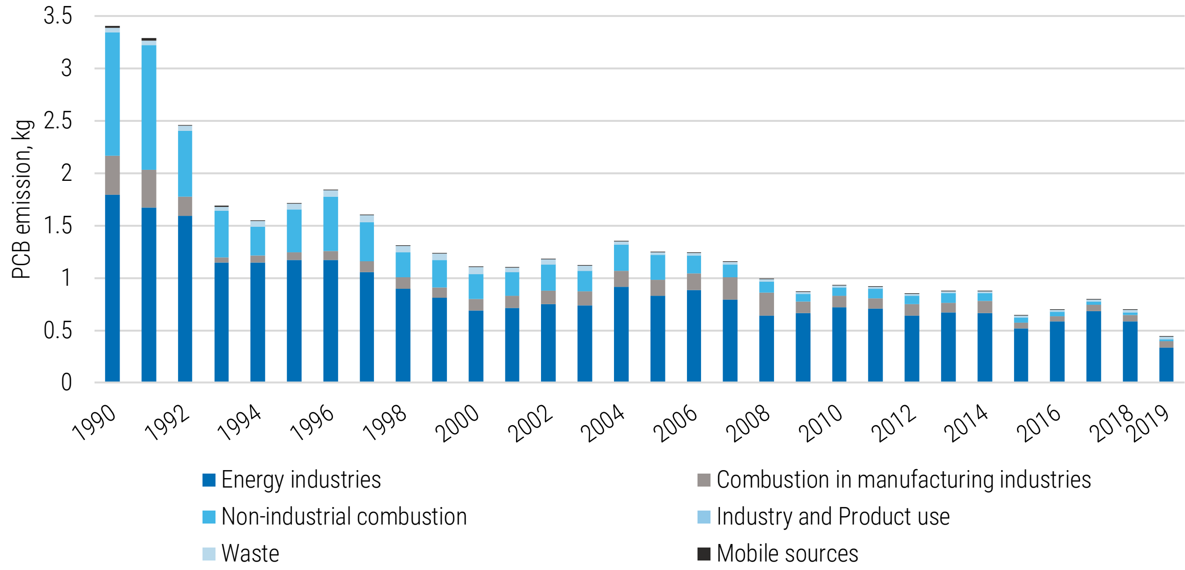

Figure 2.49 PCB emissions in the period of 1990–2019

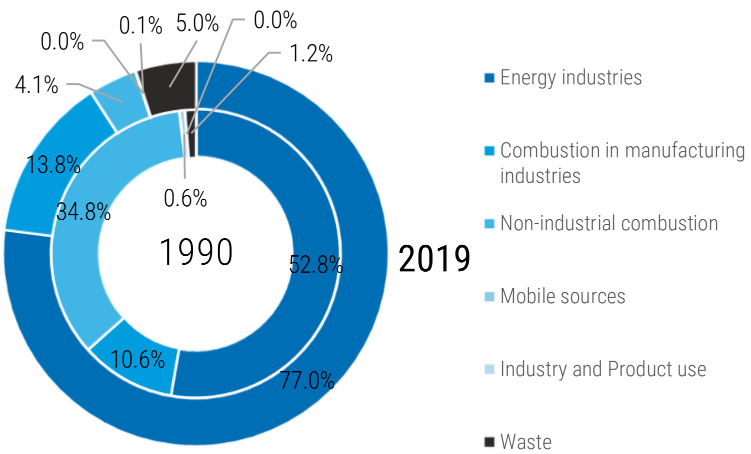

Figure 2.50 PCB emission by sources of pollution in the period of 1990 and 2019

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Photo: Piret Pärnpuu

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.

Estonia is relatively rich in natural resources, both mineral and biological. It is a unique country whose energy production depends primarily on the use of oil shale. In 2019, the share of domestic fuels – oil shale, wood and peat – accounted for approximately 91% (from which oil shale is about 71%) of the primary energy supply. Coal, natural gas and liquid fuels were imported to Estonia in 2019. Imports of natural gas decreased by about 7% compared to 2018. The imports of motor gasoline and diesel decreased by about 20% and 8% respectively compared to the previous year. The imports of coal increased by about 11% compared to 2018. Imported fuels (natural gas, fuel oils, coal, and motor fuels) made up 9% (see Figure 3.1).

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

In Estonia, renewable energy is generated from hydro-, wind and solar energy as well as from biomass. Since electricity generation has accelerated in hydroelectric power plants and wind parks, the proportion of renewable energy has increased. The generation of hydro energy has been stable over the past years (2019 saw a increase from 15 GWh to 19 GWh). The share of wind energy in gross electricity production in 2019 is 9%, solar is 1% and hydro energy only 0.2% (Statistics Estonia). In 2005, electricity generated from renewable energy sources was only 1.1%, but in 2019, it accounted for 28% (Figure 3.2). The growth was due to the enlargement of the existing wind parks and the commissioning of new combined heat and power plants working on biomass fuel.

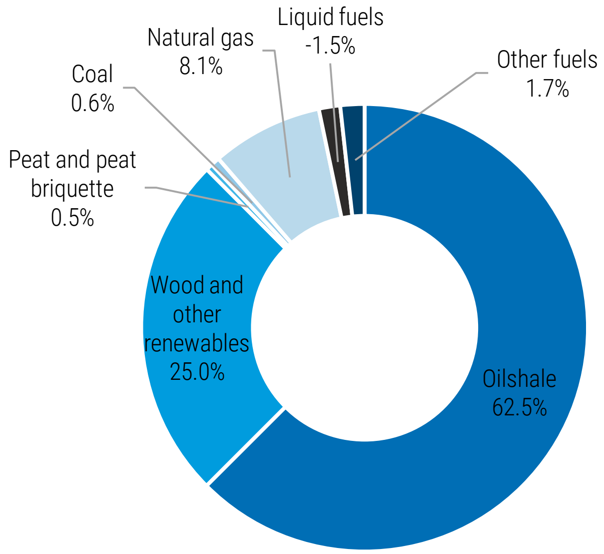

Figure 3.1 Structure of primary energy supply in Estonia in 2019

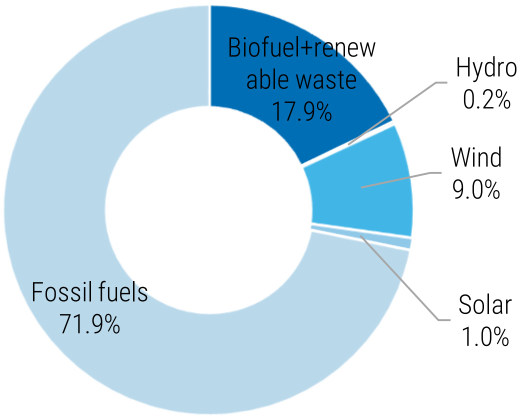

Figure 3.2 Gross electricity production by sources in 2019
(Source: Statistics Estonia)

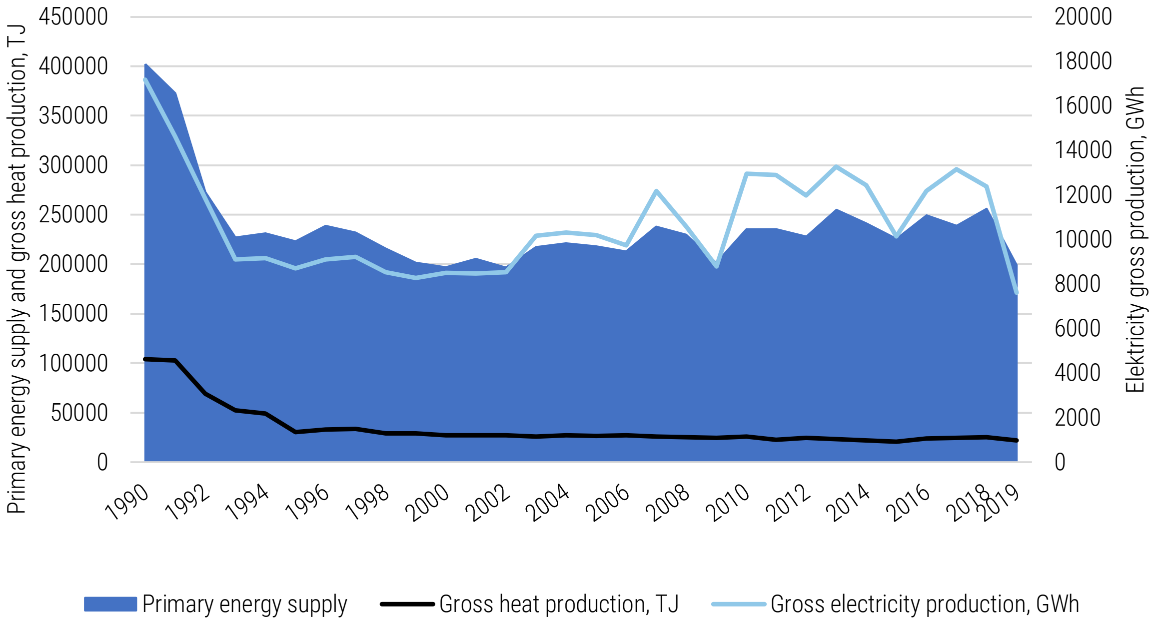

Figure 3.3 Total energy supply, electricity and heat production in the period of 1990–2019
(*Source: Statistics Estonia*)

The energy sector is the main source of SO_2, NO_x, CO, particulates, HMs and POPs in Estonia. In 2019, the energy sector contributed 99.6% of total SO_2 emissions, 90% of total NO_x emissions, 69.6% of PM_{10} emissions, 33.5% of total NMVOC emissions, 99.4% of total CO emissions, and 93.4% of Pb emissions (see Figure 3.5 - 3.7 and Table 3.1).

Table 3.1 Pollutant emissions from the energy sector in the period of 1990–2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	75.076	32.081	274.731	0.155	NR	NR	NR	271.352	253.712	206.703
1995	46.910	23.437	116.966	0.276	NR	NR	NR	124.900	220.804	87.379
2000	43.792	22.996	97.067	0.411	14.592	29.741	3.409	65.562	198.299	38.280
2005	40.500	17.434	76.159	0.719	11.965	17.498	3.073	25.983	152.386	36.661
2010	40.360	12.646	83.246	0.678	13.229	20.785	3.112	24.497	156.256	40.420
2011	38.618	11.383	72.669	0.691	17.657	31.979	3.463	37.350	130.577	39.924
2012	35.297	10.946	42.849	0.709	8.144	11.673	2.124	15.475	141.181	35.393
2013	33.872	10.369	41.647	0.735	11.365	17.387	2.459	19.901	133.388	40.863
2014	32.962	9.505	46.799	0.773	8.208	12.589	1.951	15.890	128.136	37.981
2015	28.382	9.063	36.026	0.985	9.044	11.872	2.452	13.664	128.110	29.995
2016	28.275	8.859	34.882	0.937	7.245	9.341	2.108	10.865	139.594	33.968
2017	28.916	8.653	38.627	1.106	8.607	11.083	2.452	12.632	137.573	35.727
2018	27.424	7.716	30.793	1.031	6.077	7.935	1.821	9.181	130.311	32.436
2019	22.641	7.605	18.801	1.042	5.363	6.426	1.721	7.559	130.076	10.619
Change 1990-2019, %	-69.8	-76.3	-93.2	571.6	-63.2	-78.4	-49.5	-97.2	-48.7	-94.9
Change 2018-2019, %	-17.4	-1.4	-38.9	1.1	-11.8	-19.0	-5.4	-17.7	-0.2	-67.3

Table 3.1 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCDD/F	HCB	PCB
	t								g I-Teq	kg	
1990	4.508	1.182	18.902	18.428	10.099	27.412	106.062	9.127	9.068	0.237	3.366
1995	2.209	0.669	10.132	9.970	5.029	10.484	63.525	9.863	5.845	0.341	1.658
2000	0.810	0.576	8.631	8.340	3.641	6.454	48.942	7.153	4.004	0.303	1.041
2005	0.784	0.585	9.272	8.954	4.370	6.344	51.405	5.203	3.823	0.282	1.220
2010	0.944	0.689	11.010	10.451	4.761	6.569	61.418	5.212	4.623	0.374	0.910
2011	0.902	0.690	10.927	10.259	4.741	6.389	59.364	4.310	5.577	0.352	0.895
2012	0.839	0.613	9.643	9.091	4.476	5.608	53.638	4.325	4.069	0.351	0.833
2013	1.010	0.723	11.283	10.493	4.754	6.466	61.105	4.039	3.120	0.348	0.852
2014	0.943	0.713	10.291	9.757	4.747	5.994	56.007	3.823	3.288	0.339	0.852
2015	0.792	0.574	7.790	7.515	4.235	4.617	45.471	3.570	3.210	0.320	0.623
2016	0.854	0.642	9.026	8.614	4.529	5.289	51.082	3.541	3.256	0.341	0.682
2017	0.848	0.613	9.536	9.099	4.600	5.630	54.308	3.616	3.713	0.368	0.774
2018	0.793	0.573	8.646	8.241	4.487	5.010	49.061	3.404	3.297	0.362	0.672
2019	0.596	0.308	2.014	2.409	3.504	1.507	22.429	3.214	3.399	0.335	0.416
Change 1990-2019, %	-86.8	-74.0	-89.3	-86.9	-65.3	-94.5	-78.9	-64.8	-62.5	41.3	-87.6
Change 2018-2019, %	-24.8	-46.3	-76.7	-70.8	-21.9	-69.9	-54.3	-5.6	3.1	-7.4	-38.1

During the period of 1990–2019, the emissions of sulphur dioxide from the energy sector decreased by 93.2% and the emissions of nitrogen oxides by about 69.8% resulting from a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 232 PJ in 1990 to 123 PJ in 2019) (see Figure 3.4 and Figure 3.5 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 N° 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.

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.In 2019, SO_2 emissions from energy sector had decreased by about 38.9% compared to 2018. The main reason for the reduction of emissions was caused by a decrease in electricity production by 38% (in oil shale power plants by about 50%) and a higher proportion of cleaner and more efficient units.

In 2019, NO_x emissions decreased by 17.4% in comparison to 2018's figures. The primary reason for this change was the as for sulphur dioxide - decrease of electricity production. Also, the introduction of clearing devices at oil shale power plants played a role.

In 2019, particulate emissions (TSP) decreased by 17.7% in comparison to 2018, due mainly to a a decrease in electricity production at oil shale power plants.

Decrease in electricity and heat production was the cause of decrease in emissions of heavy metals and POPs (see Figure 3.4 and Table 3.1). During the same period, insignificant increase of PCDD/PCDF emissions in public electricity and heat production sector and industrial combustion sector took place due to an increase of the wood consumption.

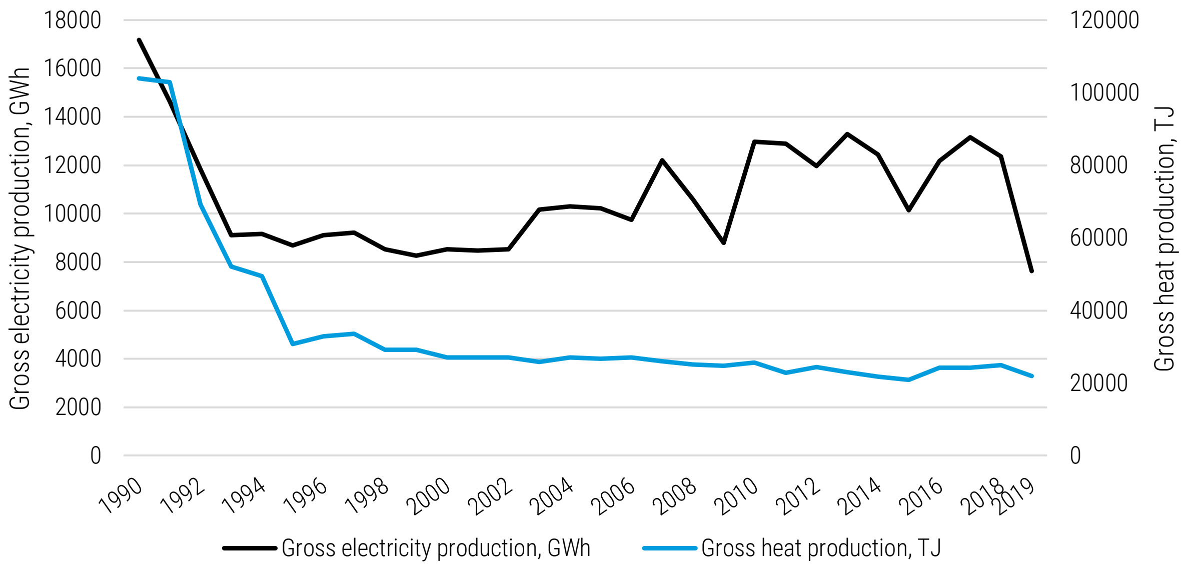

Figure 3.4 Electricity and heat production in the period of 1990–2019

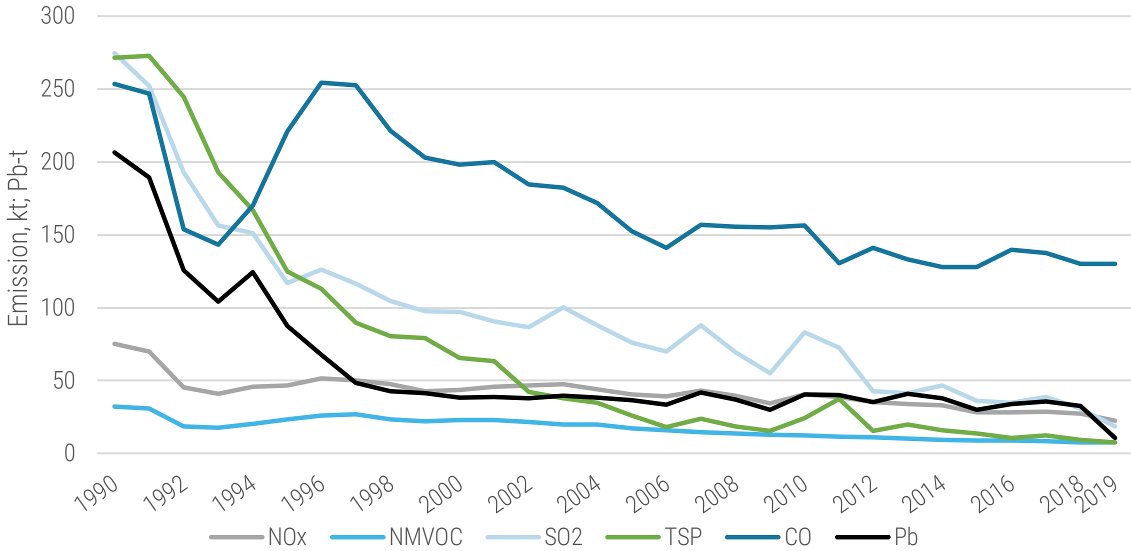

Figure 3.5 Pollutant emissions from the energy industry in the period of 1990–2019

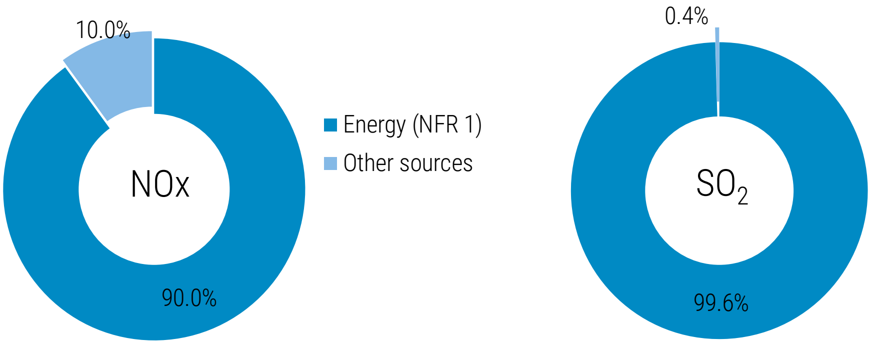

Figure 3.6 Share of SO_2 and NOx emissions from the energy sector in total emissions in 2019

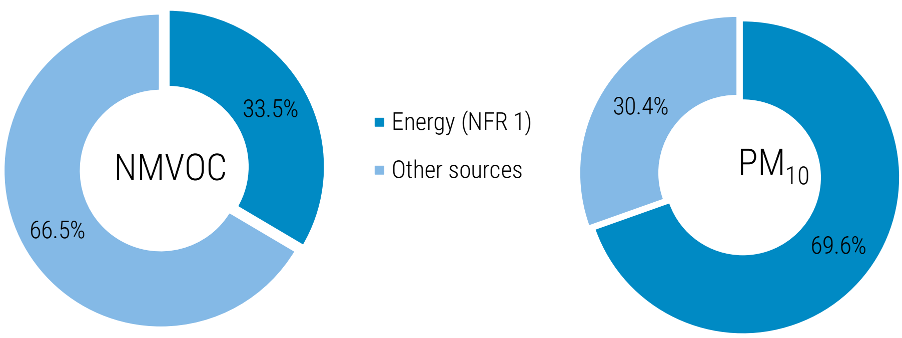

Figure 3.7 Share of NMVOC and PM_{10} emissions from the energy sector in total emissions in 2019

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 – 99.3% in 2019. The share of mobile sources of the total emissions is very small – 0.2% (see Figure 3.9-3.10, includes in other sources).

The stationary fuel combustion sector is a key source for all pollutants except ammonia. Pollutant emissions in the 1990-2019 period and the distribution of emissions between stationary combustion and other sectors are presented in the Table 3.3, Figure 3.8-3.10.

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	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.	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.	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). Only point sources data.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Ni, Zn
	b. Non-ferrous metals	Includes emissions from processes with contact (SNAP 030307 - secondary lead production, 030308 - secondary zinc production, 030310 - secondary aluminium production). Only point sources data.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Zn
	c. Chemicals	Includes emissions from combustion plants of this activity reported by 7 operators.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Zn
	d. Pulp, Paper and Print	Includes emissions from combustion plants of this activity reported by 13 operators.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, As, Cr, Cu, Ni, Zn
	e. Food processing, beverages and tobacco	Includes emissions from combustion plants and other stationary equipment of this activity reported by 52 operators.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs
	f. Non-metallic minerals	Includes emissions from all boilers in the manufacturing industry, other processes with contact: cement, lime, glass, bricks and other productions. (SNAP 0301, 030311-030320). Data reported from 34 operators.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs
	gviii. Other	Includes emissions from all boilers in the manufacturing industry, other processes with contact: (SNAP 030204-030205; 030326). Data of point and diffuse sources.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs
1A4	Non-industrial combustion plants		
	ai Commercial / institutional: Stationary	Includes emissions from boilers or other equipment in the commercial sector. Data of point and diffuse sources.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, HMs, PCDD/F, PAHs, HCB, PCBs

NFR	Source	Description	Emissions reported
	bi Residential: Stationary plants	Includes emissions from boilers and other equipment in the residential sector. Only diffuse sources data.	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 point and diffuse sources.	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

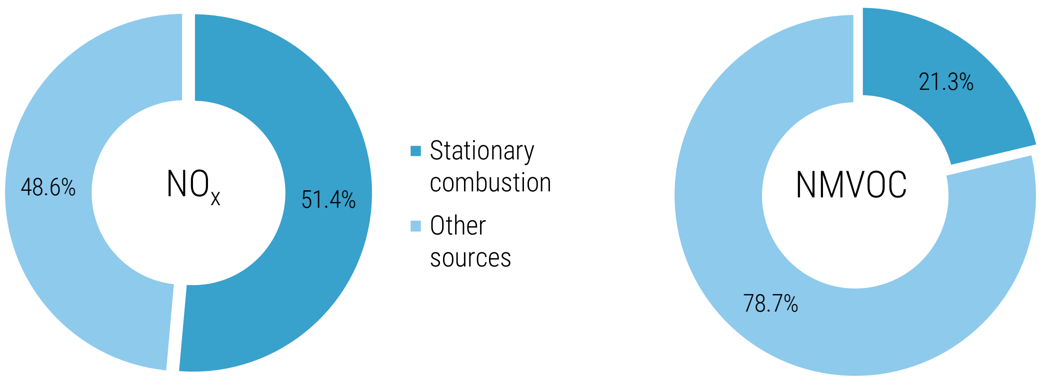

Figure 3.8 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2019

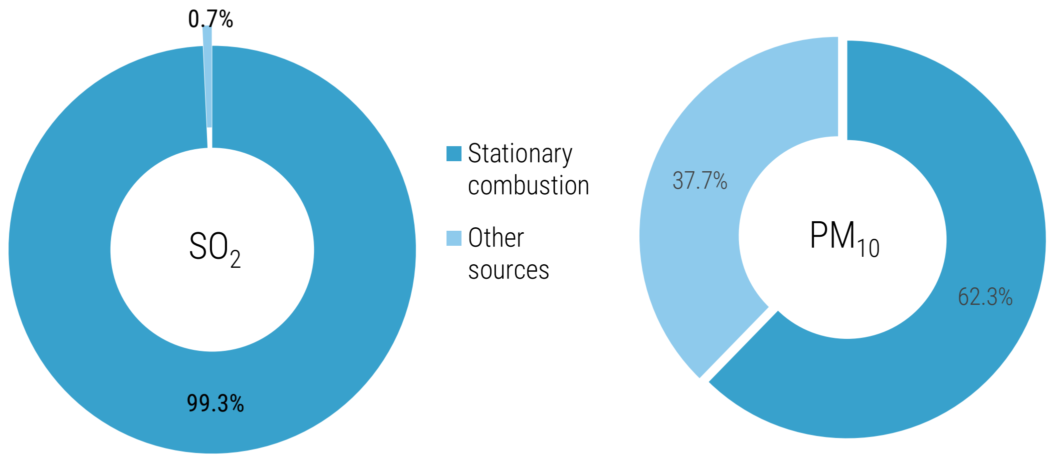

Figure 3.9 SO_2 and PM_{10} emissions from stationary fuel combustion and other sources in 2019

Table 3.3 Pollutant emissions from stationary fuel combustion in the period of 1990–2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	36.305	8.280	267.840	0.136	NR	NR	NR	268.888	100.098	128.628
1995	26.625	9.927	113.327	0.250	NR	NR	NR	123.790	153.966	62.966
2000	23.702	7.383	93.923	0.305	13.646	28.665	2.945	64.318	125.898	33.297
2005	20.587	6.797	75.778	0.470	11.022	16.359	2.584	24.616	107.761	34.531
2010	24.344	6.847	83.101	0.359	12.486	19.784	2.722	23.211	127.492	40.135
2011	23.663	5.847	72.527	0.320	16.936	30.989	3.094	36.045	105.547	39.635
2012	20.951	5.820	42.780	0.314	7.444	10.715	1.769	14.217	115.502	35.097
2013	20.872	6.059	41.568	0.384	10.754	16.571	2.138	18.849	112.245	40.578
2014	20.002	5.672	46.731	0.430	7.605	11.784	1.638	14.842	108.511	37.716
2015	15.922	5.534	35.961	0.635	8.461	11.087	2.150	12.633	109.802	29.725
2016	17.025	5.291	34.827	0.642	6.703	8.612	1.836	9.914	117.951	33.670
2017	18.022	5.352	38.561	0.792	8.080	10.357	2.193	11.671	116.953	35.419
2018	16.902	4.659	30.728	0.735	5.557	7.220	1.566	8.227	113.976	32.142
2019	12.938	4.827	18.745	0.803	4.869	5.753	1.485	6.671	113.050	10.313
Change 1990-2019, %	-64.4	-41.7	-93.0	488.4	-64.3	-79.9	-49.6	-97.5	12.9	-92.0
Change 2018-2019, %	-23.5	3.6	-39.0	9.3	-12.4	-20.3	-5.2	-18.9	-0.8	-67.9

Table 3.3 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	4.503	1.175	18.897	18.306	7.354	27.351	104.872	9.034	8.758	0.235	3.345
1995	2.207	0.666	10.129	9.904	3.628	10.460	62.939	9.821	5.672	0.340	1.651
2000	0.808	0.572	8.629	8.270	2.149	6.428	48.328	7.116	3.807	0.302	1.039
2005	0.781	0.581	9.269	8.864	2.407	6.309	50.564	5.152	3.551	0.281	1.219
2010	0.941	0.684	11.007	10.355	2.674	6.533	60.536	5.156	4.312	0.372	0.909
2011	0.900	0.685	10.923	10.160	2.607	6.358	58.475	4.253	5.255	0.351	0.894
2012	0.836	0.609	9.640	8.990	2.308	5.578	52.735	4.266	3.748	0.350	0.832
2013	1.008	0.718	11.280	10.396	2.655	6.438	60.233	3.981	2.813	0.347	0.852
2014	0.940	0.709	10.288	9.651	2.554	5.962	55.083	3.762	2.994	0.338	0.852
2015	0.789	0.570	7.786	7.408	1.982	4.584	44.521	3.506	2.902	0.319	0.622
2016	0.851	0.637	9.023	8.506	2.256	5.258	50.127	3.478	2.965	0.341	0.676
2017	0.845	0.608	9.533	8.991	2.261	5.597	53.322	3.551	3.435	0.367	0.774
2018	0.790	0.568	8.643	8.129	2.053	4.976	48.032	3.337	3.031	0.361	0.672
2019	0.517	0.295	1.995	2.295	0.965	1.474	21.393	3.147	3.132	0.334	0.416
Change 1990-2019, %	-88.5	-74.9	-89.4	-87.5	-86.9	-94.6	-79.6	-65.2	-64.2	42.0	-87.6
Change 2018-2019, %	-34.6	-48.0	-76.9	-71.8	-53.0	-70.4	-55.5	-5.7	3.4	-7.4	-38.1

The energy industry sector is responsible for the about 72% of Estonian total SO_2 emissions, 24.4% of NO_x, 21.5% of PM_{10}, and 60.4% of Pb in 2019. The main contributors are oil shale power plants.

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 7.2% of the fuel used in 2017 is biomass, which is burned together with oil shale. This has significantly increased the proportion of renewable energy both in the Eesti Energia AS portfolio and in overall electricity production in Estonia. Each year, the new power block produces 130–140 GWh of renewable energy, enough to cover 2% of annual electricity consumption in Estonia. Renewable energy from biofuel produced in the Narva PP provides enough electricity to cover the annual consumption of 50,000 Estonian families.

The oil shale power plants contribute about 44.8% to the total SO_2 emissions. 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.

(*Photo by Lembit Michelson: Eesti Power Plant*)

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.

2019 was the seventh year when waste was used as fuel for the production of heat and electricity, which can save about 70 million m^3 of natural gas by generating energy from waste. After sorting household waste, another 300,000 tonnes of mixed municipal waste remains in Estonia, which is now used for producing heat and power in Iru. In 2019, 215.7 kt of mixed municipal waste was used to produce heat and electricity. The mixed municipal waste used in Iru plant is mostly local, but the power plant is also providing environment friendly waste management services to Irish and Finnish cooperation partners. Heat generated by Iru power plant is provided to the inhabitants of Maardu and Tallinn at prices that are up to 25% lower than before. Iru waste-to-energy unit impacts every single inhabitant in Estonia since the waste management in Iru is approximately twice cheaper than landfilling. The launching of waste-to-energy unit can be seen as a nation-wide environmental project: the Estonian waste management became environmentally friendlier and the large-scale landfilling in the country has ended.[2]

(Iru Power Plant, the green building is waste-to-energy unit; Source: www.etsnord.ee)

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

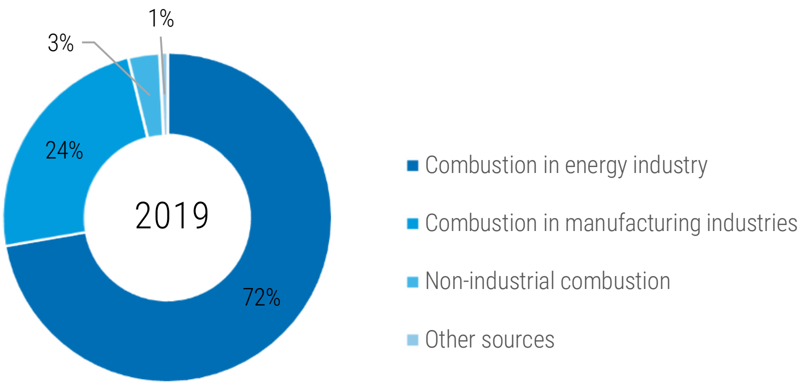

Figure 3.10 SO_2 emissions by sources of pollution in 2019

Combustion in energy industry accounts for 72.8% of SO_2, 47.5% of NO_x, 37.1% of TSP and 36.7% 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 65.4% of the total NMVOC and 57.5% of CO emissions in stationary combustion, for approximately 3.1% of SO_2 and 40.4% of TSP emissions. Combustion in manufacturing industries accounts for 24% of SO_2, for 22.5% of TSP and for the 5.8% of CO emissions in stationary combustion (see Figure 3.10-3.15).

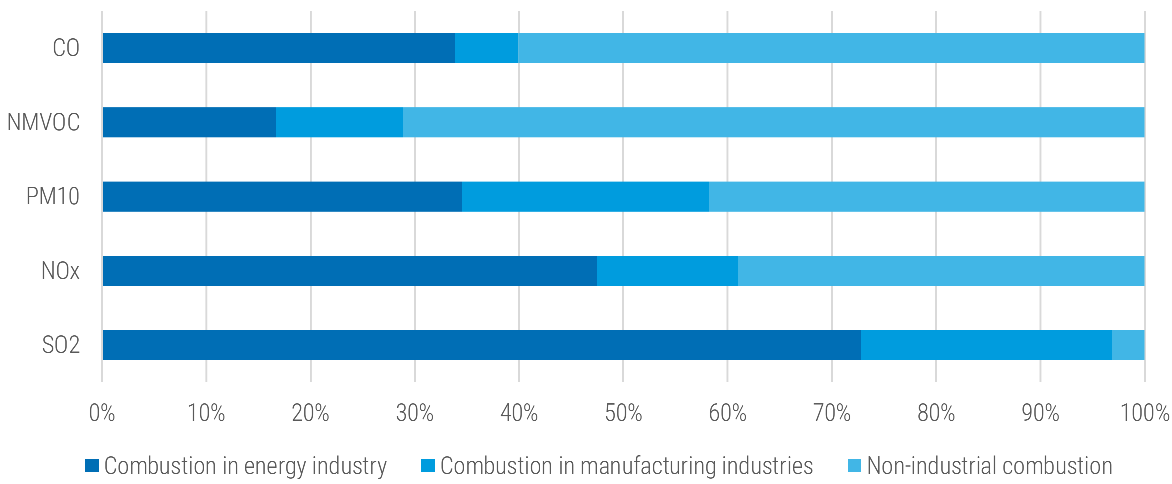

Figure 3.11 Distribution of pollutant emissions by sector in stationary combustion in 2019

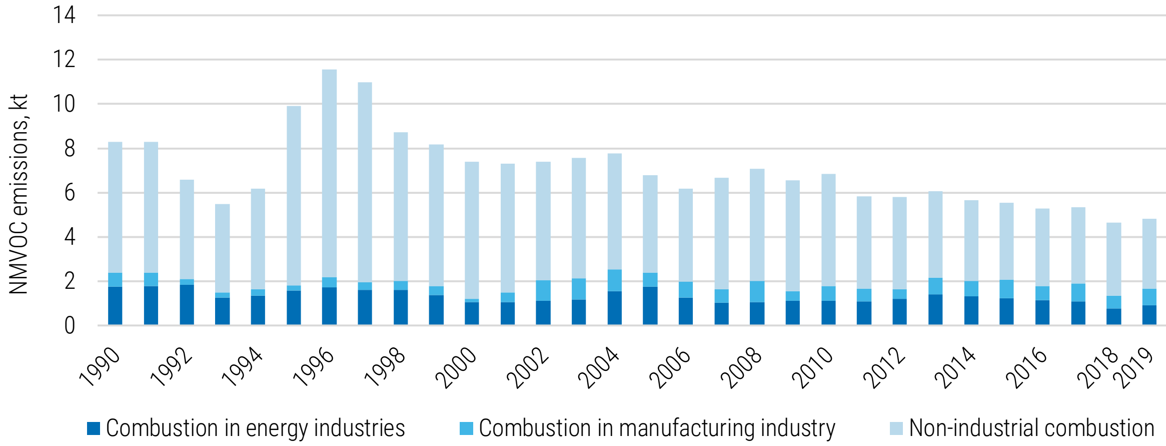

Figure 3.12 Distribution of NMVOC emissions by sector in stationary combustion in the period of 1990–2019

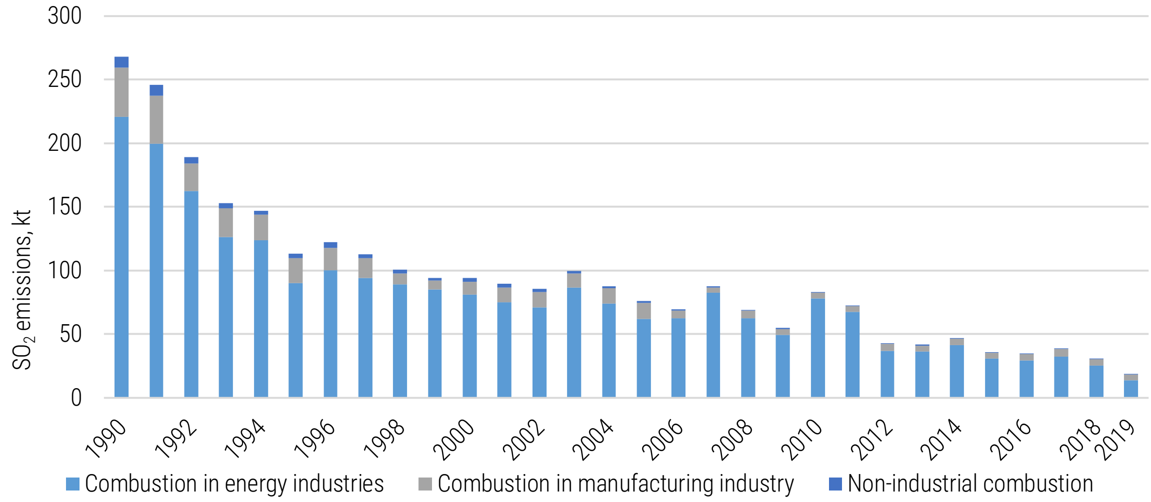

Figure 3.13 Distribution of SO_2 emissions by sector in stationary combustion in the period of 1990–2019

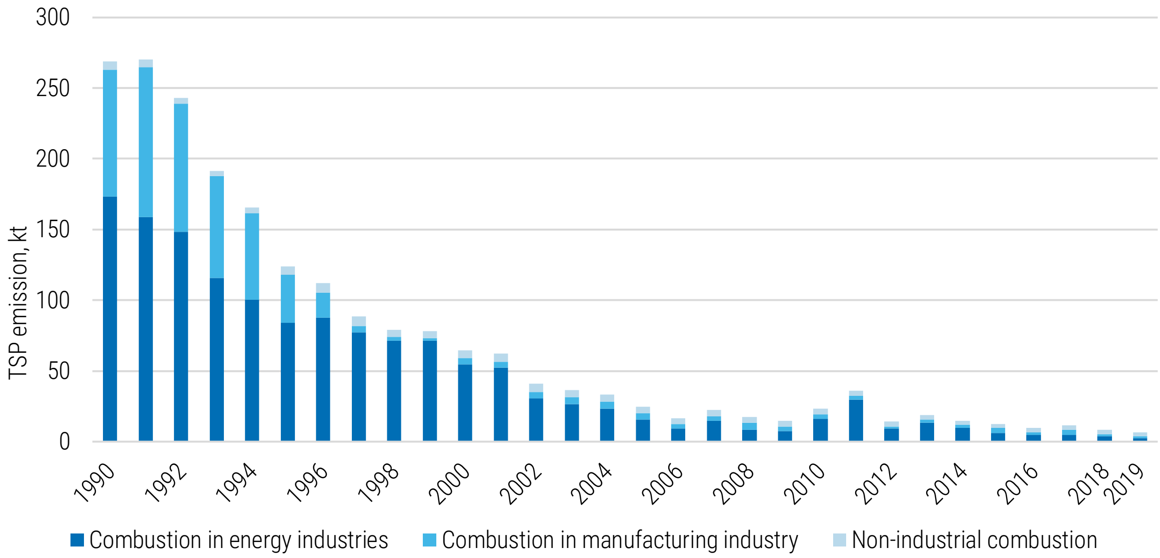

Figure 3.14 Distribution of TSP emissions by sector in stationary combustion in the period of 1990–2019

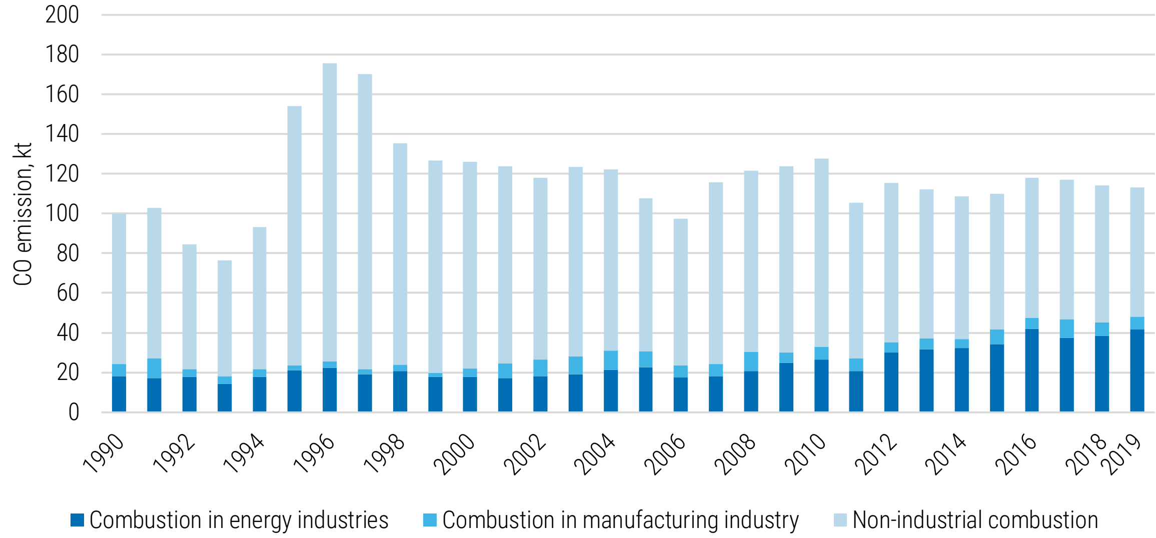

Figure 3.15 Distribution of CO emissions by sector in stationary combustion in the period of 1990–2019

3.2.1.2. Uncertainty

An uncertainty analysis was carried out to the year 2019 inventory. The uncertainty in the emission factors for main pollutants from stationary combustion sector is estimated in the range from 20% to 50%, for heavy metals and PAHs 100–200%, for dioxin 100–250%; in the activity data, in the range from 2% to 5% (for the waste combustion in domestic sector – 50%). Uncertainty estimates for stationary combustion are given in Table 3.4.

Table 3.4 Uncertainties in stationary combustion sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	12.938	kt	51.4	9.91	2.19
NMVOC	4.826	kt	21.3	6.94	1.91
SO_x	18.745	kt	99.3	6.68	0.22
NH_3	0.803	kt	7.6	2.02	0.93
$PM_{2.5}$	4.869	kt	82.8	9.59	3.31
PM_{10}	5.753	kt	62.3	6.86	3.01
TSP	6.671	kt	47.9	5.24	0.55
CO	113.050	kt	86.4	11.35	4.70
Pb	10.313	t	90.7	93.34	3.07
Cd	0.517	t	93.7	72.13	9.81
Hg	0.295	t	90.2	97.59	9.59
PCDD/F	3.132	g I-TEQ	68.3	72.01	54.61
B(a)p	0.883	t	98.1	80.58	38.57
B(b)f	0.869	t	97.3	76.33	34.62
B(k)f	0.561	t	97.5	83.11	38.76
I(1,2,3-cd)p	0.834	t	98.6	90.26	44.17
HCB	0.334	kg	97.0	106.75	65.59
PCBs	0.416	kg	94.9	156.58	9.21

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 1/Tier 3	Fuel consumption reported by operators; Energy balance from the Statistics Estonia	National EF; Measurements; Default EMEP/EEA Guidebook 2019
1A1c	Manufacture of solid fuels and other energy industries	Tier 3	Reported by operators	National methodologies; National EF; Measurements; Default EMEP/EEA Guidebook 2019

The energy and transformation industries sector is responsible for about 72.3% of total SO_2 emissions, 24.4% of NO_x, 21.5% of PM_{10}, 31.8% of CO, and 60.4% of Pb. The main contributors of all pollutants are oil shale power plants, while for CO emissions the main source is shale oil production facilities.

Pollutant emissions from this sector and the trend in emissions are presented in the Table 3.6.

During the 1990-2019 period, emissions of SO_2 decreased by 93.8% and NO_x emissions by 76.1%, resulting in a decline in energy production and also in the installation of desulphurisation technology by Eesti Narva Elektrijaamad AS (see Chapters 3.1 and 3.2.1.1).

Particulate emissions also dropped significantly during the same period – by about 98.6%. 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 growth of wood consumption was the reason for an increase in emissions of ammonia.

The increase of carbon monoxide emissions was in the result of increasing shale oil production level.

In 2019, SO_2, NO_x, PM_{10} and Pb emissions decreased by about 46.2%, 35%, 38.2% and 76% respectively compared to 2018's figures. The decrease in emissions of these and other substances resulted from the decrease of electricity production on the oil shale Power Plants (about 50%). Another reason for the decrease in lead emissions is a change in the methodology for calculating emissions of heavy metals from oil shale combustion.

Table 3.6 Pollutant emissions from energy in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	25.690	1.763	220.880	0.081	NR	NR	NR	173.286	18.020	63.142
1995	14.080	1.574	90.270	0.171	NR	NR	NR	84.206	20.870	34.474
2000	12.780	1.065	81.110	0.177	7.667	21.397	0.895	54.697	17.790	29.190
2005	12.445	1.743	62.149	0.180	4.599	9.079	0.555	15.661	22.664	30.768
2010	15.283	1.132	78.214	0.143	6.851	13.598	0.777	15.909	26.475	36.416
2011	15.111	1.096	67.393	0.115	11.940	25.532	1.431	29.830	20.772	36.144
2012	12.780	1.208	36.997	0.119	3.348	6.377	0.336	9.059	30.005	31.826

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Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
2013	12.724	1.398	36.328	0.156	6.109	11.595	0.605	13.254	31.490	37.211
2014	12.486	1.314	41.516	0.213	3.892	7.792	0.349	9.909	32.402	34.333
2015	9.234	1.229	30.577	0.348	3.149	5.462	0.394	6.202	34.127	26.141
2016	10.118	1.150	29.233	0.398	2.458	3.969	0.392	4.572	41.976	30.274
2017	10.546	1.081	32.466	0.444	2.451	4.319	0.331	4.920	37.371	31.706
2018	9.445	0.772	25.343	0.420	1.932	3.219	0.286	3.699	38.396	28.688
2019	6.143	0.923	13.645	0.455	1.329	1.989	0.246	2.478	41.530	6.865
Change 1990-2019, %	-76.1	-47.7	-93.8	464.4	-82.7	-90.7	-72.5	-98.6	130.5	-89.1
Change 2018-2019, %	-35.0	19.5	-46.2	8.4	-31.2	-38.2	-13.8	-33.0	8.2	-76.1

Table 3.6 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	1.131	1.015	18.314	17.460	4.652	20.336	84.921	1.322	1.578	0.133	1.791
1995	0.621	0.552	9.972	9.460	2.502	7.550	48.031	0.712	1.204	0.095	1.174
2000	0.505	0.476	8.532	7.810	1.970	5.640	40.090	0.338	0.773	0.085	0.689
2005	0.531	0.507	9.155	8.188	2.230	5.639	42.385	0.348	0.852	0.094	0.832
2010	0.613	0.608	10.864	9.680	2.445	6.180	49.922	0.216	2.339	0.140	0.720
2011	0.611	0.611	10.804	9.646	2.428	6.102	49.433	0.187	3.451	0.148	0.709
2012	0.533	0.533	9.510	8.474	2.131	5.363	43.610	0.193	2.100	0.147	0.643
2013	0.709	0.643	11.165	9.888	2.492	6.257	51.020	0.226	1.047	0.141	0.672
2014	0.632	0.630	10.143	9.053	2.382	5.722	46.336	0.231	1.376	0.139	0.662
2015	0.492	0.494	7.668	6.854	1.839	4.358	35.126	0.195	1.217	0.119	0.516
2016	0.549	0.562	8.900	7.963	2.107	5.043	40.706	0.242	1.359	0.140	0.586
2017	0.534	0.531	9.437	8.430	2.113	5.368	43.069	0.319	1.439	0.152	0.682
2018	0.484	0.482	8.530	7.621	1.905	4.813	38.929	0.236	1.199	0.151	0.584
2019	0.220	0.209	1.878	1.833	0.807	1.302	12.068	0.242	1.273	0.128	0.337
Change 1990-2019, %	**-80.5**	**-79.4**	**-89.7**	**-89.5**	**-82.6**	**-93.6**	**-85.8**	**-81.7**	**-19.4**	**-4.0**	**-81.2**
Change 2018-2019, %	**-54.5**	**-56.6**	**-78.0**	**-76.0**	**-57.6**	**-73.0**	**-69.0**	**2.5**	**6.1**	**-15.2**	**-42.3**

NFR 1A1a Public electricity and heat production include pollutants emission data from point sources (PS) reported by operators and from diffuse sources. Emissions from the point sources are calculated on the basis of measurements, or the combined method (measurements plus calculations), or on the basis of national emission factors.

In 2016 an in-depth review of the Estonian inventory was performed by the CLRTAP emission inventory review team (ERT), in which the ERT encourages Estonia to create some quality checks for the measurement data. The data which the ERT received on request from the Party were found to be plausible and consistent. Only the SO_2 EFs in fluidized combustion systems seem to be low compared to plants from other countries using similar technology. In such a case, there should be an explanation.

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: W_i^r = 9–13%, A^r = 45–57%, CO_2 = 16–19%, and Q_i^r = 7–11 MJ/kg. The molar ratio of Ca/S of 8–10 in oil shale exceeds by over 2–3 times the ratio of Ca/S sufficient to capture SO_2 completely. Oil shale contains a lot of carbonate minerals. Due to decomposition of the carbonate minerals, the CO_2 footprint is bigger than in typical coal firing power plant, but during the calcite decomposition, free lime is formed that binds the Sulphur during combustion process. In 2004, a novel Circulating Fluidized Bed Combustion (CFBC) was introduced

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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, MW_{el}	215/187	180
Self-consumption, %	- /9.13	8.93
Net efficiency factor, %	34 – 36/35	30
Heat rate, kJ/kWh	9230/10256	11,737
CO_2 emission, kg/kWh	0.9744	1.2985
SO_2 emission, mg/Nm^3	43,952	ca 2000
NO_x 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.

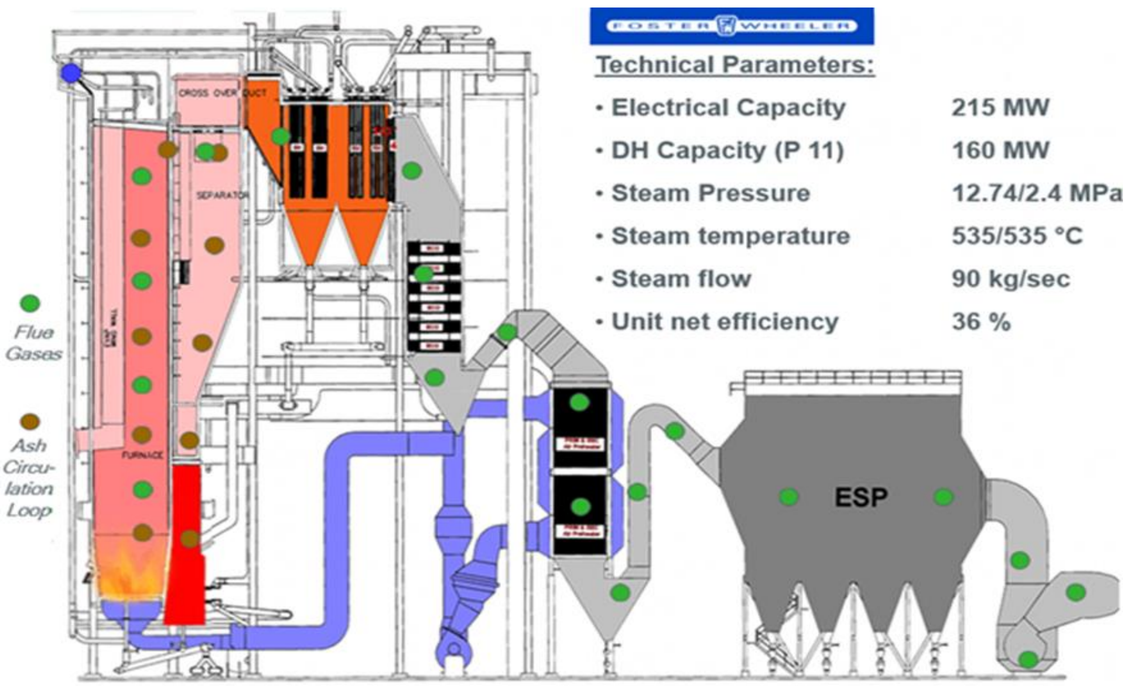

Figure 3.16 Existing EOS CFBC boiler drawing

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For CFBC units, CEMS monitoring has been applied. The monitoring values are checked periodically by accredited authorities and the sulphur increase in the ash has also been checked. Therefore, low SO_2 emissions are nothing abnormal. It is normal for EOS CFBC units.

Tallinn University of Technology has conducted a lot of laboratory and in situ experiments in the Oil Shale Firing Power Plants. We have an accredited Laboratory that has competence according to CEN/TS 15675:2007 and our flue gas measurements have validated the results given by CEMS monitoring. Also, we have published a lot of research papers regarding EOS firing and emission and ash formation. Some of the results can be seen in Table 3.8 (Konist *et. al*, Plamus *et. al*) that validate the SO_2 numbers given so far.

Table 3.8 Concentration of main pollutants in flue gas before ESP (6% O_2) (Konist *et. al*)

Fuel used	CO_2, %	CO, mg/Nm^3	NO_x, mg/Nm^3	SO_2, mg/Nm^3
OS + BIO	13.8	20 – 30	140 – 200	0
OS 8.5	14.4	20 – 45	200	15.0
OS 11.1	11.2	20 - 45	200	15.0

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

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

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

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

(Photo by Matti Kämärä: Petroter technology in VKG Oil plant)

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

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450–500 °C, due to the mixture of oil shale with hot ash (as a solid heat carrier). The vapour-gas mixture that appears in the reactor during the pyrolysis process is fed through several process vessels to be refined from ash and mechanical impurities, and then it is subject to a distillation process to produce liquid products and gas with high calorific value. Liquid products are fed to other units for loading as final products, or for further processing. Gas is fed to the heat power plant for heat and power production. Steam is fed to the heat power plant for power production. The by-products of this process include phenol water, flue gases, and ash from thermal processing.

In the Kiviõli Oil Shale Processing (KKT Oil 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.

(Photo: Enefit technology. Source: www.enefit.com)

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 2019 production figures have increased by 7.6% compared to 2018 (see Figure 3.17 and Table 3.19). In recent years the production of shale oil in solid heat carrier installations has increased, leading to a significant growth in emissions of carbon monoxide (by about 70% in 2019 in comparison with 2010). In 2019, a total of 75% of shale oil was produced with the use of new SHC technologies.

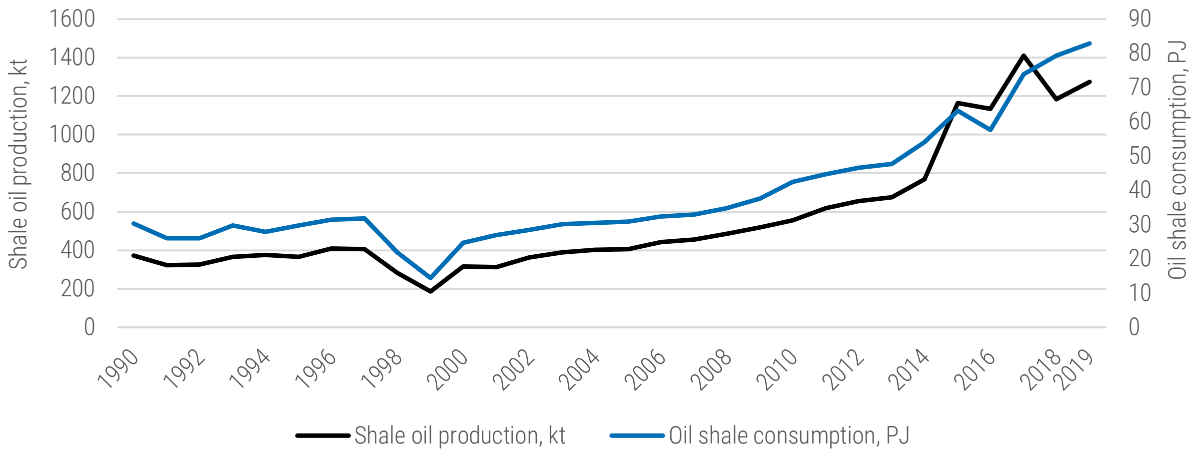

Figure 3.17 Shale oil production and oil shale consumption in the period 1990-2019

3.2.2.2. Methodological Issues

According to national legislation, all operators with boiler capacity from 1 MW_{th} must prepare an annual report. The report for the energy-related activities contains data about the type and capacity of boilers, fuel characteristics and consumption, pollutant emissions and so on.

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 Estonian Statistics:

Diffuse sources Fuel = EB fuel – PS fuel

The main tables of the Energy Balance contain summary data for the district heating and industrial boilers (SNAP 01 and SNAP 03). Fuel consumption by the manufacturing industry is only shown under final consumption (SNAP 0303). In this case, it is difficult to compare fuel data from the national database (by SNAP) and the Estonian Energy Balance. In order to determine fuel consumption by diffuse sources, combined data from two tables were used: "Energy balance sheet" and "Consumption of fuel by branches of the economy".

Emissions from PS have been calculated according to national emission factors and fuel consumption or on the basis of measurements. According to national legislation, all large combustion plants >100 MW_{th} are obliged to carry out continuous monitoring.

For other sources, the frequency of measurements is regulated by emission permits. National emission factors for the calculation of emissions from boilers were adopted by a Regulation of the Minister of the Environment in 2016 (see Table 3.9-3.13).

The SO_2 emissions are calculated by the formula:

$$Emissions = 0.02 \times B \times S^r \times (1-\eta)$$

where

B – fuel consumption;
S^r – sulphur content in fuel;
η – retention of sulphur in ash.

Table 3.9 TSP emission factors for boilers (g/GJ)

Fuel /purification equipment	P < 10 MW_{th}				50 MW_{th} > P > 10 MW_{th}		
	burner	extended furnace	grate-fired furnace	fluidized	burner	extended furnace	fluidized
Coal			3,000				
Oil shale			12,000				
- cyclone					3,000		
- electrostatic precipitator					1,000		
Peat							
- no control		1,000	2,000				
- cyclone		220	230	700			700
- cyclone + multicyclone				80			
- electrostatic precipitator							80
Wood							
- no control			1,000	1,000	1,000		1,000
- cyclone		240	240	500		70	
- electrostatic precipitator						70	80
Heavy fuel oil	100				100		
Oil shale oil	100				100		
Light fuel oil	100				100		

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 3.10 NO_x emission factors for boilers (g/GJ)

Fuel	P < 10 MW_{th}				50 MW_{th} > P > 10 MW_{th}	
	burner	extended furnace	grate-fired furnace	fluidized	burner	fluidized
Coal		200	200			
Oil shale					150	
Peat		300	300	300		300
Wood		100	100	100	100	100
Heavy fuel oil	200				250	
Oil shale oil	150				200	
Light fuel oil	100					
Gas	60				100	

Table 3.11 NMVOC emission factors for boilers (g/GJ)

Fuel	P < 10 MW_{th}	50 MW_{th} > P > 10 MW_{th}
Coal	15	1.5
Peat	100	
Wood	48	
Heavy fuel oil	3	3
Oil shale oil	1.1	
Light fuel oil	1.5	
Gas	4	2.5

Table 3.12 Carbon monoxide emission factors for boilers (g/GJ)

Fuel	P < 10 MW_{th}				50 MW_{th} > P > 10 MW_{th}	
	burner	extended furnace	grate-fired furnace	fluidized	burner	fluidized
Coal		100	100			
Oil shale					100	
Peat		1,200	500	100		200
Wood		1,200	1,000	400		200
Heavy fuel oil	100				100	
Oil shale oil	100				100	
Light fuel oil	100				100	
Gas	60				40	

Table 3.13 Heavy metals emission factors for boilers (mg/GJ)

Fuel /purification equipment	Heavy metals EFs							
	Hg	Cd	Pb	Cu	Zn	As	Cr	Ni
Coal								
- no control	5	30	700	100	230	90	400	400
- cyclone	5	10	200			20	80	80
- electrostatic precipitator	5	5	40			5	10	10
Oil shale								
- electrostatic precipitator	5	5	300	20	410	90	80	50
Peat								
- no control	5	10	200	50	150	100	80	350
- cyclone	5	4	50			30	20	80
- electrostatic precipitator	5	0.7	15			7	6	25
Wood								
- no control	0.5	5	200	5	500	1	35	30
- cyclone	0.5	2	60			0.3	10	10
- electrostatic precipitator	0.5	0.5	15			0.1	2	2
Heavy fuel oil								
- no control	0.03	0.3	20	10	40	2	1	300
- cyclone	0.03	0.2	10			1	0.5	150
Oil shale oil	0.04	0.11	50	16.0	290	24	3.5	8
Light fuel oil	0.03	0.04	10	11	6	6	2	4

At present, Estonia has no national emission factors for PM_{10} and $PM_{2.5}$. For emission calculations from point sources, CEPMEIP project emission factors were used (not directly, but shared from TSP, because some national EFs differ from CEPMEIP emission factors). For example, with regard to an oil shale power plant, TSP emission factors were first estimated on the basis of emissions (operator data on the base of measurements) and fuel usage data for various boilers, followed by emissions of fine particles, depending on the technology (high, medium or low). The calculated fine particulates and BC emission factors are presented in Table 3.14.

Table 3.14 PM_{10}, $PM_{2.5}$ and BC emission factor for point sources

Fuel	PM_{10}	$PM_{2.5}$	BC
	g/GJ		% $PM_{2.5}$
Coal	972	486	6.4
Peat and peat briquette	510	255	6.4
Wood and wood waste	950	900	28
Residual oil	83	67	56
Diesel oil	100	100	56
Gas oil	100	100	56
Shale-oil	100	100	56

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Accordance with the TERT requirements, all POPs emissions have been recalculated for the period 1990-2018. The recalculation entail the use of Guidebook 2019 Tier 2 emission factors (Table 3.15). It should be noted that in previous reports, the emissions of PAHs and PCB were overestimated, but the emissions of PCDD/PCDF and HCB were underestimated. Results are described in chapter 8.

Table 3.15 POPs emission factors (Tier 2 GB 2019)

Fuel	PCDD/PCDF	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PCB	HCB
	ng/GJ	mg/GJ				µg/GJ	
Coal, peat							
< 1MW (average GB 2019)	213.3	63.4	80.4	33.6	44,465,0	170	0.62
>1MW<50MW	100	13,0	17,0	9,0	6,0	170	0.62
> 50MW	10	0.0007	0.037	0.029	0.0011	0.0033	0.0067
Solid biomass							
< 1MW (average GB 2019)	100	10	16	5	4	0.032	5
>1MW<50MW	100	10	16	5	4	0.007	5
> 50MW	50	1.12	0.043	0.0155	0.0374	3.5	5
Oils							
< 1MW	10	8	9	6	3	NE	NE
>1MW<50MW	10	1	2	1	1	NE	NE
> 50MW	44318,000	NE	0.0045	0.0045	0.00692	NE	NE
Natural gas							
< 1MW	0.5	0.00056	0.00084	0.00084	0.00084	NE	NE
>1MW<50MW	0.5	0.00056	0.00084	0.00084	0.00084	NE	NE
> 50MW	0.5	0.00056	0.00084	0.00084	0.00084	NE	NE

Table 3.16 PM and HMs emission factors from natural gas combustion

Pollutant	Unit	EFs
$PM_{2.5}$	g/GJ	0.45 (0.89 for capacity >50MW)
PM_{10}	g/GJ	0.45 (0.89 for capacity >50MW)
TSP	g/GJ	0.45 (0.89 for capacity >50MW)
BC	g/GJ (5.4% $PM_{2.5}$)	0.02
Pb	mg/GJ	0.0015
Cd	mg/GJ	0.00025
Hg	mg/GJ	0.10
As	mg/GJ	0.12
Cr	mg/GJ	0.00076
Cu	mg/GJ	0.00008
Ni	mg/GJ	0.00051
Se	mg/GJ	0.011
Zn	mg/GJ	0.0015

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 ammonia emissions from biomass combustion and emissions of particulates, heavy metals from natural gas are calculated based on the default EMEP/EEA Guidebook 2019 emission factors for boilers with the capacity less than $50MW_{th}$ (see Table 3.16). The particulates emissions for power plants with capacity >50 MW_{th} were calculated on the base of the EMEP/EEA Guidebook 2019 EFs only from 2017. Particulate emissions from natural gas combustion for previous years are calculated, using emission factors for small boiler houses.

The calculated implied emission factors (IEF) for some pollutant for NFR 1A1a are given in the Table 3.17.

Table 3.17 NFR 1A1a pollutants IEF, g/total fuels GJ

Year	SO_2	NO_x	TSP	$PM_{2.5}$	Pb
1990	753.5	87.8	590.8	NR	215.8
1995	640.9	99.9	595.4	NR	246.2
2000	666.8	104.4	445.2	61.6	244.9
2005	474.7	94.6	113.4	32.8	240.3
2010	486.9	92.8	92.4	39.8	229.2
2011	430.4	95.8	190.1	76.2	234.8
2012	253.4	88.6	59.7	22.1	225.0
2013	226.7	80.0	82.5	38.3	238.9
2014	277.4	83.9	64.4	25.5	236.0
2015	246.6	75.9	49.5	25.6	221.0
2016	206.4	72.8	30.6	17.1	223.7
2017	214.5	71.5	31.8	16.2	221.2
2018	156.9	60.3	22.7	12.1	190.8
2019	133.6	68.5	24.2	13.7	81.4

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 3.18).

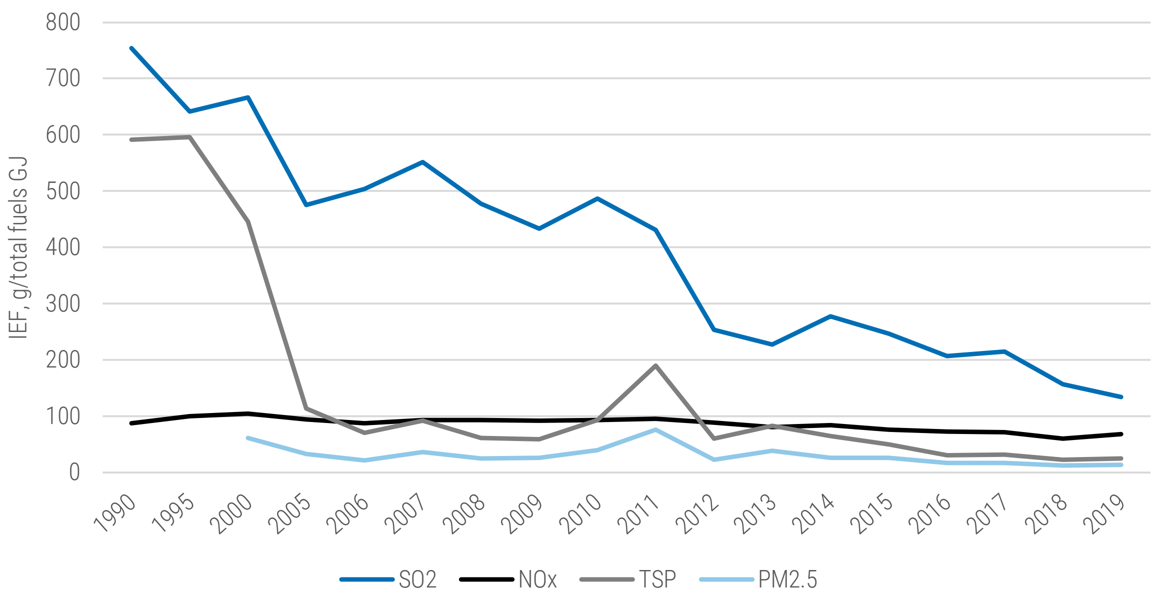

Figure 3.18 Implied emission factors for NFR 1A1a

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 main tables of the Energy Balance contain summary data for the district heating and industrial boilers (SNAP 01 and SNAP 03). Fuel consumption by the manufacturing industry is only shown under final consumption (SNAP 0303). In this case, it is difficult to compare fuel data from the national database (by SNAP) and the Estonian Energy Balance. In order to determine fuel consumption by diffuse sources, combined data from two tables were used: "Energy balance sheet" and "Consumption of fuel by branches of the economy".

Discrepancies may occur between energy balance and the point sources database in the data concerning fuels. These are the reasons for the distinction in the data regarding the consumed oil shale, the operators of which are represented in the Statistical Office and entered to the Point Sources Information System (KOTKAS) (the data in tonnes are identical, but not in TJ).

The fuel consumption data in energy and transformation industries are presented in the Table 3.18 and Figure 3.19. The consumption of all fuels by this sector with the exception of biomass (mainly wood and wood waste) has decreased across 1990-2019. The biggest decrease has been in terms of liquid fuel, by 97.2%. The consumption of solid fuels decreased by about 71.7%, mainly due to a decrease in electricity production, but it still remains the main fuel in this sector (involving mainly oil shale) (see Figure 3.20). During this period, the consumption of coal decreased significantly, but combustion of biomass has grown approximately by eight times.

Table 3.18 Fuel consumption in energy industries in the period of 1990–2019 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	44.09	210.42	2.18	35.81	0.00
1995	12.37	109.09	4.63	14.30	0.00
2000	5.74	94.21	4.77	14.73	0.00
2005	5.20	102.44	5.38	14.25	2.09
2010	3.25	126.99	10.88	12.41	6.65
2011	3.15	129.17	12.59	10.25	0.00
2012	3.17	115.04	14.21	10.28	0.00
2013	3.43	131.57	11.21	8.49	2.24
2014	2.31	121.71	12.57	7.84	2.39
2015	3.01	95.84	11.84	6.29	2.61
2016	2.63	110.72	13.74	7.43	2.32
2017	2.02	119.91	15.57	6.20	2.22
2018	1.64	126.39	16.47	8.99	2.23
2019	1.25	59.57	18.44	5.65	1.94
Change 1990-2019, %	-97.2	-71.7	746.1	-84.2	
Change 2018-2019, %	-23.7	-52.9	11.9	-37.2	-12.9

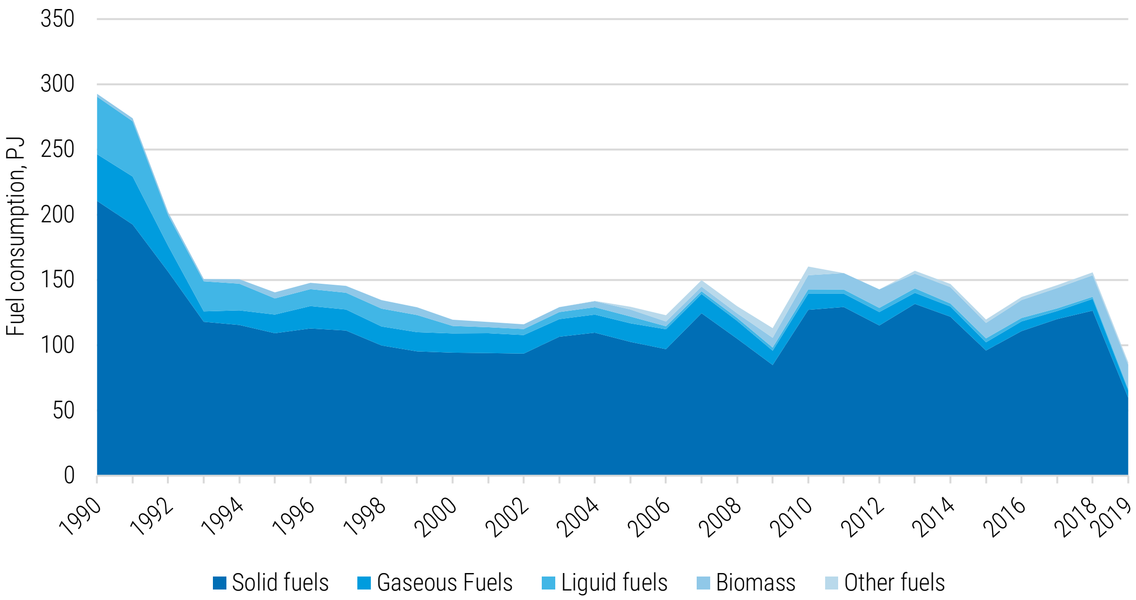

Figure 3.19 Fuel consumption by energy industries sector in the period 1990-2019

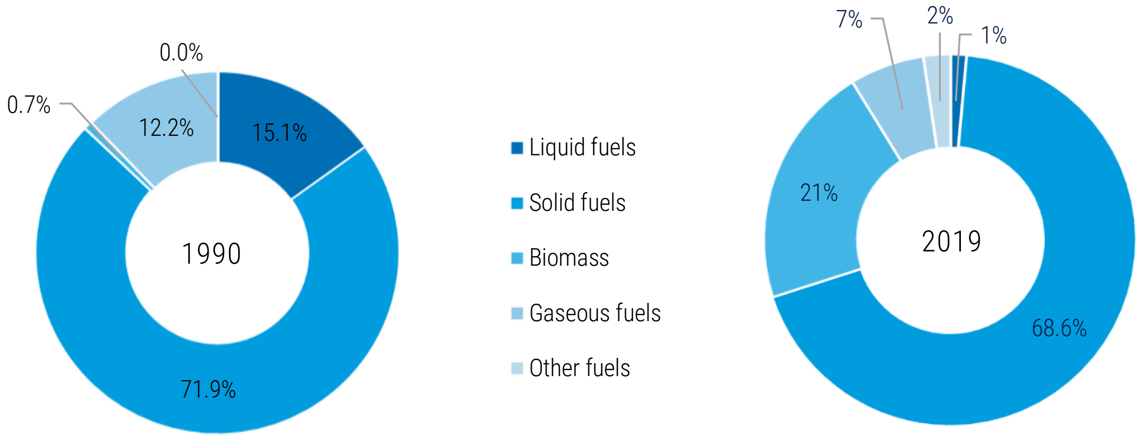

Figure 3.20 Distribution of fuel consumption in energy industries in 1990 and 2019

Table 3.19 Shale-oil production in the period of 1990-2019 (kt)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
372.98	321.62	325.96	367.14	375.42	366.39	408.87	407.04	283.61	187.02	317.02	311.59	363.82	389.04	402.23
2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
405.27	440.96	456.54	486.49	518.27	555.45	619.79	653.45	675.13	766.86	1163.71	1133.12	1408.47	1182.22	1271.95

Table 3.20 Oil-shale consumption for oil-shale production by different technologies, PJ[3]

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
2011	13.39	5.48	0.54	19.41	21.28	3.93	25.21	44.62
2012	15.13	6.00	0.31	21.44	21.18	3.86	25.04	46.48
2013	15.59	6.43	0.18	22.20	21.45	3.96	25.41	47.61
2014	18.76	9.37	0.35	28.48	21.35	4.18	25.53	54.01
2015	23.86	18.61	0.40	42.87	15.36	4.91	20.27	63.14
2016	21.66	23.88	1.50	47.04	5.71	4.85	10.56	57.60
2017	26.74	24.45	1.65	52.84	15.54	5.39	20.93	73.77
2018	27.26	26.64	1.91	55.81	18.16	5.35	23.50	79.31
2019	28.70	28.06	1.82	58.57	19.19	5.01	24.20	82.78

3.2.2.3. Uncertainty

An uncertainty analysis for the stationary combustion sector alone (NFRs 1A1, 1A2, and 1A4) was carried out upon the 2019 inventory (Chapter 3.2.1.2).

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. There are difficulties in comparing the consumption of fuel in activities. The principle of a database is that, for example, the industrial boiler is designated SNAP 03, irrespective of whether the heat is sold or is used for its own needs.

3.2.2.5. Recalculations

In the 2021 submission the following recalculations were carried out:

- Recalculated emissions of all POPs for 1990-2018 (NFR 1A1a, 1A1c). The reason for the recalculation is the application of the Tier 2 Guidebook 2019 method
- In 2021 reporting year additional calculations of SO_2, TSP and CO were made for NFR 1A1c. because in the period 1990-1993, emissions were not calculated.

3.2.2.6. Source-Specific Planned Improvements

- Correction of activity data for the period 1990-2009 (fuel groups);
- Recalculation of heavy metals emission from oil shale power plants.

[3] Greenhouse Gas Emissions in Estonia 1990-2018, National Inventory Report, Submission to the European Commission, Tallinn 2019

3.2.3. Manufacturing Industries and Construction (NFR 1A2)

This sector is a key source of SO_2 (20.2%), $PM_{2.5}$ (19.1%), PM_{10} (13.1%), TSP (8.5%), PAHs (9.4%), dioxins (21.7%).

Emissions of all pollutants from the NFR 1A2 sector have decreased across 1990-2019, with the exception of NMVOC, ammonia, carbon monoxide and HCB, which can mainly be explained by the increase in biomass combustion (see Tables 3.22, 3.24). The main reason for the decrease in the main pollutants and HM emissions is the corresponding decrease in the production of cement and also in an increase in the efficiency of combustion and cleaning equipment in the cement production plant. The other reasons are described below.

The increase in emissions for NMVOC, NH_3, $PM_{2.5}$, BC, PCDD/PCDF, HCB, PAHs and some heavy metals as produced by industrial combustion in 2019 when compared to 2018 is explained by an increase in wood burning in industrial boilers by 7% (Table 3.24). The decrease in emissions of other substances is due to a decrease in solid fuel consumption and cement production.

The main sources of SO_2 emissions from NFR 1A2gviii before 2005 was VKG Energia OÜ, Lõuna soojuselektrijaam (the main fuel is generator gas from shale oil production). Before 2000 the power plant was a part of the shale oil production enterprise Kiviter RAS (in the future Viru Keemia Grupp AS and VKG Oil AS) and units were classified as being combustion-related in manufacturing industries (SNAP 03). Since 2001 the power plant has begun independent activities as part of the Viru Keemia Grupp AS but, nevertheless, the main part of energy use was for technology needs. Since 2006 the power plant had begun to be used more as a thermal power plant for heating residential areas and has been classified as SNAP 0101, with emissions from this enterprise being reported under an NFR 1A1a.

Therefore, a different SNAP code was the cause of changes in emissions. A reallocation of emissions from NFR 1A2giii to NFR 1A1a has not influenced emissions in 2006 as, during this period, there was a decrease in emissions at the Baltic power plant. The other important SO_2 pollution source in this sector is industrial boilers at the Kiviõli oil shale production plant, which uses as its fuel oil shale and generator gas.

3.2.3.1. Source Category Description

Manufacturing industries sources category description are presented in the Table 3.21.

Table 3.21 Manufacturing industries reporting activities

NFR	Description	Method	Activity data	Emissions factor
1A2a	Iron and steel	Tier 3	Fuel consumption reported by operators, includes in NFR 1A2giii	National EF; Measurements
1A2b	Non-ferrous metals	Tier 3	Reported by operators	National EF; Measurements
1A2c	Chemicals	Tier 3	Reported by operators	National methodologies; National EF; Measurements
1A2d	Pulp, Paper and Print	Tier 3	Reported by operators	National methodologies National EF; Measurements
1A2e	Food processing, beverages and tobacco	Tier 3	Reported by operators	National EF; Measurements; EMEP/EEA Guidebook
1A2f	Non-metallic minerals	Tier 3	Reported by operators	National methodologies; National EF; Measurements
1A2gviii	Other	Tier1/Tier 3	Fuel consumption reported by operators; Statistical Energy Balance	National EF; Measurements; Default EMEP/EEA Guidebook 2019

NFR 1A2a: Iron and steel include emissions from processes with contact and combustion plants of this activity reported by 5 operators. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

NFR 1A2b: Non-ferrous metals include emissions from processes with contact (secondary lead, zinc and aluminium production) and combustion plants of this activity reported by 5 operators. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

NFR 1A2c: Chemicals include emissions from combustion plants of this activity reported by 6 operators. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

NFR 1A2d: Pulp, paper and print include emissions from combustion plants of this activity reported by 13 operators. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

NFR 1A2e: Food processing, beverages, and tobacco include emissions from combustion plants and other stationary equipment of this activity reported by 52 operators. Emissions are calculated on the basis of measurements, or the combined method (measurements plus calculations) is used.

NFR 1A2f: Non-metallic minerals include emissions from all boilers and other processes with contact in the non-metallic minerals industry: cement, lime, glass, bricks, and other productions (SNAP 0301, 030311-030326). Data are only from point sources (33 operators). Emissions from the point sources are calculated on the basis of measurements, national emission factors, or the combined method (measurements plus calculations) is used. Emissions of the main pollutants and heavy metals are calculated on the basis of national emission factors and POPs on the basis of the EMEP/EEA Guidebook. For cement production, the HCB and PAHs emissions are calculated on the basis of measurements.

NFR 1A2gviii: Others include emissions from all boilers in the other manufacturing industry (excluding NFRs 1A2a-e, 1A2f), other processes with contact: other productions (SNAP 0301, 030326). Data are from point and diffuse sources. Emissions from the point sources are calculated on the basis of measurements, national emission factors, or the combined method (measurements plus calculations) is used. Emissions of the main pollutants and heavy metals from diffuse sources are calculated on the basis of national emission factors and POPs on the basis of the EMEP/EEA Guidebook.

Table 3.22 Pollutants emissions from combustion in manufacturing industries in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	5.600	0.620	38.510	0.010	NR	NR	NR	89.791	6.180	62.460
1995	2.340	0.230	19.510	0.006	NR	NR	NR	33.610	2.720	25.340
2000	2.470	0.130	10.104	0.055	1.662	2.679	0.426	4.506	4.050	0.804
2005	1.991	0.645	12.168	0.226	2.963	3.468	0.789	4.343	7.874	0.920
2010	1.621	0.659	4.136	0.133	2.139	2.505	0.584	3.156	6.573	0.852
2011	2.397	0.576	4.445	0.138	1.994	2.289	0.531	2.685	6.293	0.699
2012	1.871	0.437	5.097	0.129	1.225	1.326	0.323	1.766	5.334	0.467
2013	2.357	0.769	4.569	0.154	1.786	1.977	0.473	2.278	5.776	0.525
2014	1.973	0.700	4.608	0.132	1.133	1.281	0.303	1.899	4.427	0.603
2015	1.405	0.856	4.915	0.209	2.722	2.906	0.773	3.401	7.417	0.809
2016	1.481	0.623	5.088	0.160	1.461	1.669	0.393	1.897	5.507	0.515
2017	2.114	0.809	5.678	0.254	2.828	3.091	0.793	3.471	9.436	0.880
2018	2.205	0.567	4.794	0.228	1.177	1.417	0.310	1.622	6.912	0.651
2019	1.746	0.748	4.518	0.258	1.259	1.360	0.345	1.500	6.569	0.669
Change 1990-2019, %	-68.8	20.7	-88.3	2 608.5	-24.3	-49.2	-19.1	-98.3	6.3	-98.9
Change 2018-2019, %	-20.8	32.1	-5.8	12.8	7.0	-4.0	11.2	-7.5	-5.0	2.7

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Table 3.22 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	3.230	0.080	0.500	0.530	2.470	6.070	15.390	0.406	1.773	0.007	0.373
1995	1.310	0.030	0.080	0.049	0.962	2.429	6.514	0.082	0.986	0.007	0.073
2000	0.030	0.010	0.021	0.069	0.040	0.289	0.578	0.106	0.670	0.011	0.110
2005	0.013	0.005	0.034	0.235	0.055	0.334	1.247	0.236	0.944	0.027	0.149
2010	0.020	0.005	0.072	0.202	0.090	0.220	1.105	0.215	0.536	0.027	0.108
2011	0.014	0.004	0.054	0.113	0.062	0.164	0.846	0.205	0.557	0.030	0.094
2012	0.016	0.004	0.063	0.102	0.053	0.130	0.489	0.149	0.398	0.022	0.104
2013	0.018	0.003	0.055	0.109	0.048	0.109	0.791	0.210	0.601	0.033	0.094
2014	0.019	0.004	0.080	0.206	0.061	0.172	0.577	0.206	0.553	0.029	0.117
2015	0.023	0.005	0.059	0.169	0.037	0.153	1.388	0.258	0.740	0.037	0.058
2016	0.014	0.004	0.054	0.092	0.028	0.094	0.893	0.225	0.630	0.032	0.047
2017	0.021	0.006	0.036	0.139	0.034	0.140	1.570	0.306	1.020	0.045	0.064
2018	0.015	0.015	0.041	0.089	0.029	0.087	0.401	0.281	0.909	0.041	0.065
2019	0.015	0.015	0.038	0.074	0.043	0.089	0.973	0.305	0.995	0.045	0.061
Change 1990-2019, %	-99.5	-81.2	-92.3	-86.1	-98.3	-98.5	-93.7	-24.9	-43.9	533.1	-83.7
Change 2018-2019, %	3.4	0.1	-7.3	-17.6	49.3	1.6	142.4	8.5	9.4	8.8	-6.8

3.2.3.2. Methodological Issues

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 Estonian Statistics:

Diffuse sources Fuel = EB fuel – PS fuel

The main tables of the Energy Balance contain summary data for the district heating and industrial boilers (SNAP 01 and SNAP 03). Fuel consumption by the manufacturing industry is only shown under final consumption (SNAP 0303). In this case, it is difficult to compare fuel data from the national database (by SNAP) and the Estonian Energy Balance. In order to determine fuel consumption by diffuse sources, combined data from two tables were used: "Energy balance sheet" and "Consumption of fuel by branches of the economy".

Emissions from PS and diffuse sources have been calculated according to national emission factors and fuel consumption, or on the basis of measurements. Emission factors are presented in Chapter 3.2.2.2.

Accordance with the TERT requirements, all POPs emissions have been recalculated for the period 1990-2018. The recalculation entail the use of Guidebook 2019 Tier 2 emission factors (Table 3.15 Chapter 3.2.2.2). It should be noted that in previous reports, the emissions of PAHs and PCB were overestimated, but the emissions of PCDD/PCDF and HCB were underestimated. Results are described in chapter 8.

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

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

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	1,359.6	197.7	3,170.1	NR
1995	1,463.3	175.5	2,520.8	NR
2000	841.8	205.9	375.6	138.5
2005	632.9	111.3	303.8	224.3
2010	267.8	104.9	204.4	138.6
2011	290.0	156.4	175.2	130.1
2012	330.7	121.4	114.6	79.5
2013	315.4	162.7	157.3	123.4
2014	316.2	135.4	130.4	77.8
2015	330.4	94.4	228.7	183.0
2016	379.6	110.5	141.6	109.0
2017	315.9	117.6	193.1	157.3
2018	286.2	131.7	96.9	70.2
2019	256.7	99.3	85.3	71.6

The main impact on the IEF decrease in the period of 1990-2000 was exerted by changes on the enterprise for cement production - primarily the introduction of effective clearing equipment and new technologies. In addition, a change of structure in the fuel consumed in this sector in general was also to blame, with a growth in the consumption of natural gas and biomass exerting an impact (see Figure 3.21 and Table 3.24).

Details on fuel consumption by manufacturing industries are presented in the Table 3.24, Figure 3.22-3.23.

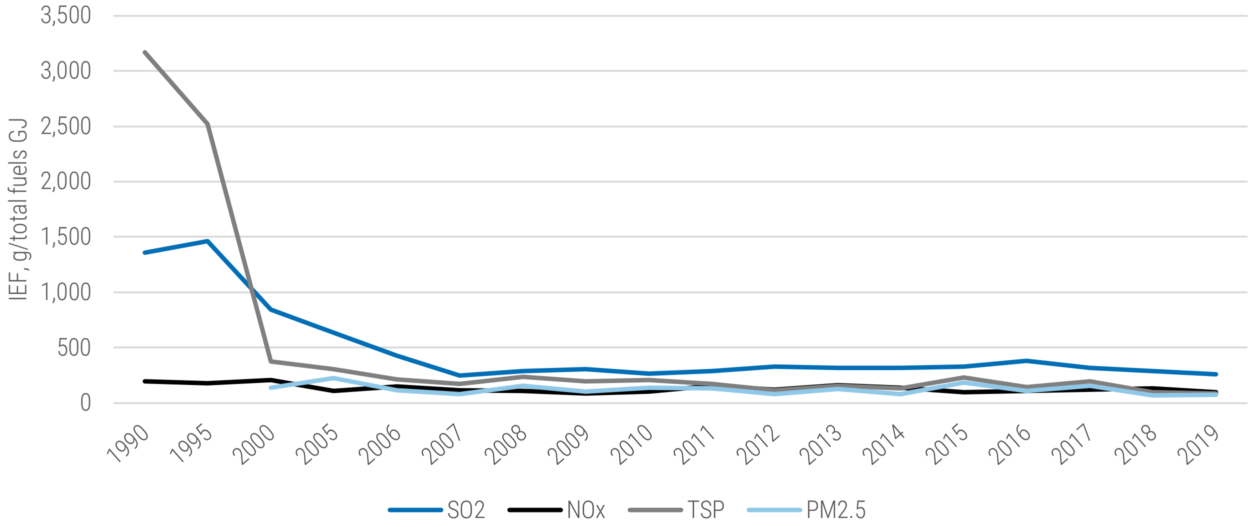

Figure 3.21 Implied emission factors for NFR 1A2

Table 3.24 Fuel consumption by manufacturing industries in the period of 1990-2019

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	19.24	6.47	0.26	2.35	NA
1995	8.81	3.34	0.17	1.01	NA
2000	2.70	3.17	1.49	4.64	NA
2005	2.32	2.93	6.10	5.14	2.73
2010	1.76	3.88	4.66	4.47	0.67
2011	2.06	4.53	3.74	4.39	0.60
2012	1.86	3.29	4.58	4.60	1.07
2013	1.06	4.26	4.15	4.33	0.69
2014	1.07	4.18	5.10	4.23	0.00
2015	1.03	2.33	7.05	3.54	0.92
2016	1.25	1.90	4.47	4.80	0.99
2017	0.99	2.69	8.51	4.46	1.33
2018	1.00	3.16	7.83	3.59	1.18
2019	1.11	2.94	8.37	4.17	1.01
Change 1990-2019, %	-94.24	-54.60	3 157.74	77.16	
Change 2018-2019, %	11.2	-6.9	7.0	16.0	-14.1

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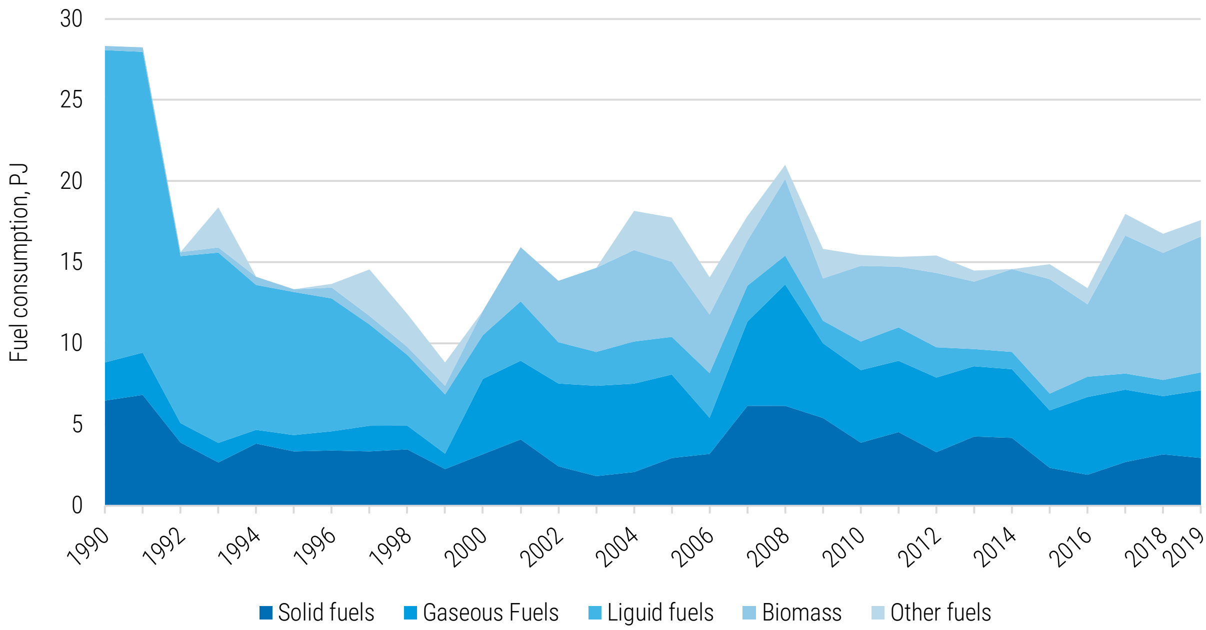

Figure 3.22 Fuel consumption by manufacturing industries in the period of 1990-2019

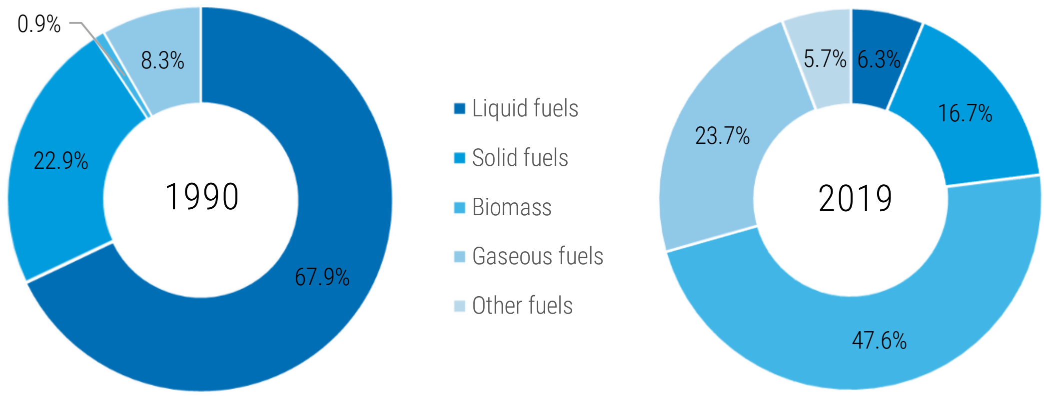

Figure 3.23 Distribution of fuel consumption in manufacturing industries in 1990 and 2019

3.2.3.3. 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. There are difficulties in comparing the consumption of fuel in activities. The principle of a database is that, for example, the industrial boiler is designated SNAP 03, irrespective of whether the heat is sold or is used for its own needs.

3.2.3.4. Recalculations

In the 2021 submission the following recalculations were carried out:

- NFR 1A2a. Additionally calculated Cd and Hg emissions for the years 2010, 2016.
- NFR 1A2b. Additionally calculated Cd, Hg, Cr, Ni and Zn emissions for the years 2010-2012; 2015-2018.
- NFR 1A2c. Additionally calculated Cd and Hg emissions for the years 2012; 2014-2018.
- NFR 1A2f. Additionally calculated Hg emissions for the years 2004-2005; As emission for 2005.
- NFR 1A2gviii. Recalculated emissions of all POPs for 1990-2018. The reason for the recalculation is the application of the Tier 2 Guidebook 2019 method and given in Chapter 8.
- NFR 1A2gviii. Emission of SO_2 reallocated from NFR 2A6 for 2001 and from NFR 2B10a for the years 2001, 2003-2004.

3.2.3.5. Source-Specific Planned Improvements

- Review of the substances emission and activity data for NFR's 1A2a – 1A2f;

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 (Table 3.25).

The non-industrial combustion sector is a key source of CO (48.9%), $PM_{2.5}$ (35.8%), PM_{10} (23.7%), TSP (17.1%), NO_x (18.2%), NMVOC (13.5%), some heavy metals and POPs emissions.

The main source of pollution inside this sector is residential stationary, which contributes to over 40% of final energy consumption in Estonia, with the largest share being consumed by building. The volume of biomass consumption in this sector increased by about three times in comparison with the 1990-s.

During the 1990-2019 period, the emission of some pollutants from this sector have decreased, and some pollutants such as NO_x, 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 3.26).

Table 3.25 Non-industrial combustion activities

NFR	Description	Method	Activity data	Emissions factor
1A4ai	Commercial / institutional: Stationary	Tier 1/Tier 3	Fuel consumption reported by operators; Energy balance of Statistics Estonia	National EF; Measurements; Default EMEP/EEA Guidebook 2019
1A4bi	Residential: Stationary plants	Tier 2	Energy balance of Statistics Estonia	National EF; Default EMEP/EEA Guidebook 2019
1A4ci	Agriculture/Forestry/Fishing: Stationary	Tier 1/Tier 3	Fuel consumption reported by operators; Energy balance of Statistics Estonia	National EF; Measurements; Default EMEP/EEA Guidebook 2019

NFR 1A4ai–ci: Commercial / institutional: Stationary and Agriculture / Forestry / Fishing: Stationary includes pollutant emissions from combustion processes in this sector. Data are from point and diffuse sources. Emissions from the point sources are calculated on the basis of measurements, national emission factors, or the combined method (measurements plus calculations) is used. Emissions of the main pollutants and heavy metals from diffuse sources

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are calculated based on national emission factors and POPs on the basis of the EMEP/EEA Guidebook.

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

Table 3.26 Pollutant emissions from combustion in non-industrial sector in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	5.015	5.897	8.450	0.046	NR	NR	NR	5.810	75.898	3.026
1995	10.205	8.123	3.547	0.072	NR	NR	NR	5.973	130.376	3.152
2000	8.452	6.189	2.708	0.073	4.317	4.589	1.624	5.115	104.058	3.303
2005	6.152	4.409	1.460	0.064	3.459	3.812	1.240	4.612	77.223	2.843
2010	7.441	5.056	0.751	0.084	3.496	3.681	1.361	4.146	94.445	2.867
2011	6.154	4.175	0.688	0.067	3.002	3.167	1.133	3.530	78.482	2.791
2012	6.301	4.174	0.685	0.065	2.871	3.012	1.110	3.393	80.163	2.803
2013	5.791	3.892	0.672	0.074	2.860	2.999	1.060	3.316	74.979	2.842
2014	5.543	3.658	0.607	0.084	2.579	2.711	0.986	3.034	71.682	2.780
2015	5.283	3.449	0.469	0.078	2.589	2.719	0.982	3.030	68.258	2.776
2016	5.426	3.518	0.506	0.084	2.785	2.973	1.051	3.445	70.468	2.880
2017	5.361	3.462	0.417	0.093	2.801	2.948	1.069	3.280	70.146	2.833
2018	5.252	3.321	0.591	0.086	2.449	2.585	0.970	2.906	68.669	2.803
2019	5.049	3.155	0.582	0.090	2.280	2.404	0.894	2.693	64.950	2.779
Change 1990-2019, %	0.7	-46.5	-93.1	94.8	-47.2	-47.6	-45.0	-53.7	-14.4	-8.2
Change 2018-2019, %	-3.9	-5.0	-1.5	4.4	-6.9	-7.0	-7.9	-7.3	-5.4	-0.8

Table 3.26 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	0.142	0.080	0.083	0.316	0.232	0.945	4.561	7.307	5.407	0.095	1.181
1995	0.276	0.083	0.077	0.395	0.164	0.481	8.394	9.027	3.482	0.238	0.405
2000	0.273	0.085	0.076	0.391	0.138	0.499	7.660	6.672	2.364	0.206	0.241
2005	0.238	0.069	0.080	0.441	0.121	0.336	6.933	4.567	1.756	0.160	0.239
2010	0.307	0.071	0.070	0.473	0.139	0.133	9.509	4.725	1.437	0.205	0.081
2011	0.275	0.071	0.065	0.401	0.117	0.093	8.196	3.861	1.247	0.173	0.091
2012	0.288	0.072	0.067	0.414	0.124	0.085	8.635	3.924	1.250	0.181	0.085
2013	0.281	0.072	0.060	0.399	0.115	0.072	8.422	3.545	1.166	0.173	0.086
2014	0.290	0.075	0.065	0.392	0.111	0.068	8.171	3.324	1.065	0.170	0.072
2015	0.274	0.071	0.060	0.386	0.107	0.072	8.007	3.052	0.944	0.163	0.048
2016	0.289	0.071	0.069	0.451	0.121	0.121	8.528	3.010	0.976	0.169	0.044
2017	0.290	0.071	0.060	0.421	0.114	0.089	8.682	2.925	0.976	0.170	0.027
2018	0.291	0.071	0.071	0.418	0.119	0.076	8.702	2.820	0.922	0.169	0.022
2019	0.281	0.071	0.079	0.389	0.115	0.083	8.352	2.600	0.865	0.161	0.018
Change 1990-2019, %	98.4	-11.9	-5.0	23.3	-50.3	-91.2	83.1	-64.4	-84.0	70.4	-98.5
Change 2018-2019, %	-3.4	-0.4	10.5	-6.9	-3.4	9.3	-4.0	-7.8	-6.2	-4.4	-20.5

3.2.4.2. Methodological Issues

Fuel consumption details from point sources (NFR 1A4ai and 1a4ci) have been summarised by SNAP codes. Emissions from the diffuse sources were calculated by using data on fuel consumption from the Energy Balance (EB), which was prepared by Statistics Estonia:

Diffuse sources: Fuel = EB fuel - PS fuel

Emissions from PS and diffuse sources have been calculated according to national emissions factors and fuel consumption, or on the basis of measurements. Emissions factors are presented in Chapter 3.2.2.2.

The calculation of main pollutants and POPs emissions for the residential stationary combustion sector was achieved by the use of national factors for wood burning defined within the project "The Geneva Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants Protocol compliance". Within the project, measurements for various types of burning installations (stoves, single household boilers, open fireplaces) were carried out and average values were defined. Measurements were also made for conventional and advanced stoves and boilers. Emission factors are shown in Table 3.29. For the calculation of heavy metals emissions from wood combustion and POPs and HMs from other fuels were used as emission factors for the new EMEP/EEA Guidebook 2019 and these are presented in the Table 3.27 and Table 3.28.

Calculations of emissions of POPs from the burning of waste in stoves were made in addition. Emission factors were also defined within the project "*Tööstuslikest allikatest ja koduahjudest eralduvate välisõhu saasteainete heitkoguste inventuuri metoodikate täiendamine*" (see Table 3.30). Data on the amount of the burned waste were obtained on the basis of the Statistics Estonia questionnaire (see Table 3.34). Emissions are included in sector 1A4bi.

In accordance with the TERT recommendations, this year submission calculations of heavy metals emissions from the burning of waste in stoves were made in addition. For calculations were used emission factors of Guidebook 2019, Chapter 5.C.1.a Municipal waste incineration, table 3-2 (see Table 3.30). This has led to a significant increase in heavy metal emissions in this sector, especially lead.

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

It is estimated that approximately 45% of private households may burn waste (see Table 3.33). It might be considered that growing awareness and continuous notification concerning the quantities of waste incinerated will assist in its downward trend.

Table 3.27 Main pollutant emission factors for NFR 1A4bi (Tier 2 EMEP/EEA Guidebook 2019)

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	80	150	158	34	69	60	42
SO_2	g/GJ	700	450	900	138	79	0.3	0.3
NH_3	g/GJ	0.3	NA	NA	NA	NA	NA	NA
NMVOC	g/GJ	600	300	174	1.2	0.17	2	1.8
CO	g/GJ	5,000	2,000	4,787	111	3.7	30	22
TSP	g/GJ	425	250	261	2.2	1.5	2.2	0.2
PM_{10}	g/GJ	390	240	225	2.2	1.5	2.2	0.2
$PM_{2.5}$	g/GJ	390	220	201	2.2	1.5	2.2	0.2
BC	g/GJ	30.634	14.08	12.864	0.286	0.059	0.119	0.011
Pb	mg/GJ	100	100	200	0.012	0.012	0.0015	0.0015
Cd	mg/GJ	1	1	3	0.001	0.001	0.00025	0.00025
Hg	mg/GJ	5	5	6	0.12	0.12	0.1	0.1
As	mg/GJ	1.5	1.5	5	0.002	0.002	0.12	0.12
Cr	mg/GJ	10	10	15	0.2	0.2	0.00076	0.00076
Cu	mg/GJ	20	15	30	0.13	0.13	0.000076	0.000076
Ni	mg/GJ	10	10	20	0.005	0.005	0.00051	0.00051
Se	mg/GJ	2	2	2	0.002	0.002	0.011	0.011
Zn	mg/GJ	200	200	300	0.42	0.42	0.0015	0.0015

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})
PCBs	µg/GJ	170	170	170				
PCDD/F	ng/GJ	1,000	500	500	10	1.8	1.5	1.5
B(a)p	mg/GJ	250	150	270	0.08	0.08	0.00056	0.00056
B(b)f	mg/GJ	400	180	250	0.04	0.04	0.00084	0.00084
B(k)f	mg/GJ	150	100	100	0.07	0.07	0.00084	0.00084
I(1,2,3-cd)p	mg/GJ	120	80	90	0.16	0.16	0.00084	0.00084
HCB	µg/GJ	0.62	0.62	0.62				

Table 3.28 HMs and PCBs emission factors for wood combustion for NFR 1A4bi (EMEP/EEA Guidebook 2019)

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

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

Pollutant	Unit	Biomass					
		Conventional stoves, fireplaces	Advanced stoves	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	140.41	117.582	2,382.816	74.512	176.21	45.875
SO_2	g/GJ	11	10.91	26.647	11	10.89	12.34
NH_3	g/GJ	2.629	2.629	9.869	0.308	2.497	0.933
NMVOC	g/GJ	66.763	60.625	1,851.82	57.883	204.556	2.28
CO	g/GJ	3,295.845	2,574.958	24,264.87	758.454	4,032.213	269.283
TSP	g/GJ	275.217	26.81	341.703	10.681	792.251	26.651
PM_{10}	g/GJ	257.627	24.153	310.639	9.71	720.228	23.986
$PM_{2.5}$	g/GJ	249.935	23.996	295.107	9.224	684.217	22.786
BC	g/GJ	120.702	11.436	140.638	4.396	326.075	10.859
PCDD/F	ng/GJ	161.9	8.8	15.025	0.4696	6.5	1.9
B(a)p	mg/GJ	37.9	1.185	489.008	0.037	2.942	3.381
B(b)f	mg/GJ	28.5	0.891	433.051	0.028	2.212	1.994
B(k)f	mg/GJ	18.2	0.569	358.864	0.018	1.413	1.098
I(1,2,3-cd)p	mg/GJ	28.1	0.878	591.64	0.027	2.181	2.137
HCB	µg/GJ	17.104	8.341	8.333	0.261	5.217	1.288

Table 3.30 National pollutants emission factors (for HMs – Guidebook 2019) 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

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

The main impact on the change of IEF in this sector is the exerted change of the situation regarding residual stationary as it is a main source of pollution inside the non-industrial sector. At the beginning of the 1990s this involved a change in energy supply, involving a decrease in the consumption of solid fuel, mainly coal and peat, and the significant growth of wood consumption after 1995 (see Table 3.32, Figure 3.25-3.26). 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 3.24).

In 2019, an decrease in the IEF of SO_x, NO_x and particulates was caused by a increase in the share of natural gas burned and decrease in the consumption of biomass.

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

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	389.0	230.9	267.5	NR
1995	162.9	468.7	274.4	NR
2000	128.1	399.8	242.0	204.2
2005	72.5	305.5	229.1	171.8
2010	27.3	270.6	150.8	127.1
2011	28.2	252.1	144.6	123.0
2012	27.1	249.2	134.2	113.5
2013	28.1	242.4	138.8	119.7
2014	25.3	230.7	126.3	107.3
2015	20.5	230.8	132.4	113.1
2016	21.3	228.5	145.0	117.2
2017	17.0	219.0	134.0	114.4
2018	24.9	221.5	122.6	103.3
2019	23.6	205.0	109.4	92.6

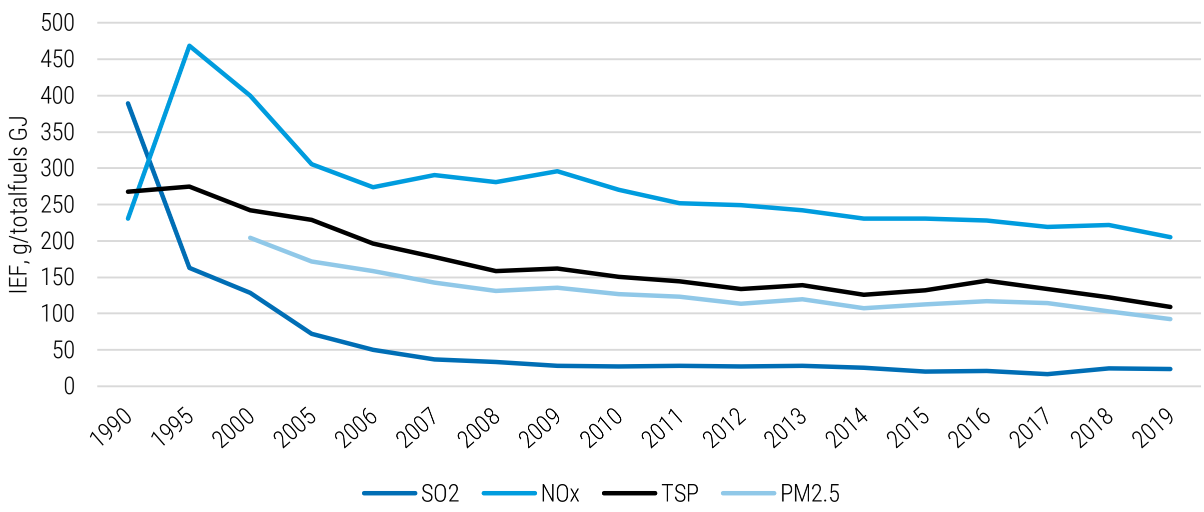

Figure 3.24 Implied emission factors for NFR 1A4

Activity Data

The fuel consumption figures for the non-industrial stationary combustion sector are presented in Table 3.32 and Figure 3.25. The consumption of liquid and solid fuels (mainly coal and peat) has decreased across 1990-2019, by about 79.5% and 98.5% respectively. At the same time, wood burning and natural gas consumption increased by about 200% and 115%. The distribution of fuel consumption rates in 1990 and 2019 are shown in Figure 3.26.

Table 3.32 Fuel consumption in non-industrial combustion plants in the period of 1990–2019 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	6.05	6.95	5.68	2.72	0.32
1995	1.75	2.37	15.20	2.01	0.44
2000	2.47	1.41	14.36	2.42	0.48
2005	1.21	1.41	12.90	4.17	0.44
2010	1.30	0.48	18.57	6.59	0.56
2011	1.00	0.53	15.93	6.55	0.40
2012	1.08	0.50	16.78	6.52	0.40
2013	0.71	0.51	16.46	5.81	0.40
2014	0.74	0.42	16.68	5.78	0.40
2015	0.76	0.29	16.11	5.29	0.44
2016	0.84	0.26	17.02	5.22	0.40
2017	0.85	0.16	17.71	5.36	0.40
2018	1.09	0.11	17.67	4.43	0.41
2019	1.24	0.10	17.02	5.85	0.41
Change 1990-2019, %	-79.5	-98.5	199.8	115.0	26.6
Change 2018-2019, %	13.7	-4.7	-3.7	32.0	0.4

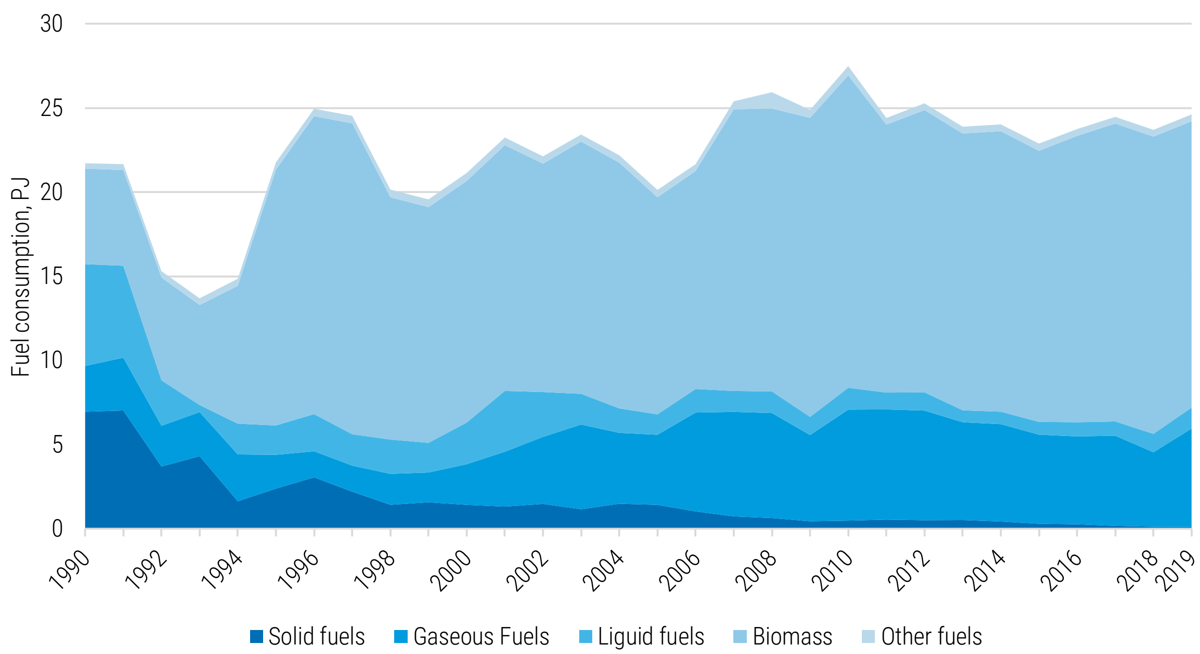

Figure 3.25 Fuel consumption by non-industrial combustion plants in the period of 1990–2019

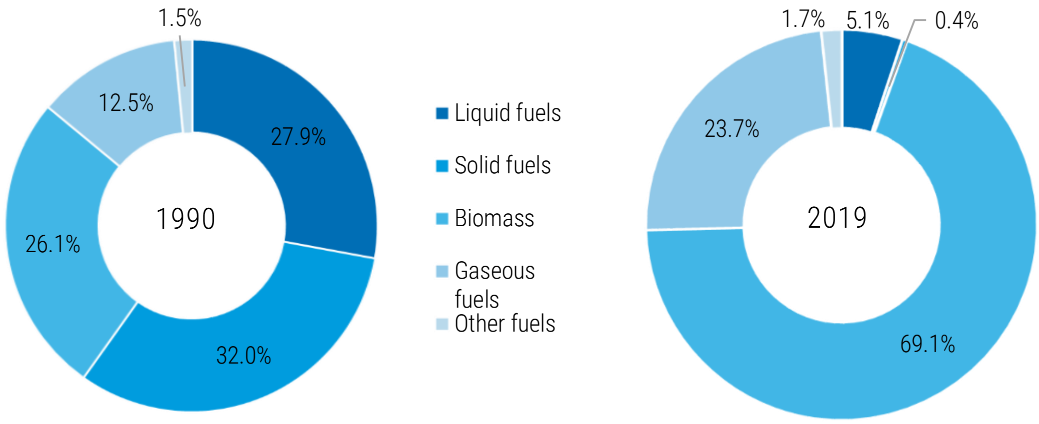

Figure 3.26 Distribution of fuel consumption in non-industrial combustion sector in 1990 and 2019

Fuel consumption figures by residential stationary sector are presented in Table 3.33. Figure 3.27 shows fuel consumption levels for each non-industrial sector in 2019. It should be noted that the domestic sector is the main source of wood burning.

Table 3.33 Fuel consumption in residential combustion plants (NFR 1A4bi) in the period of 1990–2019, PJ

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels
1990	3.464	6.715	5.093	2.382
1995	0.358	2.332	15.007	1.997
2000	0.876	1.248	13.888	1.769
2005	0.390	0.980	12.342	1.883
2010	0.349	0.361	17.728	2.299
2011	0.392	0.448	15.263	2.164
2012	0.349	0.412	16.297	2.317
2013	0.306	0.412	15.644	2.189
2014	0.351	0.342	15.552	2.186
2015	0.397	0.215	15.133	2.065
2016	0.446	0.081	16.068	2.423
2017	0.404	0.088	16.346	2.319
2018	0.358	0.044	16.500	2.302
2019	0.389	0.050	15.842	2.418
Change 1990-2019, %	-88.783	-99.257	211.054	1.499
Change 2018-2019, %	8.7	13.4	-4.0	5.0

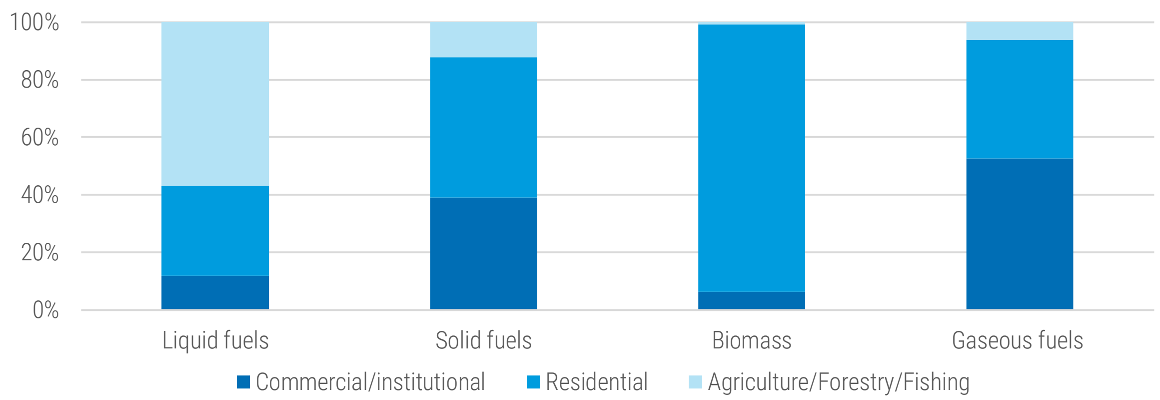

Figure 3.27 Fuel consumption by non-industrial sectors in 2019

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

Year	Amount of waste
1990	16,757.789
1995	22,886.049
2000	24,996.018
2005	19,764.689
2010	20,701.470
2011	20,980.553
2012	21,270.634
2013	21,501.930
2014	21,431.000
2015	21,389.500
2016	21,430.500
2017	21,456.489
2018	21,531.296
2019	21,611.445

3.2.4.3. 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. There are difficulties in comparing the consumption of fuel in activities. The principle of a database is that, for example, the industrial boiler is designated SNAP 03, irrespective of whether the heat is sold or is used for its own needs.

3.2.4.4. Recalculations

The recalculation for NFR 1A4bi was carried out in this reporting year:

- The emissions of all substances for residential sector (NFR 1A4bi) were recalculated for the period 1990-2018. The reasons are given in Chapter 8

The emissions of POPs for NFR 1A4ai and 1A4ci were recalculated for the period 1990-2018. The reasons are given in Chapter 8.

3.2.4.5. Source-Specific Planned Improvements

Review of the activity data for the waste incineration in domestic sector.

3.3. Transport

3.3.1. Overview of the Sector

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

Table 3.35 Transport sector reporting activities

NFR	Source	Description	Method	Emissions
1A2gvii	Mobile combustion in manufacturing industries and construction	Mobile combustion in manufacturing industries and construction land based mobile machinery (e.g. rollers, asphalt pavers, excavators, cranes, tractors, other industrial machinery)	Tier 2	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO
			Tier 1	SO_x, Pb, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
1A3ai-ii(i)	International and Civil aviation (LTO)	Activities include all use of aircraft (jets, turboprop powered and piston engine aircraft, helicopters) consisting passengers and freight transport	Tier 2	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO
1A3ai-ii(ii)	International and Civil aviation (Cruise)	Activities include all use of aircraft consisting passengers and freight transport	Tier 1	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO
1A3bi-iv	Road transport	Road transport includes use of vehicles with combustion engines: passenger cars, light duty vehicles, heavy duty trucks, buses and motorcycles	Tier 3	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs total, HCB, PCBs
1A3bv	Road transport: Gasoline evaporation	Fuel evaporation from automobiles	Tier 3	NMVOC
1A3bvi	Automobile tyre and brake wear	PM, heavy metal and PAHs emissions from automobile tyre and brake wear	Tier 3	$PM_{2.5}$, PM_{10}, TSP, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs total
1A3bvii	Road transport: Automobile road abrasion	PM emissions from road abrasion	Tier 1	$PM_{2.5}$, PM_{10}, TSP, BC
1A3c	Railways	Railway transport operated by steam and diesel locomotives	Tier 1	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

The transport sector is a major contributor to national emissions. The transport sector includes road transport which is the largest and most important emission source (Figure 3.28). The share of mobile sources in total national emissions in 2019 was the following: NO_x – 38.5%, BC – 13.6%, CO – 12.9% and NMVOC – 8.4%. The share of other pollutants is not so significant. Emissions of most compounds have decreased throughout the time series, mainly due to the stricter emission standards for road vehicles. The emissions of nitrogen oxides have decreased compared to 1990 by 75.0%. The emissions of NMVOC and CO from the transport sector have decreased by 91.0% and 89.0% respectively since 1990. The trend of the emissions of these categories is given in Figure 3.29 and Table 3.36.

Recalculations have been made for the following sectors: industrial machinery (1A2gvii), road transport (1A3bi-vii), railways (1A3c), national navigation (1A3dii), commercial machinery (NFR 1A4aii), household and gardening machinery (NFR 1A4bii), agricultural machinery (NFR 1A4cii), national fishing (NFR 1A4ciii) and international maritime navigation (1A3di(i)) sector. Recalculations entail using the new COPERT 5 program to calculate emissions from road transport, updated activity data and emission factors, which all led to a change in total emissions. A detailed overview is given in each transport subsector and in Chapter 8.

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

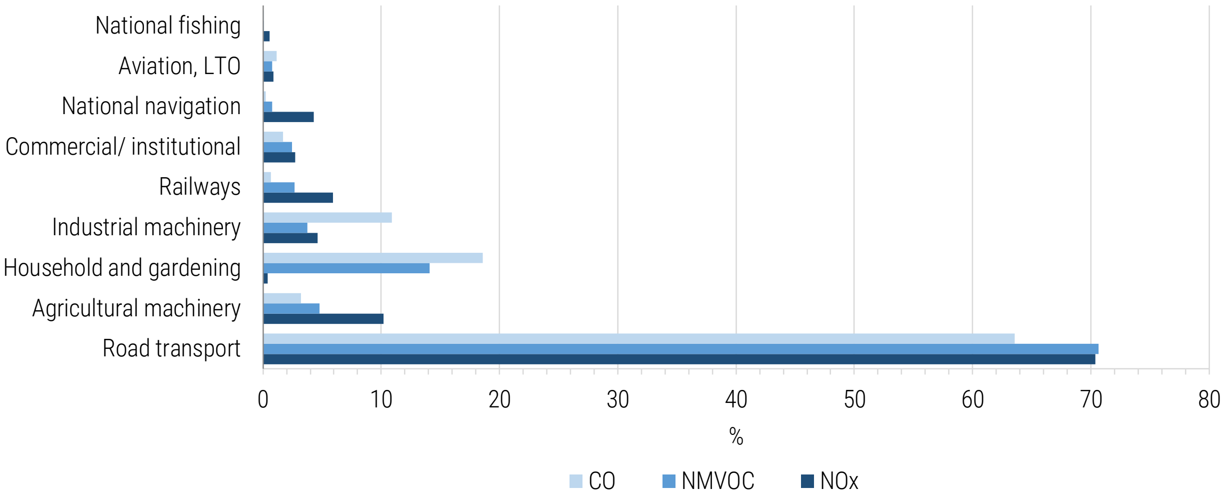

Figure 3.28 NO_x, NMVOC and CO emission shares in the transport sectors in 2019

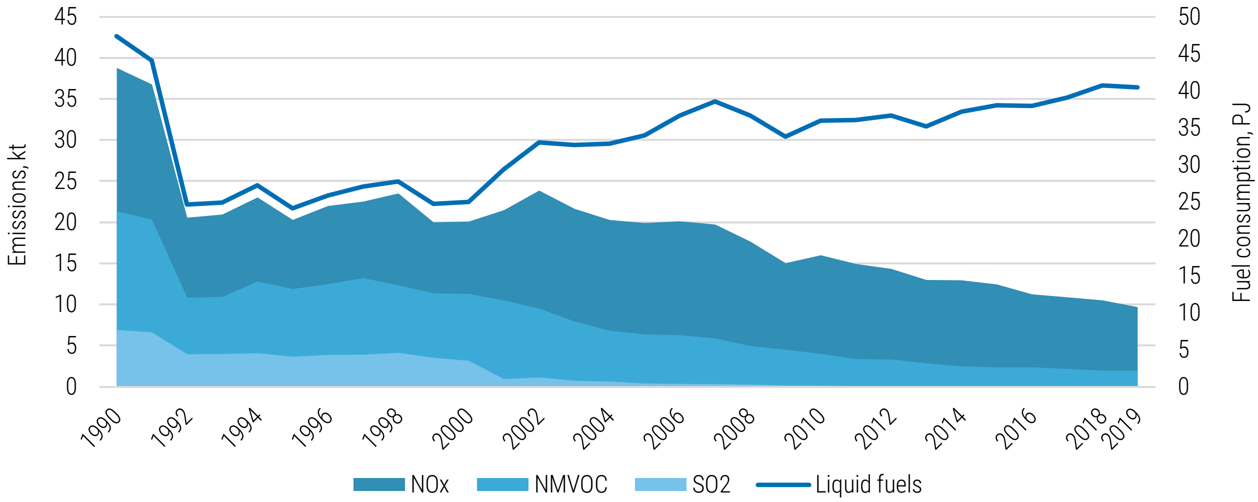

Figure 3.29 NO_x, NMVOC and CO emissions from the transport sector in the period of 1990-2019

Table 3.36 Total emissions from the transport sector in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	38.771	21.327	6.891	0.019	NR	NR	2.464	NR	153.613
1995	20.284	11.878	3.639	0.026	NR	NR	1.110	NR	66.839
2000	20.079	11.286	3.144	0.096	0.936	1.026	1.134	0.464	72.201
2005	19.902	6.354	0.381	0.199	0.933	1.048	1.186	0.489	44.455
2010	15.981	3.981	0.128	0.203	0.709	0.831	0.977	0.389	28.576
2011	14.924	3.357	0.067	0.195	0.679	0.804	0.954	0.368	24.218
2012	14.326	3.302	0.031	0.184	0.649	0.776	0.929	0.355	23.669
2013	12.976	2.839	0.028	0.159	0.589	0.713	0.862	0.321	19.790
2014	12.934	2.467	0.031	0.151	0.583	0.709	0.860	0.313	18.598
2015	12.436	2.343	0.033	0.154	0.566	0.695	0.850	0.301	18.125
2016	11.230	2.353	0.031	0.153	0.529	0.661	0.820	0.272	21.501
2017	10.870	2.156	0.036	0.146	0.514	0.650	0.813	0.259	20.449
2018	10.497	1.950	0.036	0.139	0.507	0.648	0.816	0.254	16.163
2019	9.681	1.917	0.031	0.142	0.485	0.627	0.797	0.237	16.892
Trend 1990-2019, %	-75.0	-91.0	-99.6	660.6	-48.2	-38.9	-67.6	-49.0	-89.0

Table 3.36 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	78.074	0.005	0.007	0.004	0.122	2.745	0.061	0.006	1.190
1995	24.412	0.002	0.004	0.002	0.065	1.401	0.024	0.002	0.585
2000	4.983	0.002	0.004	0.002	0.069	1.493	0.026	0.002	0.614
2005	2.130	0.003	0.005	0.003	0.091	1.964	0.035	0.003	0.841
2010	0.285	0.003	0.005	0.003	0.096	2.087	0.036	0.004	0.882
2011	0.289	0.003	0.005	0.003	0.099	2.134	0.031	0.003	0.889
2012	0.296	0.003	0.005	0.003	0.100	2.168	0.030	0.003	0.903
2013	0.284	0.002	0.004	0.003	0.098	2.099	0.028	0.003	0.872
2014	0.265	0.003	0.005	0.003	0.101	2.193	0.032	0.004	0.924
2015	0.270	0.003	0.005	0.003	0.104	2.253	0.033	0.004	0.950
2016	0.299	0.003	0.005	0.003	0.106	2.272	0.032	0.004	0.955
2017	0.308	0.003	0.005	0.003	0.109	2.339	0.034	0.004	0.986
2018	0.294	0.003	0.005	0.003	0.113	2.434	0.034	0.004	1.029
2019	0.306	0.003	0.005	0.004	0.114	2.462	0.033	0.004	1.036
Trend 1990-2019, %	-99.6	-45.8	-30.2	-19.2	-6.7	-10.3	-46.0	-37.1	-12.9

Table 3.36 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					g	
1990	0.310	0.023	0.040	0.017	0.012	0.093	1.701	20.980
1995	0.173	0.009	0.016	0.010	0.007	0.042	0.705	6.930
2000	0.197	0.007	0.014	0.009	0.006	0.037	0.882	1.402
2005	0.272	0.011	0.019	0.012	0.008	0.051	1.228	0.519
2010	0.312	0.013	0.021	0.013	0.009	0.056	1.218	0.496
2011	0.322	0.013	0.021	0.014	0.009	0.057	0.857	0.323
2012	0.321	0.014	0.022	0.014	0.010	0.059	0.786	0.289
2013	0.307	0.013	0.021	0.014	0.010	0.058	0.707	0.255
2014	0.295	0.015	0.023	0.014	0.010	0.061	0.810	0.307
2015	0.308	0.016	0.024	0.014	0.011	0.064	0.834	0.315
2016	0.291	0.015	0.023	0.014	0.011	0.063	0.800	0.304
2017	0.278	0.016	0.023	0.014	0.011	0.065	0.895	0.352
2018	0.267	0.017	0.024	0.015	0.012	0.067	0.823	0.321
2019	0.266	0.017	0.024	0.015	0.012	0.067	0.738	0.281
Trend 1990-2019, %	-14.1	-27.5	-41.0	-15.4	-2.3	-27.8	-56.6	-98.7

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

(Photo by Nordica: Nordica's Bombardier CRJ-900-NG)

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 2019 was 0.9%, 0.8%, and 1.1% respectively (see Figure 3.28). Other pollutants have an even smaller share.

Aviation emissions reflect the level of overall aviation activity. 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 3.30 and Table 3.37), mainly due to changes in fuel consumption, which increased by 55.1% (see Table 3.41) and the number of landing and take-off operations (see Figure 3.32). This is roughly in line with the trends in the number of air passengers and passenger traffic volume over the same period. Figure 3.31 illustrate the importance of the international aviation sector, which contributes the majority of the emissions from the aviation sector.

In 2019, NO_x, NMVOC, SO_2, PM and CO emissions decreased by 8.3%, 6.5%, 11.1%, 12.6% and 0.9% respectively compared to 2018. The decrease in the amount of fuel consumed, passenger traffic volumes and the number of passengers resulted in a decrease in emissions from the LTO-phase. At the same time, the number of landing and take-off operations remained almost at the level of the previous year. Consequently, the decrease in emissions has mainly been caused by the fact that the share of different aircraft types varies and therefore the average emission factor (Table 3.39) and fuel consumption changes from year to year in the LTO phase in the aviation sector.

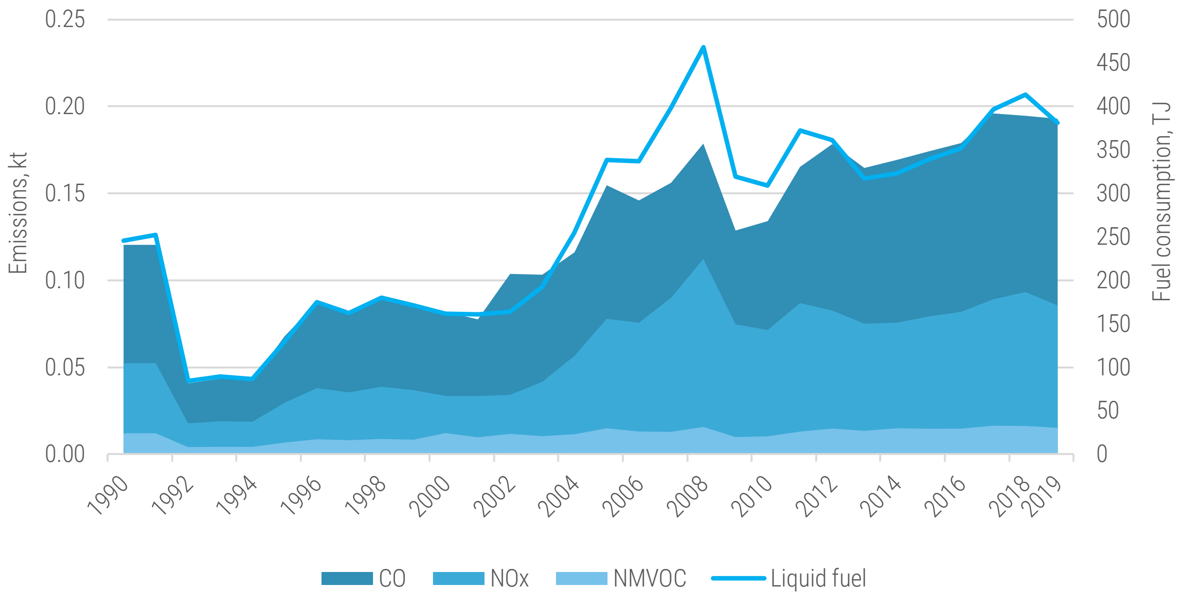

Figure 3.30 NO_x, NMVOC and CO emissions from the LTO cycle in aviation sector in the period of 1990-2019

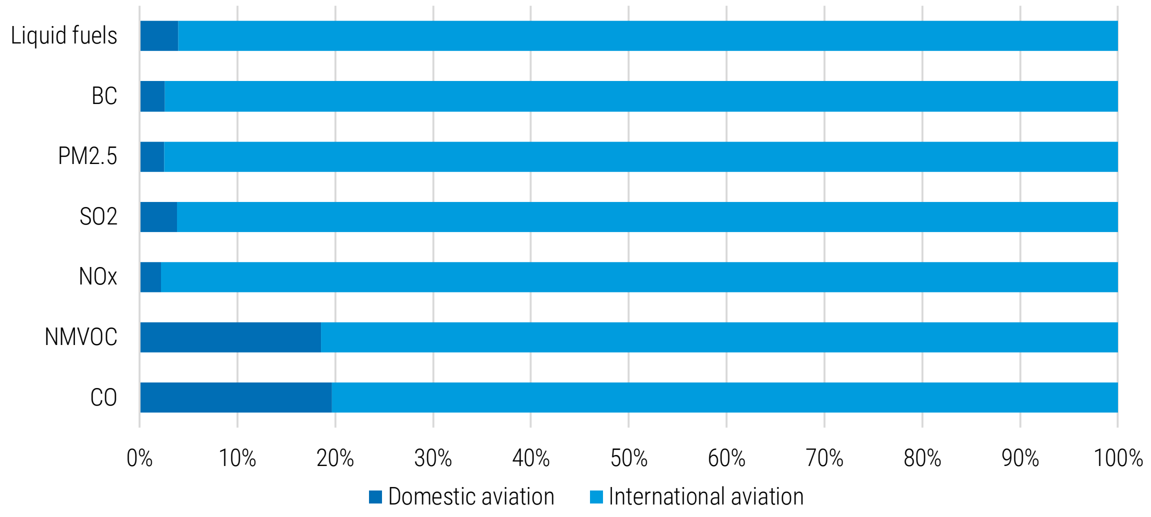

Figure 3.31 The share of pollutant emissions from the LTO cycle in aviation sector in 2019

Table 3.37 Emissions from the LTO cycle in the aviation sector in the period of 1990–2019

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt			t				kt
1990	0.052	0.012	0.006	NR	NR	0.392	NR	0.120
1995	0.030	0.007	0.003	NR	NR	0.221	NR	0.068
2000	0.033	0.012	0.004	0.314	0.314	0.314	0.150	0.082
2005	0.078	0.015	0.008	0.652	0.652	0.652	0.312	0.155
2010	0.071	0.010	0.007	0.558	0.558	0.558	0.267	0.134
2011	0.087	0.013	0.008	0.638	0.638	0.638	0.305	0.165
2012	0.083	0.015	0.008	0.466	0.466	0.466	0.223	0.178
2013	0.075	0.013	0.007	0.463	0.463	0.463	0.221	0.165
2014	0.076	0.015	0.007	0.483	0.483	0.483	0.231	0.169
2015	0.079	0.015	0.007	0.501	0.501	0.501	0.240	0.174
2016	0.082	0.015	0.008	0.517	0.517	0.517	0.248	0.179
2017	0.089	0.016	0.009	0.560	0.560	0.560	0.268	0.196
2018	0.093	0.016	0.009	0.549	0.549	0.549	0.263	0.195
2019	0.085	0.015	0.008	0.480	0.480	0.480	0.230	0.193
Trend 1990-2019, %	63.4	26.1	49.4	52.9	52.9	22.4	53.0	60.2

Table 3.38 Emissions from the cruise phase in the aviation sector in the period of 1990–2019 (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
2011	0.472	0.018	0.037	0.007	0.007	0.007	0.004	0.042
2012	0.651	0.025	0.051	0.010	0.010	0.010	0.005	0.057
2013	0.513	0.020	0.040	0.008	0.008	0.008	0.004	0.045
2014	0.512	0.020	0.040	0.008	0.008	0.008	0.004	0.045
2015	0.537	0.021	0.042	0.008	0.008	0.008	0.004	0.047
2016	0.479	0.018	0.038	0.008	0.008	0.008	0.004	0.042
2017	0.638	0.025	0.050	0.010	0.010	0.010	0.005	0.056
2018	0.757	0.029	0.059	0.012	0.012	0.012	0.002	0.066
2019	0.757	0.029	0.059	0.012	0.012	0.012	0.002	0.066
Trend 1990-2019, %	96.6	100.9	95.3	236.5	236.5	95.3	5.1	90.0

3.3.2.2. Methodological Issues

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

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

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

LTO emissions = number of LTOs × emission factor LTO

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

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

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

A complete emission calculation (LTO and cruise emissions for domestic and international flights) was carried out by ESTEA between 1992 and 2019. Extrapolation has been done for 1990 and 1991.

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

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
Turbofans (Jets)						
Airbus A310	23.20	5.00	1.50	0.14	25.80	1,540.5
Airbus A320	10.80	1.70	0.80	0.09	17.60	802.3
Bae 111	4.90	19.30	0.70	0.17	37.70	681.6
Bae 146	4.20	0.90	0.60	0.08	9.70	569.5
B727	12.60	6.50	1.40	0.22	26.40	1,412.8
B737-100	8.00	0.50	0.90	0.10	4.80	919.7
B737-400	8.30	0.60	0.80	0.07	11.80	825.4
B747-100-300	55.90	33.60	3.40	0.47	78.20	3,413.9
B747-400	56.60	1.60	3.40	0.32	19.50	3,402.2
B757	19.70	1.10	1.30	0.13	12.50	1,253.0
B767-300	26.00	0.80	1.60	0.15	6.10	1,617.1
B777	53.60	20.50	2.60	0.20	61.40	2,562.8
Fokker 100	5.80	1.30	0.70	0.14	13.70	744.4

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
Fokker 28	5.20	29.60	0.70	0.15	32.70	666.1
2XB737-100	16.00	1.00	1.80	0.20	9.60	1,839.4
McDonnell Douglas DC-9	7.30	0.70	0.90	0.16	5.40	876.1
McDonnell Douglas DC-10	41.70	20.50	2.40	0.32	61.60	2,381.2
McDonnell Douglas	12.30	1.40	1.00	0.12	6.50	1,003.1
C525	0.74	3.01	0.34	0	34.07	340.0
EC RJ_100ER	2.27	0.56	0.33	0	6.70	330.0
ERJ-145	2.69	0.50	0.31	0	6.18	310.0
GLF4	5.63	1.23	0.68	0	8.88	680.0
GLF5	5.58	0.28	0.60	0	8.42	600.0
RJ85	4.34	1.21	0.60	0	11.21	600.0
Turboprop						
turboprop, <1000sph/engine	0.30	0.58	0.07	0	2.97	70.0
turboprop, 1000-2000sph/engine	1.51	0	0.20	0	2.24	200.0
turboprop, >2000sph/engine	1.82	0.26	0.20	0	2.33	200.0
Piston engine						
microlight aircraft	0.03	0.04	0.00	0	0.94	1.4
4 seat single engine (<180hp)	0.01	0.06	0.00	0	3.93	3.9
single engine high performance (180-360hp)	0.02	0.16	0.00	0	7.33	7.5
twin engine high performance (2x235hp)	0.05	0.22	0.01	0	19.33	21.6
Helicopters						
A109	0.13	0.89	0.02	0.01	1.31	32.8
A139	0.38	0.68	0.03	0.01	0.97	60.3
ALO3	0.11	0.28	0.01	0.00	0.40	21.4
AS32	0.65	0.49	0.04	0.02	0.68	77.4
AS35	0.18	0.22	0.01	0.01	0.32	27.5
AS55	0.15	0.82	0.02	0.01	1.20	34.8
H269	0.01	0.09	0.00	0.00	6.59	6.6
B412	0.64	0.49	0.04	0.02	0.69	77.0
B06	0.08	0.35	0.01	0.00	0.50	18.2
EC35	0.21	0.71	0.02	0.01	1.03	41.1
EN48	0.08	0.34	0.01	0.00	0.48	18.6
MI8	0.53	0.55	0.04	0.02	0.78	70.0
R22	0.01	0.09	0.00	0.00	6.21	6.2
R44	0.02	0.11	0.00	0.00	8.79	8.8
S76	0.29	0.59	0.02	0.01	0.85	48.2

Table 3.40 Emission factors for the cruise phase (kg/t)

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

Table 3.41 Fuel consumption in the aviation sector (TJ)

Year	Domestic LTO	Domestic cruise	International LTO	International cruise	Total
1990	12.413	65.987	233.371	1,256.229	1,568.0
1995	6.102	39.498	123.667	571.733	741.0
2000	6.576	27.424	154.654	730.346	919.0
2005	13.244	52.847	325.441	1,576.563	1,968.1
2010	12.339	26.768	296.382	1,112.111	1,447.6
2011	14.596	51.848	357.731	1,542.408	1,966.6
2012	15.497	39.689	345.973	2,154.439	2,555.6
2013	13.473	41.053	303.570	1,691.283	2,049.4
2014	13.763	41.291	308.784	1,687.080	2,050.9
2015	13.836	44.305	325.494	1,767.179	2,150.8
2016	12.803	34.544	338.793	1,580.193	1,966.3

Year	Domestic LTO	Domestic cruise	International LTO	International cruise	Total
2017	14.395	35.598	382.477	2,115.109	2,547.6
2018	14.556	42.462	398.742	2,507.628	2.963.4
2019	15.182	39.818	365.924	2,575.076	2,996.0

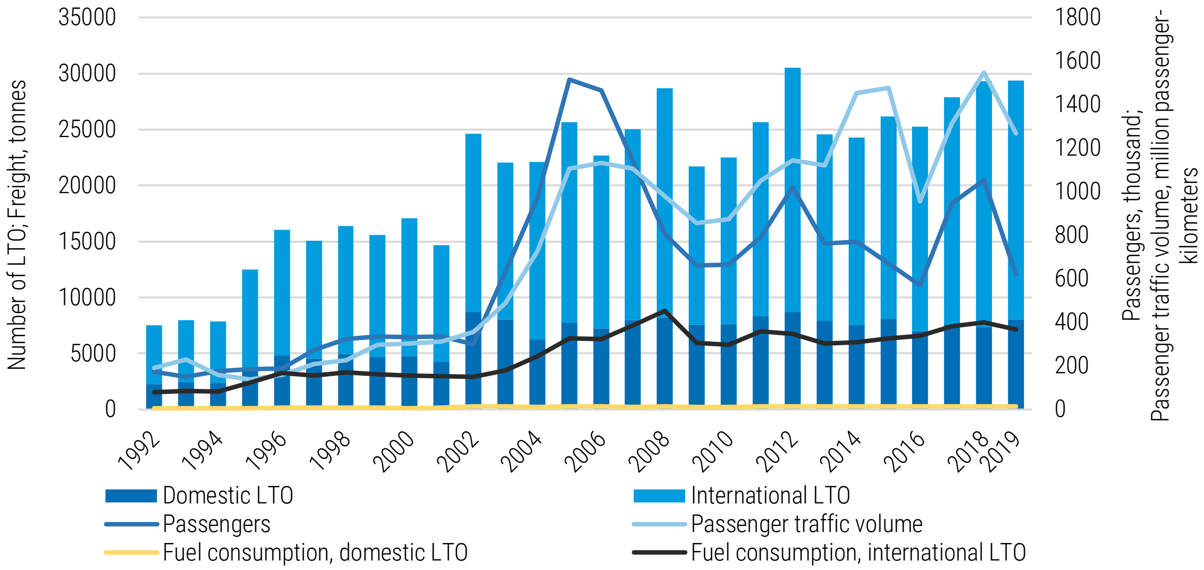

Figure 3.32 The number of LTO cycles, passengers carried and freight transported

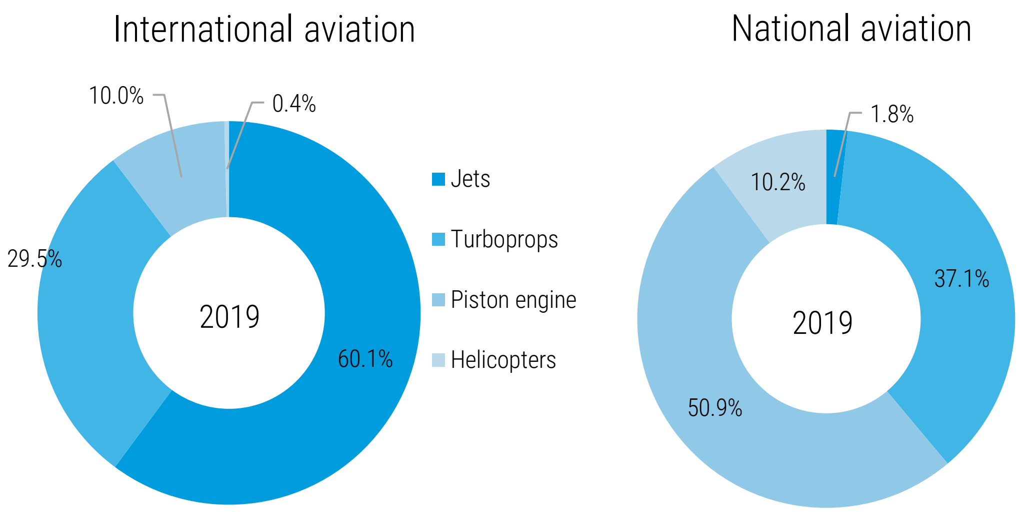

Figure 3.33 The share of different aircraft types in domestic and international civil aviation

3.3.2.3. Uncertainty

An uncertainty analysis was carried out for the 2019 inventory. The uncertainty in the emission factors for all pollutants from the aviation (LTO) sector is estimated to be 30% and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.42. No uncertainty estimation for cruise phase has been carried out.

Table 3.42 Uncertainties in the aviation (LTO) sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	0.085	kt	0.34	0.10	0.03
NMVOC	0.015	kt	0.07	0.02	0.004
SO_x	0.008	kt	0.04	0.01	0.001
$PM_{2.5}$	0.480	t	0.01	0.002	0.001
PM_{10}	0.480	t	0.01	0.002	0.0004
TSP	0.480	t	0.003	0.001	0.00005
CO	0.193	kt	0.15	0.04	0.013

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.

(Photo from www.tallinn.ee: Ülemiste intersection – one of the busiest ones in Tallinn)

In 2019, road transport contributed to the total national emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide by 27.1%, 6.0%, and 8.2% respectively, and in the transport sector, 70.4%, 70.6%, and 63.6% respectively (see Figure 3.28). Emissions from the main pollutants and particulate matter have decreased significantly throughout the time series with the exception of NH_3. The decrease in emissions (see Figure 3.34) has mainly been caused by the stricter emission standards for road vehicles. In addition, Figure 3.35 illustrates the importance of different vehicle types in pollutant emissions in the road transport sector.

The lead emissions from road transport have decreased by about 99.6% since 1990 (see Figure 3.34). The reduction of emissions is related to the prohibition on leaded petrol in 2000. The share of road transport in the total Pb emissions was 2.4% in 2019.

The reduction of sulphur content in fuels has led to a substantial decrease in SO_2 emissions in the road transport sector (see Figure 3.34). In 2001, the sulphur content was reduced from 5,000 ppm (diesel) and 1,000 ppm (petrol) to 500 ppm and since then, sulphur content in fuel has been gradually reduced even more (see Table 3.44). Currently, all road transport fuels are sulphur free (sulphur content less than 10 ppm). Therefore, SO_2 emissions have decreased by 99.8% between 1990 and 2019.

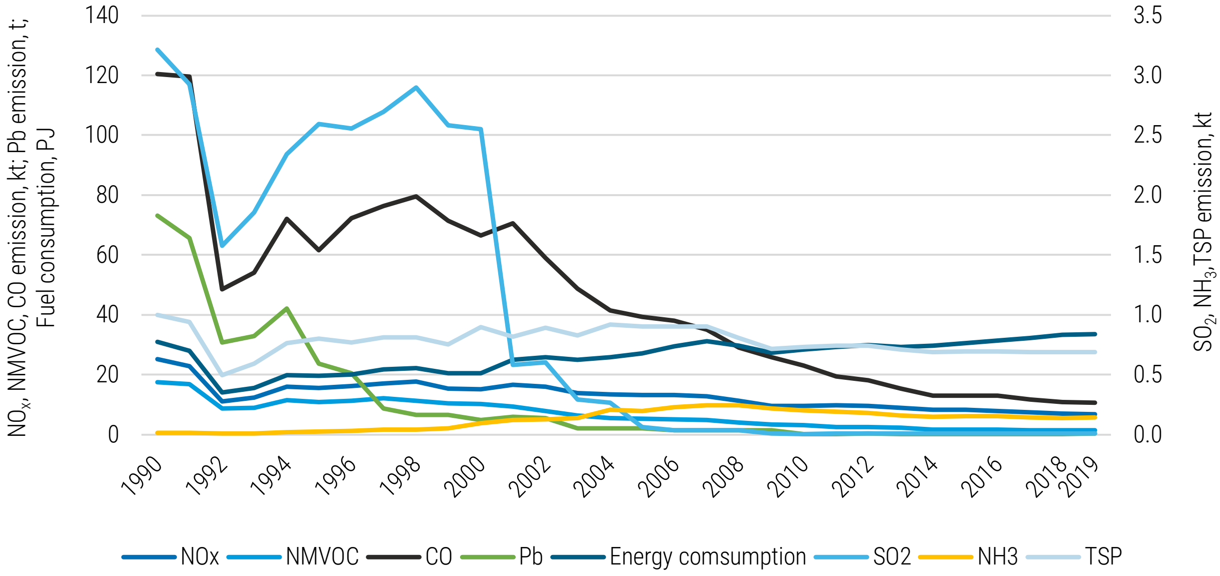

Figure 3.34 Fuel consumption and pollutant emissions from road transport in the period 1990-2019

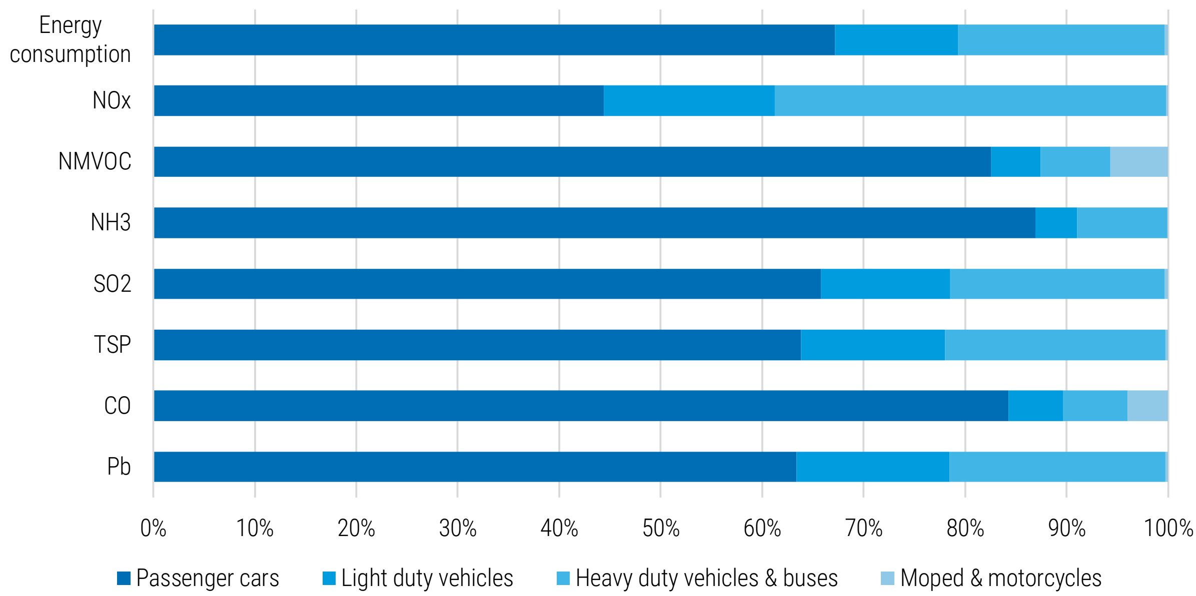

Figure 3.35 The share of pollutant emissions in the road transport sector in 2019

Fuel consumption has changed over the decades in the road transport sector. In the 1990s, petrol consumption dominated but from 2003, we can see the continuous growth in diesel consumption in road transport (see Figure 3.36 and Table 3.49). This trend can be explained by the fact that the popularity of vehicles with petrol engines has declined in recent years, and diesel engines dominate due to their greater fuel efficiency and torque compared to petrol engines.

Emissions from petrol vehicles have been dramatically reduced by the introduction of catalytic converters which have much lower CO, NMVOC, and NO_x emissions in comparison to petrol cars without catalysts. Since 1990, the number of petrol-driven passenger cars and light duty vehicles which are equipped with catalytic converters has increased, resulting in relatively decreasing emissions in such areas as NO_x and NMVOC, by 96% and 93% respectively between 1990 and 2019. 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 42.3% in 2019 in comparison to 2007's figures. The second reason for the decline in NH_3 emissions in recent years is the fact that the share of diesel vehicles has grown rapidly, which has had only a minor impact upon total road transport NH_3 emissions. Nevertheless, NH_3 emissions emitted by road transport amounted to only 1.3% of the national total NH_3 emissions in 2019.

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 and particulates 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 47.4% decrease in petrol consumption during the period of 1990–2019 and an increasing amount of new cars that are designed to reduce both energy consumption and pollutant emissions, as a result of new technologies.

In addition, Estonia has taken the obligation to reach a level of 10% in the use of renewable sources of energy in transport sector by 2020. Over the last few years, steps have been taken to use biofuels in road transport. The share of biofuels used for road transport accounted for 0.02% in 2005 and increased to 4.0% in 2019 (see Table 3.49).

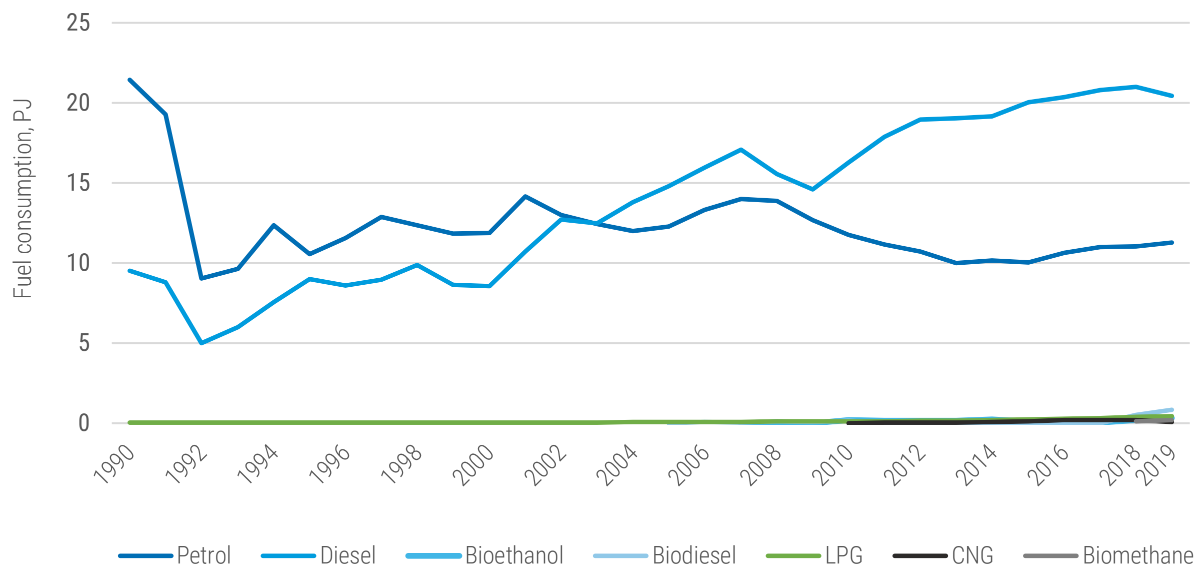

Figure 3.36 Fuel consumption in the road transport sector

TSP exhaust emissions from road transport vehicles have decreased by 61.0% during the 1990-2019 period. In 2019, petrol and diesel vehicles contributed 3.0% and 97.0% respectively of the total TSP exhaust emissions in the road transport sector. PM exhaust emissions are declining in new model vehicles due to tightening regulations, and new engine and after-treatment technologies. However, a significant part of the total PM emissions also originate from non-exhaust sources (road abrasion, and tyre and brake wear). Figure 3.37 illustrates the importance of different sources in pollutant emissions in the road transport sector.

As shown in Figure 3.37, only a small volume of heavy metal emissions originate from vehicle exhausts. Instead, a substantial share of heavy metals originate 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 32.9% between 1990 and 2019 (1.2 thousand tonnes to 1.6 thousand tonnes) which is directly linked with the change in annual mileage driven by the vehicles (an increase of 31.6%) over the same period of time. As shown in Figure 3.37, the share of lubricant combustion in heavy metals emissions are relatively high, except for Pb. The combustion of lubricants contributed around 84.1% of Cd, 22.0% of Cr, 35.5% of Cu, 74.9% of Ni, 75.7% of Se, 44.4% of Zn, and only 0.02% of Pb across the entire total road transport sector in 2019.

Concerning lubricant consumption in 4-stroke engines, all heavy metals emissions are reported in 2G (Other product use) in accordance with EMEP/EEA Guidebook 2019.

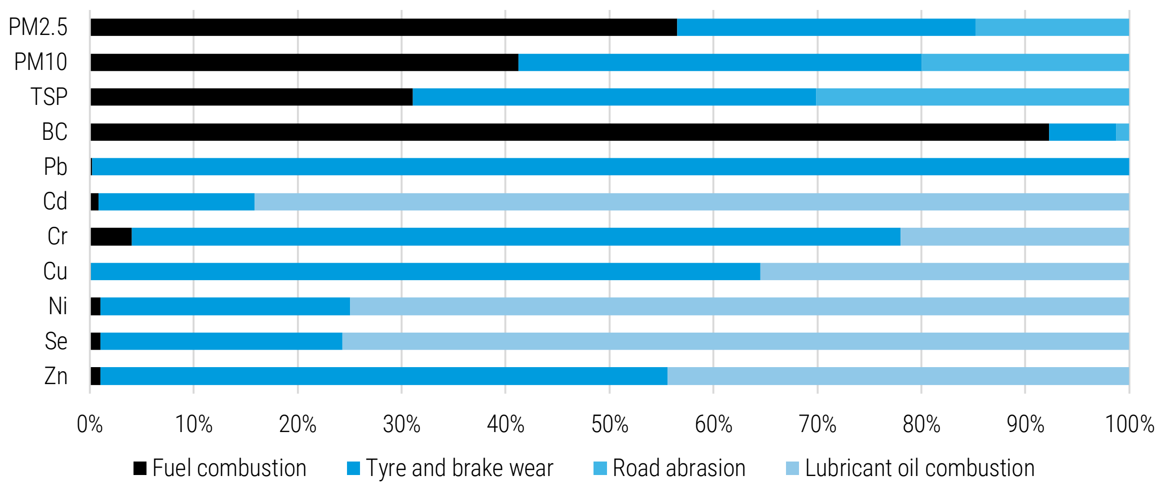

Figure 3.37 The share of different sources in pollutant emissions in 2019

The emission trend in recent years has been impacted by the improved fuel efficiency and minimised emissions of new vehicles. In 2019, statistics showed that the number of vehicles continued to increase (8.2%) compared to 2018. Therefore, the total mileage driven by vehicles and the amount of fuel consumed also increased by 2.9% and 0.4% respectively. Although there has been an increase in activity data, the main pollutant emissions from road transport decreased compared to 2018: nitrogen oxides emissions by 4.2%, non-methane volatile organic compounds by 1.9%, and carbon monoxide by 1.9%.

In the Figures 3.34-3.35, a detailed overview of NO_x, NMVOC, NH_3, SO_2, TSP, CO and Pb emission sources in the road transport sector is provided. All the emission trends are presented in Table 3.43.

Passenger cars (1A3bi)

Passenger cars contributed the majority of emissions within the road transport sector: 44.4% of NO_x, 82.5% of NMVOC, 65.8% of SO_2, 86.9% of NH_3, 63.7% of $PM_{2.5}$, 63.7% of PM_{10}, 63.8% of TSP, 64.7% of BC, 84.3% of CO in 2019.

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 628 thousand between 1990 and 2019. Cars with petrol engines make up a majority of registered passenger cars – 88% in 1990 and 54% in 2019 (see Figure 3.38). This trend reflects that the number of diesel cars has grown fast during the same period (see Figure 3.39). Significant changes have also taken place in annual mileage – annual mileage driven by diesel cars increased more than nine times (442 to 4,336 million km) and annual mileage per petrol cars decreased by 22% (5,121 to 4,020 million km). Overall fuel consumption in this subsector increased by 45% between 1990 and 2019. In detail, fuel consumed by diesel cars increased approximately ten times and petrol fuel amount decreased by 24% during the same period.

During the period of 1990–2019, the pollutant emissions decreased significantly: 76.7% of NO_x, 91.5% of NMVOC, 99.4% of SO_2 and 91.0% of CO, although all the activity data increased in the same time. Therefore, the main pollutant emissions from passenger cars have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicles categories. This means that new technologies have been introduced gradually (Euro 1-6) and the fact that older vehicles are used less compared to new ones (i.e. they have a lower annual mileage). However, medium-sized engines still dominate in diesel and petrol-powered cars, and cars which are powered by alternative fuels, including hybrid cars, make up only a minor share of the car fleet in 2019.

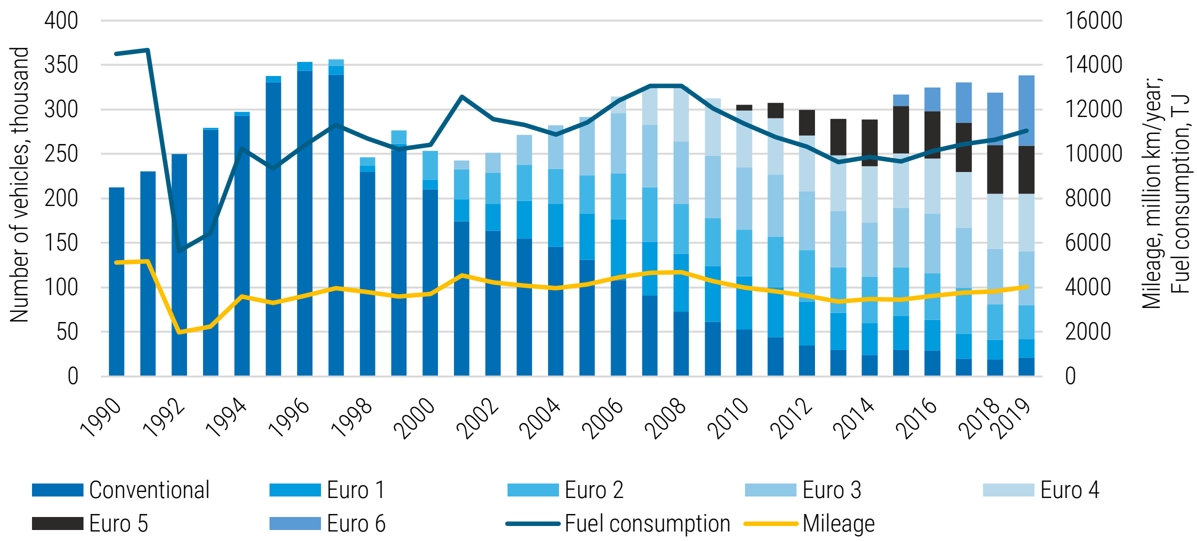

Figure 3.38 Petrol passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

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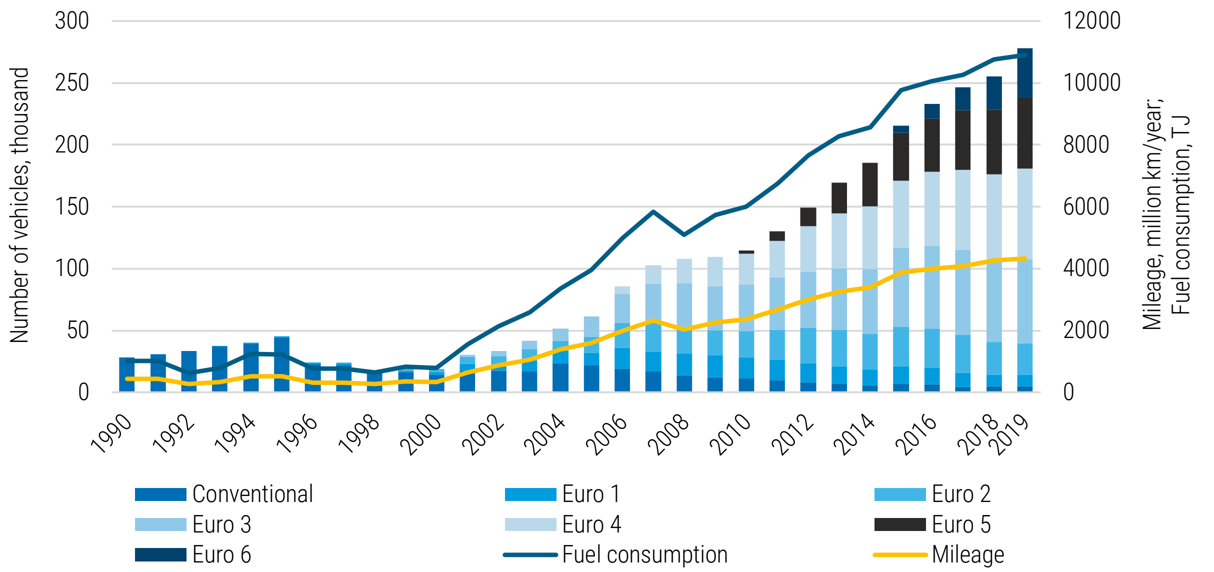

Figure 3.39 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

Light duty vehicles (1A3bii)

Light commercial vehicles contributed about 16.9% of NO_x, 4.9% of NMVOC, 12.8% of SO_2, 4.1% of NH_3, 15.5% of $PM_{2.5}$, 14.9% of PM_{10}, 14.24% of TSP, 17.3% of BC and 5.3% of CO in the total road transport sector in 2019.

The light commercial vehicle fleet has grown over the last decades from 31 thousand vehicles to 74 thousand between 1990 and 2019. Vehicles with diesel engines dominated during the entire period. The number of diesel light duty vehicles was 18 thousand in 1990 and increased approximately three times to 65 thousand vehicles in 2019 (see Figure 3.41). The petrol light duty vehicle fleet decreased by 34% over the same period from 13 thousand to 9 thousand vehicles (see Figure 3.40). A similar trend can be seen in the annual mileage and fuel consumption – mileage and fuel consumption increased by 89% and 70% respectively in this subsector. As expected, annual mileage driven by petrol vehicles declined by 69% and the total annual kilometres driven by diesel vehicles increased more than three times. In addition, petrol fuel consumption decreased by 70% and diesel fuel consumption increased more than three times in this subsector during the same period.

The pollutant emissions decreased significantly: 26.9 of NO_x, 93.2% of NMVOC, 99.7% of SO_2, 43.5% of TSP and 93.6% of CO, although all the activity data increased in the period of 1990–2019. Therefore, main pollutant emissions from light duty vehicles have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicle categories.

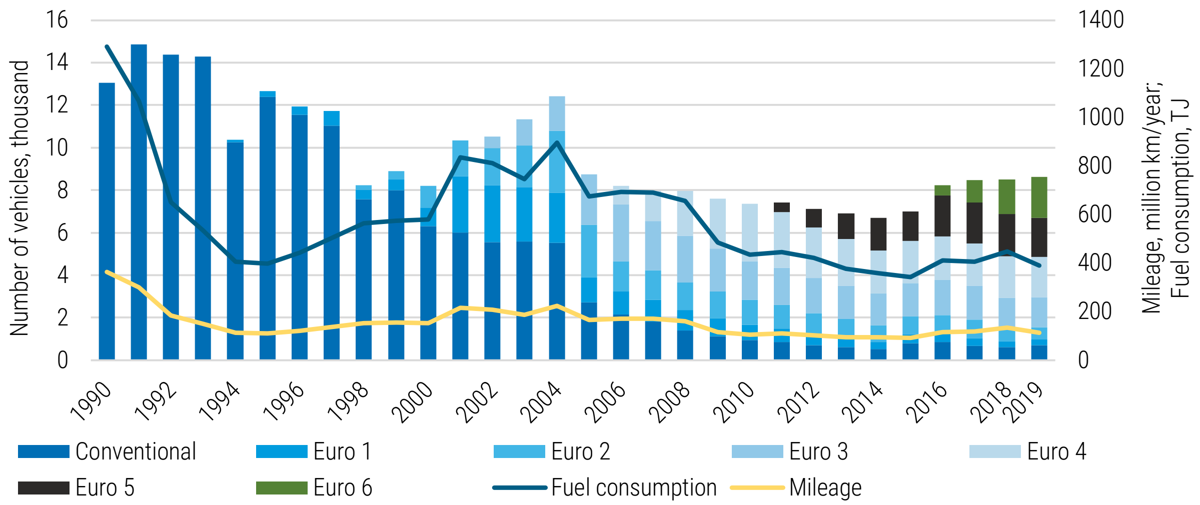

Figure 3.40 Petrol light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

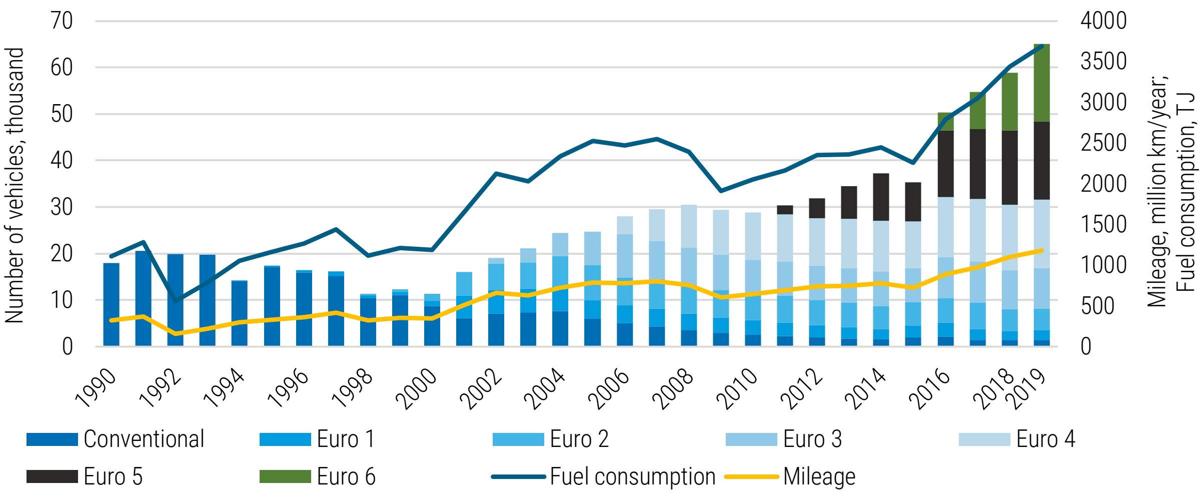

Figure 3.41 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

Heavy duty vehicles and buses (1A3biii)

Heavy duty vehicles contributed about 38.6% of NO_x, 6.9% of NMVOC, 21.2% of SO_2, 8.9% of NH_3, 20.6% $PM_{2.5}$, 21.1% of PM_{10}, 21.7% of TSP, 17.9% of BC and 6.4% of CO in the total road transport sector in 2019.

The heavy duty vehicle fleet has declined over the last decades from 45 thousand vehicles to 32 thousand between 1990 and 2019. Heavy duty vehicles with diesel engines make up the majority of registered vehicles – 60% in 1990 and 95% in 2019. The number of petrol vehicles has declined by 91% and the number of diesel vehicles increased by 12%. Total annual mileage and fuel consumption decreased by 51% and 46% respectively during this period. In detail, mileage driven by diesel vehicles increased by 3% and fuel consumed decreased approximately 9% (see Figure 3.43). However, the same indicators for petrol powered heavy duty vehicles decreased by 99.7% (see Figure 3.42).

During the period of 1990–2019, the pollutant emissions decreased significantly: 74.8% of NO_x, 96.7% of NMVOC, 99.9% of SO_2, 69.3% of TSP and 83.3% of CO.

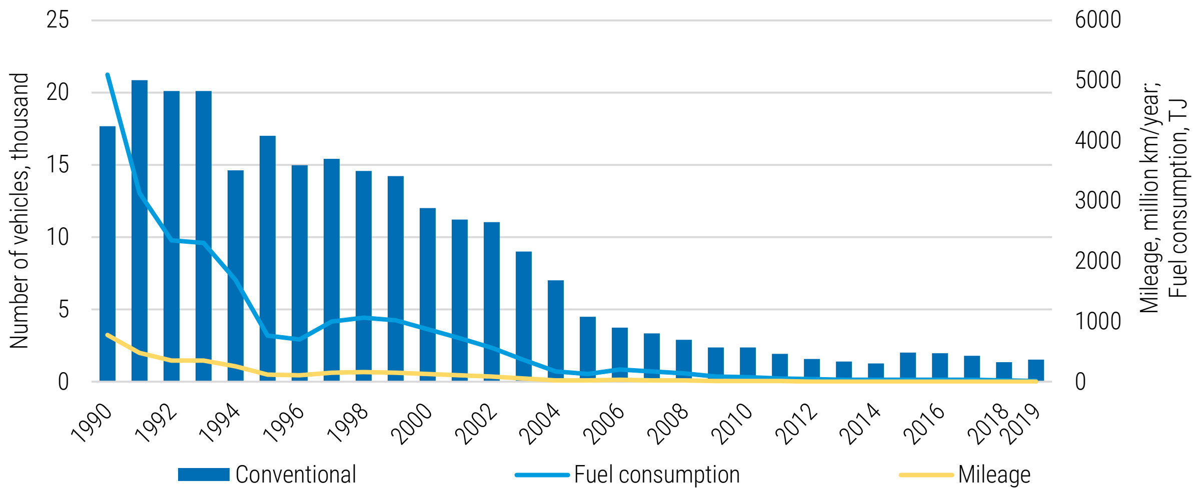

Figure 3.42 Petrol heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

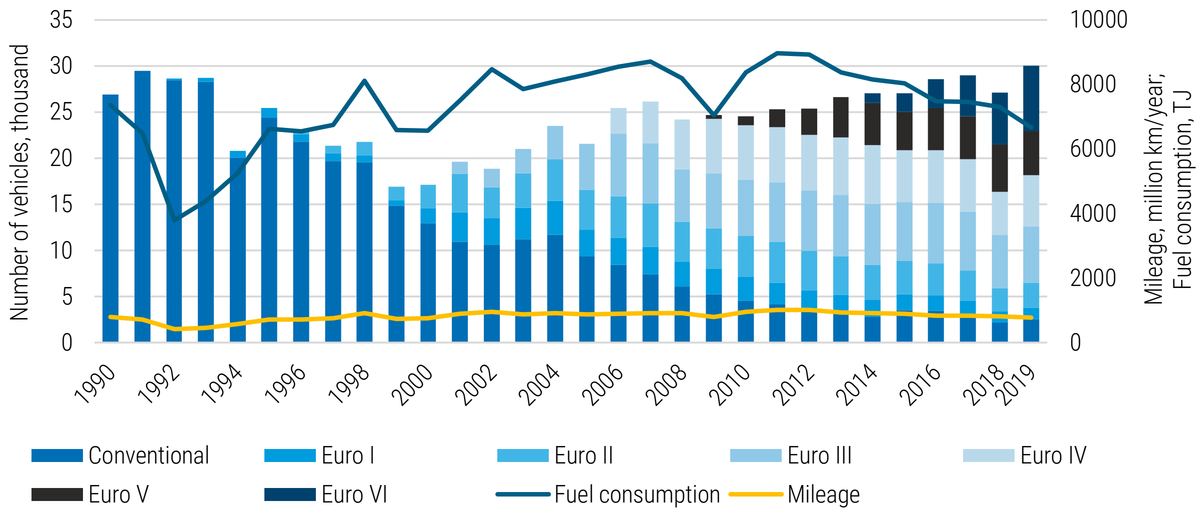

Figure 3.43 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

Motorcycles and mopeds (1A3biv)

This subsector contributes only a marginal share of the total road transport sector emissions: 0.2% of NO_x, 5.7% of NMVOC, 0.3% of SO_2, 0.1% of NH_3, 0.3% $PM_{2.5}$, 0.3% of PM_{10}, 0.3% of TSP, 0.1% of BC and 4.0% of CO in 2019.

The number of motorcycles, annual mileage, and fuel consumption decreased by 60.1%, 79.6%, and 79.5% respectively between 1990 and 2019 (see Figure 3.44). During this period, NO_x emissions decreased by 90.0%, NMVOC emissions by 86.6%, SO_2 emissions by 99.9%, and CO emissions by 93.3%.

According to Statistics Estonia, there was a very high statistical number of motorcycles in use during the period between 1990-1994. After 1994, the statistical data no longer reflects vehicles which have not been technically inspected for years.

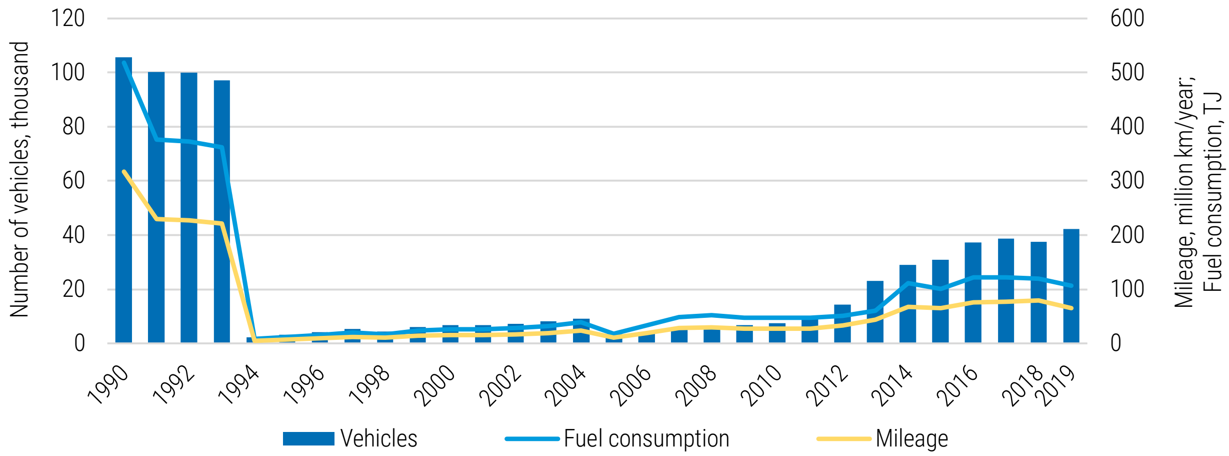

Figure 3.44 Motorcycles and mopeds: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2019

Recalculations

All the emissions from road transport have been recalculated for the period 1990-2018. Recalculations entail using corrected activity data, updated emission factors, and the taking into use of an improved new edition of the COPERT 5 program (version 5.4.36) for emission calculations. An overview of the updated data is given in Chapter 8.

Table 3.43 Emissions from road transport in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	25.109	17.495	3.213	0.016	NR	NR	1.001	NR	120.400
1995	15.609	10.783	2.591	0.026	NR	NR	0.802	NR	61.653
2000	15.154	10.167	2.553	0.095	0.709	0.795	0.900	0.341	66.403
2005	13.228	5.276	0.063	0.198	0.657	0.768	0.902	0.331	39.332
2010	9.676	3.101	0.006	0.202	0.474	0.591	0.733	0.247	23.146
2011	9.790	2.619	0.008	0.194	0.473	0.595	0.743	0.245	19.369
2012	9.477	2.552	0.009	0.183	0.470	0.594	0.745	0.247	18.103
2013	8.890	2.236	0.008	0.158	0.443	0.564	0.711	0.232	15.266
2014	8.362	1.764	0.007	0.150	0.415	0.539	0.689	0.212	13.041
2015	8.255	1.695	0.009	0.153	0.413	0.541	0.695	0.209	12.945
2016	7.863	1.672	0.007	0.152	0.405	0.536	0.694	0.200	13.083
2017	7.450	1.460	0.009	0.145	0.390	0.525	0.686	0.187	11.732
2018	7.111	1.381	0.009	0.138	0.383	0.522	0.689	0.178	10.949
2019	6.815	1.354	0.008	0.141	0.380	0.521	0.691	0.174	10.737
Trend 1990-2019, %	-72.9	-92.3	-99.8	768.3	-46.4	-34.4	-31.0	-48.8	-91.1

Table 3.43 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
1990	73.240	0.001	0.005	0.003	0.102	2.120	0.016	0.002	0.780
1995	23.655	0.001	0.003	0.002	0.059	1.232	0.009	0.001	0.471
2000	4.900	0.001	0.003	0.002	0.064	1.330	0.010	0.001	0.507
2005	2.105	0.001	0.004	0.003	0.083	1.721	0.013	0.002	0.684
2010	0.258	0.001	0.004	0.003	0.088	1.815	0.014	0.002	0.710
2011	0.266	0.001	0.004	0.003	0.091	1.889	0.014	0.002	0.738
2012	0.268	0.001	0.004	0.003	0.093	1.922	0.015	0.002	0.752
2013	0.262	0.001	0.004	0.003	0.091	1.884	0.014	0.002	0.740
2014	0.237	0.001	0.004	0.003	0.093	1.920	0.014	0.002	0.756
2015	0.244	0.001	0.004	0.003	0.096	1.975	0.015	0.002	0.779

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
2016	0.251	0.001	0.005	0.003	0.098	2.036	0.015	0.002	0.809
2017	0.259	0.001	0.005	0.003	0.101	2.096	0.016	0.002	0.835
2018	0.268	0.001	0.005	0.003	0.105	2.169	0.016	0.002	0.866
2019	0.273	0.001	0.005	0.003	0.106	2.210	0.017	0.002	0.881
Trend 1990-2019, %	-99.6	4.7	-14.6	3.7	4.7	4.3	2.6	12.5	12.9

Table 3.43 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					g	
1990	0.283	0.006	0.015	0.013	0.010	0.044	0.201	0.072
1995	0.164	0.004	0.009	0.007	0.006	0.027	0.123	0.035
2000	0.195	0.004	0.009	0.008	0.006	0.026	0.161	0.042
2005	0.270	0.007	0.012	0.010	0.008	0.037	0.252	0.056
2010	0.310	0.008	0.013	0.012	0.008	0.041	0.304	0.062
2011	0.321	0.009	0.014	0.013	0.009	0.044	0.314	0.065
2012	0.320	0.009	0.014	0.013	0.009	0.046	0.313	0.064
2013	0.306	0.010	0.014	0.013	0.010	0.047	0.299	0.061
2014	0.294	0.010	0.015	0.013	0.010	0.047	0.286	0.058
2015	0.307	0.011	0.015	0.014	0.011	0.050	0.299	0.061
2016	0.290	0.011	0.016	0.014	0.011	0.052	0.282	0.058
2017	0.276	0.011	0.016	0.014	0.011	0.052	0.269	0.055
2018	0.266	0.012	0.016	0.014	0.012	0.054	0.259	0.053
2019	0.265	0.012	0.016	0.014	0.012	0.054	0.259	0.053
Trend 1990-2019, %	-6.3	97.1	7.7	11.9	22.8	24.8	28.9	-26.4

3.3.3.2. Methodological Issues

1) Fuel combustion

Emission calculations from road transport are based on the Tier 3 method, whereby exhaust emissions are calculated by using a combination of reliable technical and detailed activity data. Tier 3 is implemented in the COPERT 5 program (Computer Program to calculate Emissions from Road Transport, COPERT 5 version 5.4.36), which is used for the calculations and distributed by the EEA. Total emissions are calculated through a combination of default COPERT emission factors and activity data (e.g. number of vehicles, annual mileage per vehicle, average trip, speed, fuel consumption, monthly temperatures, driving and evaporation share). The vehicle classes are defined by the vehicle category, fuel type, weight class, environmental class and, in some instances, the engine type and/or the emission reduction technology. Therefore, the calculation of emissions from road vehicles is a very complicated and demanding procedure that requires good quality activity data and detailed emission factors.

Meteorological data is obtained from the Estonian Weather Service and fuel consumption data from Statistics Estonia. Calculations also require annual mileage per vehicle category (see Table 3.47) and the number of vehicles (see Table 3.48), which is supplied by the Estonian Road Administration. Annual mileage per vehicle category is based on odometer readings taken during the annual technical inspection. The number of vehicles is not taken directly from statistics; this is a combination of Estonian vehicle register and technical inspection data. This approach was proposed and formulated by the scientists of the Tallinn University of Technology during the project "Calculation and analysis of the pollution of mobile sources". This suggested approach presumes that the older vehicles in the Estonian vehicle register are not actually taking part of every-day traffic; therefore, periodic technical inspections data is used. On the other hand, new vehicles do not have to be examined by technical inspection every year;

therefore, the Estonian vehicle register data is used. These improved statistics are available from 2001 and data for the years 1990–2000 is extrapolated. However, changes have been implemented in Estonian vehicle register procedures since 2015, where vehicles that had not had a technical inspection for two years or more were marked as "stopped" and removed during the data export from the register. From now on, there is no need to combine different datasets. This change in data helped improve the quality of activity data and prevent mistakes in data management.

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

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

where

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

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

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

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

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

where

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

Table 3.44 Sulphur content in fuel (mg/kg)

Year	Petrol	Diesel
1990	1000	5000
2001	500	500
2003	150	350
2004	130	300
2005	50	50
2006	10	40
2007	8	40
2009	8	10
2010	5	4.8
2011	5.5	6.2
2012	6.3	7.1
2013	5.9	6.1
2014	5.9	5.4
2015	5.9	6.6
2016	5.3	5.2
2017	5.4	6.6
2018	6.0	6.6
2019	5.0	5.6

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

Equation:

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

where

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

Table 3.45 Lead content in fuel (mg/kg)

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

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

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

where

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

FC – fuel consumption.

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

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

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

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	5,566.4	684.8	1,578.4	316.8	8,146.5
1995	3,816.4	444.1	839.1	7.6	5,107.2
2000	4,055.0	501.6	895.1	15.6	5,467.2
2005	5,748.5	954.7	895.9	10.6	7,609.6
2010	6,395.9	752.1	967.5	27.0	8,142.5
2011	6,528.1	799.9	1,034.9	27.7	8,390.5
2012	6,675.7	846.8	1,028.2	33.7	8,584.4
2013	6,695.9	843.0	955.3	43.5	8,537.7
2014	6,954.2	876.0	927.4	68.1	8,825.6
2015	7,425.6	814.7	914.4	65.7	9,220.3
2016	7,715.8	1,008.4	852.0	76.4	9,652.6
2017	7,972.7	1,092.7	846.1	76.9	9,988.3
2018	8,279.9	1,232.1	823.3	79.1	10,414.4
2019	8,571.4	1,297.0	787.6	64.8	10,720.8

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

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	240.9	31.1	44.5	105.7	422.2
1995	383.4	30.1	42.5	3.3	459.3
2000	273.1	19.5	29.1	6.7	328.5
2005	354.7	33.5	26.0	3.5	417.7
2010	422.2	36.2	26.9	7.5	492.8
2011	440.3	37.8	27.2	10.2	515.5
2012	452.4	39.0	26.9	14.3	532.7
2013	462.5	41.3	28.1	23.1	555.0
2014	479.1	43.9	28.3	29.1	580.4
2015	537.1	42.3	29.1	30.8	639.3
2016	564.2	58.5	30.6	37.3	690.6
2017	584.6	63.2	30.9	38.8	717.5

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
2018	582.8	67.3	28.6	37.5	716.2
2019	627.6	73.6	31.7	42.2	775.2

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

Year	Petrol	Diesel	Bioethanol	Biodiesel	LPG	CNG	Total
1990	21,406.3	9,499.9	0.0	0.0	9.1	0.0	30,915.3
1995	10,527.3	8,999.8	0.0	0.0	15.9	0.0	19,543.1
2000	11,872.0	8,539.9	0.0	0.0	31.9	0.0	20,443.8
2005	12,248.7	14,780.8	0.0	6.5	62.2	0.0	27,098.2
2010	11,744.8	16,283.5	185.2	136.4	94.6	2.0	28,446.4
2011	11,143.6	17,849.3	160.0	27.5	104.4	11.0	29,295.8
2012	10,695.0	18,934.9	151.9	0.0	135.9	23.0	29,940.7
2013	9,967.3	19,017.0	128.9	0.0	159.7	36.0	29,308.9
2014	10,144.9	19,157.1	215.4	0.0	191.0	66.0	29,774.5
2015	10,033.0	20,042.6	107.8	0.0	227.8	116.0	30,527.2
2016	10,604.8	20,337.4	84.7	0.0	255.7	173.0	31,455.6
2017	10,971.6	20,767.6	39.7	6.5	306.5	196.0	32,287.8
2018	11,028.6	20,969.1	204.4	526.3	369.4	298.0	33,395.6
2019	11,258.3	20,416.0	309.0	838.0	440.0	268.0	33,529.4

2) 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 2019). 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 2019 (Table 3.50).

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

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

3) 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 2019).

4) 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

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

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by taking into account oil consumption factors for different vehicle types, fuel used, the engine category, and the vehicle age (see Table 3.51). Necessary lubricant metal content factors for heavy metal emissions calculations are provided in Table 3.46. The full total of heavy metals in fuel is presumed to be emitted into the atmosphere.

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

Category	Fuel/engine category	Age	Lubricant oil consumption
Passenger cars	Petrol	Old	1.45
	Petrol	New	1.28
	Diesel	Old	1.49
	Diesel	New	1.28
Light duty vehicles	Petrol	Old	1.45
	Petrol	New	1.28
	Diesel	Old	1.49
	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 2019 inventory. The uncertainty in the emission factors for main pollutants, particulate matter, and heavy metals from the road transport sector is estimated to be 20–50%, for POPs 100–250%, and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.52.

Table 3.52 Uncertainties in the road transport sector

Pollutant	Emissions, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	6.815	kt	27.08	3.33	0.38
NMVOC	1.354	kt	5.97	0.83	0.87
SO_x	0.008	kt	0.04	0.01	0.01
NH_3	0.141	kt	1.33	0.23	0.11
$PM_{2.5}$	0.380	kt	6.47	0.65	0.21
PM_{10}	0.521	kt	5.65	0.59	0.14
TSP	0.691	kt	4.96	0.53	0.03
CO	10.737	kt	8.21	1.40	3.39
Pb	0.273	t	2.40	0.72	0.28
Cd	0.001	t	0.21	0.07	0.01
Hg	0.005	t	1.38	0.21	0.04
PCDD/F	0.265	g I-TEQ	5.79	11.33	3.34
B(a)p	0.012	t	1.34	1.96	0.59
B(b)f	0.016	t	1.84	2.43	0.54
B(k)f	0.014	t	2.45	3.12	0.85
I(1,2,3-cd)p	0.011	t	1.41	2.08	0.68
HCB	0.0003	kg	0.08	0.15	0.03
PCBs	0.0001	kg	0.01	0.01	0.001

3.3.3.4. Source-Specific QA/QC and Verification

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

3.3.3.5. Source-Specific Planned Improvements

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

A more detailed emissions estimation is required for the 1A3bvii sector so that the use of studded tyres can be included in the calculations, since the use of studded tyres in winter has been widespread in Estonia.

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.

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.

(Photo: Estonian Railways' GE C36-7 diesel-electric locomotive #1504; source: www.bahnbilder.de)

Nowadays, emissions from rail use originate primarily from the combustion by locomotives of diesel and light fuel oil. Coal-powered railway locomotives were only used in the period between 1990-2002. Since emissions from the railway sector are calculated by using the Tier 1 method which takes into account the amount of fuel consumed and default emission factors, deviations in the time series can be explained by statistical fuel consumption deviations in the railway sector.

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 5.9%, 2.6% and 0.7% respectively (see Figure 3.28), in the transport sector in 2019. The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 76.5%, 77.4% and 80.6% respectively. The trend of all the emissions is given in Table 3.53. During the same period, fuel consumption decreased 76.3%.

The number of passengers carried by rail decreased by approximately 81.8% during the period between 1990-2013 (23.1 million passengers down to 4.2 million passengers). After 2014, when the train fleet for passenger transport had been fully replaced by new and refurbished units, the number of passenger carried by rail has increased. In 2014, passenger numbers increased from 4.2 million passengers to 5.9 million passengers (40.9%), and the growth in the number of passengers continued across the next few years. This increase is roughly in line with the trends in passenger traffic volumes in the same period.

In 2019, despite the increasing trend in the number of passengers, freight turnover figures and the emissions decrease in the railway sector. Liquid fuel consumption decreased by 25.5% in 2019 when compared to 2018, and a similar decrease in emissions for this period can be observed. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have decreased by 25.5% during that period (see Figure 3.45).

Recalculations

All emissions have been recalculated for the years 2012-2014 and 2018. An overview of the updated data is given in Chapter 8.

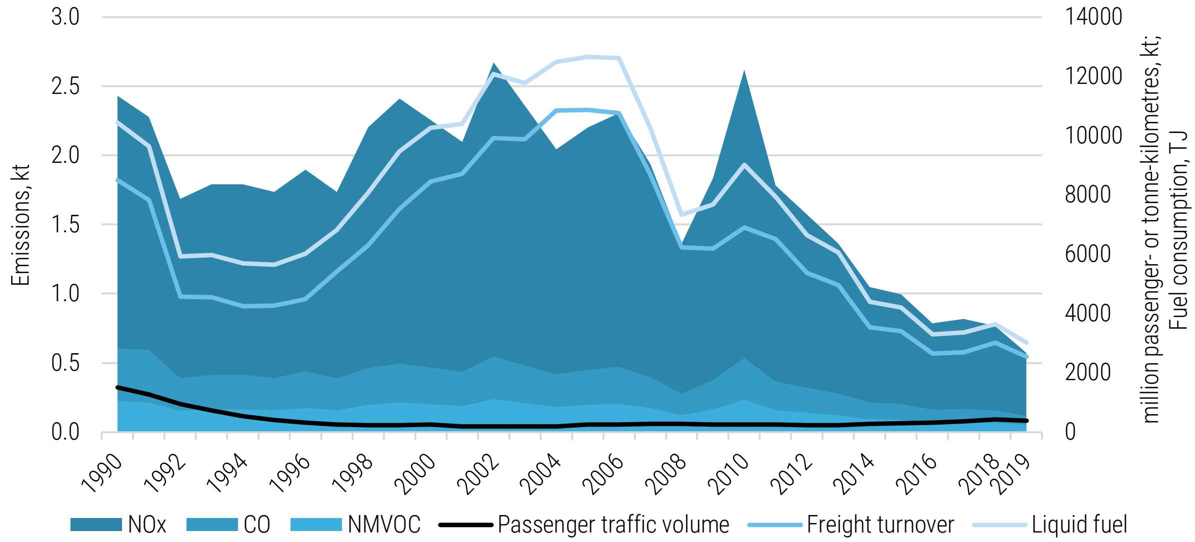

Figure 3.45 NO_x, NMVOC and CO emissions from the railway sector

Table 3.53 Emissions from railway transport in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
		kt		t			kt		
1990	2.431	0.224	0.567	0.322	NR	NR	0.085	NR	0.603
1995	1.736	0.157	0.365	0.231	NR	NR	0.055	NR	0.389
2000	2.254	0.200	0.177	0.301	0.060	0.063	0.066	0.038	0.466
2005	2.201	0.195	0.168	0.294	0.058	0.060	0.064	0.037	0.449
2010	2.620	0.233	0.070	0.350	0.069	0.072	0.076	0.045	0.535
2011	1.782	0.158	0.001	0.238	0.047	0.049	0.052	0.030	0.364
2012	1.572	0.140	0.001	0.210	0.041	0.043	0.046	0.027	0.321
2013	1.362	0.121	0.001	0.182	0.036	0.037	0.040	0.023	0.278
2014	1.048	0.093	0.000	0.140	0.027	0.029	0.030	0.018	0.214
2015	0.996	0.088	0.000	0.133	0.026	0.027	0.029	0.017	0.203
2016	0.786	0.070	0.000	0.105	0.021	0.022	0.023	0.013	0.161
2017	0.818	0.073	0.000	0.109	0.021	0.022	0.024	0.014	0.167
2018	0.767	0.068	0.000	0.102	0.020	0.021	0.022	0.013	0.157
2019	0.572	0.051	0.000	0.076	0.015	0.016	0.017	0.010	0.117
Trend 1990-2019, %	-76.5	-77.4	-100.0	-76.4	-74.9	-74.9	-80.4	-74.7	-80.6

Table 3.53 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg			t		kg	t
1990	0.016	0.674	0.940	0.476	0.004	0.080	0.005	0.674	0.070
1995	0.005	0.400	0.308	0.156	0.002	0.057	0.003	0.400	0.041
2000	0.001	0.441	0.047	0.024	0.002	0.073	0.003	0.441	0.044
2005	NE	0.420	NE	NE	0.002	0.071	0.003	0.420	0.042
2010	NE	0.500	NE	NE	0.003	0.085	0.004	0.500	0.050
2011	NE	0.340	NE	NE	0.002	0.058	0.002	0.340	0.034
2012	NE	0.300	NE	NE	0.002	0.051	0.002	0.300	0.030
2013	NE	0.260	NE	NE	0.001	0.044	0.002	0.260	0.026
2014	NE	0.200	NE	NE	0.001	0.034	0.001	0.200	0.020
2015	NE	0.190	NE	NE	0.001	0.032	0.001	0.190	0.019
2016	NE	0.150	NE	NE	0.001	0.026	0.001	0.150	0.015
2017	NE	0.156	NE	NE	0.001	0.027	0.001	0.156	0.016
2018	NE	0.146	NE	NE	0.001	0.025	0.001	0.146	0.015
2019	NE	0.109	NE	NE	0.001	0.019	0.001	0.109	0.011

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Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t	kg			t			kg	t
Trend 1990-2019, %	-100.0	-83.8	-100.0	-100.0	-86.0	-76.9	-84.0	-83.8	-84.4

Table 3.53 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					g	kg
1990	0.024	0.007	0.009	0.004	0.003	0.023	0.074	0.020
1995	0.008	0.003	0.004	0.002	0.001	0.010	0.024	0.007
2000	0.001	0.002	0.003	0.002	0.000	0.006	0.004	0.001
2005	NE	0.001	0.002	0.001	0.000	0.005	NA	NA
2010	NE	0.002	0.003	0.002	0.000	0.006	NA	NA
2011	NE	0.001	0.002	0.001	0.000	0.004	NA	NA
2012	NE	0.001	0.002	0.001	0.000	0.004	NA	NA
2013	NE	0.001	0.001	0.001	0.000	0.003	NA	NA
2014	NE	0.001	0.001	0.001	0.000	0.002	NA	NA
2015	NE	0.001	0.001	0.001	0.000	0.002	NA	NA
2016	NE	0.000	0.001	0.001	0.000	0.002	NA	NA
2017	NE	0.000	0.001	0.001	0.000	0.002	NA	NA
2018	NE	0.000	0.001	0.001	0.000	0.002	NA	NA
2019	NE	0.000	0.001	0.000	0.000	0.001	NA	NA
Trend 1990-2019, %	-100.0	-95.2	-94.1	-91.5	-96.6	-94.2	-100.0	-100.0

3.3.4.2. Methodological Issues

All the emission calculations are based on the Tier 1 method. Emissions from the railway transport sector are calculated by multiplying the statistical fuel consumption (see Table 3.56) by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Guidebook 2019 and are presented in Table 3.54.

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

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

where

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

Table 3.54 Emission factors for railway transport

Pollutant	Diesel / light fuel oil		Coal	
	Unit	Value	Unit	Value
NO_x	kg/t	52.4	g/GJ	173
NMVOC	kg/t	4.65	g/GJ	88.8
SO_2	kg/t	equation	g/GJ	900
NH_3	kg/t	0.007	g/GJ	NE
$PM_{2.5}$	kg/t	1.37	g/GJ	108
PM_{10}	kg/t	1.44	g/GJ	117
TSP	kg/t	1.52	g/GJ	124
BC	kg/t	0.891	g/GJ	6.912
CO	kg/t	10.7	g/GJ	931
Pb	g/t	NE	mg/GJ	134
Cd	g/t	0.01	mg/GJ	1,8
Hg	g/t	NE	mg/GJ	7,9
As	g/t	NE	mg/GJ	4
Cr	g/t	0.05	mg/GJ	13.5

Pollutant	Diesel / light fuel oil		Coal	
	Unit	Value	Unit	Value
Cu	g/t	1.70	mg/GJ	17.5
Ni	g/t	0.07	mg/GJ	13
Se	g/t	0.01	mg/GJ	1.8
Zn	g/t	1.00	mg/GJ	200
PCDD/F	TEQµg /t	NE	ng I-TEQ/GJ	203
B(a)p	g/t	0.03	mg/GJ	45.5
B(b)f	g/t	0.05	mg/GJ	58.9
B(k)f	g/t	0.034	mg/GJ	23.7
I(1,2,3-cd)p	g/t	0.008	mg/GJ	18.5
HCB	mg/t	NA	µg/GJ	0.62
PCBs	mg/t	NA	µg/GJ	170

Table 3.55 Sulphur content of fuel (by weight)

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

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

Year	Fuel consumption			Passenger traffic volume million passenger-km	Freight turnover million tonne-km
	Coal	Diesel	Light fuel oil		
	TJ				
1990	119	0	1,945	1,510.0	6,977
1995	39	0	1,396	408.2	3,851
2000	6	0	1,819	260.5	8,186
2005	0	0	1,777	247.0	10,629
2010	0	635	1,481	247.9	6,642
2011	0	1,438	0	241.3	6,261
2012	0	1,269	0	235.8	5,126
2013	0	1,100	0	224.9	4,722
2014	0	846	0	281.9	3,256
2015	0	804	0	288.7	3,114
2016	0	635	0	315.7	2,339
2017	0	660	0	366.0	2,325
2018	0	619	0	416.8	2,594
2019	0	462	0	391.7	2,157

3.3.4.3. Uncertainty

An uncertainty analysis was carried out for the 2019 inventory. The uncertainty in the emission factors for NO_x, NMVOC, NH_3 and CO from railways is estimated to be 100%, for SO_x, NH_3 and heavy metals 50%, for particulate matter 20%, for POPs 100-250% and in the activity data 2%. Uncertainty estimates for railway sector are described together with non-road mobile machinery sector in Table 3.67.

3.3.4.4. Source-Specific QA/QC and Verification

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

3.3.4.5. Source-Specific Planned Improvements

More detailed emission calculations for the railway transport sector which are based on Tier 2 method. 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.

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.

(Photo by Madis Press: Riverboat Pegasus on the river Emajõgi)

National navigation in Estonia is also a small emission source in the transport sector. The share of navigation transport in total transport emissions in 2019 was: NO_x – 4.3%, NMVOC – 0.8%, CO – 0.2% (see Figure 3.28). Detailed emission data are provided in Table 3.57.

Deviations of time series can be explained by changing statistical fuel consumption in the national navigation sector (see Figure 3.46). Fuel consumption decreased 23.9% in 2019 compared to 2018, therefore all the emissions decreased also.

Recalculations

In the national navigation sector, the emissions of all pollutants were recalculated for some years (1991, 1999, 2012-2016, 2018) due the correction of the fuels consumption data. The emissions of heavy metals and polyaromatic hydrocarbons were also recalculated for the period 1990-2018. The reason for the recalculation was the correction of emission factors used for emission calculations. An overview of the updated data is given in Chapter 8.

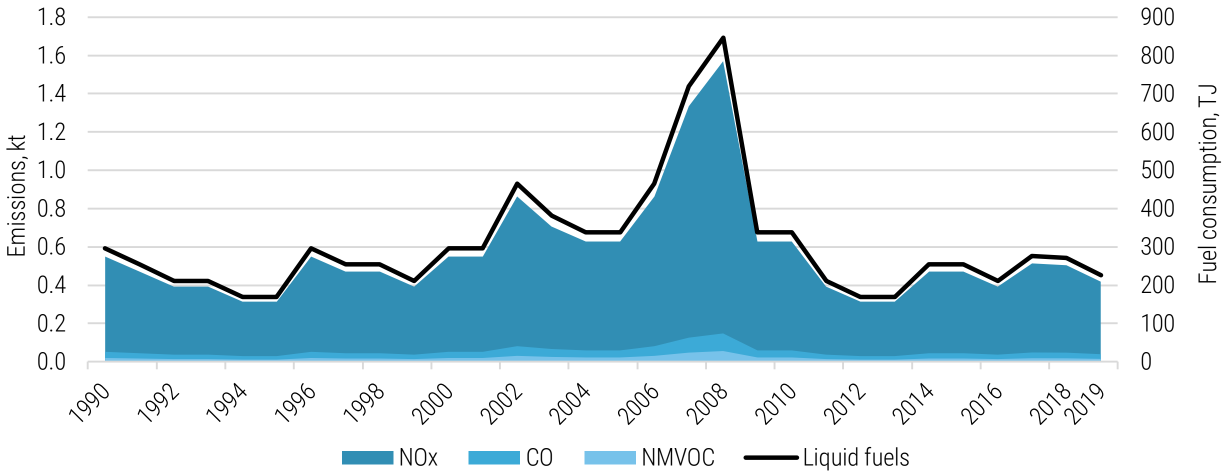

Figure 3.46 NO_x, NMVOC and CO emissions from the national navigation sector

Table 3.57 Emissions from national navigation in the period of 1990-2019

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

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Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
2010	0.628	0.022	0.016	NE	0.011	0.012	0.012	0.004	0.059
2011	0.393	0.014	0.010	NE	0.007	0.008	0.008	0.002	0.037
2012	0.314	0.011	0.008	NE	0.006	0.006	0.006	0.002	0.030
2013	0.314	0.011	0.008	NE	0.006	0.006	0.006	0.002	0.030
2014	0.471	0.017	0.012	NE	0.008	0.009	0.009	0.003	0.044
2015	0.471	0.017	0.012	NE	0.008	0.009	0.009	0.003	0.044
2016	0.393	0.014	0.010	NE	0.007	0.008	0.008	0.002	0.037
2017	0.514	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2018	0.504	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2019	0.418	0.015	0.011	NE	0.007	0.008	0.008	0.002	0.039
Trend 1990-2019, %	-23.9	-23.9	-84.8	NE	-23.9	-23.9	-23.9	-23.9	-23.9

Table 3.57 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t	kg				t		kg	t
1990	0.001	0.070	0.210	0.280	0.350	0.001	0.007	0.070	0.008
1995	0.001	0.040	0.120	0.160	0.200	0.001	0.004	0.040	0.005
2000	0.001	0.070	0.210	0.280	0.350	0.001	0.007	0.070	0.008
2005	0.001	0.080	0.240	0.320	0.400	0.002	0.008	0.080	0.010
2010	0.001	0.080	0.240	0.320	0.400	0.002	0.008	0.080	0.010
2011	0.001	0.050	0.150	0.200	0.250	0.001	0.005	0.050	0.006
2012	0.001	0.040	0.120	0.160	0.200	0.001	0.004	0.040	0.005
2013	0.001	0.040	0.120	0.160	0.200	0.001	0.004	0.040	0.005
2014	0.001	0.060	0.180	0.240	0.300	0.001	0.006	0.060	0.007
2015	0.001	0.060	0.180	0.240	0.300	0.001	0.006	0.060	0.007
2016	0.001	0.050	0.150	0.200	0.250	0.001	0.005	0.050	0.006
2017	0.001	0.065	0.196	0.262	0.327	0.001	0.007	0.065	0.008
2018	0.001	0.064	0.193	0.257	0.321	0.001	0.006	0.064	0.008
2019	0.001	0.053	0.160	0.213	0.267	0.001	0.005	0.053	0.006
Trend 1990-2019, %	-23.8	-24.3	-23.8	-23.9	-23.7	-23.9	-23.9	-24.3	-23.9

Table 3.57 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	Total PAHs	HCB	PCBs
	g I-Teq	kg					g	
1990	0.001	0.014	0.070	0.070	0.007	0.161	0.560	0.266
1995	0.001	0.008	0.040	0.040	0.004	0.092	0.320	0.152
2000	0.001	0.014	0.070	0.070	0.007	0.161	0.560	0.266
2005	0.001	0.016	0.080	0.080	0.008	0.184	0.640	0.304
2010	0.001	0.016	0.080	0.080	0.008	0.184	0.640	0.304
2011	0.001	0.010	0.050	0.050	0.005	0.115	0.400	0.190
2012	0.001	0.008	0.040	0.040	0.004	0.092	0.320	0.152
2013	0.001	0.008	0.040	0.040	0.004	0.092	0.320	0.152
2014	0.001	0.012	0.060	0.060	0.006	0.138	0.480	0.228
2015	0.001	0.012	0.060	0.060	0.006	0.138	0.480	0.228
2016	0.001	0.010	0.050	0.050	0.005	0.115	0.400	0.190
2017	0.001	0.013	0.065	0.065	0.007	0.150	0.524	0.249
2018	0.001	0.013	0.064	0.064	0.006	0.147	0.514	0.244
2019	0.001	0.011	0.053	0.053	0.005	0.122	0.426	0.203
Trend 1990-2019, %	-23.8	-21.4	-24.3	-24.3	-28.6	-24.2	-23.9	-23.7

3.3.5.2. Methodological Issues

All the emission calculations are based on the Tier 1 method. Emissions in the national navigation sector are calculated by multiplying the statistical fuel consumption (see Table 3.60) by respective emission factors. Default emission factors for the main pollutants are taken from EMEP/EEA Guidebook 2019 and are presented in Table 3.58.

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

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

where

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

Table 3.58 Emission factors for national navigation transport

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

Table 3.59 Sulphur content of fuel (by weight)

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

Table 3.60 Fuel consumption in the navigation sector in the period of 1990-2019 (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
2011	0	212	212
2012	0	169	169
2013	0	169	169
2014	0	254	254
2015	0	254	254
2016	0	212	212
2017	0	277	277
2018	0	272	272
2019	0	225	225

3.3.5.3. Uncertainty

An uncertainty analysis was carried out for the 2019 inventory. The uncertainty in the emission factors for NO_x, NMVOC, NH_3 and CO from national navigation is estimated to be 100%, for SO_x, NH_3 and heavy metals 50%, for particulate matter 20%, for POPs 100-250% and in the activity data 2%. Uncertainty estimates for national sector are described together with non-road mobile machinery sector in Table 3.67.

3.3.5.4. Source-Specific QA/QC and Verification

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

3.3.5.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

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.

(Photo: Tractor on the field; Source: Shutterstock)

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

3.3.6.1. Source Category Description

Other non-road machinery includes following sectors and activities:

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

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 18.5%, 25.1% and 34.4% respectively, in the transport sector in 2019.

As the emissions depend on the amount of fuel used, emissions from the other non-road mobile machinery sector show trends similar to fuel consumption. All the emissions have decreased in the period 1990 to 2019, where the emissions of nitrogen oxides, non-methane volatile compounds, sulphur oxide and carbon monoxide have decreased by approximately 83.2%, 86.5%, 99.9% and 82.1% compared to 1990. Also, the amount of fuel consumed decreased by 63.3% during that period. Therefore, deviations of time series can be explained by changing statistical fuel consumption in non-road machinery sector (see Figures 3.47-3.49) and the share of some specific sector in total non-road machinery emissions. Detailed emission data are provided in Table 3.61.

In 2019, fuel consumption decreased by approximately 2.6% when compared to 2018's figures. As a result of this, NO_x and SO_x emissions decreased by 11.4% and 3.1% respectively. In opposition to this, NMVOC and CO emissions increased by 3.4% and 20.6% respectively. The significant increase in NMVOC and CO emissions was due to the increase in petrol consumption in the 1A2gvii and 1A4bii sector, which was approximately 26.3% higher compared to 2018 and has relatively high impact on non-road machinery emissions.

In general, the most important deployment of other off-road mobile machinery is its use in the agricultural and industrial sectors, which are responsible for about 80% of total energy use in these sectors, with diesel being the dominant fuel type, accounting for 95% of the total energy use in 2019.

Recalculations

In the 2020 submission the following recalculations were carried out:

- Recalculations have been carried out for the industrial machinery (NFR 1A2gvii), commercial machinery (NFR 1A4aii), household and gardening machinery (NFR 1A4bii) and agricultural machinery (NFR 1A4cii) sector for the period 1990-2018. Recalculations entail using Tier 2 methodology and corresponding emission factors for main pollutants and particulate matter.
- NFR 1A4ciii. The emissions of BC, HMs (Cu, Se) and PAHs from national fishing were recalculated for the period 1990 – 2018 due to the correction of emission factors.

These changes have led to a change in total emissions. A detailed overview is given in Chapter 8.

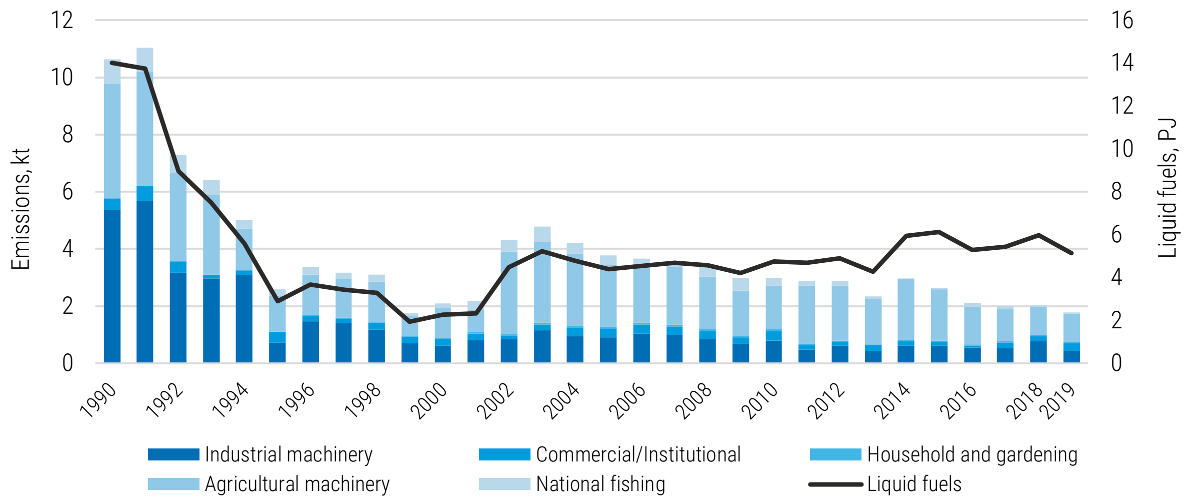

Figure 3.47 NO_x emissions from other non-road machinery

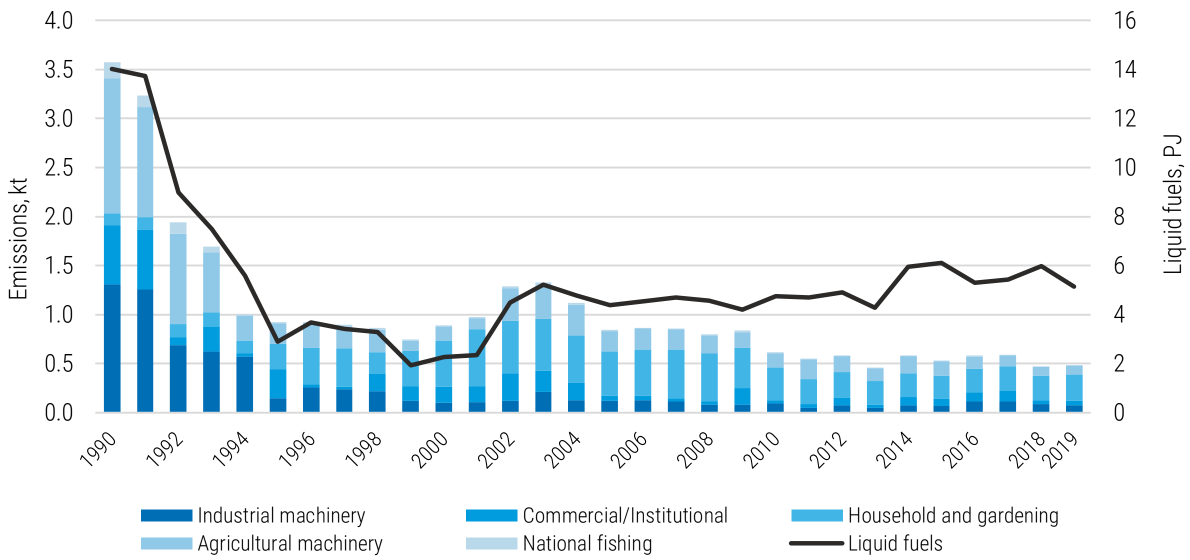

Figure 3.48 NMVOC emissions from other non-road machinery

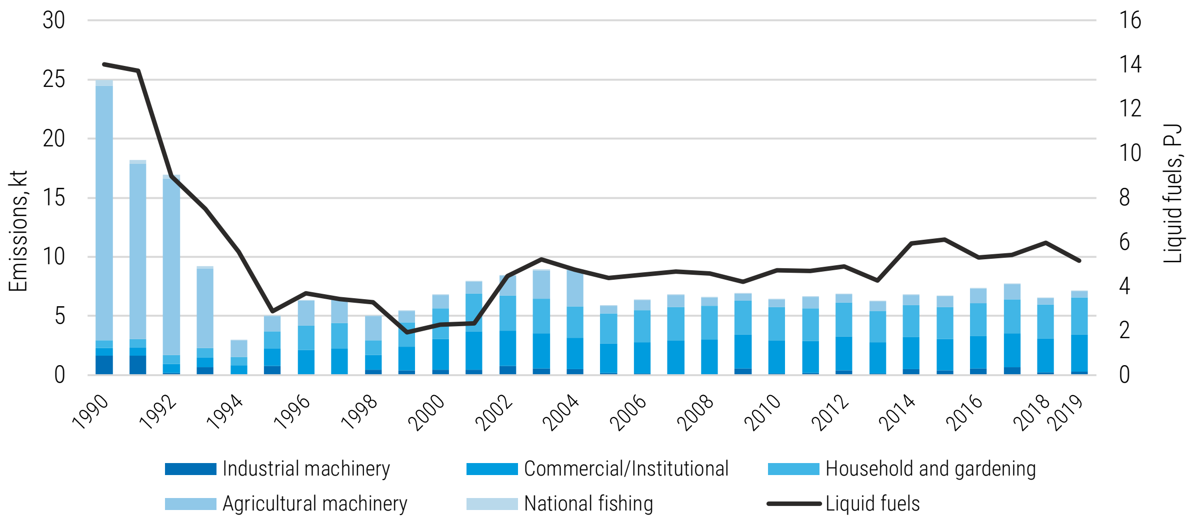

Figure 3.49 CO emissions from other non-road machinery

Table 3.61 Emissions from other non-road machinery in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	10.629	3.575	3.036	0.002	NR	NR	1.368	NR	32.438
1995	2.596	0.920	0.640	0.000	NR	NR	0.246	NR	4.699
2000	2.088	0.888	0.382	0.000	0.157	0.158	0.158	0.081	5.199
2005	3.768	0.845	0.111	0.001	0.207	0.207	0.207	0.117	4.460
2010	2.985	0.615	0.028	0.001	0.155	0.155	0.155	0.094	4.702
2011	2.872	0.553	0.040	0.001	0.151	0.152	0.152	0.090	4.282
2012	2.880	0.585	0.006	0.001	0.132	0.132	0.132	0.079	5.037
2013	2.334	0.457	0.004	0.001	0.105	0.105	0.105	0.063	4.052
2014	2.977	0.578	0.004	0.001	0.132	0.132	0.132	0.080	5.129
2015	2.635	0.528	0.004	0.001	0.117	0.117	0.117	0.073	4.758
2016	2.106	0.583	0.005	0.001	0.095	0.095	0.095	0.056	8.041
2017	1.999	0.589	0.005	0.001	0.093	0.093	0.093	0.055	8.306
2018	2.021	0.466	0.004	0.001	0.095	0.095	0.095	0.060	4.815
2019	1.790	0.482	0.004	0.001	0.081	0.082	0.082	0.050	5.805
Trend 1990-2019, %	-83.2	-86.5	-99.9	-49.9	-48.2	-48.3	-94.0	-38.9	-82.1

Table 3.61 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg		t				
1990	4.817	0.003	0.325	0.433	0.016	0.543	0.033	0.003	0.331
1995	0.752	0.001	0.089	0.119	0.003	0.111	0.008	0.001	0.069
2000	0.082	0.001	0.059	0.078	0.003	0.088	0.006	0.001	0.054
2005	0.024	0.001	0.126	0.168	0.005	0.170	0.011	0.001	0.104
2010	0.026	0.001	0.103	0.137	0.006	0.185	0.011	0.001	0.113
2011	0.022	0.001	0.054	0.071	0.006	0.186	0.009	0.001	0.111
2012	0.028	0.001	0.057	0.076	0.006	0.194	0.010	0.001	0.116
2013	0.022	0.001	0.033	0.044	0.005	0.170	0.008	0.001	0.101
2014	0.027	0.001	0.016	0.022	0.007	0.238	0.010	0.001	0.140
2015	0.025	0.001	0.021	0.028	0.007	0.244	0.011	0.001	0.144
2016	0.047	0.001	0.044	0.059	0.006	0.210	0.010	0.001	0.125
2017	0.049	0.001	0.038	0.051	0.006	0.216	0.010	0.001	0.128
2018	0.026	0.001	0.019	0.025	0.007	0.239	0.010	0.001	0.141
2019	0.032	0.001	0.020	0.026	0.007	0.232	0.010	0.001	0.137
Trend 1990-2019, %	-99.3	-58.3	-93.8	-94.0	-58.3	-57.2	-69.1	-58.3	-58.5

Table 3.61 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	mg I-Teq	t					g	
1990	1.408	0.010	0.016	0.000	0.000	0.026	0.866	0.412
1995	0.387	0.002	0.003	0.000	0.000	0.005	0.238	0.113
2000	0.255	0.002	0.003	0.000	0.000	0.004	0.157	0.074
2005	0.546	0.003	0.005	0.000	0.000	0.008	0.336	0.159
2010	0.445	0.003	0.005	0.000	0.000	0.009	0.274	0.130
2011	0.232	0.003	0.005	0.000	0.000	0.009	0.143	0.068
2012	0.248	0.003	0.006	0.000	0.000	0.009	0.153	0.073
2013	0.144	0.003	0.005	0.000	0.000	0.008	0.088	0.042
2014	0.071	0.004	0.007	0.000	0.000	0.011	0.044	0.021
2015	0.090	0.004	0.007	0.000	0.000	0.012	0.055	0.026
2016	0.192	0.004	0.006	0.000	0.000	0.010	0.118	0.056
2017	0.166	0.004	0.006	0.000	0.000	0.010	0.102	0.048
2018	0.082	0.004	0.007	0.000	0.000	0.011	0.050	0.024
2019	0.086	0.004	0.007	0.000	0.000	0.011	0.053	0.025
Trend 1990-2019, %	-93.9	-57.9	-56.9	-93.5	-90.9	-57.5	-93.9	-93.9

3.3.6.2. Methodological Issues

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

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

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

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

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 3.65). Equation:

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

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

Fuel	NFR	Pollutant	Technology								
			<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V
Diesel	1A2gvii/ 1A4aii/ 1Abii	NO_x	26,552	33,942	43,552	31,077	22,101	15,653	11,933	1,570	7,663
		NMVOC	8,077	6,962	5,851	1,725	1,587	1,470	625	536	930
		NH_3	7	7	8	8	8	8	8	8	8
		PM	6,207	4,308	3,642	1,005	1,034	950	98	98	116
		BC	3,414	2,369	2,001	800	825	758	78	78	56
		CO	20,690	18,890	16,258	6,639	7,135	6,826	6,445	6,019	7,352
	1A4cii Agriculture	NO_x	29,901	37,383	49,002	30,799	20,612	12,921	9,318	1,587	1,861
		NMVOC	7,760	6,439	4,493	1,544	1,181	1,173	544	530	526
		NH_3	7	7	8	8	8	8	8	8	8
		PM	5,861	4,047	1,974	947	624	550	99	99	59
		BC	3,221	2,221	1,074	727	483	416	74	73	9
		CO	19,804	17,566	14,147	6,463	6,104	6,035	6,087	6,024	6,077
	1A4cii Forestry	NO_x	33,028	44,030	49,963	31,344	20,593	12,845	9,454	1,586	1,915
		NMVOC	7,423	5,827	4,907	1,420	1,160	1,161	514	515	542
		NH_3	7	7	8	8	8	8	8	8	8
		PM	5,493	3,731	2,130	789	595	573	99	99	59
		BC	3,021	2,052	1,172	607	456	437	74	74	9
		CO	19,014	16,045	14,239	5,919	5,940	5,947	5,940	5,947	6,008
Petrol	1A2gvii/ 1A4aii/ 1A4bii/ 1A4cii Petrol 2-stroke	NO_x	1,050	1,682	1,852	3,445	2,495				2,490
		NMVOC	298,703	258,562	229,630	225,579	113,157				111,450
		NH_3	2	3	3	4	4				4
		PM	7,037	47,86	3,869	3,683	4,299				4,278
		BC	352	239	193	184	215				214
		CO	754,523	699,494	621,083	620,519	695,237				694,870
	1A2gvii/ 1A4aii/ 1A4bii/ 1A4cii 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

Table 3.63 Tier 1 emission factors for other mobile sources

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

Table 3.64 Sulphur content of fuel (by weight)

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

Table 3.65 Lead content in fuel

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

Table 3.66 Total fuel consumption in other mobile sectors for the period of 1990-2019 (TJ)

Year	Diesel	Light fuel oil	Petrol	Total
1990	12,185	381	1,445	14,010
1995	2,527	138	178	2,843
2000	1,326	675	277	2,279
2005	3,268	917	207	4,392
2010	4,059	461	179	4,699
2011	3,808	695	185	4,687
2012	4,221	448	241	4,910
2013	4,069	17	219	4,304
2014	5,619	84	237	5,941
2015	5,654	240	235	6,129
2016	4,668	222	410	5,299
2017	4,917	87	424	5,428
2018	5,721	28	223	5,972
2019	5,530	3	282	5,816

3.3.6.3. Uncertainty

An uncertainty analysis was carried out for the 2019 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%, for POPs 100-250% and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.67.

Table 3.67 Uncertainties in non-road mobile machinery sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	2.780	kt	11.05	3.59	0.93
NMVOC	0.548	kt	2.41	0.70	0.46
SO_x	0.015	kt	0.08	0.03	0.03
NH_3	0.001	kt	0.01	0.003	0.001
$PM_{2.5}$	0.104	kt	1.77	0.48	0.07
PM_{10}	0.105	kt	1.14	0.31	0.04
TSP	0.106	kt	0.76	0.21	0.01
CO	5.962	kt	4.56	1.41	2.20
Pb	0.033	t	0.29	0.10	0.05
Cd	0.002	t	0.28	0.08	0.01
Hg	0.0002	t	0.06	0.02	0.01

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Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
PCDD/F	0.001	g I-TEQ	0.02	0.04	0.28
B(a)p	0.004	t	0.50	0.57	0.18
B(b)f	0.007	t	0.83	0.95	0.18
B(k)f	0.0004	t	0.08	0.13	0.14
I(1,2,3-cd)p	0.0001	t	0.01	0.02	0.14
HCB	0.0005	kg	0.14	0.12	0.47
PCBs	0.0002	kg	0.05	0.05	0.08

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.

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

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

3.3.7.1. Source Category Description

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

(Photo on the left: Tallinn Passenger Terminal)

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 decreased by 8.1% between 1990 and 2019. As of 2012, a significant increase in fuel consumption is apparent: fuel consumption is more than twice higher (7 562 to 16 384 TJ) compared to 2011. This can be explained by the structural changes in the statistical information collection by Statistics Estonia – since 2012, data for imports and exports also include re-exports data.

As emission levels depend upon the amount of fuel being used, emissions from the international maritime navigation sector show trends similar to those for fuel consumption. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have decreased by approximately 18.8%, 5.2%, and 8.6% in comparison to 1990's figures. Sulphur oxide emissions have decreased by 61.1% during the same period due to stringent measures having been adopted by the IMO in relation to sulphur content in marine fuels. The dominant fuel in this sector is bunker fuel oil. But recent years have shown a rise in marine diesel and gas oil consumption at the expense of bunker fuel oil. Therefore a decrease in SO_2 emissions has occurred, since marine diesel and gas oil has a lower sulphur content in fuel. Detailed emissions data are provided in Table 3.68.

According to Statistics Estonia, in 2019, Estonian sea transport enterprises carried 9.5 million passengers, which is almost as much as in 2018. The number of passengers carried was 2.6 million in domestic sea traffic (up by 4%) and 6.9 million in international sea traffic (down by 1%). The passenger traffic volume of sea transport enterprises was nearly 1.3 billion passenger-kilometres in 2019. International sea traffic accounted for 98% of the passenger traffic volume.

In 2019, emissions from the international maritime navigation sector have decreased compared to 2018. This decrease in emissions occurred due to lower fuel consumption in 2019 (42.7%). The emissions of NO_x, NMVOC, SO_x and CO decreased by 45.9%, 42.7%, 26.8% and 43.1% respectively during the same period.

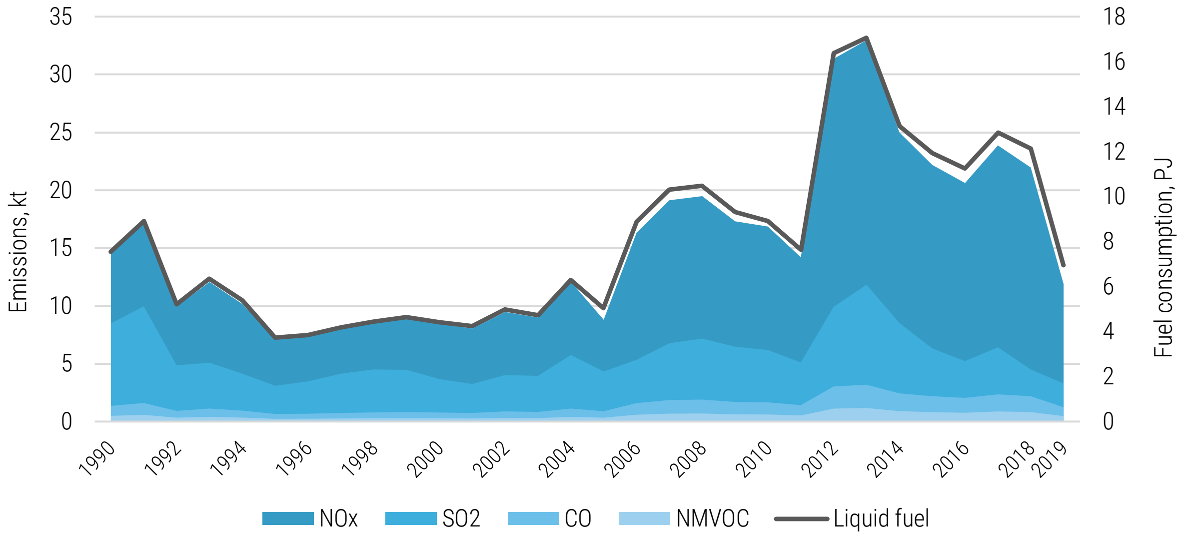

Figure 3.50 NO_x, NMVOC, SO_x and CO emissions from the international navigation sector

Table 3.68 Emissions from the international maritime navigation sector in the period of 1990-2019

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
2011	14.218	0.535	5.118	NE	0.975	1.055	1.055	0.124	1.428
2012	31.365	1.130	9.922	NE	1.934	2.112	2.112	0.256	3.041
2013	32.975	1.182	11.840	NE	2.244	2.455	2.455	0.281	3.197
2014	25.009	0.910	8.530	NE	1.637	1.783	1.783	0.210	2.449
2015	22.197	0.822	6.334	NE	1.268	1.371	1.371	0.177	2.198
2016	20.631	0.772	5.232	NE	1.081	1.163	1.163	0.160	2.057
2017	23.884	0.883	6.434	NE	1.307	1.413	1.413	0.187	2.361
2018	21.974	0.832	4.514	NE	0.995	1.061	1.061	0.162	2.198
2019	11.893	0.477	3.306	NE	0.673	0.709	0.709	0.098	1.251
Trend 1990-2019, %	-18.8	-5.2	-61.1	NE	59.1	52.2	-28.2	59.1	-8.6

Table 3.68 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	0.032	0.003	0.004	0.009	0.110	0.037	4.866	0.006	0.222
1995	0.014	0.001	0.002	0.004	0.038	0.018	1.640	0.002	0.108
2000	0.017	0.002	0.003	0.005	0.049	0.021	2.122	0.003	0.128
2005	0.020	0.002	0.003	0.006	0.058	0.024	2.509	0.004	0.146
2010	0.040	0.004	0.005	0.011	0.149	0.045	6.581	0.008	0.271
2011	0.034	0.004	0.004	0.009	0.123	0.039	5.432	0.007	0.232
2012	0.070	0.007	0.009	0.020	0.238	0.082	10.486	0.014	0.493
2013	0.076	0.008	0.009	0.021	0.284	0.086	12.584	0.016	0.518
2014	0.057	0.006	0.007	0.016	0.205	0.066	9.042	0.012	0.397
2015	0.049	0.005	0.007	0.014	0.152	0.059	6.652	0.009	0.356
2016	0.044	0.004	0.007	0.013	0.126	0.056	5.455	0.008	0.334
2017	0.052	0.005	0.008	0.015	0.155	0.064	6.736	0.009	0.383
2018	0.046	0.004	0.008	0.013	0.109	0.059	4.637	0.007	0.356
2019	0.027	0.003	0.004	0.008	0.079	0.034	3.455	0.005	0.203
Trend 1990-2019, %	-13.7	-18.2	-0.7	-12.2	-28.0	-8.6	-29.0	-23.7	-8.6

Table 3.68 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					kg	
1990	0.075	0.001	0.005	0.003	0.001	0.010	0.024	0.087
1995	0.029	0.000	0.002	0.001	0.000	0.004	0.010	0.030
2000	0.036	0.000	0.002	0.002	0.001	0.005	0.012	0.039
2005	0.042	0.000	0.003	0.002	0.001	0.006	0.014	0.046
2010	0.099	0.001	0.006	0.004	0.002	0.014	0.030	0.118
2011	0.083	0.001	0.005	0.004	0.002	0.011	0.026	0.097
2012	0.164	0.002	0.011	0.007	0.003	0.023	0.052	0.189
2013	0.189	0.002	0.012	0.008	0.004	0.026	0.058	0.225
2014	0.139	0.002	0.009	0.006	0.003	0.019	0.043	0.162
2015	0.108	0.001	0.007	0.005	0.002	0.015	0.036	0.120
2016	0.093	0.001	0.006	0.004	0.002	0.013	0.032	0.099
2017	0.112	0.001	0.007	0.005	0.002	0.016	0.038	0.122
2018	0.086	0.001	0.006	0.004	0.001	0.013	0.032	0.086
2019	0.058	0.001	0.004	0.003	0.001	0.008	0.020	0.063
Trend 1990-2019, %	-23.1	-20.3	-21.8	-18.2	-27.0	-21.2	-16.7	-28.1

3.3.7.2. Methodological Issues

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

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

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

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

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

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

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

Table 3.70 Sulphur content of fuel (by weight)

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

Table 3.71 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2019

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
2011	1,092	1,789	318	1,870	6,251	2	18	11,340
2012	1,044	1,612	435	1,884	6,469	1	27	11,472
2013	1,051	1,455	382	2,384	5,878	1	34	11,185
2014	1,173	1,319	362	2,347	5,809	0	11	11,021
2015	819	1,007	359	2,653	6,303	0	4	11,145
2016	900	876	374	2,721	6,533	0	6	11,410
2017	904	1,000	350	2,731	6,495	0	32	11,512
2018	944	159	295	9,322	342	26	250	11,338
2019	991	175	263	9,299	340	66	300	11,434

Table 3.72 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2019 (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
2011	23,658	7,203	3,223	27,962	168,999	0	19	231,063
2012	21,046	6,633	4,976	24,424	179,017	0	37	236,133
2013	21,102	5,875	4,896	35,152	191,938	0	1,019	259,982
2014	21,767	5,479	5,512	27,750	189,853	0	13	250,374
2015	15,058	4,715	4,989	29,621	195,666	0	7	250,056
2016	13,617	4,711	5,664	30,047	205,522	0	10	259,571
2017	13,768	5,421	5,126	31,618	223,137	0	98	279,168
2018	14,073	3,473	4,467	247,310	24,028	10	2,071	295,431
2019	14,401	4,032	4,054	246,109	24,878	28	2,291	295,793

Table 3.73 Fuel consumption in the international maritime navigation sector in the period of 1990-2019 (TJ)

Year	Bunker fuel oil	Marine diesel oil/ Marine gas oil	Total
1990	6,100	1,462	7,562
1995	2,020	1,720	3,740
2000	2,626	1,806	4,432
2005	3,111	1,935	5,046
2010	8,040	888	8,928
2011	6,628	1,015	7,643
2012	12,747	3,638	16,384
2013	15,374	1,692	17,066
2014	11,021	2,115	13,136
2015	8,040	3,892	11,932
2016	6,550	4,695	11,245
2017	8,119	4,738	12,856
2018	5,491	6,641	12,132
2019	4,282	2,665	6,947

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

As of 2018, there has been a significant change in the number of general cargo and passenger vessels and their gross tonnage, which are being used in emission calculations for manoeuvring and hostelling activities in this sector. According to Statistics Estonia, there was a structural change in the statistical information collection by Statistics Estonia and therefore, there is a need to check all the time series to ensure the consistency of data for the entire time series.

As of 2019, there has been a significant change in fuel consumption data which needs further analysis to understand why the large decrease occurred. There are plans to double-check fuel consumption data presented in the energy balance and try to explain emission fluctuations for the time series in next year's submission.

3.4. 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 (Table 3.74):

(Photo on the left: Muuga Terminal; source: www.portoftallinn.com)

Table 3.74 Fugitive emissions activities

NFR	Source	Description	Emissions reported
1B	Fugitive emissions from fuel		
	1c Other fugitive emissions from solid fuels	Includes emissions from open oil shale mining activity, mainly explosive works. Only point sources data.	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
	1c Other fugitive emissions from solid fuels	Includes emissions from open oil shale mining activity, mainly explosive works. Only point sources data.	SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO

NMVOC emissions from this sector (NFR 1B) contribute about 4% to total national emissions and have decreased by about 65% up to 2019 compared to 1990 due to decreasing emissions from gasoline distribution and also has decreased (by 22%) in comparison with 2018 due to decreasing emissions from terminals (see Figure 3.51, Figure 3.53 and Table 3.76). Emissions of other pollutants are very small compared to the emissions from the other sectors (see Table 3.75).

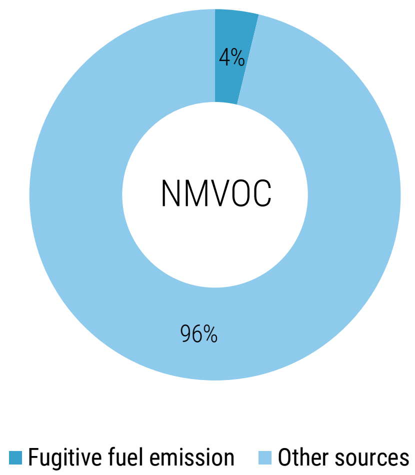

Figure 3.51 NMVOC emission distribution in 2019

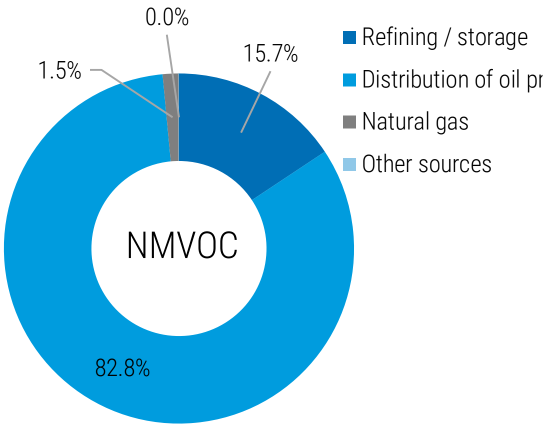

Figure 3.52 NMVOC emission distribution within the fuel fugitive emission sector in 2019

Figure 3.52 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (82.8%).

Table 3.75 Fugitive emission in the period of 1990-2019 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	NA	2.474	NA	NA	NR	NR	NR	NR	NA
1995	NA	1.632	NA	NA	NR	NR	NR	NR	NA
2000	0.010	4.326	NA	0.010	0.010	0.050	0.110	NA	0.200
2005	0.010	4.284	NA	0.050	0.017	0.106	0.207	NA	0.170
2010	0.038	1.818	0.018	0.115	0.034	0.170	0.309	0.0002	0.188
2011	0.032	2.179	0.076	0.175	0.042	0.187	0.351	0.0002	0.813
2012	0.019	1.824	0.038	0.212	0.051	0.182	0.329	0.0001	2.011
2013	0.024	1.471	0.051	0.192	0.021	0.103	0.190	0.0003	1.353
2014	0.025	1.366	0.038	0.191	0.020	0.096	0.187	0.0002	1.028
2015	0.025	1.186	0.032	0.196	0.018	0.090	0.181	0.0001	0.183
2016	0.021	1.215	0.024	0.142	0.013	0.068	0.131	0.0001	0.142
2017	0.025	1.145	0.029	0.168	0.013	0.076	0.148	0.00003	0.171
2018	0.026	1.107	0.030	0.157	0.013	0.067	0.138	0.00005	0.172
2019	0.022	0.861	0.025	0.097	0.010	0.045	0.090	0.00002	0.134
Change 1990-2019, %		-65.2							
Change 2018-2019, %	-14.9	-22.2	-13.9	-38.2	-24.0	-32.9	-34.5	-48.9	-21.7

The emission data for 1B1c Other fugitive emissions from solid fuels (mainly explosive works in the open 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.

3.4.2. Distribution of Oil Products (NFR 1B2av)

3.4.2.1. Source Category Description

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

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

In Estonia, oil terminals and service stations must have permits when the total loading turnover exceeds 10 000 m^3 per year[5] (before 2017 was 2000 m^3 per year). That means the smallest service stations are regarded as diffuse sources. Emissions from oil terminals are based only on the facilities data. 24 terminals presented reports on emissions in 2019. In the table below NMVOC emissions from gasoline distribution and terminals are presented.

Table 3.76 NMVOC emissions from liquid fuel distribution in the period of 1990-2019 (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	
Gasoline distribution	2.055	0.971	1.108	0.467	0.482	0.514	0.508	0.467	0.447	
Terminals	0.323	0.625	3.157	3.199	2.626	1.2	0.629	0.799	0.644	
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**1990-2019, %**
Gasoline distribution	0.478	0.511	0.46	0.427	0.397	0.404	0.418	0.441	0.451	-78.1
Terminals	1.265	0.854	0.74	0.737	0.594	0.642	0.521	0.474	0.262	-18.9

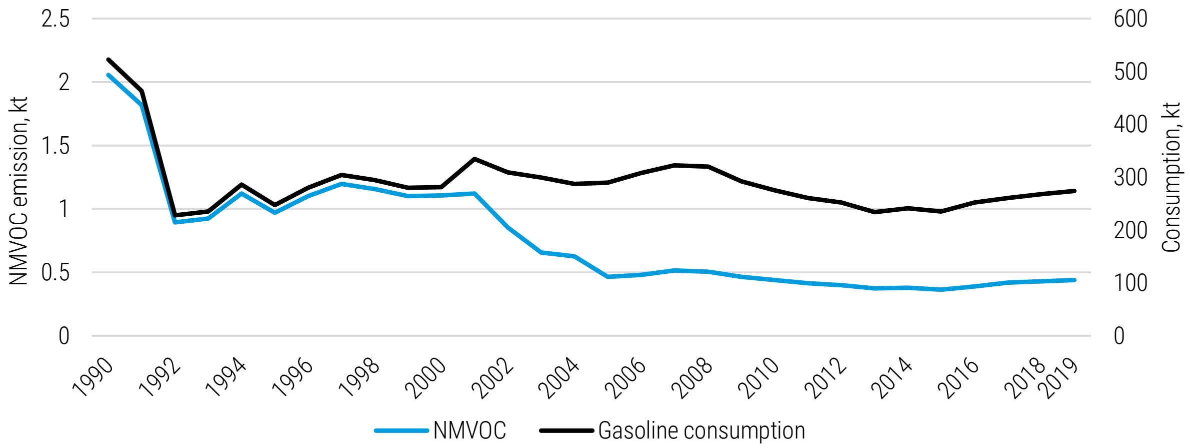

Figure 3.53 NMVOC emission and gasoline distribution in the period of 1990-2019

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

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

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.

3.4.2.2. Methodological Issues

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

From 2005, facilities data are used in emission estimates (about 80% from total gasoline distribution in 2016 and only 17% in 2018 after changes were made in the legislation concerning the total loading turnover, Chapter 3.4.2.1). Facilities are obligate to use the national method for NMVOC emission calculation Naftasaaduste laadimisel välisõhku väljutatavate lenduvate orgaaniliste ühendite heidete arvutusliku määramise meetodid - Elektrooniline Riigi Teataja

In the period 2005-2019, activity data relating to point sources is available and activity data for emission calculations from diffuse sources is calculated using the following method:

Gasoline distribution in diffuse sources = total gasoline consumption – gasoline distribution in point sources

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 2005-2019, the Tier 2 technology specific emission factors for Service Stations from the EMEP/EEA Guidebook 2019 is applied (Chapter 1.B.2.a.v, tables 3-8 – 3-11). As the majority of the emissions at service stations are from gasoline storage and refuelling (compared to emissions from gasoil), emission factors are only provided for gasoline.

Abatement

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

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

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

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

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

where

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

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

The RVP for gasoline (gasoline 95) in Estonia according to the Register of Fuel Monitoring in the period 2005-2015 is presented in the following Table 3.77.

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

Table 3.77 Annual average RVP of gasoline 95 in Estonia in the period 2005-2015

Year	Annual average RVP, kPa
2005	72.3
2006	75.8
2007	74.8
2008	75.3
2009	74.5
2010	75.3
2011	76.9
2012	75.5
2013	73.8
2014	73.0
2015	72.8
Average	74.6

RVP for gasoline is up to 74.6 kPa.

$TVP = 74.6 \times 10^{(0.000007047x74.6+0.0132)*5+(0.0002311x74.6-0.5236)} = 27.2$ kPa

Consequently, an average true vapour pressure for gasoline is 27.2 kPa (5 ˚C).

One integrated emission factor representing all activities in the small service station is calculated for emission calculations.

Table 3.78 Total Tier 2 emission factor for emissions from gasoline handling in service stations

Category	Emission source	NMVOC emission factor, g/m^3 throughput/kPa TVP	Abatement efficiency ($\eta_{abatement}$), %	True Vapour Pressure (TVP), kPa	NMVOC emission factor for gasoline, g/m^3 throughput
Gasoline in service stations	Storage tank Filling with no Stage 1.B	24	95%	27.2	33
	Storage tank Breathing	3	-	27.2	82
	Automobile refuelling with no emission controls in operation	37	-	27.2	1,006
	Automobile refuelling Drips and minor spillage	2	-	27.2	54
	Emission factor for all the activities total	66	-	-	1,175

Activity data

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

Table 3.79 Consumption of motor gasoline in the period of 1990-2019 (kt)

Year	Gasoline consumption
1990	523
1995	247
2000	282
2005	290
2010	276
2011	261
2012	252
2013	234
2014	241
2015	236
2016	252
2017	261
2018	269
2019	274

3.4.2.3. Source-Specific QA/QC and Verification

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

3.4.2.4. Source-Specific Planned Improvements

Revision RVP for the last years and correction of NMVOC emission factor if necessary.

3.4.3. Natural Gas (NFR 1B2b)

3.4.3.1. 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.

(Photo: Natural gas distribution; source: www.delfi.ee)

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.

Natural gas is imported into Estonia from Russia and from the Inčukalns underground gas storage in Latvia (see Figure 3.54).

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

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

The gas network in Estonia is 2314 km long, of which 878 km are for transmission and 1436 km for distribution. There are three GMSs in Värska, Karksi and Misso and 36 gas distribution stations. The system is owned by Eesti Gaas AS, and operated by EG Võrguteenus, which provides transmission and distribution services, and operates the gas metering systems on the Estonian border. Eesti Gaas AS owns the entire gas transmission and distribution system and supplies gas to all the wholesale markets and the majority of the retail markets. The only exception is the large chemical industry Nitrofert, a Kohtla-Järve company producing mineral fertilisers, which imports gas for its own use[8]. Nitrofert halted operations since 2014.

[7] Eesti Gaas. Annual Report 2006
[8] Estonia 2013. Energy Policies Beyond IEA Countries. OECD/IEA 2013

Figure 3.54 Map of high-pressure gas distribution pipelines in Estonia

The gas pipeline passes through ten counties: Ida-Viru, Lääne-Viru, Harju, Rapla, Jõgeva, Tartu, Põlva, Võru, Viljandi and Pärnu. There are gas consumers in every county.

The main reason for the reduction of NMVOC emissions in 2019 compared to 1990 is a decrease in gas consumption over the same period (see Table 3.80, Table 3.83 and Figure 3.55).

Table 3.80 NMVOC emissions from gas distribution in the period of 1990-2019 (kt)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	
NMVOC	0.096	0.036	0.031	0.028	0.028	0.028	0.027	0.018	0.019	
	2011	2012	2013	2014	2015	2016	2017	2018	2019	1990-2019, %
NMVOC	0.018	0.019	0.019	0.015	0.013	0.014	0.014	0.014	0.013	-85.4

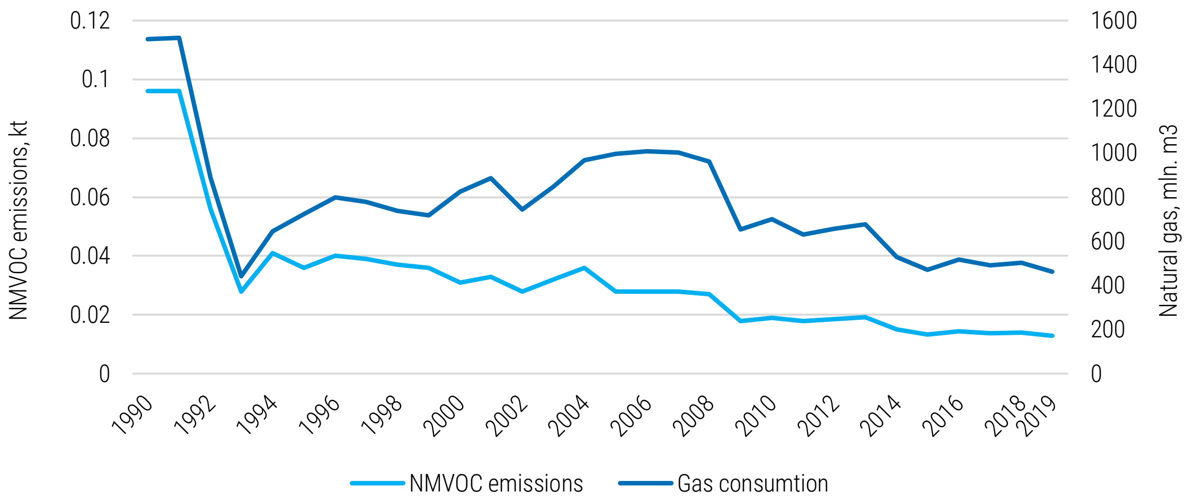

Figure 3.55 NMVOC emission from natural gas distribution in the period of 1990-2019

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3.4.3.2. Methodological Issues

Emission factors

For NMVOC calculations from gas distribution the IPCC Guidelines for National Greenhouse Gas Inventories (2006) are used.

Tier 1 emission factors are used (Equation 1).

The activity rate for this sector is natural gas consumption. Unit: million m^3.

Emission factor unit: Gg per 10^6 of marketable gas/Utility sales.

The available default emission factors are presented below in Tables 3.81-3.82. While some types of fugitive emissions correlate poorly with, or are unrelated to, throughput on an individual source basis (e.g. fugitive equipment leaks), the correlations with throughput become more reasonable when large populations of sources are considered. Furthermore, throughput statistics are the most consistently available activity data for use in Tier 1 calculations.

Table 3.81 Tier 1 NMVOC emission factors for fugitive emissions (including venting and flaring) from gas operations

Category	Sub-category	Emission source	IPCC Code	Developed countries		Developing countries and countries with economies in transition		Units of measure
				Value	Uncertainty value (% of value)	Value	Uncertainty value (% of value)	
Gas transmission & Storage	Trans-mission	Fugitives	1.B.2.b	7.0E-06	+-100%	7.0E-06 to 1.6E-05	-40 to +250%	Gg per 10^6 m^3 of marketable gas
		Venting	1.B.2.b	4.6E-06	+-75%	4.6E-06 to 1.1E-05	-40 to +250%	Gg per 10^6 m^3 of marketable gas
Gas Distribution	All	All	1.B.2.b	1.6E-05	-20 to +500%	1.6E-05 to 3.6E-5	-20 to +500%	Gg per 10^6 m^3 of utility sales

Table 3.82 Tier 1 emission factors for fugitive emissions (including venting and flaring) from gas operations for different years

Category	Sub-category	Emission source	IPCC Code	1990	1995	2000	2005-2016	Units of measure
Gas transmission & Storage	Trans-mission	Fugitives	1.B.2.b	1.6E-05	1.3E-05	9.6E-06	7.0E-06	Gg per 10^6 m^3 of marketable gas
		Venting	1.B.2.b	1.1E-05	8.7E-06	6.4E-06	4.6E-06	Gg per 10^6 m^3 of marketable gas
Gas Distribution	All	All	1.B.2.b	3.6E-05	2.9E-05	2.2E-05	1.6E-05	Gg per 10^6 m^3 of utility sales
Total	-	-	-	6.3E-05	5.0E-05	3.8E-05	2.8E-05	Gg per 10^6 m^3 of utility sales

The Estonian economy up to 2004 can be classified as an economy in transition. The emission factors are chosen accordingly. For the transition period from 1990 to 2004, the emission factor for countries with economies in transition is used. It is expected that the emissions have decreased equally within this period.

Activity data

Activity data on the subject of annual natural gas consumption are available from Statistics Estonia (see Table 3.83).

Table 3.83 Gas consumption in the period 1990-2019 (mln m^3)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	
Gas consumption	1, 516	723	826	997	1 009	1 003	961	653	701	
	2011	2012	2013	2014	2015	2016	2017	2018	2019	1990-2019, %
Gas consumption	632	657	678	530	471	518	492	504	461	-69.6

3.4.3.3. Uncertainty

An uncertainty analysis was carried out to the year 2019 inventory. The uncertainty in the emission factors for main pollutants from fugitive emission sector is estimated in the range from 20% to 100%; in the activity data in the range from 2% to 50%. Uncertainty estimates for fugitive emission sector are given in Table 3.84.

Table 3.84 Uncertainties in fugitive emission sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	0.022	kt	0.09	0.04	0.01
NMVOC	0.861	kt	3.79	1.57	0.08
SO_x	0.025	kt	0.13	0.03	0.00
NH_3	0.097	kt	0.91	0.46	0.22
$PM_{2.5}$	0.010	kt	0.17	0.12	0.04
PM_{10}	0.045	kt	0.49	0.38	0.07
TSP	0.090	kt	0.65	0.51	0.03
CO	0.134	kt	0.10	0.10	0.05
Pb	0.00002	t	0.000	0.00	0.00

3.4.3.4. Source-specific QA/QC and Verification

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

3.4.3.5. Source-specific Planned Improvements

- Calculate emissions for NFRs 1B1c for 1990-1999.

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%).

In manufacturing, the production volume increased by a few percent in 2019, but at the end of the year production started to decline. The number of employed decreased slightly. At the beginning of 2020, production was still on the positive side, but the spread of the coronavirus has taken a toll on almost all industries, and the negative impact of the virus may be seen in the year as a whole

In the year as a whole, Estonia was again among the strongest in the EU in terms of industrial production developments.

In the European Union, the production volume of the manufacturing industry started to decrease from the end of 2018, and also in 2019, the production decreased by almost 1%. In Estonia, the manufacturing industry remained on a growth rate until the second half of the year. In the year as a whole, Estonia was again among the strongest in the EU in terms of industrial production developments, the growth of production volume was similar to Latvia and Finland.

According to short-term statistics, the Estonian manufacturing industry produced more than 2% more output in 2019 than a year earlier. In the fourth quarter, however, production decreased in more than half of the branches of industry. In the year as a whole, production grew faster in the oil industry, in the manufacture of other transport equipment, and in the repair and installation of machinery and equipment. However, clothing production decreased the most.[9]

The main activities in the industrial processes sector in Estonia are the paper, wood and chemical industries as well as the production of mineral products and food. The industry has undergone major changes since 1990. The industrial sector's share of total emissions is no longer as significant as it used to be. This is mainly due to a decrease in production volume; also, some enterprises have ceased operating (phosphor fertilizers, benzene and toluene).

The Estonian inventory of air pollutants from industrial processes presently includes emissions from the chemical, pulp, paper, metal, metal and mineral products industries, as listed inTable 4.1.

Table 4.1 Industrial processes reporting activities

NFR		Source	Description	Emissions reported
2A	Mineral Products			
	2A1	Cement production	Includes emissions from cement production. Data reported by one operator. 5 operators of concrete production	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 of glass production.	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. Data reported by operators.	NO_X, SO_X, TSP, PM_{10}, $PM_{2.5}$, CO
	2A5b	Construction and demolition	Includes emissions from construction and demolition.	TSP, PM_{10}, $PM_{2.5}$
	2A6	Other Mineral products	Includes emissions mainly from crushed stone production. Data reported by operators.	NO_X, NMVOC, SO_X,TSP, PM_{10}, $PM_{2.5}$, CO
2B	Chemical industry			

[9] Overview of economy 2019. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2020

NFR		Source	Description	Emissions reported
	2B10a	Other chemical industry	Includes emission from urea and formaldehyde production. Data reported by two operators.	NO_X, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO
	2B10b	Storage, handling and transport of chemical products	Includes emission from storage, handling and transport of chemical products. Data reported by operators.	NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC
2C	Metal Production			
	2C1	Iron and steel production	Includes emission from Iron and steel production. Data reported by operators.	NO_X, NMVOC, SO_x, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cd, Cr, Cu, Ni, Zn
	2C3	Aluminium production	Includes emission from secondary aluminium production. Data reported by operators.	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. 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.	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 23 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 86 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. 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) and only NMVOC emissions from the food industry and NMVOC, particulates from road paving with asphalt are calculated as diffuse sources on the basis of statistical data and the EMEP/EEA Guidebook 2019 emission factors (Tier 2 and Tier 1 method).

TSP, PM_{10} and $PM_{2.5}$ emissions from constructions and demolition are also calculated as diffuse sources (EMEP/EEA Guidebook 2019 Tier 1 method).

BC emissions from industry are calculated for the period 2000–2019.

The share of industry sources in total emissions in 2019 was: NO_x – 0.3%, NMVOC – 3.8%, $PM_{2.5}$ – 4.2%, PM_{10} – 15.7% and TSP about 33%. The shares of other pollutants were not so significant. The emissions of NMVOC, NH_3 and NO_x have decreased in comparison with 1990 by 94.4%, 86.6% and 64.7%, respectively. The main reason is that during the period of 1990–2019, the production of chemical products fell.

The emissions of PM_{10} and TSP decreased in 2019 compared to 2018 by 19.5% and 20.7%. Lower growth in the construction sector (mainly non-residential building) was the cause of decrease in emissions of particulates.

The trend of NMVOC and PM emissions in these categories 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 2019 are shown in Figure 4.2 and Figure 4.3. The biggest polluter of NMVOC emissions were Pulp, paper and food industries – 88.9% (mainly food production), the chemistry industry is responsible for the 4% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (79%, mainly construction and demolition sector).

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

Table 4.2 Pollutant emissions from the industrial sector in the period of 1990-2019 (kt; heavy metals in t)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO
					kt				
1990	0.190	15.341	NA	0.667	NR	NR	NR	6.172	0.340
1995	0.070	4.379	NA	0.291	NR	NR	NR	1.390	0.030
2000	0.201	2.082	0.042	0.134	0.322	1.037	0.005	2.776	0.534
2005	0.178	1.570	0.131	0.197	0.583	2.270	0.008	6.473	0.354
2010	0.037	0.861	0.030	0.070	0.340	1.400	0.004	3.982	0.462
2011	0.062	0.919	0.022	0.093	0.234	1.209	0.002	3.605	0.420
2012	0.047	0.909	0.001	0.103	0.198	1.142	0.001	3.510	0.336
2013	0.200	0.892	0.000	0.162	0.366	1.736	0.005	4.989	0.381
2014	0.032	0.860	0.001	0.052	0.238	1.338	0.001	4.150	0.413
2015	0.045	0.809	0.002	0.065	0.230	1.300	0.002	4.042	0.405
2016	0.045	0.768	0.001	0.071	0.225	1.315	0.001	4.149	0.378
2017	0.057	0.790	0.0002	0.082	0.325	1.627	0.002	5.044	0.451
2018	0.054	0.805	0.0002	0.097	0.289	1.806	0.001	5.767	0.553
2019	0.067	0.856	0.0002	0.089	0.248	1.453	0.001	4.576	0.629
Change 1990-2019, %	**-64.7**	**-94.4**	**-99.5**	**-86.6**	**-23.1**	**40.1**	**-73.7**	**-25.9**	**85.1**
Change 2018-2019, %	**24.3**	**6.3**	**22.0**	**-7.3**	**-14.4**	**-19.5**	**7.6**	**-20.7**	**13.8**

Table 4.2 continues

Year	Pb	Cd	Cr	Cu	Ni	Zn	PCCD/F	HCB	PCB
	t						g I-Teq	kg	
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0.034	0.003	0.018	0.024	0.014	0.020	0.022	NA	0.00002
2005	0.008	0.003	0.075	0.012	0.027	0.110	0.041	NA	0.00003
2010	0.014	0.002	0.129	0.009	0.013	0.046	0.055	0.002	0.00004
2011	0.012	0.002	0.144	0.011	0.018	0.077	0.070	0.002	0.00005
2012	0.010	0.002	0.071	0.009	0.017	0.125	0.050	0.002	0.00004
2013	0.011	0.003	0.169	0.009	0.020	0.168	0.027	0.002	0.00002
2014	0.017	0.003	0.079	0.008	0.017	0.178	0.030	0.002	0.00002
2015	0.010	0.003	0.069	0.003	0.021	0.181	0.030	0.002	0.00002
2016	0.011	0.005	0.048	0.002	0.012	0.177	0.030	0.003	0.00002
2017	0.015	0.018	0.037	0.006	0.023	0.175	0.032	0.002	0.00003
2018	0.009	0.004	0.037	0.003	0.014	0.157	0.030	0.002	0.00002
2019	0.007	0.003	0.029	0.006	0.013	0.150	0.030	0.001	0.00002
Change 2000-2019, %	**-79.9**	**12.5**	**66.2**	**-73.3**	**-5.0**	**648.0**	**39.0**		**33.3**
Change 2018-2019, %	**-20.6**	**-22.6**	**-20.3**	**128.1**	**-1.7**	**-4.6**	**1.2**	**-6.9**	**0.0**

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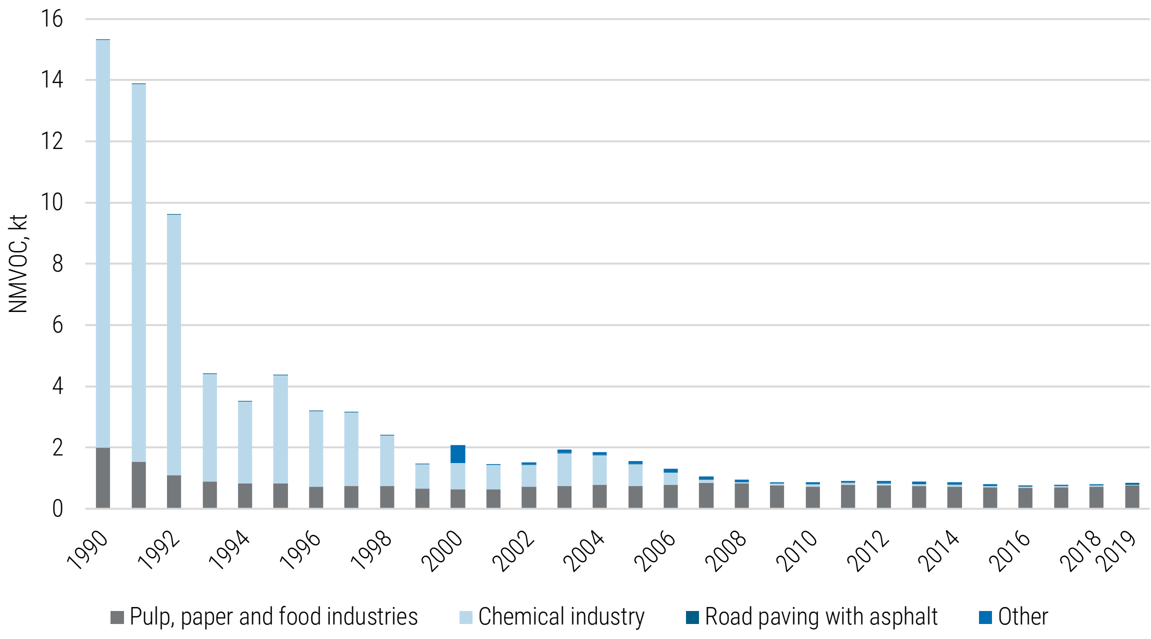

Figure 4.1 NMVOC emissions from the industrial sector in the period of 1990-2019

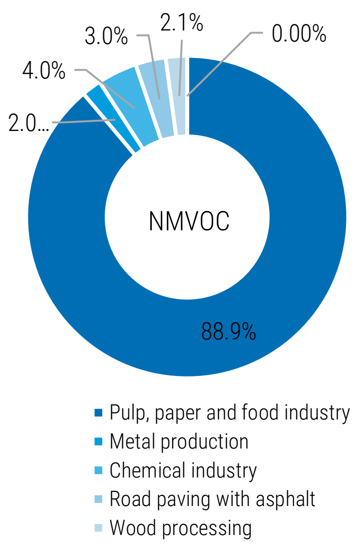

Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2019

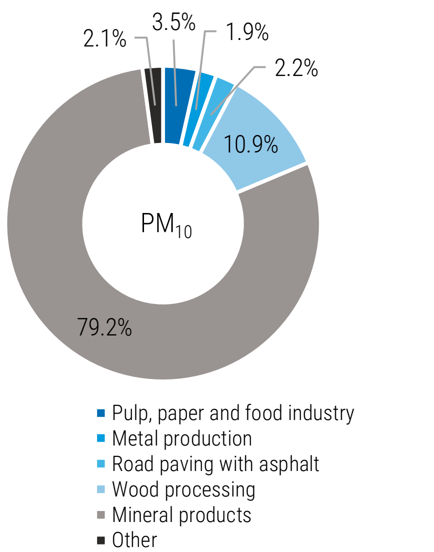

Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2019

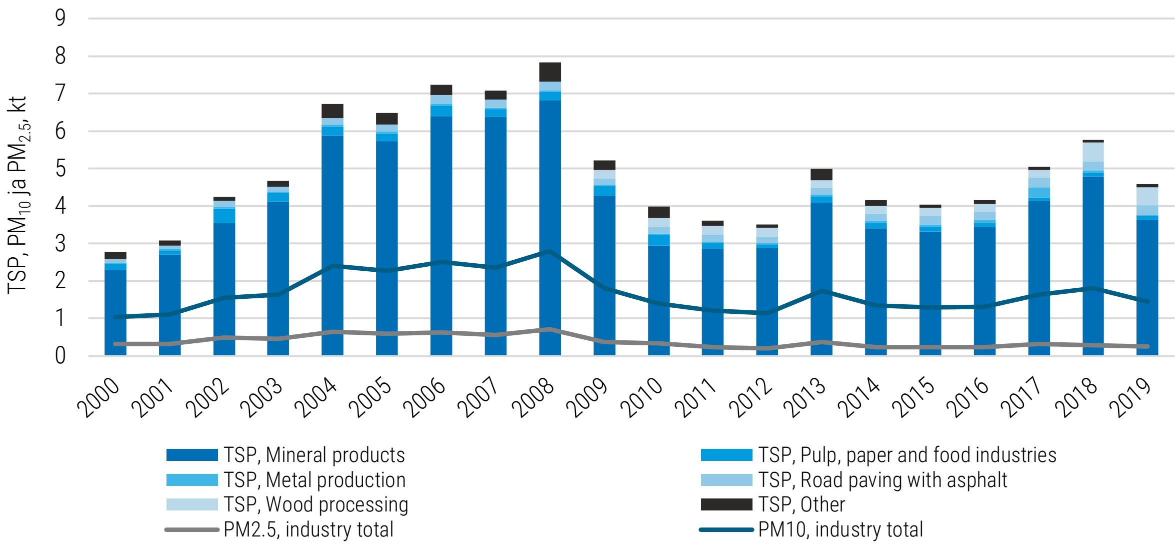

Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2019

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;
- Other mineral products.

In Estonia, the only enterprise that produces cement is Kunda Nordic Tsement AS. Cement is produced by the standard wet process. The clinker burning process takes place in three rotary kilns. Crushed limestone is blended with prepared clay (raw material contains calcium, aluminium, iron and silica oxides) and heated to about 1450 ˚C in a kiln. The ingredients react and turn into an intermediate product called clinker, which is then further mixed with gypsum and, in some cases, limestone, blast furnace slag or fly ash. This mixture is then ground into a fine powder, known as cement, the binding agent of concrete. The production process is energy-intensive, resulting in the emission of CO_2, SO_x, NO_x and dust. During the period 1993-2000, cement manufacturing in Kunda was thoroughly modernised. The main goal was to eliminate dust pollution from clinker kilns and cement mills, which were provided with filters required for exhaust cleaning. In 1999, the company closed the local electricity and heat production plant, which had operated on natural gas. (Sustainability report 2007. Kunda Nordic Tsement AS, 2007).

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 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.

(Photo by Ilmar Saabas: Limestone excavation in Väo quarry)

The quarrying and mining of minerals in Estonia include limestone and dolomite extraction as well as crushed stone production (Paekivitoodete Tehase OÜ, Saare Dolomiit-Väokivi OÜ etc).

Currently in Estonia, only one container glass manufacturing facility. Particulates emissions not related to fuel combustion reallocated to NFR 2A3.

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%. Larger Estonian construction companies are AS Merko Ehitus, Nordecon AS, AS TREV-2 Grupp, AS YIT Eesti, OÜ Astlanda Ehitus, OÜ Mapri Ehitus, AS Ehitusfirma Rand ja Tuulberg, Empower AS, Kodumaja AS, OÜ Fund Ehitus.[10]

The completed residential dwelling has increased by about 12.6% in 2019 comparing to 2018, but non-residential has decreased in the same period by 36.5%. It is a primary reason of the decreasing of particulates emissions from the mineral industry. The TSP, PM_{10} and $PM_{2.5}$ emissions decreased in 2019 compared to 2018 by 24.3%, 22.2% and 14.9% respectively (Table 4.3). The main source of BC emission is cement production.

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 chapte

Table 4.3 Pollutant emissions from mineral products in the period of 1990-2019 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	NA	NA	NA	NA	NR	NR	4.975	NR	NA
1995	NA	NA	NA	NA	NR	NR	0.829	NR	NA
2000	NA	0.570	NA	0.010	0.128	0.722	2.296	0.0002	0.040
2005	0.010	0.080	NA	NA	0.285	1.779	5.719	0.0003	0.020
2010	0.006	NA	0.0004	NA	0.100	0.954	2.935	0.0001	0.005
2011	0.010	NA	0.0009	NA	0.099	0.929	2.849	0.0001	0.008
2012	0.008	NA	0.0009	NA	0.101	0.923	2.873	0.0002	0.007
2013	0.008	NA	0.0000	NA	0.136	1.295	4.079	0.0002	0.007
2014	0.006	NA	0.0000	NA	0.113	1.068	3.405	0.0001	0.006
2015	0.006	NA	0.0001	NA	0.110	1.045	3.315	0.0001	0.006
2016	0.006	NA	0.0000	NA	0.114	1.072	3.438	0.0001	0.006
2017	0.007	NA	0.0001	NA	0.134	1.281	4.135	0.0001	0.008
2018	0.006	NA	0.0001	NA	0.155	1.477	4.783	0.0002	0.007
2019	0.006	NA	0.0002	0.000	0.132	1.149	3.621	0.0006	0.008
Change 2000-2019, %				**3.055**	**59.168**	**57.726**	**148.020**		
Change 2018-2019, %	**-1.1**		**121.7**		**-14.9**	**-22.2**	**-24.3**	**259.3**	**14.6**

4.1.2.2. Methodological Issues

As was mentioned above (overview of the industrial sector), emissions data 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

[10] Overview of Economy 2018. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2019

activity – NFR 1A2f, excluding fugitive emissions, emissions from construction and excavations and storage and handling activities. In recent years, the cement industry have not been the key source of pollution because very large efforts were made for the reduction of pollutant emissions. The emission of dust from Kunda Nordic Tsement during the period 1990-2009 was reduced by 99.7%.

The enterprise has been presenting data regarding heavy metal emissions since 2004 on the basis of measurements; therefore, emissions for the period 1990-2003 have been calculated on the basis of national emissions factors and clinker production data.

The dioxin emissions from the mineral industry (cement, lime and brick) have been calculated on the basis of productions and the UNEP "Standardized Toolkit for Identification of Dioxin and Furan Releases" emissions factors. For cement production, Toolkit EF was used from 1990 to 1996, and from 1997 to 2010 calculations were carried out on the basis of results from the "Dioxin in Candidate Countries" project, in which frameworks for the measurements of dioxins from technological equipment have been implemented (see Table 4.5). Now, Kunda Nordic is obliged to carry out measurements twice a year and report on dioxin emissions. It must be noted that the measured dioxin emissions are much less than the emissions calculated on the basis of the emissions factor. Dioxin emissions are reported under NFR 1A2giii.

Table 4.4 Clinker production and heavy metal emission factors

Year	Clinker, thousand tonnes	Heavy metals EF, g/t of clinker					
		Pb	Cd	Hg	Cu	Ni	Zn
1990	790.0	78.125	4.060	0.088	2.687	0.313	18.000
1991	773.0	78.125	4.060	0.088	2.687	0.313	18.000
1992	517.0	78.125	4.060	0.088	2.687	0.313	18.000
1993	378.0	78.125	4.060	0.088	2.687	0.313	18.000
1994	540.0	78.125	4.060	0.088	2.687	0.313	18.000
1995	571.0	43.750	2.275	0.049	1.505	0.175	10.080
1996	590.0	12.500	0.650	0.014	0.430	0.050	2.880
1997	651.0	0.780	0.040	0.004	0.030	0.003	0.180
1998	659.0	0.780	0.040	0.004	0.030	0.003	0.180
1999	590.0	0.780	0.040	0.004	0.030	0.003	0.180
2000	620.0	0.780	0.040	0.004	0.030	0.003	0.180
2001	629.0	0.780	0.040	0.004	0.030	0.003	0.180
2002	590.0	0.780	0.040	0.004	0.030	0.003	0.180
2003	560.0	0.780	0.040	0.004	0.030	0.003	0.180

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
2006	848.900	0.07	0.059	39.700	0.07	0.0027	82.667	0.2	0.016
2007	936.200	0.07	0.065	43.500	0.07	0.0030	143.485	0.2	0.029
2008	806.100	0.07	0.056	59.400	0.07	0.0041	113.081	0.2	0.023
2009	326.000	0.07	0.023	30.200	0.07	0.0021	38.938	0.2	0.007
2010	536.700	0.07	0.037	27.200	0.07	0.0019	56.500	0.2	0.011
2011	719.002	0.004	0.003	36.100	0.07	0.0025	84.544	0.2	0.017
2012	714.600	0.006	0.004	72.000	0.07	0.005	107.213	0.2	0.021

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
2013	691.400	0.011	0.007	69.600	0.07	0.0049	118.148	0.2	0.024
2014	720.480	0.007	0.005	69.600	0.07	0.0049	118.148	0.2	0.024
2015	356.287	0.036	0.013	43.018	0.07	0.0030	61.341	0.2	0.012
2016	422.800	0.0175	0.0074	42.084	0.07	0.0029	54.407	0.2	0.011
2017	503.000	0.323	0.1625	69.324	0.07	0.00485	54.94	0.2	0.011
2018	527.000	0.238	0.125	53.714	0.07	0.0038	49.870	0.2	0.010
2019	405.700	0.345	0.140	45.728	0.07	0.003	68.542	0.2	0.014

Construction and demolition sector is a key source of emissions of TSP (24.3% of total emission, Figure 4.5) and PM_{10} (11.1% of total emission)

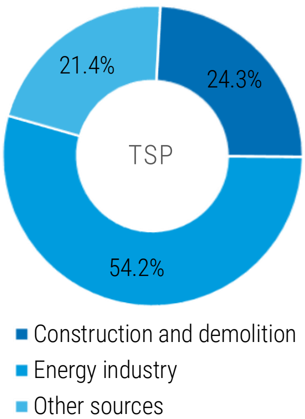

Figure 4.5 The share of construction and demolition sector in total TSP emissions in 2019

Emission calculations from construction and demolition (2A5b) sectors are based on the Tier 1 method from the renewed EMEP/EEA Guidebook 2016.

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

4.1.2.3. Activity Data

Information regarding completed dwelling (houses and apartments) and non-residential buildings, new construction and demolition for the years 2000-2019 is available from Statistics Estonia (www.stat.ee). Data on the years 1994-2000 were obtained from the Statistical Yearbooks 1994-2000. 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).

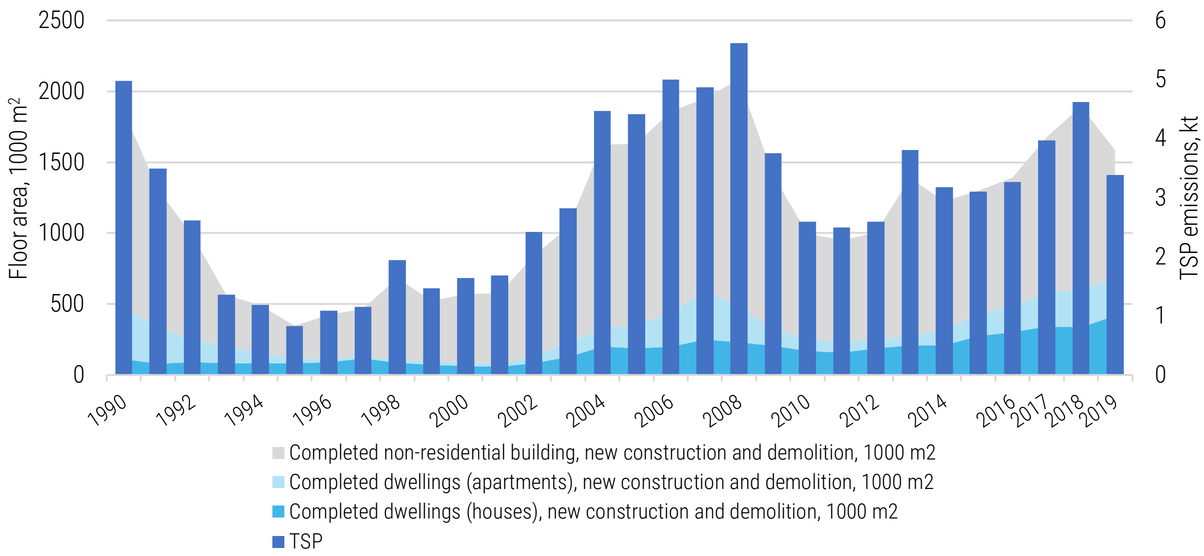

Figure 4.6 The completed dwelling and non-residential building, new construction and demolition and TSP emission in the period of 1990-2019

Table 4.7 Activity data for PM emission calculations from the construction sector in the period of 1990-2019 (1000 m^2 floor area)

Year	Completed dwellings (houses), new construction and demolition, 1000 m^2	Completed dwellings (apartments), new construction and demolition, 1000 m^2	Completed non-residential building, new construction and demolition, 1000 m^2
1990	111.8	361.4	1,388.3
1995	81.6	29.2	235.2
2000	62.4	23.2	483.2
2005	187.5	176.4	1,268.8
2010	168.0	87.0	744.5
2011	157.7	69.9	721.3
2012	186.5	66.9	750.8
2013	208.7	63.6	1,116.1
2014	208.4	105.4	912.6
2015	273.1	158.6	867.0
2016	301.5	185.3	905.7
2017	341.2	233.4	1,102.2
2018	336.1	270.9	1,288.0
2019	416.0	258.2	911.8

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 household chemistry. The smallest subsector (with a few hundred employees) is the pharmaceutical industry. The chemical industry is a capital-heavy area of activity, the growth of production volume has not resulted in a significant increase in the number of jobs. Despite the growth of productivity, the lag behind developed countries still remains notable.

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 KKT Oil OÜ (manufacture of shale oil, Enefit Energiatootmise

AS is also involved in manufacturing oil on the side of energy production); Akzo Nobel Baltics AS, AS Tikkurila and AS Eskaro (paints and varnishes), NPM Silmet OÜ (rare metals), OÜ EUROBIO LAB (manufacture of cosmetics), AS Novotrade Invest (reprocessing of oil products), OÜ Krimelte and Henkel Balti Operations OÜ (assembly foams), Eastman Specialties OÜ (benzoic acid, sodium benzoate, plasticizers), Orica Eesti OÜ (explosives), AS Takeda Pharma (medicine) and Interchemie Werken De Adelaar Eesti AS (veterinary medicine and products).

Large investments in the oil industry create new jobs, but the industry is highly dependent on world oil prices and climate policy, and it is therefore difficult to assess whether or not plans to construct new oil plants and refineries are being met.

In the chemical industry as a whole, the production volume became greater by a few percent in 2019, but the developments by subsectors were different.[11]

Estonia's only producer of fertiliser, Nitrofert AS, halted operations since 2014.

(Photo by Rauno Volmar: Nitrofert production facility)

The share of NMVOC emissions from the chemical industry in the total country emissions amounted to approximately 32% in 1990, and only 0.1% in 2019 (see Figure 4.7). The main reason for this is the decrease in the manufacturing of chemical production at shale oil enterprises.

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

During 1990-2019 emissions of all substances were reduced considerably, except carbon monoxide emission. The main source of CO and NMVOC emissions is facility for benzoic acid, sodium benzoate, plasticizers production and also storage in shale oil industry. The main sources of NO_x and NH_3 are bitumen emulsion and ammonia storage in terminals.

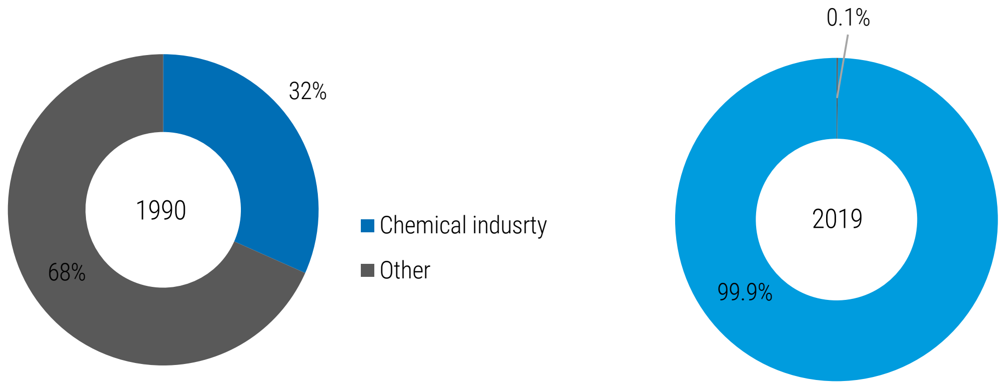

Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2019

[11] Overview of Economy 2019. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2020

Table 4.8 Emissions from the chemical industry in the period of 1990-2019 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.190	13.305	NA	0.37	NR	NR	0.940	NR	0.340
1995	0.070	3.532	NA	0.14	NR	NR	0.490	NR	0.030
2000	0.189	0.845	NA	0.044	0.089	0.163	0.190	0.002658	0.340
2005	0.156	0.716	NA	0.131	0.146	0.266	0.310	0.004355	0.300
2010	0.000	0.071	0.000005	0.010	0.005	0.014	0.042	0.000082	0.405
2011	0.000	0.073	0.000006	0.017	0.004	0.013	0.038	0.000076	0.374
2012	0.024	0.073	0.000006	0.023	0.004	0.012	0.036	0.000072	0.305
2013	0.134	0.074	0.000005	0.076	0.092	0.171	0.213	0.002725	0.327
2014	0.00012	0.073	0.000005	0.008	0.004	0.012	0.037	0.000074	0.367
2015	0.00018	0.046	0.000005	0.007	0.001	0.002	0.007	0.000014	0.353
2016	0.00000	0.054	0.000005	0.007	0.001	0.003	0.009	0.00001	0.328
2017	0.00001	0.041	0.00000	0.007	0.001	0.003	0.008	0.00001	0.420
2018	0.00000	0.037	0.00000	0.014	0.001	0.002	0.006	0.00001	0.514
2019	0.00000	0.034	0.00000	0.017	0.001	0.002	0.008	0.00002	0.588
Change 1990-2019, %	**-100.0**	**-99.7**		**-95.4**	**-99.1**	**-98.5**	**-99.2**	**-99.4**	**72.9**
Change 2018-2019, %	**-7.4**		**25.9**	**18.5**	**18.5**	**18.4**	**24.3**	**14.4**	

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 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 2019 emission factors.

In this reporting year, additionally the emissions of NO_x for the years 2010, 2013-2014 and emissions of CO for 1995-1996 and 1999 were calculated for NFR 2B10a. For NFR 2B1 were additionally calculated CO emissions for 2002-2003 and 2005-2006. Description is given in 8 Chapter.

4.1.4. Metal Production (NFR 2C)

4.1.4.1. Source Category Description

The metal industry is involved in several areas, such as the manufacture and construction of machinery and equipment. 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 1,300 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).

The long-term expectation in the metal industry is the continued growth in production volumes, with exports as the main driver.

In the metal industry, both sales and production died down slightly in 2019. The number of employed dwindled significantly, while according to the preliminary data, more was invested in machinery and equipment. The beginning of 2020 was difficult for businesses, and the impact of the coronavirus could exacerbate the situation with a delay.

In the metal industry, production started to decrease from the second half of the year, and the whole year ended with one percent decline in production. The sales index of industrial production also decreased. Producer prices changed relatively little, growth was close to 1%. Although exports of industrial products increased slightly, domestic sales also led to a decline in total sales.[12]

(Machine-building plant of BLRT Masinaehtius OÜ; source: www.masinaehitus.ee)

Emissions from the metal industry are presented in Table 4.9. The share of this sector in total Estonian emission is insignificant.

Emissions data presented in the table are data provided by enterprises, excluding POPs, which are additionally calculated for secondary aluminium and lead production on the basis of activities data provided by operators and Guidebook 2019 emission factors.

The NFR C1 includes mainly emissions from welding, plasma and gas cutting, metal surface cleaning and some other activities of metal production or mechanical treatment. The NFR 2C3 includes data from secondary aluminium production, 2C6 – from secondary zinc production and plating. The NFR 2C5 includes emission from lead battery and accumulators recycling.

The main sources of ammonia emission is rare-earth metals factory in Sillamäe.

Table 4.9 Emissions from the metal production sector in the period of 1990-2019 (kt, heavy metals in t)

Year	NO_x	SO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	NA	NA	NA	0.160	NR	NR	NA	NR	NA
1995	NA	NA	NA	0.100	NR	NR	NA	NR	NA
2000	0.002	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
2011	0.014	0.0001	0.008	0.070	0.015	0.020	0.033	0.00008	0.009
2012	0.014	0.0001	0.007	0.072	0.015	0.021	0.034	0.00008	0.009
2013	0.015	0.0001	0.008	0.074	0.020	0.028	0.045	0.00009	0.011
2014	0.020	0.0001	0.007	0.043	0.025	0.034	0.056	0.00011	0.021
2015	0.023	0.0001	0.008	0.058	0.026	0.035	0.058	0.00011	0.027
2016	0.025	0.0001	0.010	0.051	0.040	0.053	0.088	0.00025	0.026
2017	0.033	0.0001	0.013	0.066	0.124	0.160	0.268	0.00075	0.011
2018	0.046	0.0001	0.007	0.074	0.028	0.036	0.060	0.00010	0.015
2019	0.060	0.0001	0.017	0.067	0.022	0.028	0.048	0.00008	0.017
Change 2000-2019, %	2363.7	-95.9	121.3	33.6	15.7	16.2	18.8	15.3	26.0
Change 2018-2019, %	30.2	-29.1	139.2	-10.3	-22.4	-22.1	-20.2	-22.3	16.7

Table 4.9 continues

Year	Pb	Cd	Cr	Cu	Ni	Zn	PCCD/F	HCB	PCB
	t						g I-Teq	kg	
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0.034	0.003	0.018	0.014	0.014	0.020	0.022	NA	0.00002
2005	0.008	0.003	0.075	0.012	0.027	0.110	0.041	NA	0.00003
2010	0.014	0.002	0.129	0.009	0.013	0.046	0.055	0.002	0.00004

[12] Overview of Economy 2019. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2020

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Year	Pb	Cd	Cr	Cu	Ni	Zn	PCCD/F	HCB	PCB
2011	0.012	0.002	0.144	0.011	0.018	0.077	0.070	0.002	0.00005
2012	0.010	0.002	0.071	0.009	0.017	0.125	0.050	0.002	0.00004
2013	0.011	0.003	0.169	0.009	0.020	0.168	0.027	0.002	0.00002
2014	0.017	0.003	0.079	0.008	0.017	0.178	0.030	0.002	0.00002
2015	0.010	0.003	0.069	0.003	0.021	0.181	0.030	0.002	0.00002
2016	0.011	0.005	0.048	0.002	0.012	0.177	0.030	0.003	0.00002
2017	0.015	0.018	0.037	0.006	0.023	0.175	0.032	0.002	0.00003
2018	0.009	0.004	0.037	0.003	0.014	0.157	0.030	0.002	0.00002
2019	0.007	0.003	0.029	0.006	0.013	0.150	0.030	0.001	0.00002
Change 2000-2019, %	**-79.9**	**12.5**	**66.2**	**-53.7**	**-5.0**	**648.0**	**39.0**		**33.3**
Change 2018-2019, %	**-20.6**	**-22.6**	**-20.3**	**128.1**	**-1.7**	**-4.6**	**1.2**	**-6.9**	**0.0**

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 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.

BC emission have been calculated on the base EMEP/EEA Guidebook 2019 emission factors.

Emissions of POPs are additionally calculated for secondary aluminium and lead production on the basis of activities data provided by operators and Guidebook 2019 emission factors.

Table 4.10 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

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 2019. Emissions from the road paving with asphalt are presented in Table 4.11 and Figure 4.8.

(Photo: Road paving with asphalt; source: Scanpix)

Table 4.11 Emissions from the road paving with asphalt in the period of 1990-2019 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
1990	0.0274	NR	NR	0.2567	NR
1995	0.0076	NR	NR	0.0713	NR
2000	0.0107	0.0007	0.0133	0.1001	0.00004
2005	0.0186	0.0012	0.0233	0.1746	0.00007
2010	0.0179	0.0011	0.0224	0.1677	0.00006
2011	0.0204	0.0013	0.0256	0.1917	0.00007
2012	0.0181	0.0011	0.0226	0.1693	0.00006

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Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
2013	0.0189	0.0012	0.0237	0.1775	0.00007
2014	0.0206	0.0013	0.0258	0.1934	0.00007
2015	0.0232	0.0015	0.0291	0.2180	0.00008
2016	0.0232	0.0015	0.0291	0.2179	0.00008
2017	0.0264	0.0017	0.0330	0.2477	0.00009
2018	0.0253	0.0016	0.0316	0.2368	0.00009
2019	0.0260	0.0016	0.0325	0.2441	0.00009
Change 1990-2019, %	-4.9	144.0	144.0	-4.9	144.1
Change 2018-2019, %	3.1	3.1	3.1	3.1	3.1

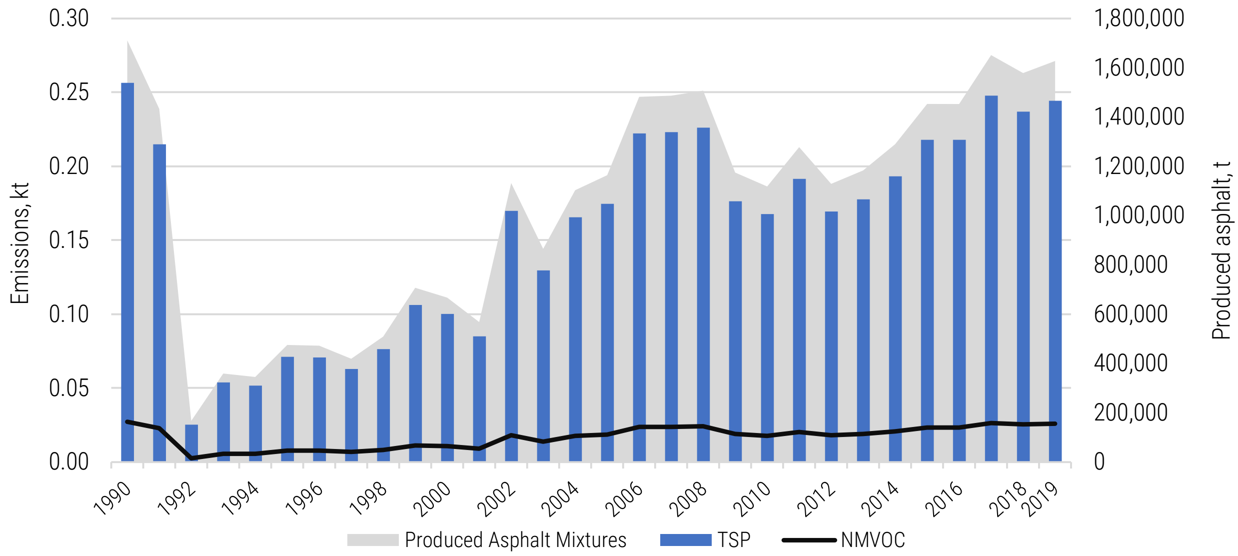

Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production in the period of 1990-2019

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. The Tier 1 method uses readily available statistical data and default emission factors (see Table 4.12). For particles 99% abatement efficiencies are used.

Table 4.12 NMVOC emission factors for road paving with asphalt and PM emission factors for construction and demolition

NFR	Unit	NMVOC	PM_{10}	$PM_{2.5}$	BC	TSP
2D3b Road paving with asphalt	g/Mg asphalt	16	2 000	100	5.7 % of $PM_{2.5}$	15000

4.1.5.3. Activity Data

Information regarding asphalt production and laying is available from the Estonian Asphalt Pavement Association (www.asfaldiliit.ee) for the years 1990-2019 (see Table 4.13). 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 4.13 Activity data for NMVOC emission calculations from asphalt production in the period of 1990-2019 (tonnes)

Year	Produced Asphalt Mixtures
1990	1,711.000
1995	475.000
2000	667.000
2005	1,164.000
2010	1,118.187
2011	1,277.793
2012	1,128.815
2013	1,183.263
2014	1,289.663
2015	1,453.025
2016	1,452.025
2017	1,651.228
2018	1,578.371
2019	1,627.448

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

4.1.6.1. Source Category Description

This chapter includes the pollutant emissions from pulp and paper, food and drink, wood and furniture industries.

The pulp and paper industry in Estonia has a long tradition, having been established as far back as the 17th century. The high level of automation and modern technology has made the production of pulp one of the highest productivity sectors in Estonia. There are about 60 companies in Estonia that manufacture paper, pulp or paper products. Over 81% of the sector’s production is exported which is why, as users of local raw materials, they are important in improving foreign trade balance. 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 with a slightly smaller turnover. 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.

2019 was a difficult year for the paper industry. Both of the largest companies in the sector lost turnover and exports. Demand for their products on the world market was rather weak and sales prices were low. Although the pandemic increased online sales, it was probably not enough to cover the shortcomings occurred elsewhere, which could also prove difficult for the sector of 2020.[13]

The paper industry is a heavily concentrated industry in Estonia. Horizon Tselluloosi ja Paberi AS is the largest paper and cardboard producer. Horizon 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.

(Photo by Rauno Volmar: Horizon Tselluloosi ja Paberi AS)

Horizon only manufactures unbleached varieties. Estonian Cell AS, an aspen pulp factory in Kunda (established in 2006), is the largest pulp producer.

The wood industry is one of largest industries. Wood is one of the most important natural resources in Estonia besides oil shale and makes a significant contribution to the balancing of foreign trade. Timber industry is one of the largest industries in Estonia.

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

[13] Overview of Economy 2019. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2020

has a wide range of products, from the manufacture and processing of lumber to the manufacture of wooden houses, windows and doors. When a decade age, the largest companies of the wood industry were involved in sawing wood, then now the manufacturers of wooden houses and other wooden products have taken the lead. Value is added to raw material increasingly often and more expensive products are exported.[14]

Furniture industry has also long traditions in Estonia. The larger companies of furniture industry in terms of the number of employees are located mainly in North and South Estonia

The food industry is one of the largest ones in Estonia in terms of production volume and it is the main activity of more than 700 companies.

The food industry consists of two major sectors: food and beverage production. 2019 was a bit more successful for food producers, sales in beverage production fell by a few percent over the year. [15]

The emissions from sector NFR 2H are presented in Table 4.14. Emissions of all pollutants has decreased in the period 2000-2019 and in 2019 compared to 2018 due to increase of emissions in food and pulp industry.

Table 4.14 Pollutant emissions from the pulp, paper and food industries in the period of 1990-2019 (kt)

Year	NO_x	NMVOC	SO_x	$PM_{2.5}$	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	0.000	0.744	0.130	0.127	0.171	0.220	0.003	0.020
2010	0.018	0.729	0.028	0.158	0.217	0.290	0.004	0.028
2011	0.038	0.785	0.020	0.079	0.111	0.158	0.002	0.015
2012	0.000	0.757	0.000	0.046	0.069	0.110	0.001	0.000
2013	0.043	0.739	0.000	0.083	0.120	0.180	0.002	0.019
2014	0.003	0.718	0.000	0.060	0.089	0.141	0.001	0.003
2015	0.015	0.706	0.002	0.057	0.085	0.134	0.001	0.005
2016	0.013	0.673	0.001	0.037	0.059	0.104	0.001	0.002
2017	0.015	0.708	0.000	0.032	0.052	0.094	0.001	0.011
2018	0.002	0.730	0.000	0.040	0.062	0.105	0.001	0.017
2019	0.002	0.760	0.000	0.030	0.051	0.100	0.001	0.015
Change 2000-2019, %	**-82.5**	**17.2**	**-100.0**	**-64.4**	**-55.4**	**-33.6**	**-71.7**	**-89.6**
Change 2018-2019, %	**-26.8**	**4.2**	**-90.9**	**-24.2**	**-17.4**	**-4.8**	**-32.0**	**-12.5**

The emissions of NMVOC and particulates from the wood processing (NFR 2I) are presented in Table 4.15; emissions of other substances from this sector are insignificant and aren't given in the table. Emissions from 2000 for 2008 are given under NFR sectors 2A6 and 2L.

Table 4.15 NMVOC and PM emission from the wood processing (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
2009	0.009	0.024	0.072	0.219
2010	0.014	0.027	0.082	0.248
2011	0.013	0.026	0.079	0.240
2012	0.010	0.026	0.077	0.233
2013	0.009	0.023	0.073	0.210
2014	0.001	0.023	0.076	0.212
2015	0.002	0.025	0.074	0.226
2016	0.001	0.023	0.069	0.210
2017	0.002	0.024	0.072	0.221
2018	0.004	0.056	0.169	0.516
2019	0.018	0.053	0.159	0.484

[14] Overview of Economy 2018. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2019
[15] Overview of Economy 2019.. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2020

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 2019 default emission factors (Tier 2 method).

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 4.16). 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 (Maseko and Spratfil in Harju and Ida-Viru 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 4.16 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

Product group (food and drink)	Emission factor	Unit
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 1990-2019 (Table 4.17-4.18).

Table 4.17 Activity data for the food industries in the period of 1990-2019 (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
2011	77.0	9.5	80.6	81.3	..	..	216.2
2012	76.7	8.1	78.4	67.8	..	..	198.8
2013	79.2	8.6	79.8	70.1	..	..	161.9
2014	80.0	9.9	80.7	69.2	..	..	117.5
2015	78.9	11.2	85.6	73.7	..	..	127.4
2016	76.98	10.69	77.9	76.4	..	..	109.9
2017	79.93	13.3	71.5	83.4	..	..	160.9
2018	81.85	11.04	74.4	88.2	..	..	176.2
2019	81.99	11.44	73.3	88.0	..	..	168.5

Table 4.18 Activity data for the drinks industries in the period of 1990-2019 (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
2011	73.3	1,358.8	13.3	169.2
2012	96.3	1,460.0	4.5	182.0
2013	106.6	1,472.7	1.8	157.7
2014	107.3	1,636.7	11.6	136.0
2015	107.7	1,446.9	18.1	157.3
2016	117.45	1,419.1	20.2	150.9
2017	97.77	1,389.9	23.7	142.96
2018	82.6	1,372.5	23.7	125.5
2019	120.5	1,410.2	23.7	137.5

4.1.7. Uncertainty

An uncertainty analysis was carried out to the year 2019 inventory. The uncertainty in the emission factors for NO_x, NMVOC and SO_x from industrial processes is estimated in the range from 20% to 50%, for ammonia 20-200%, for particulates 20-100%; in the activity data in the range from 2% to 5%. Uncertainty estimates for stationary combustion are given in Table 4.19.

Table 4.19 Uncertainties in industrial processes sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	0.0670	kt	0.27	0.12	0.05
NMVOC	0.8557	kt	3.77	1.61	3.38
SO_x	0.0002	kt	0.001	0.00	0.00
NH_3	0.0894	kt	0.84	1.26	0.61
$PM_{2.5}$	0.2476	kt	4.21	2.01	0.69
PM_{10}	1.4529	kt	15.73	11.30	2.82
TSP	4.5761	kt	32.84	24.70	1.14
CO	0.6293	kt	0.48	0.23	0.08
Pb	0.0069	t	0.06	0.03	0.00
Cd	0.0030	t	0.54	0.00	0.03
PCDD/PCDF	0.0300	g I-TEQ	0.66	0.59	0.27
HCB	0.0015	kg	0.43	0.43	0.59
PCB	0.00002	kg	0.01	0.00	0.00

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

In the 2021 submission the following recalculations were carried out:

- In comparison with the previous submission, the emissions of ammonia were reallocated from NFR 2A6 to NFR 2L for the period 2000–2003.
- This year, POPs emissions from a metal production industry (2C3 and 2C5 for the period 2000–2018 were additionally calculated.
- Emissions of SO_2 for the years 2001, 2003-2004 were reallocated from NFR 2B20a to 1A2gviii.
- Emissions of particulate for the period 2009-2018 were reallocated fron NFR 2C7a to NFR 2C1.
- Emissions of Zn were corrected for the 2010-2018.
- Additionally calculated CO emission for NFR 2B1 for the years 2002-2003, 2005-2006; for NFR 2B10a for the 1995-1996 and NO_x for the 2010, 2013-2014.

4.1.10. Source-Specific Planned Improvements

Allocate the historical emission from wood and furniture industries from NFR 2A6 and NFR 2L and to include in NFR 2I Wood processing. This process demands certain efforts as corrections are necessary for carrying this out in a national point sources database.

4.2. Solvent and Other Product Use

4.2.1. Source Category Description

This chapter describes emissions from solvents and other product use. The use of solvents and products containing solvents results in emissions of non-methane volatile organic compounds (NMVOC) when emitted into the atmosphere. In addition to solvents, this sector also includes the emissions of particulate matter from painting, tobacco smoking and the use of fireworks under NFR 2G. Also, the heavy metals, CO, SO_x, NH_3, NO_x and POPs emissions are calculated from tobacco smoking.

In 2009-2010, the Estonian Environment Information Centre (nowadays Estonian Environment Agency, 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 2019.

This sector covers emissions from the use of solvents and other products for the following NFR14 categories: domestic solvent use including fungicides (NFR 2D3a), coating application (NFR 2D3d), degreasing (NFR 2D3e), dry-cleaning (NFR 2D3f), chemical products (NFR 2D3g), printing (NFR 2D3h), other solvent use (NFR 2D3i) and other product use (NFR 2G).

Source: www.hdwallpapersos.com

Air pollutants under solvent and other product use sector in the Estonian inventory are presented in Table 4.20.

Table 4.20 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 applications	Includes emissions from domestic and industrial paint application	Tier 2 / Tier 3	NO_x, NMVOC, SO_x, PM_{10}, TSP, CO, Pb, Cu, Zn
2D3e	Degreasing	Includes emissions from degreasing (vapour and cold cleaning), electronic components manufacturing and other industrial cleaning	Tier 2 / Tier 3	NO_x, NMVOC, SO_x,NH_3, PM_{10}, TSP, Pb, Cr, Cu
2D3f	Dry cleaning	Includes emissions from dry cleaning	Tier 1 / Tier 3	NMVOC
2D3g	Chemical products	Includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other use of solvents	Tier 3	NO_x, NMVOC, SO_x, NH_3, PM_{10}, TSP, CO, Pb, Cr, Zn
2D3h	Printing	Includes emissions from solvents in printing houses	Tier 1 / Tier 3	NO_x, NMVOC, NH_3, TSP, CO
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, fireworks and 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, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs

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4.2.2. Quantitative Overview of NMVOCs

In 2019, the solvent and other product use sector, which was the largest pollution source of NMVOC emissions in Estonia, accounted for 41.7% of total NMVOC emissions. The largest share within the solvent and other product sector was for coating application at 48.1%, with the others being domestic solvent use at 32.9%, other solvent use 11.0%, printing 5.6%, chemical products 1.2%, degreasing 0.7%, other product use and dry cleaning 0.6% (see Figure 4.9).

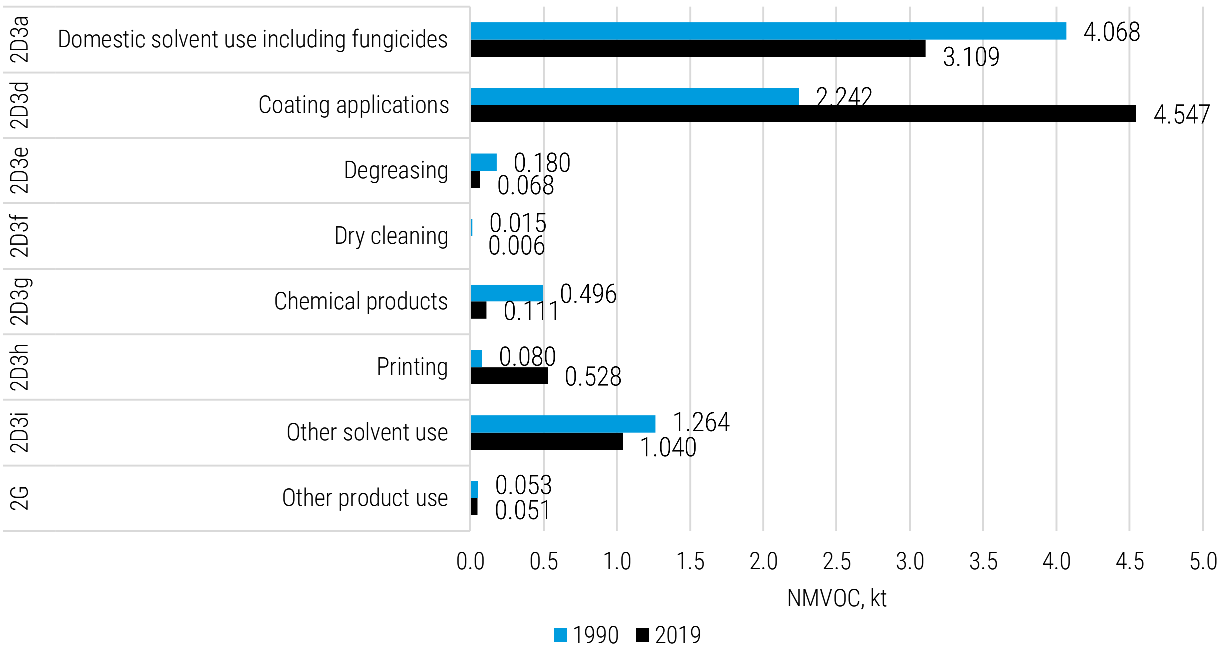

Figure 4.9 NMVOC emissions by sectors in 1990 and 2019

There has been a slight increase in trends of NMVOC emissions from solvent and other product use in recent years. Since 1990, NMVOC emissions have increased in the solvent sector by 12.7% (see Figure 4.10). The trend in emissions is determined, in order of importance, by NFR categories 2D3d (Coating application) and 2D3a (Domestic solvent use). The major category where an increase in NMVOC emissions has occurred in recent years is the coating application (NFR 2D3d). The fluctuation of NMVOC emissions in the period of 1990-2019 has mostly occurred due to the welfare of the economic state of the country. The decrease in emissions between 1991 and 1993 was due to the renewed independence of the Republic of Estonia and the cessation of large-scale production that was distinctive of the Soviet Union. Between 1993 and 1998, the economic growth induced the growing usage of NMVOC containing paints in decorative and industrial coating applications. At the end of 1998, the world was struck by an economic crisis that affected the construction sector, resulting in a knock-on effect on the usage of decorative coatings. From 2001, the economy began to grow again until 2008, when the world suffered its worst ever economic depression, which also greatly affected the Estonian economy. As a result, by the year 2010, NMVOC emissions fell 42.7% in comparison with 2006 (see Figure 4.11). In 2011, there was an 17% increase in NMVOC emissions compared to 2010, which meant that the bottom of the emissions was reached, and henceforward, the emissions have been started to rise again.

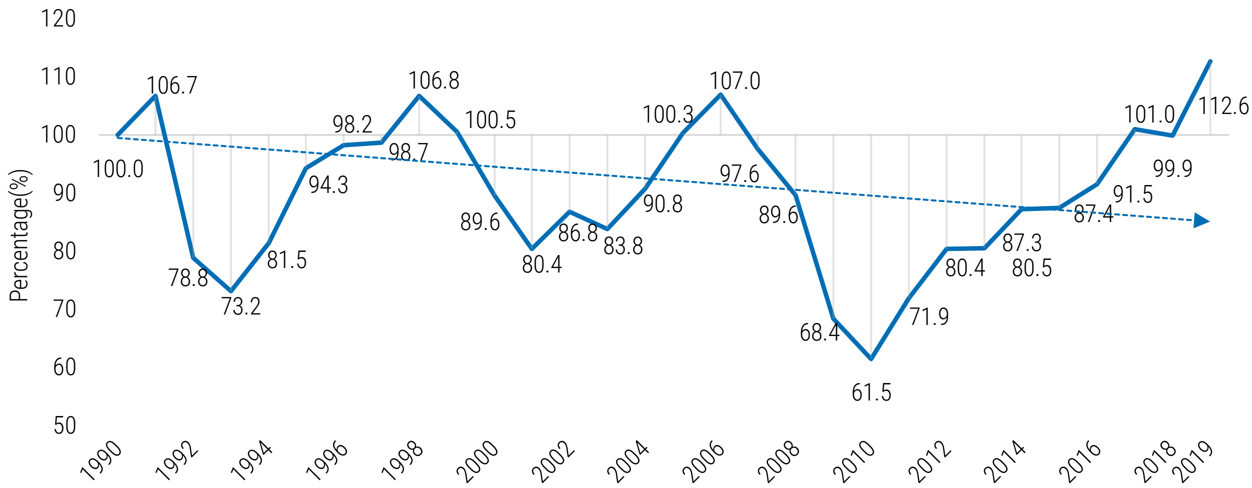

Figure 4.10 The dynamics of NMVOC emissions from the solvent and other product use sector in the period of 1990-2019 (1990 = 100%)

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 on the graph is because the emissions from the point sources, which are calculated more precisely by the facilities than the emissions from the diffuse sources, represent only about 20% of total solvent sectors NMVOC emissions.

In 2019, NMVOC emissions from the use of solvents and other products increased by almost 12.7% compared to 2018. The main reason for the increase in emissions is the increased consumption of solvent-based paints for decorative coatings (NFR 2D3d) and the increased consumption of adhesive (NFR 2D3i).

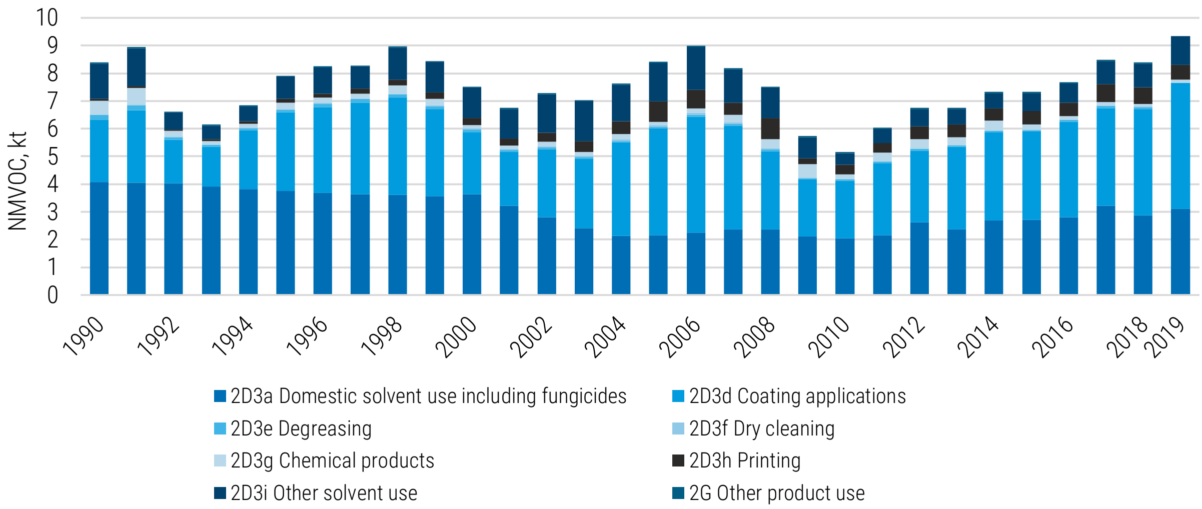

Figure 4.11 NMVOC emissions from the solvent and other product use sector in the period of 1990-2019

Table 4.21 NMVOC emissions from the solvent and other product use sector in the period of 1990-2019 (kt)

Year\NFR	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G
1990	4.068	2.242	0.180	0.015	0.496	0.080	1.264	0.053
1995	3.751	2.848	0.077	0.025	0.250	0.126	0.810	0.032
2000	3.629	2.258	0.084	0.050	0.107	0.248	1.115	0.032

Year\NFR	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G
2005	2.168	3.842	0.053	0.062	0.125	0.745	1.384	0.044
2010	2.034	2.092	0.047	0.012	0.164	0.354	0.423	0.039
2011	2.153	2.600	0.054	0.019	0.313	0.344	0.512	0.043
2012	2.617	2.599	0.058	0.008	0.337	0.456	0.630	0.044
2013	2.375	2.961	0.051	0.039	0.268	0.461	0.563	0.044
2014	2.699	3.167	0.051	0.041	0.338	0.439	0.551	0.045
2015	2.711	3.179	0.058	0.030	0.179	0.473	0.665	0.047
2016	2.812	3.432	0.075	0.007	0.125	0.479	0.705	0.049
2017	3.219	3.508	0.093	0.007	0.129	0.663	0.810	0.050
2018	2.883	3.816	0.088	0.007	0.108	0.584	0.857	0.051
2019	3.109	4.547	0.068	0.006	0.111	0.528	1.040	0.051
Trend 1990-2019, %	-23.6	102.8	-62.3	-57.30	-77.59	562.2	-17.8	-4.1

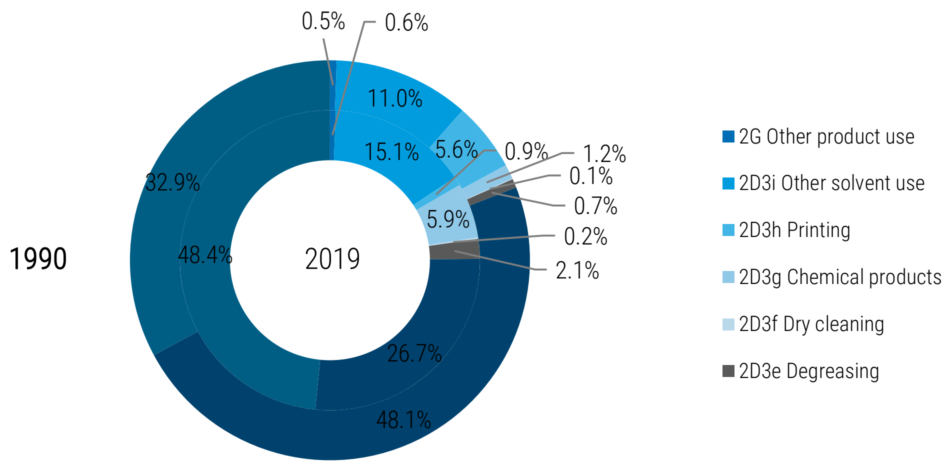

Figure 4.12 The share of NMVOC emissions in 1990 and 2019 by NFR solvent subcategory codes

4.2.3. Methods

NMVOC emission estimations from solvent and other product use are based on several data sources and methods. Emissions from point sources are gathered from the web-based air emissions data system for point sources and the emissions for diffuse sources are calculated from the data received and gathered mainly from Statistics Estonia using international emission factors and expert opinions. Information sources for the NMVOC inventory by different subcategories are presented in the Table 4.22 together with emission sources not included in the inventory.

Table 4.22 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,	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 (2004-2019, GB2019)

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NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
	adhesives and sealants, pharmaceutical products	060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: EF from Table 3.5 (2004-2019, GB2019)
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, GB2019, solvent based), 2007-2019 IEF from the PS; Table 3-7 in combination with Table 3-19 (1990-2007, GB2019, water based), 2008-2019 IEF from the PS; PS: facility specific
		060103	Construction and buildings	Statistics Estonia and expert estimate	DS: Tables 3-4 and 3-5 (1990-2019, GB2019, solvent based); Tables 3-4 and 3-5 in combination with Table 3-17 (1990-2019, GB2016, water based); 149.5 g/kg of paint applied (1990-2019, calculated as an average of SB and WB EFs)
		060104	Domestic use	Statistics Estonia and expert estimate	
		060105	Coil coating	Reported by operators (for the years 2012-2017)	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 (GB2019)
		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 (GB2019); 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	Not relevant	NA
		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 (GB2019); 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	Not included	NA
		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, GB2019); 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 (GB2019)
		060603	Use of shoes	Not included	NA
		060604	Other	Lubricant oil consumption is calculated by use the COPERT 5 model	DS: Table 3-17 (GB2019) see Chapter 3.3.3.2

Emissions, other than NMVOC, are taken from the point sources database (reported by operators and are facility-specific), except emissions from fireworks and tobacco use, where Tier 2 emission factors are taken from the EMEP/EEA Guidebook 2019, and lubricant use, where COPERT 5 model are used.

The facilities that are obliged to have an ambient air pollution permit or IPPC permit submit their annual air emissions and activity data into point sources database by point sources. An ambient air pollution permit is required for facilities where the total NMVOC emissions are more than 0.5 tonnes per year.

The data collected in the annual air emissions report for the solvent use are:

- Class – solvent, varnish, adhesive, paint or other chemicals that do not fall into any other previously named categories, such as hardeners, stains, resins, etc.;
- Type – water based (WB) or solvent based (SB);
- Total NMVOC content of the used chemical in mass%;
- Activity or technological process by the SNAP activity codes where the reported chemical has been used;
- The annual consumption of solvent or solvent containing mixture (i.e. paint, varnish, adhesive or other chemical) in tonnes per year;
- Emissions of pollutants by the used solvent or solvent containing mixture – CAS number, name of the substance, NMVOC emission in tonnes per year;
- The number of a source of pollution on a plan or map of the facility.

4.2.4. Uncertainty

An uncertainty analysis was carried out to the year 2019 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 5%. Uncertainty estimates for solvent and other product use are given in Table 4.23.

Table 4.23 Uncertainties in solvent and other product use sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	0.003	kt	0.01	0.01	0.00
NMVOC	9.459	kt	41.68	12.58	3.25
SO_x	0.002	kt	0.01	0.004	0.00
NH_3	0.008	kt	0.08	0.03	0.01
$PM_{2.5}$	0.069	kt	1.18	0.59	0.16
PM_{10}	0.093	kt	1.00	0.50	0.12
TSP	0.105	kt	0.75	0.35	0.02
CO	0.088	kt	0.07	0.03	0.01
Pb	0.385	t	3.38	1.70	0.09
Cd	0.017	t	3.06	1.54	0.14
Hg	0.004	t	1.34	0.68	0.04
PCDD/F	0.0002	g I-TEQ	0.00	0.01	0.001
B(a)p	0.0002	t	0.02	0.04	0.001
B(b)f	0.00007	t	0.01	0.01	0.00
B(k)f	0.00007	t	0.01	0.02	0.00
I(1,2,3-cd)p	0.00007	t	0.01	0.02	0.00
HCB	NA	kg	NA	NA	NA
PCB	NA	kg	NA	NA	NA

4.2.5. Domestic Solvent Use Including Fungicides (NFR 2D3a)

4.2.5.1. Source Category Description

Emissions occur due to the evaporation of NMVOCs contained in the products during their domestic use. This category does not include the use of decorative paints, which is covered under NFR 2D3d (Coating applications).

The products sold for public use can be divided into a number of categories presented in Table 4.24.

Table 4.24 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.

For most products, all NMVOCs will be emitted into the atmosphere. However, in some products, the NMVOCs will be lost mainly in wastewater.

In 2019, NMVOC emissions from the NFR sector 2D3a had decreased by 23.58% compared to the year 1990. Compared to 2018, NMVOC emissions in 2019 increased by 7.83%. The increase in NMVOC emissions was mainly due to an increase in the consumption of pesticides and car care products.

4.2.5.2. 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 4.25 presents the EMEP/EEA Guidebook 2019 default Tier 2 emission factors for NFR source category 2D3a for NMVOC by the four main subcategories: household products, car care products, cosmetics and toiletries, and DIY/buildings in addition to pharmaceutical products and pesticides.

Although the EMEP/EEA Guidebook 2019 provides the so-called Tier 2b emission factors for NMVOC emission calculations using population as activity data, it is recommended that those emission factors are to be used only when the product statistics for the use of Tier 2a approach are not complete in terms of the product types covered by domestic solvent use. Because of that, Tier 2b EFs have been applied for some source categories.

Table 4.25 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	2a	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.4
Car care product (all)	NMVOC	180	g/kg product	2a	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.4
Cosmetics and toiletries (all)	NMVOC	127	g/kg product	2a	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.4
DIY/buildings (adhesives)	NMVOC	66	g/kg product	2a	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.4
DIY/buildings (paint thinner)	NMVOC	205	g/person	2b	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.5
DIY/buildings (paint and varnish removers, solvents)	NMVOC	68	g/person	2b	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.5
DIY/buildings (sealants, filling agents)	NMVOC	23	g/person	2b	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.5
Pharmaceutical products	NMVOC	48	g/person	2b	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.5
Pesticides	NMVOC	150	g/kg product	2a	EMEP/EEA GB2019, Ch. 2.D.3.a, Table 3.4

4.2.5.3. Activity Data and Results

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 4.26).

It should be noted that the activity data used for estimating the amounts of used products is still a first estimate and includes some interpolation and filling data gaps due to the negative balance in international trade data for some years. In addition, there is not yet full confidence that the activity data taken into account is complete. For that, Estonia is planning to outsource a project if the financing is approved by the Ministry of the Environment.

Table 4.26 NMVOC emissions from domestic solvent use (other than paint application) and the population of Estonia in the period of 1990-2019

Year	Population, mln. inhab.	Used products, kt				
		Cosmetics and toiletries (all)	Household products (all)	Car care products (all)	DIY/ buildings (adhesives)	Pesticides
1990	1.5706	NA	NA	NA	NA	NA
1995	1.4481	NA	NA	NA	NA	NA
2000	1.4013	NA	NA	NA	NA	NA
2004	1.3663	4,134.571	14,122.796	3,752.046	7,66.440	1,301.627
2005	1.3589	4,619.914	14,026.552	3,711.227	7,66.440	1,140.390
2010	1.3333	3,810.263	11,815.882	3,006.139	3,103.142	1,042.520
2011	1.3297	3,029.784	17,004.347	3,244.642	3,456.409	1,512.685
2012	1.3252	3,666.114	37,906.788	2,999.132	3,734.204	2,016.795
2013	1.3202	3,862.264	15,340.151	3,030.801	4,446.274	2,304.206
2014	1.3158	3,892.606	23,952.504	4,706.692	3,304.468	2,022.482
2015	1.3133	3,851.297	34,237.736	4,021.843	2,391.283	2,272.225
2016	1.3159	3,523.506	54,517.063	2,400.419	2,797.990	2,821.454
2017	1.3156	3,339.843	60,235.090	4,745.382	3,297.790	2,044.741
2018	1.3191	5,614.479	15,572.838	4,795.665	5,418.211	1,640.724
2019	1.3248	4,984.702	11,434.145	6,837.636	4,035.033	2,265.557

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Table 4.26 continues

Year	NMVOC emissions by domestic solvent use categories, kt									
	Cosmetics and toiletries (all)	Household products (all)	Car care products (all)	DIY/ buildings (adhesives)	DIY/ buildings (sealants, filling agents)	DIY/ buildings (paint thinner)	DIY/ buildings (paint and varnish removers, solvents)	Pesticides	Pharmaceutical products	Total
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.0679
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.7505
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.6292
2004	0.5251	0.2260	0.6754	0.0506	0.0314	0.2801	0.0929	0.1952	0.0656	2.1422
2005	0.5867	0.2244	0.6680	0.0506	0.0313	0.2786	0.0924	0.1711	0.0652	2.1683
2010	0.4839	0.1891	0.5411	0.2048	0.0307	0.2733	0.0907	0.1564	0.0640	2.0339
2011	0.3848	0.2721	0.5840	0.2281	0.0306	0.2726	0.0904	0.2269	0.0638	2.1533
2012	0.4656	0.6065	0.5398	0.2465	0.0305	0.2717	0.0901	0.3025	0.0636	2.6168
2013	0.4905	0.2454	0.5455	0.2935	0.0304	0.2706	0.0898	0.3456	0.0634	2.3747
2014	0.4944	0.3832	0.8472	0.2181	0.0303	0.2697	0.0895	0.3034	0.0632	2.6989
2015	0.4891	0.5478	0.7239	0.1578	0.0302	0.2692	0.0893	0.3408	0.0630	2.7113
2016	0.4475	0.8723	0.4321	0.1847	0.0303	0.2698	0.0895	0.4232	0.0632	2.8124
2017	0.4242	0.9638	0.8542	0.2177	0.0303	0.2697	0.0895	0.3067	0.0632	3.2190
2018	0.7130	0.2492	0.8632	0.3576	0.0303	0.2704	0.0897	0.2461	0.0633	2.8829
2019	0.6331	0.1829	1.2308	0.2663	0.0305	0.2716	0.0901	0.3398	0.0636	3.1087

4.2.5.4. 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.

4.2.5.5. Source-Specific Planned Improvements

It is planned to outsource a project for estimating Tier 2 emissions for the whole time series in the domestic solvent use sector and specify/update currently used activity data if the financing for that project is approved by the Ministry of the Environment.

4.2.6. Coating Applications (NFR 2D3d)

4.2.6.1. Source Category Description

This chapter deals with the use of paints within the industrial and domestic sectors. Traditionally, the term ‘paint’ has often been used to describe pigmented coating materials only, thus excluding clear coatings such as lacquers and varnishes. However, here, the term ‘paint’ is taken to include all materials applied as a continuous layer to a surface with the exception of glues and adhesives, which are covered by NFR source category 2D3i. Inks, which are coatings applied in a non-continuous manner to a surface to form an image, are excluded by the definition given above and are covered by NFR source category 2D3h.

Most paints contain organic solvents, which must be removed by evaporation after the paint has been applied to a surface for the paint to dry or ‘cure’. Unless captured and either recovered or destroyed, these solvents can be considered emitted into the atmosphere. Some organic solvent may be added to coatings before application, which will also be emitted. Further solvent used for cleaning coating equipment is also emitted.

The proportion of organic solvent in paints can vary considerably. Traditional solvent-based paints contain approximately 50% organic solvents and 50% solids. In addition, more solvent may be added to further dilute the paint before application. High solids and water-based paints both contain less organic solvent, typically less than 30%, while powder coatings and solvent-free liquid coatings contain no solvent at all.

The most important pollutants released from painting activities are NMVOCs. Particulate matter can also be emitted where spraying is used as an application technique; however, many spraying operations are carried out in spray booths fitted with some type of particulate arrestment device. Heavy metal compounds used as pigments could be emitted into the air; however, no emission factors are available.

Due to the wide range of paint applications and the even larger number of paint formulations available, there must be considerable scope for uncertainty in emission factors. Due to developments in paint formulation, the emission factors may only be valid for a short period. Therefore, improved emission factors are especially required for controlled processes.

Another aspect is the variation of paint types. This requires good activity data, which may not be present, particularly with the increasing use of alternatives to high-solvent paints.

By 2019, NMVOC emissions from this sector had increased by 102.8% compared to 1990. Compared to 2018, NMVOC emissions had increased by 19.2%. The increase in NMVOC emissions was mainly due to an increase in the consumption of solvent-based decorative coatings (SNAP activities 060103 and 060104). By 2019, NMVOC emissions from the consumption of decorative coatings had increased by 39.3% compared to 2018.

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 air pollution 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.

4.2.6.2. 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 4.5% in 2006 up to 22.4% in 2019. 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 4.27 provides an overview of emission factors used in calculating NMVOC emissions from coating application activities.

Table 4.27 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	GB2019, 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	GB2019, 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.

SNAP	SNAP name	Chemical Type	Value	Unit	Tier	Source	Comment
060102	Paint application: car repairing	WB	216	g/kg paint applied	2/3	GB2019, Chapter 2.D.3.d Coating applications; Table 3-7 in combination with Table 3-19; Abetment efficiency is taken for "Conventional primer; very high solid surfacer; improved topcoat(s); better cleaning agent(1)" (Efficiency 0.7)	DS: for the years 1990-2007. For 2008 and onwards, annual IEFs from point sources are applied.
060103	Paint application: construction and buildings	SB	230	g/kg paint applied	2	GB2019, 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 (GB2019) in combination with Table 3-17 (GB2016); Abetment efficiency is taken for "Substitution with dispersion/emulsion, water-based and high solids paints" (Eff. 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	GB2019, 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 (GB2019) in combination with Table 3-17 (GB2016); Abetment efficiency is taken for "Substitution with dispersion/emulsion, water-based and high solids paints" (Eff. 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 these groups, 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.

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As a result of discussions, it is estimated that up to 60% of paint can be assigned to professional painters and the remaining 40% to private customers.

The Tier 2 emission factors of the EMEP/EEA Guidebook 2019 (see Table 4.27) 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 2019, 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 2016) 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 100 tonnes in 1990 to 227,6 tonnes in 2019. As this is a rough estimate, the annual growth is estimated to be equal. The EMEP/EEA Guidebook 2019 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 4.28) 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 2019 Tier 1 NMVOC emission factor of 400 g/kg paint applied for industrial coating application.

Table 4.28 Implied emission factors from point sources for solvent and water-based refinishing products in car repair coating applications (g/kg paint applied)

Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
WB	-	181	255	234	76	110	113	114	133	151	143	174	172
SB	569	443	448	341	349	332	364	421	449	456	453	443	419

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Emissions

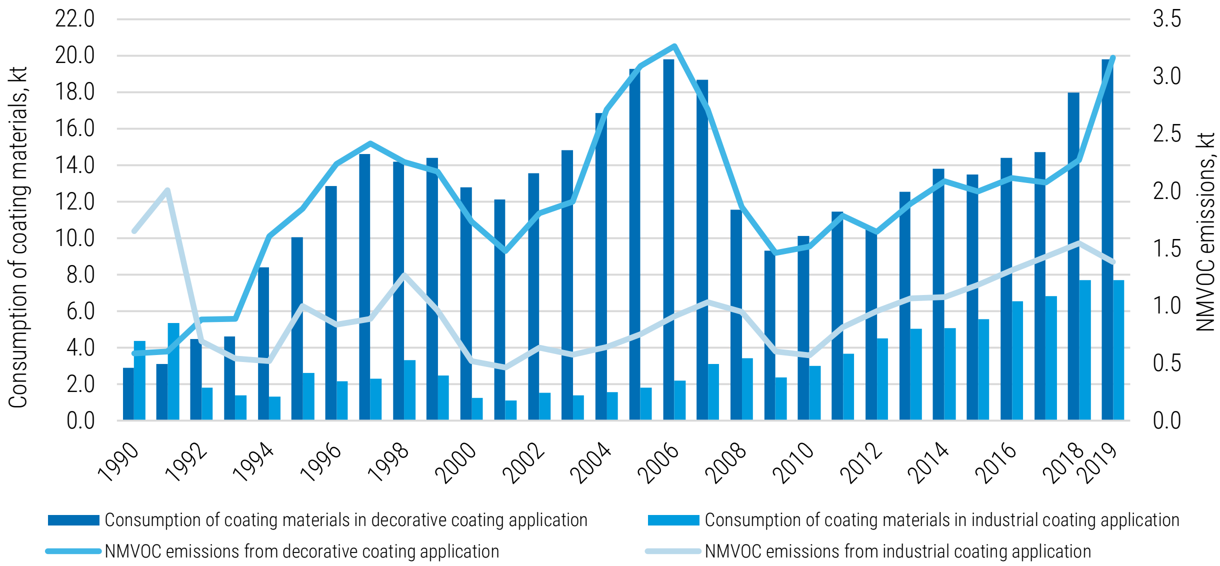

Figure 4.13 The consumption of coating materials and NMVOC emissions from decorative and industrial coating applications in the period of 1990-2019

The huge drop in industrial paint consumption and NMVOC emissions in 1992 (see Figure 4.13) was due to the renewed independence of the Estonian Republic and the cessation of large-scale production which was distinctive of the Soviet Union. Extensive restructuring took place in industry, and many of the large enterprises went bankrupt and were shut down due to inefficient operation.

Table 4.29 NMVOC emissions and the consumption of coating materials from decorative paint application by SNAP codes in the period of 1990-2019 (kt)

SNAP code	060103		060104	
Year	NMVOC	Activity data	NMVOC	Activity data
1990	0.354	1.734	0.236	1.156
1995	1.108	6.034	0.739	4.023
2000	1.041	7.674	0.694	5.116
2005	1.854	11.563	1.236	7.709
2010	0.913	6.067	0.608	4.044
2011	1.071	6.869	0.714	4.579
2012	0.987	6.299	0.658	4.199
2013	1.136	7.533	0.757	5.022
2014	1.253	8.291	0.835	5.527
2015	1.199	8.096	0.799	5.398
2016	1.270	8.645	0.847	5.763
2017	1.247	8.830	0.832	5.886
2018	1.362	10.787	0.908	7.191
2019	1.897	11.875	1.265	7.917

Table 4.30 NMVOC emissions and consumption of coating materials from industrial paint application by SNAP codes in the period of 1990-2019 (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	1.575	4.229	NA	NA	0.052	0.100	NA	NA	IE	IE	IE	IE	0.025	0.063
1995	0.795	2.135	NA	NA	0.063	0.122	NA	NA	IE	IE	0.047	0.119	0.094	0.236
2000	--	--	NA	NA	0.075	0.144	NA	NA	0.117	0.292	0.119	0.298	0.211	0.528
2005	--	--	0.002	0.004	0.086	0.166	NA	NA	0.131	0.329	0.184	0.459	0.350	0.874
2010	--	--	NA	NA	0.052	0.192	NA	NA	0.157	0.575	0.239	1.526	0.122	0.730
2011	--	--	NA	NA	0.044	0.196	NA	NA	0.135	0.470	0.448	2.056	0.187	0.938
2012	--	--	NA	NA	0.052	0.207	0.002	0.005	0.109	0.385	0.527	2.723	0.263	1.193
2013	--	--	NA	NA	0.068	0.220	0.011	0.021	0.117	0.385	0.567	3.158	0.304	1.257
2014	--	--	NA	NA	0.081	0.234	0.013	0.024	0.101	0.355	0.589	3.228	0.295	1.259
2015	--	--	NA	NA	0.084	0.336	0.010	0.018	0.087	0.264	0.655	3.539	0.345	1.396
2016	--	--	NA	NA	0.107	0.469	0.008	0.014	0.083	0.303	0.672	3.776	0.444	1.978
2017	--	--	NA	NA	0.115	0.289	0.011	0.021	0.079	0.342	0.664	4.405	0.559	1.775
2018	--	--	NA	NA	0.121	0.294	NA	NA	0.090	0.320	0.690	4.731	0.645	2.363
2019	--	--	NA	NA	0.129	0.314	NA	NA	0.076	0.248	0.560	4.582	0.621	2.551

NMVOC emissions presented in the Table 4.30 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 fine and ultra-fine particulate matter emissions, which are collected from the point sources 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.

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.

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'.

4.2.6.3. 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 reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.6.4. Source-Specific Planned Improvements

Some corrections and recalculations of the NMVOC emissions from the point sources for the years 1990–1999 are planned. Primarily, they will concern the emissions currently under SNAP 060100, which need to be distributed under the correct SNAP code. In addition, emissions under the SNAP codes 060107 and 060108 need to be revised for that period.

4.2.7. Degreasing (NFR 2D3e)

4.2.7.1. 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 2019, NMVOC emissions from this sector had decreased by 62.26% in comparison to the year 1990.

Vapour Cleaning

The most common organic solvents for vapour cleaning are:

- methylene chloride (MC);
- tetrachloroethylene (PER);
- trichloroethylene (TRI);
- xylenes (XYL).

The use of chlorofluorocarbons (CFC) in the past is now displaced by HFCs or PFCs. The use of 1,1,1-trichloroethane (TCA) has been banned since the Montreal Protocol and replaced by TRI. Further details of the calculation of the emissions can be found in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The application of MC, PER and TRI normally requires a closed cleaning machine.

Cold Cleaning

The two basic types of cold cleaners are maintenance and manufacturing. Cold cleaners are batch loaded, non-boiling solvent degreasers, usually providing the simplest and least expensive method of metal cleaning. Maintenance cold cleaners are smaller, more numerous, and they generally use petroleum solvents as mineral spirits (petroleum distillates and Stoddard solvents).

Cold cleaner operations include spraying, brushing, flushing, and immersion. In a typical maintenance cleaner, dirty parts are cleaned manually by first spraying and then soaking in the tank. After cleaning, the parts are either suspended over the tank to drain or are placed on an external rack that directs the drained solvent back into the cleaner. The cover is intended to be closed whenever parts are not being handled in the cleaner. Typical manufacturing cold cleaners vary widely in design, but there are two basic tank designs: the simple spray sink and the dip tank. Of these, the dip tank provides more thorough cleaning through immersion, and often the cleaning efficiency is improved by agitation. Small cold cleaning operations may be numerous in urban areas.

4.2.7.2. Methodological Issues

The EMEP/EEA Guidebook 2019 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 2019 for the open-top degreasers. The Table 4.31 below presents used emission factors and the reduction efficiencies for degreasing which are taken from the Table 3-2 presented in the Chapter '2.D.3.e Degreasing' of the EMEP/EEA Guidebook 2019.

Table 4.31 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 4.32). The shares of different technologies within the pillar years have been interpolated (see Figure 4.14).

Table 4.32 The shares of different technologies within the degreasing industry (for the pillar years)

Technology	1990	1995	2000	2005	2010	2015	2020
Open-top degreaser	25%	20%	15%	5%	0%	0%	0%
Semi open-top degreaser and good housekeeping	5%	10%	10%	10%	10%	5%	0%
Semi open-top degreaser and good housekeeping with activated carbon	0%	0%	5%	10%	15%	20%	25%
Sealed chamber system using chlorinated solvents	10%	10%	10%	10%	5%	5%	0%
Cold cleaner	60%	60%	60%	65%	70%	70%	75%

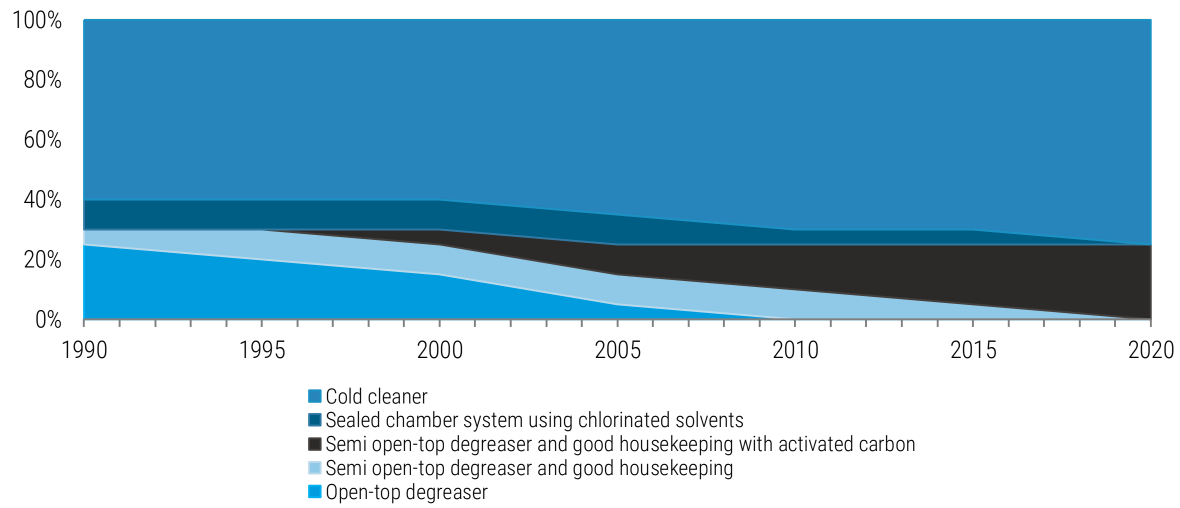

Figure 4.14 The shares of different technologies within the degreasing industry for the period of 1990-2020

For some years the degreasing sector also includes fine particulate matter emissions which are collected from the OSIS point sources database.

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'.

4.2.7.3. Activity Data

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 1995-2019. 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. The point sources database provides some information regarding xylenes production between 2006 and 2019.

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.

4.2.7.4. Results

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 2019, the point sources database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2019, activity data for calculations were calculated as follows:

Solvent use in diffuse sources = Total solvent use – Solvent use in point sources

Some companies reported emissions between 1995 and 2005, but without access to activity data. Emissions from point sources were subtracted from the total calculated NMVOC emission.

NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2019 are presented in the Table 4.33.

Table 4.33 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2019

SNAP code	060200		060201		060203		060204	
Year	NMVOC (vapour and cold cleaning)	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	0.180	0.705	NA	NA	NA	NA	NA	NA
1995	0.077	0.312	NA	NA	NA	NA	NA	NA
2000	0.084	0.389	NA	NA	0.001	0.001	NA	NA
2005	0.049	0.326	0.000	0.000	0.003	0.004	0.001	0.001
2010	0.015	0.159	0.011	0.012	0.005	0.008	0.016	0.020
2011	0.014	0.161	0.007	0.008	0.005	0.008	0.027	0.028
2012	0.009	0.129	0.005	0.006	0.003	0.008	0.040	0.036
2013	0.007	0.123	0.005	0.007	0.002	0.006	0.037	0.048
2014	0.000	0.081	0.011	0.013	0.005	0.009	0.035	0.057
2015	0.006	0.148	0.010	0.011	0.004	0.013	0.038	0.062
2016	0.008	0.173	0.008	0.009	0.003	0.005	0.056	0.077
2017	0.014	0.251	0.009	0.010	0.008	0.017	0.062	0.081
2018	0.004	0.160	0.012	0.013	0.008	0.016	0.064	0.092
2019	0.000	0.104	0.011	0.012	0.007	0.016	0.050	0.076

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For the SNAP codes 060201, 060203 and 060204, emissions and solvent consumption are based only on the reported data from the point sources for the period 2000-2019.

4.2.7.5. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.7.6. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.8. Dry Cleaning (NFR 2D3f)

4.2.8.1. 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.

4.2.8.2. 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[16]; UBA, 1989[17]). Also, a significant amount of the solvent goes back to the producers and to the recyclers, along with the sludge.

Solvent consumption data may be available from the industry and can be compared with a per capita emission factor. In addition, the proportion of solvent lost directly from the machine can also be estimated.

The Tier 1 default emission factors for NMVOC emissions from dry cleaning are a weighted average, calculated from the sum of all activity

[16] Passant N.R. (1993). Emissions of Volatile Organic Compounds from Stationary Sources in the United Kingdom: A Review of Emission Data by Process.
[17] UBA (1989). Luftreinhaltung '89 – Tendenzen – Probleme – Lösungen. Edited by the German Federal Protection Agency (Umweltbundesamt), Erich Schmidt Verlag GmbH, Berlin 1989.

and emission data from the GAINS model (IIASA, 2008[18]) – 40 g/kg textile treated.

Situation in Estonia

In order to understand the market situation, a descriptive interview with the representative of the main dry cleaning service provider, SOL Estonia, was carried out in 2010. SOL Estonia operates eight dry cleaning facilities in Tallinn, Pärnu, Kunda and Tartu.

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 4.34.

Table 4.34 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

4.2.8.3. Activity Data

As the quantity of textile treated is very difficult to estimate because even dry cleaning shops do not have the relevant statistics, solvent consumption is taken as a basis for NMVOC calculations.

Solvent emissions direct from the cleaning machine into the air represent about 80% of solvent consumption (i.e. 80% of solvent used for the replacement of lost solvent) for open-circuit equipment and a little more than 40% for a closed-circuit machine.

All dry cleaning facilities questioned have closed-circuit equipment and use PER as a cleaning agent. Used solvent goes to hazardous waste companies.

The quantity of PER used in Estonia can be estimated by import and export data. Data regarding import and export are not available for the years 1990-1994; therefore, these amounts were calculated by the change in percentage of the current prices in industrial production of chemicals and chemical products in that period.

As there is no information on stock data for the end of the year, it is assumed that all PER has been used in the specific year.

According to point sources database, no production of tetrachloroethylene/PER is reported for the years 2006-2019.

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.

[18] IIASA (2008). Greenhouse Gas and Air Pollution Integrations and Synergies (GAINS) model, www.iiasa.ac.at/rains/gains-online.html.

4.2.8.4. Results

Perchloroethylene might also be used in the degreasing process. It is difficult to divide the consumption of PER between dry cleaning and degreasing, which is why all PER used in Estonia is deemed to be used for dry cleaning purposes.

The emission factor for degreasing is also 460 g/kg cleaning products, which is more or less about 40% of the used products. Because of that it is reasonable to use the emission factor 400 g/kg solvent use for dry cleaning activity.

Table 4.35 NMVOC emissions and the consumption of solvents from dry cleaning in the period of 1990-2019 (kt)

SNAP code	060202	
Year	NMVOC	Activity data
1990	0.015	0.036
1995	0.025	0.062
2000	0.050	0.126
2005	0.062	0.149
2010	0.012	0.026
2011	0.019	0.042
2012	0.008	0.016
2013	0.039	0.093
2014	0.041	0.098
2015	0.030	0.071
2016	0.007	0.007
2017	0.007	0.013
2018	0.007	0.011
2019	0.006	0.010

For the dry cleaning sector for the years 1990 to 2001, only statistical data is used, whereas for the period of 2002 to 2019, both statistical and reported data are used.

4.2.8.5. 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 reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.8.6. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.9. Chemical Products (NFR 2D3g)

4.2.9.1. Source Category Description

This chapter covers emissions from the use of chemical products. These include many activities such as paints, inks, glues and adhesives manufacturing, polyurethane and polystyrene foam processing, tyre production, fat, edible and non-edible oil extraction and more. However, many of these activities are considered insignificant. For example, the total NMVOC emissions from these activities contributed just 0.49% to the total national NMVOC emissions in 2019 and only 1.2% to the whole solvent sector.

By 2019, NMVOC emissions from the chemical products sector had decreased by 77.59% compared to the year 1990.

4.2.9.2. Methodological Issues

This sector includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other chemical products manufacturing or processing activities under SNAP 060314. All emission estimates for the years 2006-2019 from the chemical products sector are based on emission data reported by operators in the point source database; hence they are divided by different SNAP codes. At present, only the total NMVOC emissions for the years 1990-2005 are known to be without any activity data. Also, for some activities within NFR 2D3h, the activity data is unknown for the period of 2006-2019.

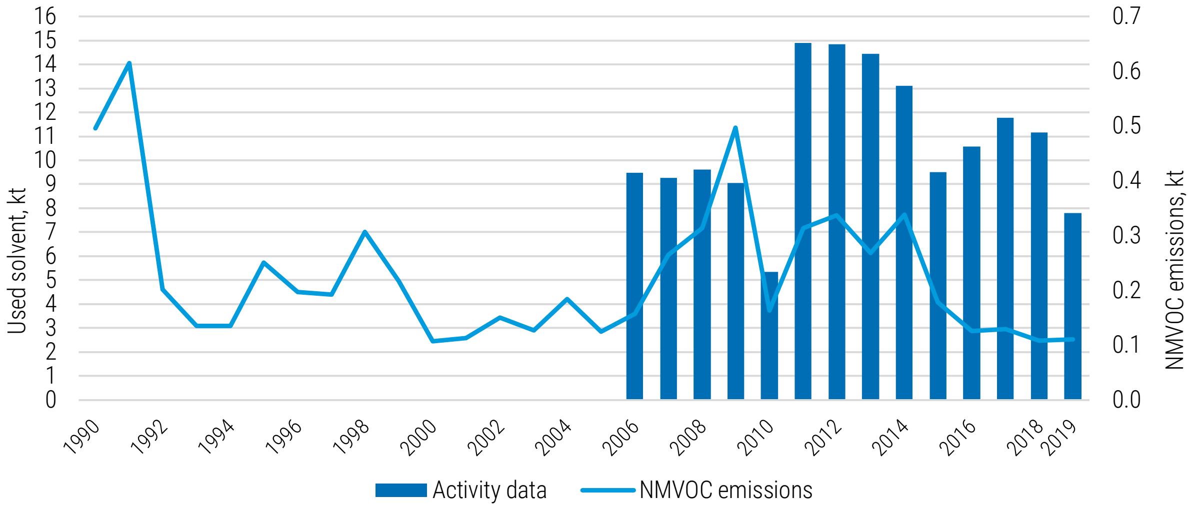

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 1990-2019

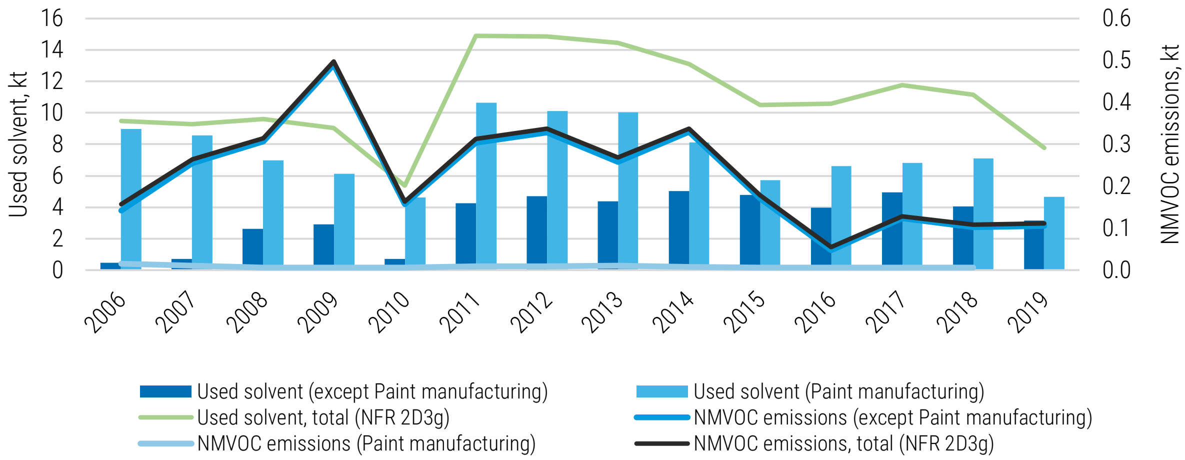

Figure 4.16 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 2006-2019

Figure 4.16 explains quite well why Figure 4.15 indicates that NMVOC emissions still grew from 2006 to 2009, although the amount of used solvent remained almost constant through that period. It is clear that the dynamics of emissions are dependent on the changes in used solvent within the sector, except the solvent used in paint manufacturing. It is because the emissions in paint manufacturing are marginal and do not affect the dynamics of the total NMVOC emissions in that sector.

NMVOC emissions for the period of 1990 to 2005 came only from point sources, but without the availability of the activity data for that period.

NMVOC emissions and the consumption of solvents from chemical production manufacturing or processing by SNAP codes in the period of 1990-2019 are presented in the Table 4.36.

Table 4.36 NMVOC emissions and the consumption of solvents from chemical products manufacturing or processing by SNAP codes in the period of 1990-2019 (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	0.496	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	0.250	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0.107	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	0.125	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010	--	--	0.0082	0.005	0.052	0.073	0.014	0.010	0.006	4.628
2011	--	--	0.0126	3.421	0.062	0.106	0.019	0.019	0.009	10.628
2012	--	--	0.0104	3.892	0.060	0.091	0.019	0.011	0.009	10.120
2013	--	--	0.0100	3.590	0.057	0.079	0.021	0.018	0.010	10.046
2014	--	--	0.0100	3.791	0.058	0.109	0.023	0.016	0.008	8.103
2015	--	--	0.0079	3.023	0.055	0.102	0.021	0.013	0.007	5.709
2016	--	--	0.0078	3.091	0.071	0.060	0.019	0.016	0.007	6.605
2017	--	--	0.0088	3.600	0.076	0.036	0.014	0.011	0.006	6.811
2018	--	--	0.0081	2.940	0.070	0.037	0.005	0.005	0.006	7.088
2019	--	--	0.0058	2.088	0.065	0.011	0.004	0.200	0.006	4.651

Table 4.36 continues

SNAP code	060308		060309		060312		060313		060314	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010	0.0003	0.026	0.00043	0.001	0.000001	NA	0.00030	0.014	0.082	0.601
2011	NA	NA	0.00004	NA	0.000356	0.0003	0.00018	0.013	0.210	0.714
2012	NA	NA	0.00001	NA	0.000350	0.0002	0.00017	0.018	0.238	0.703
2013	NA	NA	0.00007	NA	0.000330	0.0001	0.00001	0.018	0.170	0.688
2014	NA	NA	0.00003	NA	0.000373	0.0001	0.00012	0.010	0.238	1.090
2015	NA	NA	NA	NA	0.000214	0.0001	0.00016	0.009	0.087	0.642
2016	NA	NA	NA	NA	0.000554	0.3870	0.00019	0.007	0.020	0.413
2017	NA	NA	NA	NA	0.001305	0.6890	0.00016	0.008	0.023	0.611
2018	NA	NA	NA	NA	0.001302	0.6928	0.00018	0.006	0.018	0.389
2019	NA	NA	NA	NA	0.001899	0.4542	NA	NA	0.028	0.386

For some years, the chemical products sector also includes ultra-fine particulate matter emissions, which are collected from the OSIS 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.

4.2.9.3. 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 reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.9.4. Source-Specific Planned Improvements

As some activities are not included in this inventory (by the SNAP codes 060301, 060302, 060306, 060311), it is necessary to research whether the emissions from these activities are important for this inventory or whether they exist in Estonia at all. It is also necessary to review NMVOC emissions for the years 1990-2005 and to study the possibility of obtaining the activity data for these emissions.

4.2.10. Printing (NFR 2D3h)

4.2.10.1. Source Category Description

Printing involves the use of inks, which may contain a proportion of organic solvents. These inks may then be subsequently diluted before use. Different inks have different proportions of organic solvents and require dilution to varying extents. Printing can also require the use of cleaning solvents and organic dampeners. Ink solvents, diluents, cleaners and dampeners may all make a significant contribution to emissions from industrial printing and involve the application of inks using presses.

In the EMEP/EEA guidebook, the following printing categories are identified:

- Heat set offset printing;
- Publication and packaging;
- Rotogravure and Flexography.

The emissions of NMVOCs from printing have been significantly reduced following the introduction of the Solvent Emissions Directive 1999/13/EC in March 1999, which was adopted in Estonia in 2004. Larger facilities are now required to control their emissions in such a way that the emission limit value in the residual gas does not exceed a maximum concentration. The threshold is 15 tonnes/year for the heat set offset and flexography/rotogravure in packaging and 25 tonnes/year for the publication gravure (for the latter installations below, the thresholds are not likely to exist).

Situation in Estonia

The Association of Estonian Printing Industry collects information from about 100 printing facilities in Estonia. Based on their main field of activity, they are divided into four groups: printing houses for periodicals, books, etiquettes and labels, and advertisements.

(Photo by Mari Luud; The printing machine in Kroonpress Ltd.)

The total number of printing houses is decreasing, and smaller facilities, in particular, will close down. The total capacity exceeds local market needs and any increase is connected with export.

In 2019, NMVOC emissions from the NFR 2D3h sector had increased by 562.18% compared to the year 1990. By 2019, NMVOC emissions from the consumption of printing had decreased by 9.52% compared to 2018.

4.2.10.2. Methodological Issues

The EMEP/EEA Guidebook 2019 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

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

- cold set web offset – 54 kg/t (g/kg) ink consumed;
- heat set web offset – 82 kg/t (g/kg) ink consumed;
- rotogravure – 425 kg/t (g/kg) ink consumed.

As these stay below the current emission factor, it does not change over the period.

4.2.10.3. Activity Data

The quantity of ink (CN code 3215) used in Estonia can be estimated by the import and export data from Statistics Estonia (1995-2019). 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.

4.2.10.4. Results

A number of printing facilities are permitted.

Between 2006 and 2019, 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 4.37 NMVOC emissions and the consumption of solvents from the printing industry by SNAP code in the period of 1990-2019 (kt)

SNAP code	060403	
Year	NMVOC	Activity data
1990	0.080	0.160
1995	0.126	0.252
2000	0.248	0.497
2005	0.745	1.490
2010	0.354	2.150
2011	0.344	2.062
2012	0.456	2.385
2013	0.461	2.306
2014	0.439	2.491
2015	0.473	2.493
2016	0.479	2.693
2017	0.663	2.426
2018	0.584	2,710
2019	0.528	2.259

4.2.10.5. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

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

4.2.10.6. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.11. Other Solvent Use (NFR 2D3i)

4.2.11.1. 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.

1) 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.

2) 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.

3) 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.

4) 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.

5) 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[20]).

In 2019, NMVOC emissions from the NFR 2D3i sector had decreased by 17.8% compared to the year 1990.

4.2.11.2. Methodological Issues

NMVOC emissions and corresponding activity data for the following activities are presented in the next chapter in the Table 4.39.

1) Glass and Mineral wool enduction (SNAP 060401, 060402)

This is not included in the emissions inventory due to the lack of information on whether these activities have been conducted in Estonia.

2) Fat, edible and non-edible oil extraction (SNAP 060404)

The major type of seed used for oil production in Estonia is rape. Some smaller units also press oil out from other seeds, such as flax.

The main oil extracting company in Estonia is Werol Industries plc.

An interview carried out in 2010 with a representative of the company determined that the company does not use solvents for oil extraction.

At Werol Industries, they use mechanical hot pressing for oil extraction, which leaves 8%-10% of the oil in rape cake. This technology has been in use since the factory was opened in 1999.

In the second largest oil producer, Oru Vegetable Oil Industry, the oil is only pressed out mechanically. The production began in 1985, but no solvents have ever been employed.

It was discovered that some small farms also produce small amounts of oil: Kaarli farm in Väike-Maarja, Raismiku farm in Vändra and in Mooste. The oil is mechanically cold pressed.

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.

3) Application of glues and adhesives (SNAP 060405)

The Tier 2 emission factor is used for calculations: 780 g/kg adhesive[21] for the period of 1990-2000, 522 g/kg adhesive[22] for the period of 2005 and onward. The emission factors for the period of 2001-2004 are interpolated.

[20] 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.
[21] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[22] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019

Activity Data

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 and export data are available from Statistics Estonia. Production data are available from the point sources database for the years 2006-2019. 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.

Results

A number of facilities using adhesives are permitted.

In the period from 2006 to 2019, activity data regarding adhesives use in point sources are collected in the point sources database (SNAP 060405).

For the years 2006-2019, 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.

4) *Preservation of wood (SNAP 060406)*

The Estonian Forest Industries Association was questioned in 2010 regarding wood preservation.

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.

In 2005, all wood impregnation companies in Estonia were listed by the Estonian Forest Industries Association.

The amount of wood impregnated accounted for ca. 135,000 fm (Festmeter[23]). The largest wood impregnation companies were the following (only waterborne preservatives were used):

- Hansacom Ltd. – 33,000 m^3;
- Kestvuspuit plc – 30,000 m^3;
- Imprest plc – 15,000 m^3;
- Kehra Wood Industries Ltd. – 8,000 m^3;
- Natural plc – 5,000 m^3.

Solvent borne preservatives are used by some companies that produce windows, doors and log houses.

The major solvent borne supplier VBH was contacted, and it was discovered that companies that apply solvent borne preservatives use more than five tonnes a year. This is the threshold for an air pollution permit. Therefore, it is estimated that these installations are covered with permits (point sources) and are not subject to diffuse emissions.

5) *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

[23] The Festmeter is that amount of solid wood which is contained in a one-meter cube; it is therefore identical with one cubic meter of solid wood.

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the leading car body and car paint shops technology and materials supplier.

Between 1990 and 2000, treatment with bituminous materials was widespread, but there are no statistics available. Nowadays, treatment with bituminous coating is negligible, and treatment is done by special polymers, if needed.

So, NMVOC emissions from this activity are calculated for the years 1990 to 2004, and emissions from the treatment of vehicles are considered negligible since 2005.

The Tier 2 emission factor from the EMEP/EEA Guidebook 2019 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 4.38 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.

6) *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.

7) *Other (SNAP 060412)*

NMVOC emissions and activity data for the years 2000-2019 are gathered from point sources and CollectER databases and are reported by operators.

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4.2.11.3. Results

Table 4.39 NMVOC emissions from other solvent use and the activity data by SNAP codes in the period of 1990-2019

SNAP code	060400		060404		060405		060406		060407		060412	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data, mln.inhab.	NMVOC	Activity data
1990	0.817	NA	NA	NA	0.324	0.415	NA	NA	0.124	1.571	NA	NA
1995	0.412	NA	NA	NA	0.218	0.279	NA	NA	0.180	1.448	NA	NA
2000	--	--	NA	NA	0.906	1.162	0.00050	NA	0.200	1.401	0.008	NA
2005	--	--	0.0018	NA	1.379	2.641	0.00001	NA	NO	--	0.003	NA
2010	--	--	0.0015	NA	0.398	1.259	0.01143	0.018	NO	--	0.012	0.069
2011	--	--	0.0009	NA	0.478	1.466	0.01075	0.022	NO	--	0.022	0.081
2012	--	--	0.0003	NA	0.585	1.684	0.01061	0.022	NO	--	0.034	0.137
2013	--	--	0.0012	NA	0.513	1.779	0.01128	0.029	NO	--	0.037	0.108
2014	--	--	0.0032	NA	0.499	1.789	0.01293	0.036	NO	--	0.036	0.132
2015	--	--	0.0021	NA	0.605	2.376	0.01321	0.030	NO	--	0.044	0.093
2016	--	--	0.0024	NA	0.652	2.281	0.00846	0.023	NO	--	0.042	0.084
2017	--	--	0.0021	NA	0.762	2.268	0.00584	0.025	NO	--	0.040	0.112
2018	--	--	0.0021	NA	0.818	2.904	0.00337	0.012	NO	--	0.034	0.210
2019	--	--	NA	NA	1.001	3.036	0.00497	0,019	NO	--	0.034	0.064

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 and emissions data from the point sources database are compared to previous years to detect calculation errors and errors in the reported data or in allocation. The reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the point sources database by operators are first checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.11.5. Source-Specific Planned Improvements

As some activities are not included in this inventory, there is a need for research to determine whether emissions from these activities are important for this inventory. Also, it is necessary to review NMVOC emissions for the years 1990-1999 and to study the possibility of obtaining activity data for these emissions.

4.2.12. Other Product Use (NFR 2G)

4.2.12.1. Source Category Description

This sector includes emissions from activities such as the use of fireworks, combustion (smoking) of tobacco and the use of shoes. The use of shoes is not currently included in the inventory, as it is not clear from the EMEP/EEA Guidebook 2019 to what kind of activity exactly the emission factor for the use of shoes applies. For this inventory it is assumed that all the NMVOC emission is emitted from the application of adhesives in the manufacture of shoes.

4.2.12.2. Methodological Issues

1) Use of fireworks (SNAP 060601)

The Tier 2 emission factors are used for pollutant emissions calculations (see Table 4.40).

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Table 4.40 Emission factors from the EMEP/EEA Guidebook 2019 for calculating pollutant emissions from the use of fireworks

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

2) Use of tobacco (SNAP 060602)

The Tier 2 emission factors are used for pollutant emissions calculations (see Table 4.41).

Table 4.41 Emission factors from the EMEP/EEA Guidebook 2019 for calculating pollutant emissions from tobacco combustion

Pollutant	Emission Factor	Unit
NMVOC	4.84	kg/t tobacco
NO_x	1.80	kg/t tobacco
CO	55.1	kg/t tobacco
NH_3	4.15	kg/t tobacco
TSP	27.0	mg/cigarette
PM_{10}	27.0	mg/cigarette
$PM_{2.5}$	27.0	mg/cigarette
BC	0.45	% of $PM_{1.8}$
PCDD/F	0.1	µg I-TEQ/t tobacco
B(a)p	0.111	g/t tobacco
B(b)f	0.045	g/t tobacco
B(k)f	0.045	g/t tobacco
I(1,2,3-cd)p	0.045	g/t tobacco
Cd	5.4	µg/cigarette
Ni	2.7	µg/cigarette
Zn	2.7	µg/cigarette
Cu	5.4	µg/cigarette

3) Use of lubricant (SNAP 060604)

he EMEP/EEA Guidebook 2019 Tier 2 emission factor was used for calculating NMVOC emissions from the use of lubricants (see Table 4.42).

Table 4.42 Emission factors from the EMEP/EEA Guidebook 2019 for calculating NMVOC emissions from the use of lubricant

Pollutant	Emission Factor	Unit
NMVOC	28,000	g/t product

4.2.12.3. Results

1) Use of fireworks

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 amounts of used fireworks and pollutant emissions for the period of 1990-2019 are presented in Table 4.43.

Table 4.43 The use of fireworks and pollutant emissions in the period of 1990-2019

Year	Product, t	SO_2	CO	NO_x	TSP	PM_{10}	$PM_{2.5}$
		t					
1990	2.539	0.008	0.018	0.001	0.279	0.254	0.132
1995	21.880	0.066	0.156	0.006	2.403	2.186	1.136
2000	68.993	0.208	0.493	0.018	7.578	6.894	3.584
2005	332.275	1.003	2.376	0.086	36.494	33.201	17.258
2010	276.950	0.836	1.980	0.072	30.417	27.673	14.385
2011	293.392	0.886	2.098	0.076	32.223	29.316	15.239
2012	393.956	1.190	2.817	0.102	43.268	39.364	20.462

Year	Product, t	SO_2	CO	NO_x	TSP	PM_{10}	$PM_{2.5}$
		t					
2013	439.705	1.328	3.144	0.114	48.293	43.935	22.838
2014	517.402	1.563	3.699	0.135	56.826	51.699	26.874
2015	367.391	1.110	2.627	0.096	40.351	36.710	19.082
2016	425.393	1.285	3.042	0.111	46.721	42.505	22.095
2017	432.853	1.307	3.095	0.113	47.540	43.251	22.482
2018	526.573	1.590	3.765	0.137	57.834	52.615	27.350
2019	491.008	1.483	3.511	0.128	53.927	49.062	25.503

Table 4.43 continues

Year	Product, t	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
		kg							
1990	2.539	0.003	0.004	0.040	1.127	0.000	0.076	1.990	0.660
1995	21.880	0.029	0.032	0.341	9.714	0.001	0.656	17.154	5.689
2000	68.993	0.092	0.102	1.076	30.633	0.004	2.070	54.091	17.938
2005	332.275	0.442	0.492	5.183	147.530	0.019	9.968	260.504	86.392
2010	276.950	0.368	0.410	4.320	122.966	0.016	8.309	217.129	72.007
2011	293.392	0.390	0.434	4.577	130.266	0.017	8.802	230.019	76.282
2012	393.956	0.524	0.583	6.146	174.916	0.023	11.819	308.862	102.429
2013	439.705	0.585	0.651	6.859	195.229	0.025	13.191	344.729	114.323
2014	517.402	0.688	0.766	8.071	229.726	0.030	15.522	405.643	134.525
2015	367.391	0.489	0.544	5.731	163.122	0.021	11.022	288.035	95.522
2016	425.393	0.566	0.630	6.636	188.874	0.024	12.762	333.508	110.602
2017	432.853	0.576	0.641	6.753	192.187	0.025	12.986	339.357	112.542
2018	526.573	0.700	0.779	8.215	233.798	0.030	15.797	412.833	136.909
2019	491.008	0.653	0.727	7.660	218.008	0.028	14.730	384.950	127.662

2) *Use of tobacco*

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 amounts of used tobacco and pollutant emissions for the period of 1990-2019 are presented in Table 4.44.

Table 4.44 The use of tobacco and pollutant emissions from tobacco combustion in the period of 1990-2019

Year	Use of tobacco, kt	NMVOC	NO_x	CO	NH_3	TSP	PM_{10}	$PM_{2.5}$	BC	PCDD/F
		kt								g I-Teq
1990	4.165	0.020	0.007	0.229	0.017	0.135	NR	NR	NR	0.0004
1995	2.218	0.011	0.004	0.122	0.009	0.060	NR	NR	NR	0.0002
2000	1.949	0.009	0.004	0.107	0.008	0.052	0.053	0.052	0.024	0.0002
2005	2.598	0.013	0.005	0.143	0.011	0.067	0.070	0.067	0.030	0.0003
2010	1.231	0.006	0.002	0.068	0.005	0.033	0.033	0.033	0.015	0.0001
2011	1.884	0.009	0.003	0.104	0.008	0.050	0.051	0.050	0.023	0.0002
2012	1.798	0.009	0.003	0.099	0.007	0.048	0.049	0.048	0.022	0.0002
2013	1.825	0.009	0.003	0.101	0.008	0.049	0.049	0.049	0.022	0.0002
2014	1.880	0.009	0.003	0.104	0.008	0.050	0.051	0.050	0.023	0.0002
2015	1.879	0.009	0.003	0.104	0.008	0.050	0.051	0.050	0.023	0.0002

Year	Use of tobacco, kt	NMVOC	NO_x	CO	NH_3	TSP	PM_{10}	$PM_{2.5}$	BC	PCDD/F
		kt								g I-Teq
2016	1.903	0.009	0.003	0.105	0.008	0.051	0.051	0.051	0.023	0.0002
2017	1.819	0.009	0.003	0.100	0.008	0.048	0.049	0.048	0.022	0.0002
2018	1.656	0.008	0.003	0.091	0.007	0.044	0.045	0.044	0.020	0.0002
2019	1.474	0.007	0.003	0.081	0,006	0.044	0.044	0.044	0.020	0.0001

Table 4.44 continues

Year	Use of tobacco, kt	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	Cd	Hg	As	Cu
		kg							
1990	4.165	0.462	0.187	0.187	0.187	26.988	13.494	13.494	26.988
1995	2.218	0.246	0.100	0.100	0.100	11.949	5.975	5.975	11.949
2000	1.949	0.216	0.088	0.088	0.088	10.493	5.247	5.247	10.493
2005	2.598	0.288	0.117	0.117	0.117	13.442	6.721	6.721	13.442
2010	1.231	0.137	0.055	0.055	0.055	6.591	3.295	3.295	6.591
2011	1.884	0.209	0.085	0.085	0.085	10.050	5.025	5.025	10.050
2012	1.798	0.200	0.081	0.081	0.081	9.592	4.796	4.796	9.592
2013	1.825	0.203	0.082	0.082	0.082	9.750	4.875	4.875	9.750
2014	1.880	0.209	0.085	0.085	0.085	10.047	5.023	5.023	10.047
2015	1.879	0.209	0.085	0.085	0.085	10.013	5.007	5.007	10.013
2016	1.903	0.211	0.086	0.086	0.086	10.145	5.073	5.073	10.145
2017	1.819	0.202	0.082	0.082	0.082	9.645	4.822	4.822	9.645
2018	1.656	0.184	0.075	0.075	0.075	8.773	4.387	4.387	8.773
2019	1.474	0.164	0.066	0.066	0.066	8.739	4.369	4.369	8.739

3) Use of lubricant

The amounts of used lubricants and pollutant emissions for the period of 1990-2019 are presented in Table 4.45.

Table 4.45 The use of lubricants and pollutant emissions in the period of 1990-2019

Year	Lubricant consumed [kt]	NMVOC	Pb	Cd	Cr	Cu	Ni	Se	Zn
		kt	t						
1990	1.177	0.033	0.00004	0.005	0.023	0.916	0.038	0.005	0.530
1995	0.757	0.021	0.00003	0.003	0.015	0.589	0.024	0.003	0.341
2000	0.797	0.022	0.00003	0.004	0.015	0.620	0.025	0.004	0.359
2005	1.107	0.031	0.00004	0.005	0.021	0.862	0.035	0.005	0.499
2010	1.182	0.033	0.00004	0.005	0.023	0.919	0.038	0.005	0.532
2011	1.220	0.034	0.00004	0.006	0.023	0.950	0.039	0.006	0.549
2012	1.252	0.035	0.00004	0.006	0.024	0.974	0.040	0.006	0.564
2013	1.253	0.035	0.00004	0.006	0.024	0.975	0.040	0.006	0.564
2014	1.289	0.036	0.00004	0.006	0.025	1.003	0.041	0.006	0.580
2015	1.355	0.038	0.00005	0.006	0.026	1.054	0.043	0.006	0.610
2016	1.415	0.040	0.00005	0.006	0.027	1.101	0.045	0.006	0.637
2017	1.462	0.041	0.00005	0.007	0.028	1.137	0.047	0.007	0.658
2018	1.524	0.043	0.00005	0.007	0.029	1.185	0.049	0.007	0.686
2019	1.564	0.044	0.00005	0.007	0.031	1.264	0.052	0.007	0.731

4.2.12.4. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions are compared to the previous years in order to detect calculation errors, errors in the reported data or in allocation. Reasons behind any fluctuation in the emission figures are studied.

4.2.12.5. 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
			NMVOC, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B2	Sheep	Includes emissions from sheep	NO_x, NMVOC, NH_3, TSP, PM10, $PM_{2.5}$	Tier 1
3B3	Swine	Includes emissions from fattening pigs and sows	NH_3	Tier 3
			NO_x, NMVOC	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, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4e	Horses	Includes emissions from horses	NO_x, NMVOC, NH_3, 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, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3Da1	Synthetic N-fertilizers	Includes emissions from application of nitrogen fertilizers and field preparation	NH_3	Tier 2
			NO_x	Tier 1
3Da2a	Animal manure applied to soils	NH_3 emissions from this sector are allocated to NFR 3B1a, 3B1b, 3B2, 3B4gi and 3B4gii	NH_3	Tier 2
			NO_x	Tier 1
3Da2b	Sewage sludge applied to soils	Includes emission from sewage sludge applied into soils	NO_x, NH_3	Tier 1
3Da2c	Other organic fertilisers applied to soils (including compost)	Includes emission from compost applied to soils	NO_x, NH_3	Tier 1
3Da3	Urine and dung deposited by grazing animals	NH_3 emissions from this sector are allocated to NFR 3B1a, 3B1b and 3B2	NH_3	Tier 2
			NO_x	Tier 1
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Includes emissions from farm-level agricultural operations	TSP, PM_{10}, $PM_{2.5}$	Tier 1
3De	Cultivated crops	Includes emissions from cultivated crops	NMVOC	Tier 2
3Df	Use of pesticides	Emissions have not been estimated due to lack of activity data for the previous years	NE	
3F	Field burning of agricultural residues	Since 2004, the burning of crop residues was prohibited	NO	

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The share of agricultural sources in total emissions in 2019 was as follows: NO_x – 9.6%, NH_3 – 88.7%, NMVOC – 20.3%, and TSP – 11%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 49.1%, 50.9%, 54.6% and 56.6% 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 producer remain the rest were all small-scale producers. The number of livestock on farms and the use of nitrogen fertilisers were significantly decreased. Since the end of the nineties the number of agricultural holdings has started to decline and the share of large-scale production began to increase.[24]

After Estonia joined the EU in 2004, livestock numbers and the consumption of mineral N-fertilisers increased in comparison to mid-nineties due the free market and EU supporting mechanisms. In the past decade, the volume of emissions was also affected by changes in livestock housing and manure holding systems.

In 2019, NO_x and NH_3 emissions increased slightly by 4.5%, and 1.8% respectively when compared to the results for 2018, mainly due to an increase in the use of fertilizers. At the same time the number of fattening pigs is still significantly less than that of a few years ago, with the number of swine having decreased by 8% when compared to 2014's figures for Estonia as a result of an outbreak of African swine fever.

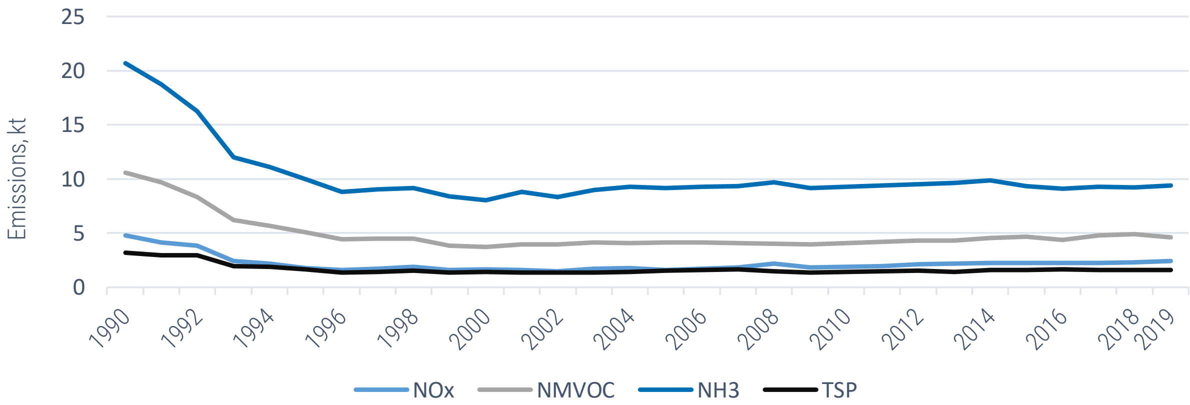

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector in the period of 1990-2019 (kt)

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

Table 5.2 Total emissions from the agriculture sector in the period of 1990-2019 (kt)

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
1990	4.772	10.601	20.717	3.210	NR	NR
1995	1.761	5.058	9.967	1.620	NR	NR
2000	1.644	3.716	8.045	1.392	0.111	0.939
2005	1.591	4.154	9.134	1.541	0.111	1.065
2010	1.912	4.064	9.289	1.397	0.103	0.925
2011	1.939	4.209	9.384	1.471	0.108	1.003
2012	2.122	4.312	9.507	1.527	0.110	1.037
2013	2.152	4.296	9.660	1.437	0.106	0.967
2014	2.241	4.562	9.856	1.571	0.115	1.072
2015	2.220	4.653	9.346	1.605	0.119	1.123
2016	2.223	4.382	9.123	1.664	0.121	1.227
2017	2.264	4.758	9.275	1.609	0.109	1.167
2018	2.324	4.908	9.232	1.577	0.112	1.160
2019	2.428	4.605	9.400	1.576	0.112	1.163
Trend 1990-2019, %	**-49.1**	**-56.6**	**-54.6**	**-50.9**	**1.5**	**23.8**

More than half of NH_3 emissions comes from the agricultural soil sector (including animal manure application to soils and grazing) – 52% – and 48% is from the manure management (see Figure 5.2). The main source of pollution of PM_{10} is agricultural crop operations – 79% (see Figure 5.3).

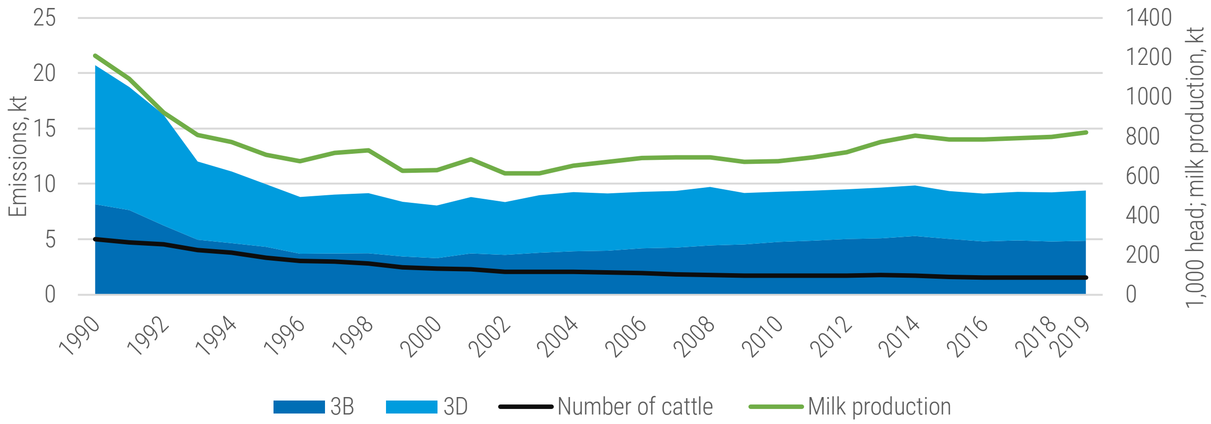

Figure 5.2 NH_3 emission distributions by the agriculture sector activities in the period of 1990-2019

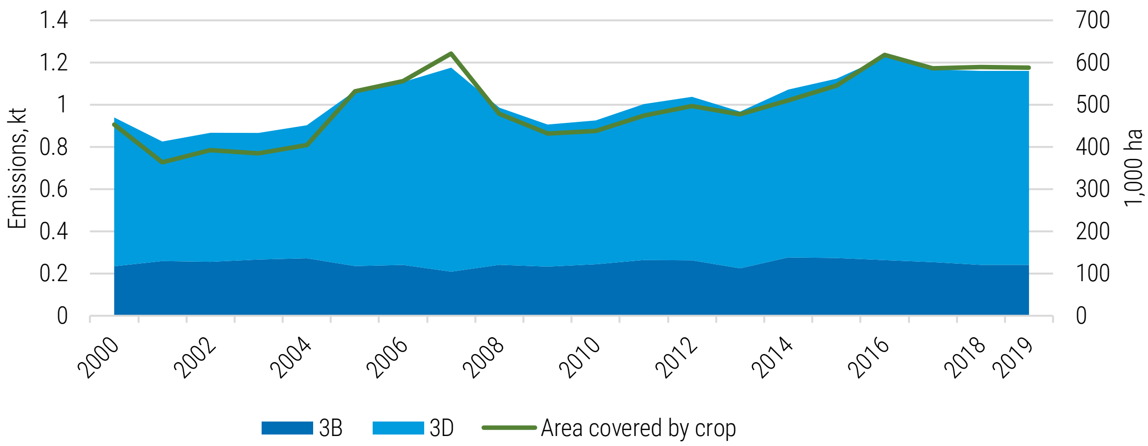

Figure 5.3 PM_{10} emissions from livestock (3B) and agricultural soils (3D) in in the period of 2000-2019

5.2. Manure Management (NFR 3b)

5.2.1. Source Category Description

Manure management is the main source of NH_3 emissions in Estonia. Almost half of the total NH_3 emissions was from manure management in 2019. 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.

NO_x and NH_3 emissions from manure management are recalculated due to the correction of the activity data and updated emission factors in EMEP/EEA Guidebook 2019 (see Chapter 8).

(Manure storage in Ekseko swine farm; source: www.arhliit.ee)

In addition to NH_3, NO_x, NMVOC, TSP, PM_{10} and $PM_{2.5}$ are generated from manure management.

All the emission time series are presented in Tables 5.3-5.7.

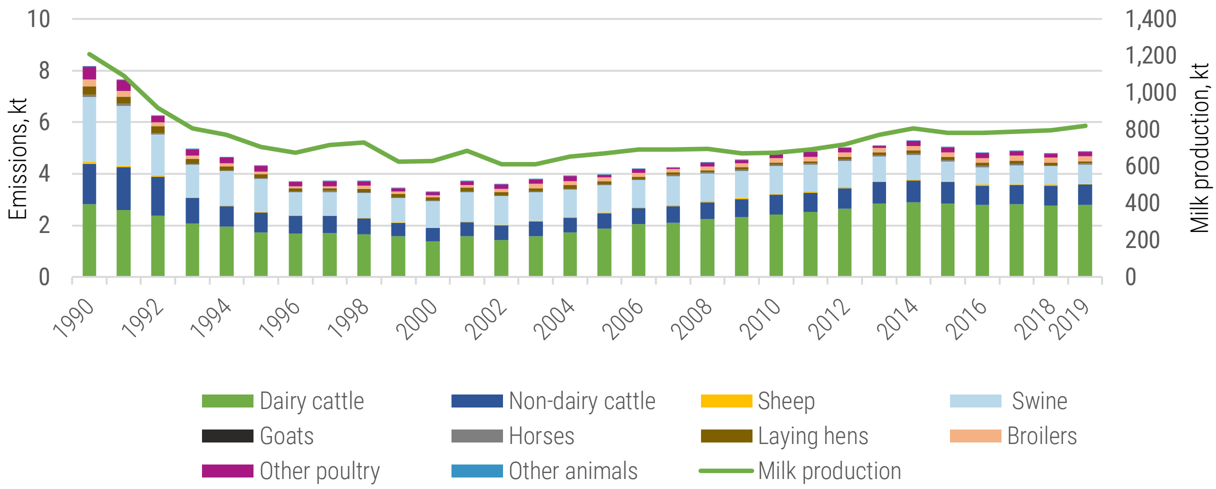

Figure 5.4 NH_3 emissions from manure management in the period of 1990-2019

During the period of 1990–2019, the emission of NH_3 decreased by 40% (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).[25] Changes in manure-handling technology have decreased the levels of ammonia emissions because liquid manure generates less ammonia than does solid manure.

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 1990-2019 the annual average nitrogen production per head of dairy cattle was increased by 47%.

In 2019, ammonia emissions increased by 1% in comparison to 2018 figures, due to the increase in the numbers of cattle non-dairy and swine during the same period.

Table 5.3 Total emissions of NO_x from manure management in the period of 1990-2019 (kt)

Year	Dairy cattle*	Non-dairy cattle*	Sheep	Swine *	Goats	Horses	Laying hens*	Broilers*	Other poultry*	Other animals
1990	0.068	0.042	0.002	0.005	0.00003	0.002	0.015	0.007	0.004	0.00023
1995	0.041	0.022	0.001	0.004	0.00003	0.001	0.005	0.003	0.002	0.00013
2000	0.034	0.014	0.000	0.004	0.00005	0.001	0.005	0.002	0.001	0.00005
2005	0.028	0.016	0.001	0.004	0.00004	0.001	0.005	0.004	0.001	0.00013
2010	0.019	0.017	0.001	0.004	0.00006	0.002	0.004	0.004	0.001	0.00010
2011	0.017	0.016	0.001	0.003	0.00006	0.002	0.004	0.004	0.001	0.00011
2012	0.015	0.016	0.001	0.003	0.00007	0.002	0.005	0.004	0.001	0.00011
2013	0.013	0.016	0.001	0.002	0.00007	0.002	0.004	0.005	0.001	0.00010
2014	0.010	0.016	0.001	0.002	0.00006	0.002	0.005	0.005	0.001	0.00011
2015	0.007	0.014	0.001	0.001	0.00006	0.002	0.005	0.005	0.001	0.00012
2016	0.007	0.012	0.001	0.001	0.00007	0.001	0.005	0.005	0.001	0.00005
2017	0.007	0.012	0.001	0.001	0.00007	0.001	0.005	0.005	0.001	0.00005
2018	0.007	0.012	0.001	0.001	0.00007	0.001	0.004	0.005	0.001	0.00004
2019	0.007	0.012	0.001	0.001	0.00006	0.001	0.004	0.005	0.001	0.00000
Trend 1990-2019%	-90.3	-70.2	-55.5	-81.0	100.0	-33.5	-74.7	-25.5	-63.6	-98.3

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

Table 5.4 Total emissions of NMVOC from manure management in the period of 1990-2019 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1990	3.144	4.247	0.044	0.851	0.001	0.067	0.367	0.211	0.616	0.448
1995	1.857	1.647	0.015	0.443	0.001	0.036	0.137	0.093	0.274	0.256
2000	1.551	1.084	0.009	0.306	0.002	0.033	0.119	0.067	0.153	0.098
2005	1.663	1.217	0.015	0.363	0.002	0.037	0.120	0.112	0.137	0.245
2010	1.629	1.245	0.027	0.380	0.003	0.053	0.095	0.131	0.184	0.195
2011	1.637	1.265	0.026	0.375	0.003	0.051	0.094	0.140	0.251	0.217
2012	1.689	1.328	0.025	0.392	0.003	0.048	0.114	0.137	0.223	0.216
2013	1.764	1.453	0.023	0.373	0.003	0.049	0.097	0.147	0.094	0.191
2014	1.756	1.505	0.024	0.366	0.003	0.049	0.124	0.151	0.247	0.216
2015	2.127	1.251	0.024	0.308	0.003	0.049	0.136	0.149	0.233	0.226
2016	2.019	1.196	0.025	0.274	0.003	0.044	0.120	0.154	0.233	0.098
2017	2.339	1.207	0.023	0.325	0.003	0.044	0.135	0.157	0.240	0.103
2018	2.299	1.484	0.020	0.320	0.003	0.044	0.100	0.157	0.200	0.080
2019	2.185	1.504	0.020	0.193	0.003	0.044	0.093	0.157	0.224	0.007
Trend 1990-2019, %	**-30.5**	**-64.6**	**-55.3**	**-100.0**	**124.4**	**-33.7**	**-74.7**	**-25.5**	**-63.6**	**-98.3**

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

Table 5.5 Total emissions of NH_3 from manure management in the period of 1990-2019 (kt)

Year	Dairy cattle*	Non-dairy cattle *	Sheep*	Swine*	Goats*	Horses*	Laying hens*	Broilers*	Other *poultry	Other* animals
1990	3.144	4.247	0.044	0.851	0.001	0.067	0.367	0.211	0.616	0.448
1995	1.857	1.647	0.015	0.443	0.001	0.036	0.137	0.093	0.274	0.256
2000	1.551	1.084	0.009	0.306	0.002	0.033	0.119	0.067	0.153	0.098
2005	1.663	1.217	0.015	0.363	0.002	0.037	0.120	0.112	0.137	0.245
2010	1.629	1.245	0.027	0.380	0.003	0.053	0.095	0.131	0.184	0.195
2011	1.637	1.265	0.026	0.375	0.003	0.051	0.094	0.140	0.251	0.217
2012	1.689	1.328	0.025	0.392	0.003	0.048	0.114	0.137	0.223	0.216
2013	1.764	1.453	0.023	0.373	0.003	0.049	0.097	0.147	0.094	0.191
2014	1.756	1.505	0.024	0.366	0.003	0.049	0.124	0.151	0.247	0.216
2015	2.127	1.251	0.024	0.308	0.003	0.049	0.136	0.149	0.233	0.226
2016	2.019	1.196	0.025	0.274	0.003	0.044	0.120	0.154	0.233	0.098
2017	2.339	1.207	0.023	0.325	0.003	0.044	0.135	0.157	0.240	0.103
2018	2.299	1.484	0.020	0.320	0.003	0.044	0.100	0.157	0.200	0.080
2019	2.185	1.504	0.020	0.193	0.003	0.044	0.093	0.157	0.224	0.007
Trend 1990-2019, %	-30.5	-64.6	-55.3	-100.0	124.4	-33.7	-74.7	-25.5	-63.6	-98.3

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

Table 5.6 Total emissions of $PM_{2.5}$ from manure management in the period of 2000-2019 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
2000	0.054	0.017	0.001	0.002	0.0001	0.001	0.002	0.001	0.006	0.0002
2005	0.046	0.019	0.001	0.002	0.0001	0.001	0.002	0.002	0.006	0.0005
2010	0.040	0.020	0.002	0.002	0.0001	0.001	0.002	0.002	0.008	0.0004
2011	0.039	0.021	0.002	0.002	0.0001	0.001	0.002	0.003	0.010	0.0005
2012	0.040	0.022	0.002	0.002	0.0001	0.001	0.002	0.003	0.009	0.0004
2013	0.040	0.024	0.002	0.002	0.0001	0.001	0.002	0.003	0.004	0.0004
2014	0.039	0.025	0.002	0.002	0.0001	0.001	0.002	0.003	0.010	0.0004
2015	0.047	0.020	0.002	0.002	0.0001	0.001	0.002	0.003	0.010	0.0005
2016	0.047	0.019	0.002	0.001	0.0001	0.001	0.002	0.003	0.010	0.0002
2017	0.035	0.019	0.002	0.001	0.0001	0.001	0.002	0.003	0.010	0.0002
2018	0.035	0.024	0.001	0.001	0.0001	0.001	0.002	0.003	0.008	0.0002
2019	0.035	0.025	0.001	0.001	0.0001	0.001	0.002	0.003	0.009	0.0000
Trend 2000-2019, %	-35.1	45.2	111.9	-11.0	25.0	35.6	-22.2	135.8	46.2	-90.0

Table 5.7 Total emissions of PM_{10} from manure management in the period of 2000-2019 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
2000	0.083	0.026	0.002	0.036	0.0002	0.001	0.029	0.012	0.044	0.0004
2005	0.071	0.030	0.003	0.039	0.0002	0.001	0.029	0.021	0.039	0.0010
2010	0.061	0.031	0.006	0.043	0.0003	0.002	0.023	0.024	0.053	0.0008
2011	0.061	0.031	0.006	0.042	0.0003	0.001	0.023	0.026	0.072	0.0009
2012	0.061	0.033	0.005	0.042	0.0003	0.001	0.028	0.025	0.064	0.0009
2013	0.062	0.036	0.005	0.041	0.0003	0.001	0.024	0.027	0.027	0.0008
2014	0.060	0.038	0.005	0.041	0.0003	0.001	0.030	0.028	0.071	0.0009
2015	0.073	0.030	0.005	0.035	0.0003	0.001	0.033	0.028	0.067	0.0009
2016	0.072	0.029	0.005	0.030	0.0003	0.001	0.029	0.028	0.067	0.0004
2017	0.054	0.029	0.005	0.032	0.0003	0.001	0.033	0.029	0.069	0.0004
2018	0.054	0.037	0.004	0.032	0.0003	0.001	0.024	0.029	0.057	0.0003
2019	0.054	0.038	0.004	0.033	0.0003	0.001	0.023	0.029	0.064	0.0000
Trend 2000-2019, %	-35.0	42.3	119.5	-11.0	39.1	35.5	-15.9	135.4	30.7	-17.5

5.2.2. Methodological Issues

NH_3 and NO_x emission calculations from manure management of swine, poultry and cattle are based on the Tier 3 and Tier 2 (for both mass flow approach) methods from the EMEP/EEA Guidebook 2019 and stem from country-specific values with abatement measures data whenever possible.

For particles and NMVOC (mainly with silage use) except for dairy cattle, the Tier 1 methods from the EMEP/EEA Guidebook 2019 were used in calculations. Tier 1 was also used to calculate emissions from the manure management of sheep, goats, horses, other poultry, and fur animals.

For particles calculations were made with assumption that due the weather condition in wintertime in Estonia the housing is a common practise. The share of $PM_{2.5}$ from manure management (the sum of all animal categories) in national total emissions in 2019was less than 1% and the share of PM_{10} was less than 2%. At the same time the proportion of grazing decreases year by year in main animal categories, who's PM has the highest share in agriculture.

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 2019, 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'.

Table 5.8 NO_x, NH_3, NMVOC and PM emission factors for manure management, kg/capita

NFR	NO_x solid	NMVOC	NH_3			$PM_{2.5}$	PM_{10}	TSP
			Manure management	Manure applied to soils	Excreta deposited by grazing livestock			
Sheep	0.012	0.279	0.400	0.200	0.800	0.020	0.060	0.140
Goats	0.012	0.624	0.400	0.200	0.800	0.017	0.056	0.139
Horses	0.250	7.781	7.000	2.700	6.100	0.140	0.220	0.480
Fur animals	0.001	1.941	0.020	0.010	0.000	0.004	0.008	0.018
Dairy cows		17.937				0.410	0.630	1.380
Other cattle		8.902				0.180	0.270	0.590
Calves						0.100	0.160	0.340
Fattening pigs		0.551				0.060	0.340	0.750
Weaners						0.020	0.100	0.210
Sows		1.704				0.120	0.040	1.530
Laying hens		0.165				0.003	0.040	0.190
Broilers		0.108				0.002	0.020	0.040
Turkeys		0.489				0.020	0.110	0.110
Ducks		0.489				0.020	0.140	0.140
Geese		0.489				0.030	0.240	0.240

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The Tier 2 methods from the EMEP/EEA Guidebook 2019 were used to calculate NMVOC emissions from the manure management of 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 2020[26] (see Table 5.10) and the emission factor from the EMEP/EEA Guidebook 2019 (see Table 5.9).

Table 5.9 NMVOC emission factors for manure management of 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

The Tier 3 methods from the EMEP/EEA Guidebook 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 2019 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 and other poultry also for NO emissions from non-dairy cattle, swine and dairy-cattle.

For non-dairy cattle and swine, category emissions were calculated separately for sub-categories as presented in Tables 5.11-5.12.

NH_3 emission from cattle, swine, horses, goats, sheep, poultry and fur animals manure application to soils (NFR 3D2a) were calculated separately from sector 3B. In addition emissions from grazing of cattle (NFR 3D3) were calculated separately from sector 3B.

The Tier 2 and 3 methods use a mass flow approach which is based on the concept of the flow of Total Ammoniacal Nitrogen (TAN) through the manure management system. Calculations (Equations 5-41) were carried out with the Excel spreadsheet which was provided in the previous EMEP/EEA Guidebook, Appendix B, Chapter 3B - Manure management. For the calculation method involving total annual nitrogen levels, use was made of the method that covers excretion by dairy cattle and non-dairy cattle as described in the Estonian GHG National Inventory Report 2020.[27] The results for nitrogen excretion estimations are presented in Tables 5.11-5.12. For nitrogen excretion, use was made of the rates for swine (Regulation No 66 by the Minister of the Environment, 14.12.2016). 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

[26] Estonian GHG National Inventory Report 2021, Ch. 5 Agriculture (CFR 3)
[27] Estonian GHG National Inventory Report 2020, Ch. 5 Agriculture (CFR 3)

sub-categories were calculated for each year using a share of various technologies and the corresponding emissions reduction measures. The additional project, '*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.[24] 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[28] on preventing and abating ammonia emissions from agricultural sources (see Table 5.14 and Table 5.15).

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock in 1990-2019[29]

Year	Nitrogen excretion rate, kg N/head/yr	Gross energy intake, MJ/head/year
1990	84.7	87,965
1995	81.6	79,205
2000	88.5	92,345
2005	104.6	103,660
2010	111.5	113,150
2011	111.8	114,245
2012	113.5	117,165
2013	116.4	120,815
2014	118.1	123,005
2015	119.0	123,005
2016	122.3	123,005
2017	122.9	123,005
2018	123.3	123,005
2019	124.8	123,005

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

Livestock category of non-dairy cattle	Nitrogen excretion rate, kg N/head/yr
Mature males (2 years and over)	80.3
Mature females (2 years and over)	44.8
Bovine animals (aged between 1 and 2 years)	58.5
Calves (6-12 months)	18.7
Calves (0-6 months)	4.4

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 2019, there are different emissions factors for housing, manure storage, and grazing (see Table 5.16).

In terms of separately assessing the proportions of different manure management types for different livestock categories, a country-specific manure management system (MMS) was used (involving liquid/slurry, solid storage, and pasture/range). Any MMS which was used to store animal waste that had been generated by cattle and swine is presented in Table 5.13.

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

[28] https://www.riigiteataja.ee/akt/122122016004
[29] https://www.riigiteataja.ee/akt/122122016004

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Estonian, Latvian, & Lithuanian Environment Ltd[30]. For further insight regarding leakage and N-excretion estimations, see the Estonian GHG National Inventory Report 2021.

Table 5.13 Manure management system usage for swine and cattle in 1990, 1995, 2000, 2005, 2010, 2015 and 2019[31]

Livestock category	Year	Fattening pig	Piglets	Shows	Young pig	Dairy cattle	Bowine animals	Calvess	Mature females	Mature males
Liquid/Slurry, %	1990	87.0	87.0	85.5	87.0	0.0	0.0	0.0	0.0	0.0
	1995	80.0	80.0	77.9	80.0	0.0	0.0	0.0	0.0	0.0
	2000	78.0	78.0	75.7	78.0	0.0	0.0	0.0	0.0	0.0
	2005	79.0	79.0	76.8	79.0	20.1	2.5	2.8	1.8	1.8
	2010	80.0	80.0	77.9	80.0	51.0	29.3	6.8	23.1	23.1
	2015	86.4	100.0	100.0	100.0	81.8	28.9	20.8	0.5	0.5
	2019	86.4	100.0	100.0	100.0	81.8	28.9	20.8	0.5	0.5
Solid Storage +deep litter, %	1990	13.0	13.0	14.5	13.0	82.7	67.8	85.7	51.3	51.3
	1995	20.0	20.0	22.1	21.2	80.5	67.8	85.7	51.3	51.3
	2000	22.0	22.0	24.3	23.3	82.7	62.4	85.7	44.4	44.4
	2005	21.0	21.0	23.2	22.3	63.0	46.3	82.8	37.4	37.4
	2010	20.0	20.0	22.1	21.2	45.0	42.0	83.7	55.2	55.2
	2015	13.6	0.0	0.0	13.6	13.5	42.0	65.3	55.2	55.2
	2019	13.6	0.0	0.0	13.3	13.5	42.0	65.3	55.2	55.2
Pasture/Range, %	1990	0.0	0.0	0.0	0.0	17.3	32.1	14.3	48.7	48.7
	1995	0.0	0.0	0.0	0.0	19.5	32.1	14.3	48.7	48.7
	2000	0.0	0.0	0.0	0.0	17.3	32.1	14.3	48.7	48.7
	2005	0.0	0.0	0.0	0.0	16.9	35.1	14.4	53.8	53.8
	2010	0.0	0.0	0.0	0.0	3.9	24.4	9.3	39.5	39.5
	2015	0.0	0.0	0.0	0.0	4.8	29.1	14.0	44.3	44.3
	2019	0.0	0.0	0.0	0.0	4.8	29.1	14.0	44.3	44.3

Table 5.14 Used NH_3 emission abetment techniques for cattle and pig slurry manure storage

NH_3 abatement techniques		Replacement of lagoon with tall open tank, %	Tight lid roof, %	Low tech floating cover, %
2005	Dairy cattle	0.0	0.0	0.0
	Bowine animals	0.0	0.0	0.0
	Calvess	0.0	0.0	0.0
	Mature females	0.0	0.0	0.0
	Mature males	0.0	0.0	0.0
	Fattening pig	21.0	0.0	0.0
	Shows	20.0	0.0	0.0
2010	Dairy cattle	10.0	0.0	0.0
	Bowine animals	0.0	0.0	0.0
	Calvess	10.0	0.0	0.0
	Mature females	10.0	0.0	0.0
	Mature males	0.0	0.0	0.0
	Fattening pig	34.4	0.0	45.9
	Shows	40.0	30.0	0.0
2015	Dairy cattle	35.8	0.8	0.0
	Bowine animals	31.9	1.0	0.0
	Calvess	40.0	0.8	0.0
	Mature females	32.0	0.0	0.0
	Mature males	31.9	0.9	0.0
	Fattening pig	82.3	4.8	12.9
	Shows	85.7	0.9	0.0
NH_3 emission reduction coefficient, %		45.0	80.0	45.0

[30] 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
[31] https://www.envir.ee/sites/default/files/nh3_eriheite_ja_sonnikukaitlustehnoloogiate_ajaloolise_ulevaate_lopparuanne_0.pdf

Table 5.15 NH_3 emission abetment techniques for manure application to land

NH_3 abatement techniques	2005		2010		2015		NH_3 emission reduction coefficient, %
	Cattle	Swine	Cattle	Swine	Cattle	Swine	
Used abatement techniques for solid application to land, %							
Incorporation within 12hours (solid)	0.0	0.0	100.0	100.0	100.0	100.0	50.0
Used abatement techniques for slurry application to land,%							
Incorporation of surface applied slurry within 12hours	0.0	0.0	79.2	78.6	5.4	0.0	50.0
Band spreading with trailing shoe within 12hours	0.0	0.0	21.8	21.4	81.0	97.1	45.0
Injecting slurry (open slot)	0.0	0.0	0.0	0.0	13.2	2.9	70.0
Injecting slurry (closed slot) (shallow slot 5-10cm)	0.0	0.0	0.0	0.0	0.0	0.0	80.0

Table 5.16 NO and NH_3 emission factors for manure management from cattle and swine

NFR	NH_3 house, slurry	NH_3 house, solid	NH_3 storage, slurry	NH_3 storage, solid	NO storage, slurry	NO storage, solid	NH_3 application, slurry	NH_3 application, solid	NH_3 grazing
Dairy cows	0.240	0.080	0.250	0.320	0.000	0.008	0.550	0.680	0.140
Other cattle	0.240	0.080	0.250	0.320	0.000	0.008	0.550	0.680	0.140
Calves									
Fattening pigs	0.270	0.230	0.110	0.290	0.000	0.008	0.400	0.450	0.000
Weaners									
Sows	0.350	0.240	0.110	0.290	0.000	0.008	0.290	0.450	0.000
Laying hens		0.410		0.140				0.690	
Broilers		0.210		0.300				0.380	
Turkeys		0.350		0.240				0.540	
Ducks		0.240		0.240				0.540	
Geese		0.570		0.160				0.450	

Activity data

Information regarding the numbers of livestock in agriculture is available from Statistics Estonia (www.stat.ee) for the years 1990-2019. 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 5.17 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	145.6
1995	185.4	185.0	55.4	2.0	4.6	425.4	23.4	828.3	862.2	561.0	38.5
2000	131.0	121.8	33.3	3.7	4.2	261.6	38.6	723.5	616.7	313.5	6.8
2005	112.8	136.7	55.4	3.1	4.8	312.2	34.3	725.7	1 033.8	279.8	87.2
2010	96.5	139.8	95.8	5.0	6.8	336.6	35.1	578.2	1 212.2	377.2	87.7
2011	96.2	142.1	94.0	4.8	6.5	330.1	35.6	568.9	1 298.3	513.7	97.6
2012	96.8	149.2	90.9	5.4	6.2	340.8	34.3	693.9	1 267.9	456.5	96.6
2013	97.9	163.5	82.7	5.1	6.3	325.4	33.3	590.8	1 361.5	191.5	98.4
2014	95.6	169.1	85.8	4.6	6.3	323.3	34.6	752.8	1 398.0	505.1	111.2
2015	115.7	140.5	85.9	5.0	6.3	279.4	25.1	825.0	1 376.9	475.6	116.5
2016	86.1	162.1	91.3	5.5	5.7	240,0	25.9	727.6	1 423.9	464.8	50.2
2017	86.4	164.5	80.8	5.1	5.7	262,6	26.5	819.4	1 452,8	491.0	50.2
2018	85.2	166.7	73.1	5.2	5.7	265.5	24.9	608.2	1 451.7	410.0	41.4
2019	85.0	169.0	70.8	4.7	5.7	275.5	26.1	562.8	1 453.5	458.2	3.8

5.2.3. Uncertainty

An uncertainty analysis was carried out for the 2019 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 5.18.

Table 5.18 Uncertainties in agriculture sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	2.4	kt	9.6	7.0	0.9
NMVOC	4.6	kt	20.3	11.8	1.7
NH_3	9.4	kt	88.7	39.5	10.1
$PM_{2.5}$	0.1	kt	1.9	1.0	0.2
PM_{10}	1.7	kt	12.6	1.0	2.2
TSP	1.6	kt	11.3	7.0	0.

5.2.4. Source-Specific QA/QC and Verification

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

5.2.5. Source-Specific Planned Improvements

Improve data quality to introduce other Tier 2 methods for emission estimation, which is based on detailed activities data and emission factors.

5.3. Agricultural Soils (NFR 3D)

5.3.1. Source Category Description

Direct NH_3 emissions from fertilisers are reported under NFR 3D1a. Particle emissions and NMVOC from grain fields are reported under NFR 3Dc and 3De respectively. NH_3 and NO_x emissions from animal manure applied to soils are reported under NFR 3Da2a and emissions from grazing under NFR 3Da3.

NO_x and NH_3 emissions from animal manure applied to soils and grazing are recalculated due to the correction of the activity data and updated emission factors in EMEP/EEA Guidebook 2019 (see Chapter 8).

The share of agricultural soils in the total NH_3 emissions in 2019 was at 48%.

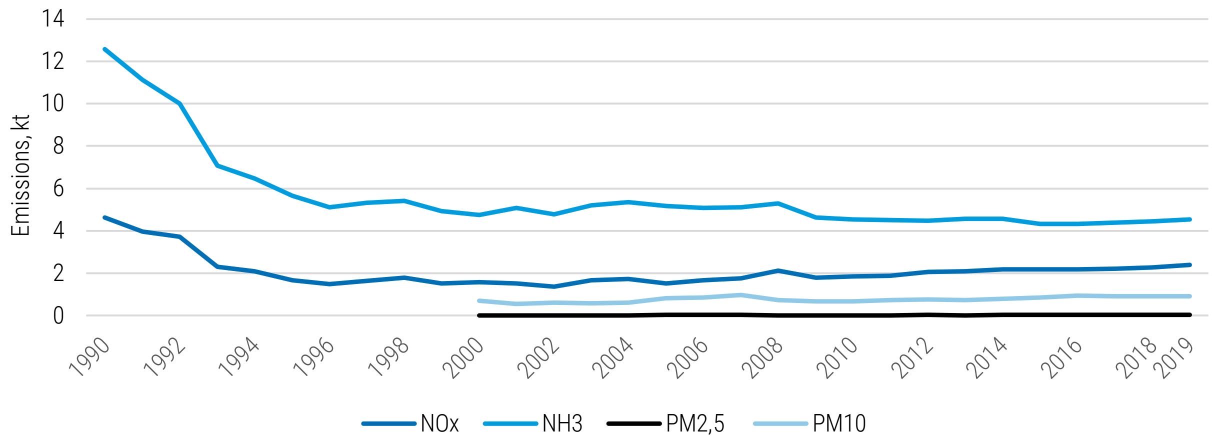

Figure 5.5 NO_x, NH_3 and PM_{10} emissions from agricultural soils in the period of 1990-2019

During the 1990-2019 period, emissions of NH_3 decreased to 63.9% (see Figure 5.5), mainly due to changes in Estonian agriculture. The reduction of NH_3 emissions in recent years is mainly related to the development of manure-spreading technologies. In the 1990s, the spreading method was in use. Nowadays the main method of spreading liquid manure is through band spreading, although there has been a shortening of the manure spreading period.[32]

All the emission time series are presented in Tables 5.19-5.21.

In 2019, NH_3 emissions increased by 2% compared to 2018, mainly due to an increase in the fertiliser use.

Table 5.19 NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions from agricultural soils in the period 1990-2019 (kt)

Year	NO_x	NMVOC	NH_3	$PM_{2.5}$
1990	4.628	0.606	12.562	NR
1995	1.682	0.298	5.652	NR
2000	1.583	0.293	4.754	0.027
2010	1.533	0.245	5.169	0.032
2011	1.860	0.123	4.533	0.026
2012	1.891	0.151	4.517	0.028
2013	2.076	0.136	4.493	0.030
2014	2.109	0.101	4.578	0.029
2015	2.200	0.121	4.568	0.031
2016	2.183	0.147	4.319	0.033
2017	2.190	0.216	4.323	0.037
2018	2.230	0.181	4.384	0.035
2019	2.291	0.199	4.440	0.035
Trend 1990-2019, %	2.395	0.174	4.539	0.035

Table 5.20 NH_3 emissions from agricultural soils in the period 1990-2019 (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	3.642	7.637	0.011	0.004	1.267
1995	0.982	4.074	0.010	0.005	0.581
2000	1.145	3.187	0.010	0.011	0.401
2010	1.085	3.580	0.009	0.055	0.441
2011	1.432	2.683	0.009	0.114	0.295
2012	1.491	2.635	0.009	0.078	0.304
2013	1.439	2.639	0.009	0.087	0.319
2014	1.486	2.623	0.009	0.120	0.340
2015	1.562	2.531	0.009	0.106	0.360
2016	1.583	2.251	0.009	0.113	0.364
2017	1.588	2.191	0.009	0.153	0.382
2018	1.633	2.231	0.009	0.136	0.375
2019	1.701	2.212	0.009	0.143	0.374
Trend 1990-2019, %	1.813	2.212	0.009	0.130	0.375

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

Table 5.21 NO_x emissions from agricultural soils in the period 1990-2019 (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	2.868	1.329	0.003	0.002	0.426
1995	0.756	0.721	0.003	0.003	0.199
2000	0.896	0.543	0.003	0.006	0.136
2005	0.803	0.557	0.003	0.027	0.143
2010	1.145	0.587	0.003	0.057	0.068
2011	1.192	0.584	0.003	0.039	0.073
2012	1.319	0.630	0.003	0.043	0.080
2013	1.346	0.609	0.003	0.060	0.091
2014	1.432	0.614	0.003	0.053	0.098
2015	1.451	0.574	0.003	0.057	0.099
2016	1.456	0.549	0.003	0.077	0.106
2017	1.493	0.559	0.003	0.068	0.107
2018	1.555	0.554	0.003	0.072	0.109
2019	1.658	0.560	0.003	0.065	0.110
Trend 1990-2019, %	**-42.2**	**-57.9**	**-15.7**	**3 187.6**	**-74.2**

5.3.2. Methodological Issues

Emission calculations from sewage sludge and other organic fertilizers on soils and NO_x emissions from grazing and animal manure application on soils are based on the Tier 1 method.

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.

Emissions from the use of mineral fertilisers are based conditionally on the Tier 2 method. Statistics Estonia can only separately submit data covering the use of urea fertilisers (a detailed description is included in the activity data chapter). There are no statistics available for the whole data series on the distribution of other fertiliser types. With that in mind, two different emission factors were implemented to calculate NH_3 emissions. For urea, EF 0.155 (kg kg-1 fertiliser-N applied) was used, and for others, EF 0.05 (kg kg-1 fertiliser-N applied) was used with an arithmetical mean of Tier 2 emission factors (except urea) as represented in Table 3.2 of the chapter on crop production and agricultural soils of the EMEP/EEA Guidebook 2019. 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 result was 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. The project is planned to take place in the years 2020–2023 and an analysis of the fertiliser data is planned for the first year.

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 2019 as the last available version at the time of inventory preparation.

For calculating NMVOC emissions from cultivated crops sector, the Tier 2 methodology and default valued for NMVOC emission factor calculation was used (see Table 5.23).

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

$$\boldsymbol{EFi} = \sum(\mathbf{Ej{,}NMVOC} * \mathbf{24} * \mathbf{365} * \boldsymbol{Fracemit{,}j}) * \boldsymbol{mdmj} * \boldsymbol{Fraci{,}j}$$

Where,

i = Inventory year

j = Crops species

Ej,NMVOC = Hourly emission flux of NMVOC per species (kg/dm3 /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 5.24) and default emission factors (see Table 5.22).

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.

Table 5.22 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	0.155
	NH3	kg NH_3 kg-1 fertilizer-N applied	0.0500
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	NOx	NO kg kg−1 fertiliser and manure N applied	0.040
3Dc	$PM_{2.5}$	kg ha^{-1}	0.060
	PM_{10}	kg ha^{-1}	1.560
3De	TSP	kg ha^{-1}	1.560

Table 5.23 Default values for NMVOC emission factor calculation

Species (i)	Ej	NMVOC Fracemit	mdm	Fracij
Wheat	0.000000026	0.3	4 700	0.4
Rye	0.000000141	0.3	2 800	0.1
Rape	0.000000202	0.3	2 500	0.1
Grass (15 C)	0.000000010	0.5	9 000	0.3
Grass (25 C)	0.000000047	0.5	9 000	0.3

Due the lack of activity data for the previous years (1990–2011), HCB emissions are not estimated from the use of pesticides category (3Df). An additional analysis for finding an alternative source of activity data is ongoing.

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 1990-2019.

In 2015 the Statistics Estonia stopped gathering mineral fertilizer data by their own and started to use data gathered by the Estonian Rural Economy Research in the framework of the Centre Farm Accounting Data Network (FADN).

Information regarding urea fertilizer is available also from Statistics Estonia. In 2014-2019 there was no production of urea fertilizers in Estonia therefore using urea fertilizer marketing data provided by the Estonian Agricultural Board was used.

In addition, Information regarding compost application from Estonian Environment Agency were used.

Table 5.24 Active data for agricultural soil sector in the period of 1990-2019

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	ha					tonnes	mln,inhab
1990	58,360	1 360.2	952,103	65,900	26,000	600.0	…	49,559	1,571
1995	18,905	873.0	415,952	32,000	38,600	600.0	…	65,102	1,448
2000	22,396	592.9	452,538	28,900	68,900	28,800	…	139,058	1,401
2005	20,083	1 919.7	532,319	7,400	85,400	46,600	143,400	684,523	1,359
2010	28,628	10.3	437,302	12,600	119,400	98,200	107,400	1426,440	1,333
2011	29,803	14.6	474,102	13,300	128,400	89,000	111,100	975,697	1,336
2012	32,978	35.4	497,269	16,900	124,300	87,100	159,300	1085,268	1,325
2013	33,659	498.9	476,623	11,500	124,200	86,100	189,200	1502,496	1,320
2014	35,803	31.7	510,317	15,400	154,400	80,000	172,300	1326,385	1,316
2015	36,276	37.9	545,010	14,300	169,700	70,800	172,300	1412,791	1,313
2016	36,390	34.5	617,919	12,400	164,500	70,100	172,300	1913,635	1,316
2017	37,333	139.5	585,712	13,300	169,700	73,800	172,300	1702,609	1,316
2018	38,867	181.2	589,894	10,540	154,579	72,683	172,300	49,559	1,319
2019	41,438	181.2	587,857	28,901	166,984	72,411	172,300	65,102	1,630

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2019. 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 5.18.

5.3.4. Source-Specific QA/QC and Verification

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

5.3.5. 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.

5.4. 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, no. 57 of 20 April 2007, and no. 20 of 23 February 2011).

As no other official records of agricultural burning of crop waste exist in Estonia, then for the reporting period of 1990–2004, an inquiry was made to the Estonian Ministry of Rural Affairs and according to their best knowledge, no widespread practice of burning agricultural waste has taken place during the reporting period or it has been marginal, as the generation of agricultural waste in the form of litter is scant and often insufficient to cover the demand for it. In the 2020 submission, notation key NO was applied to the entire time series, but following the question raised in the review, an analysis of possible historical data is ongoing. The results will be revealed for the next submission.

Source: www.bioneer.ee

6. WASTE (NFR 5)

6.1. Overview of the Sector

Emissions from solid waste disposal on land (landfills), waste incineration, cremation, waste water treatment and other waste sources are included in this category. Emissions from the waste sector are based on point sources (facilities) while area sources data are included for some sectors.

Emissions from point sources are taken from the point sources database and the emissions for diffuse sources are calculated from the data received from Statistics Estonia, Estonian Rescue Board and the waste data management system JATS in ESTEA. The emission factors given in EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 and expert opinions are used in the additional emission calculations.

Used methods and reported emissions for the waste sector are presented in the Table 6.1.

Table 6.1 Used methods and reported emissions for the waste sector (NFR 5)

NFR	Source	Description	Method	Emissions reported
5A	Solid waste disposal on land	Includes point and diffuse sources emissions from treatment and disposal of municipal, industrial and other solid waste at landfills	Tier 2 / Tier 3	NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP
5B1	Compost production	Includes point and diffuse sources emissions from the biological treatment of waste – composting	Tier 2 / Tier 3	NMVOC, NH_3
5B2	Anaerobic digestion at biogas facilities	Includes point sources emissions from anaerobic digestion at biogas facilities	Tier 3	NO_x, NMVOC, SO_x, NH_3, TSP, CO
5C1a	Municipal waste incineration	Includes point source emissions from municipal solid waste (MSW) incineration process with heat recovery	Tier 3	IE under NFR 1A1a Public electricity and heat production
5C1bi	Industrial waste incineration	Includes point sources emissions from flaring in chemical industry and waste oil incineration	Tier 2 / Tier 3	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, As, Cr, Cu, Ni, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total
5C1bii	Hazardous waste incineration	--	--	NA
5C1biii	Clinical waste incineration	Includes point sources emissions from the incineration of hospital wastes	Tier 2	PCDD/F (*expert estimation*)
5C1biv	Sewage sludge incineration	--	--	NA
5C1bv	Cremation	Includes point and diffuse sources emissions from the incineration of human bodies in a crematorium and animal carcass incineration	Tier 1 / Tier 3	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, 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 2	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, PAHs Total, HCB, PCBs
5D1	Domestic wastewater handling	Includes point sources emissions from domestic wastewater handling	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 an insignificant sector, except dioxins emissions, which in 2019 comprised about 25.2% of the total dioxins emissions. Over the years that share has been decreasing, reaching the peak of 44.05% in 2002. The main reason for that decrease is almost 3 times less unintentional car and building fires in 2019 compared to the year 2002, which is one of the main sources for dioxins emissions in the waste sector beside industrial waste incineration.

6.2. Uncertainty

An uncertainty analysis was carried out to the year 2019 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 6.2.

Table 6.2 Uncertainty estimation of the waste sector

Pollutant	Emission, 2019	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2019, %
NO_x	0.026	kt	0.1	0.060	0.003
NMVOC	0.170	kt	0.75	0.570	0.120
SO_x	0.081	kt	0.43	0.190	0.013
NH_3	0.055	kt	0.52	0.250	0.120
$PM_{2.5}$	0.087	kt	1.480	1.080	0.150
PM_{10}	0.103	kt	1.12	0.790	0.020
TSP	0.120	kt	0.86	0.610	0.030
CO	0.008	kt	0.01	0.002	0.001
Pb	0.363	t	3.19	3.200	0.160
Cd	0.012	t	2.22	2.160	0.190
Hg	0.023	t	6.98	3.580	0.350
PCDD/F	1.155	g I-TEQ	25.2	37.300	16.440
B(a)p	0.00002	t	0.002	0.003	0.0003
B(b)f	0.00001	t	0.001	0.002	0.0003
B(k)f	0.00001	t	0.002	0.004	0.0003
I(1,2,3-cd)p	0.0000001	t	0.00001	0.00001	0.00001
HCB	0.008	kg	2.4	5.080	13.800
PCBs	0.022	kg	5.020	6.460	0.610

6.3. Solid Waste Disposal on Land (NFR 5A)

6.3.1. Source Category Description

This chapter includes emissions from treatment and disposal of municipal, industrial and other solid waste at landfills and mainly causes greenhouse gas emissions. This sector, however, is only a minor source of air pollutant emissions.

Small quantities of NMVOC and NH_3 had been emitted. Also, particulate emissions from waste handling are generated (see Table 6.3).

In 2019, Estonia had five functioning landfills (Tallinn Recycling Center, Uikala, Väätsa, Torma and Paikre) classified as managed SWD sites and one landfill for construction waste. These landfills conform fully to environmental and technical requirements and standards, and are capable of servicing more than one county or service area. 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.[33]

During the period of 1990-2015 the disposal of solid waste at landfills has decreased quite drastically (see Figure 6.1) due to the closing of many landfills and because of better knowledge how to recycle and reuse waste.

Also, in 2013 Eesti Energia finished building the modern and efficient waste-to-energy power unit at the Iru Power Plant to generate heat and electricity from mixed municipal solid waste (MSW), which also reduced depositing of mixed MSW in landfills.

Since 2016 the amounts of landfilled MSW has started to grow because of higher gate-tax for waste carriers at the Iru Power Plant and lower tax for landfilling waste. Also, Iru Power Plant imports more waste from abroad which has less organic waste in it and because of that has a higher calorific value.

Table 6.3 Emissions from solid waste disposal on land in the period of 1990-2019

Year	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
	kt	t			
1990	0.135	NE	NR	NR	0.360
1995	0.162	NE	NR	NR	0.329
2000	0.278	NE	0.017	0.114	0.240
2005	0.249	NE	0.017	0.111	0.234
2010	0.230	0.025	0.011	0.071	0.209
2011	0.216	0.025	0.010	0.311	0.920
2012	0.202	0.025	0.007	0.287	0.868
2013	0.179	0.025	0.004	0.306	0.907
2014	0.160	0.025	0.003	0.285	0.984
2015	0.153	0.025	0.003	0.327	0.943
2016	0.139	0.025	0.003	0.428	1.095
2017	0.136	0.006	0.006	0.552	1.530
2018	0.128	0.006	0.009	0.407	1.105
2019	0.128	0.034	0.008	0.410	1.151

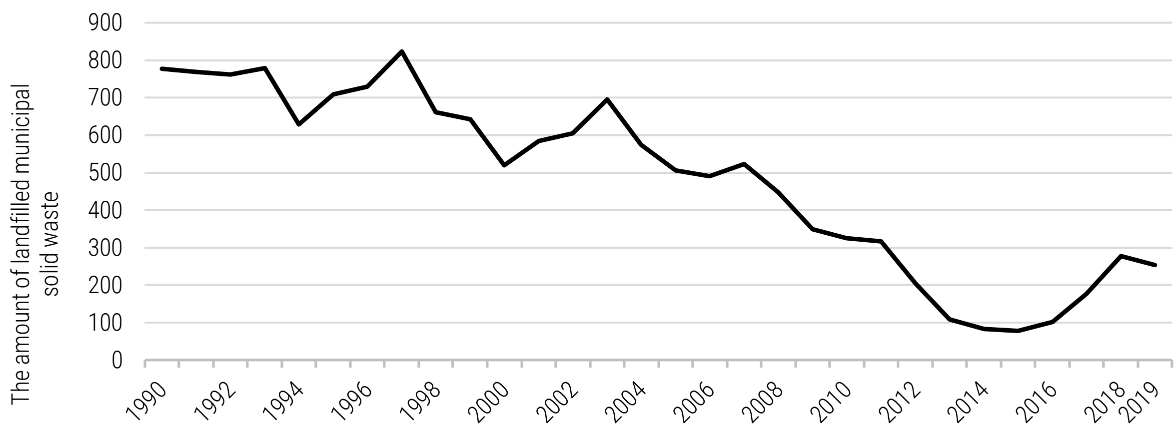

Figure 6.1 The amount of landfilled solid waste in the period of 1990-2019 (kt)

[33] „Greenhouse Gas Emissions in Estonia 1990-2018. National Inventory Report", Estonia 2020, p 359 (preliminary report). https://www.envir.ee/sites/default/files/nir_est_1990-2018_15.01.2020.pdf

6.3.2. Methodological Issues

For diffuse sources the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 Tier 1 methodology is used for calculating particulate emissions. The annual amount of landfilled solid waste is gathered from the waste management information system JATS in ESTEA.

Also some point sources emissions from point sources database, reported by operators, are used. In 2019 there were 7 operators.

NMVOC emissions from the NFR source category 5A were calculated by using the amounts of biodegradable solid waste deposited in landfills and the quantities of CH_4 that is generated from the biodegrading process of that waste. Those amounts were obtained from the Estonian GHG inventory (see Table 6.4).

The note under the Table 3-1 of the Chapter 5.A from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 refers to the UK Inventory (2004) where NMVOC emission factor from solid waste disposal on land is 5.65 g NMVOC per m^3 landfill gas. This note also explains that the default CH_4 content of landfill gas is 50% (IPCC, 2006, Vol. 5, Ch. 3.2.3).

Table 6.4 The amounts of deposited biodegradable solid waste deposited in landfills and the amounts of CH_4 and landfill gas emitted from it in the period of 1990-2019

Year	Amount of deposited biodegradable SW in landfills, kt	CH_4 generation potential, kt	CH_4 generation potential, thousand m^3	Volume of CH_4 per ton of deposited biodegradable SW, m^3/ton	Volume of landfill gas from SWDS, thousand m^3	Volume of landfill gas per ton of deposited biodegradable SW, m^3/ton	Amount of landfill gas used in boilers/ incinerators, thousand m^3	Amount of landfill gas emitted, thousand m^3
1990	356.355	8.549	11,922.902	33.458	23,845.804	66.916	NO	23,845.804
1995	423.457	11.884	16,574.571	39.141	33,149.143	78.282	4,392.149	28,756.993
2000	487.411	19.053	26,572.951	54.519	53,145.901	109.037	3,927.098	49,218.803
2005	279.936	18.575	25,907.083	92.547	51,814.166	185.093	7,699.180	44,114.986
2010	142.604	16.070	22,412.355	157.165	44,824.709	314.329	4,174.470	40,650.239
2011	122.895	15.589	21,741.501	176.911	43,483.002	353.823	5,314.929	38,168.073
2012	61.585	15.014	20,940.502	340.023	41,881.004	680.047	6,153.318	35,727.686
2013	30.568	14.048	19,592.765	640.959	39,185.530	1,281.919	7,449.901	31,735.629
2014	21.434	12.963	18,079.772	843.516	36,159.543	1,687.032	7,906.530	28,253.013
2015	19.908	11.949	16,665.303	837.136	33,330.606	1,674.272	6,172.077	27,158.529
2016	33.216	11.046	15,406.486	463.832	30,812.973	927.664	6,257.996	24,554.977
2017	54.058	10.342	14,424.142	266.829	28,848.284	533.658	4,817.974	24,030.310
2018	63.371	9.872	13,768.176	217.262	27,536.352	434.525	4,799.821	22,736.531
2019	41.174	9.510	13,263.496	322.130	26,526.992	644.259	3,854.431	22,672.561

The following equation was used to calculate NMVOC emissions:

$$E_{NMVOC} = \left(\left(\frac{\frac{L_o}{\rho_{CH4}}}{F_{CH4}} \right) - V_{LFG,burnt} \right) * EF_{NMVOC}/10^9$$

where

E_{NMVOC} – NMVOC emission (kt);
L_o – CH_4 generation potential (kg);
ρ_{CH4} – CH_4 density at STP (0.717 kg/m^3)[34];
F_{CH4} – fraction of CH_4 in landfill gas (0.5);
$V_{LGF,burnt}$ – amount of landfill gas used in boilers/ incinerators (m^3);
EF_{NMVOC} – NMVOC emission factor (g/m^3).

6.3.3. Source-Specific QA/QC and Verification

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

[34] https://www.engineeringtoolbox.com/gas-density-d_158.html

6.3.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

6.4. Biological Treatment of Waste (NFR 5B)

6.4.1. 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).

Table 6.5 The amount of organic waste composted and NMVOC and NH_3 emissions from compost production in the period of 1990-2019 (kt)

Year	Amount of organic waste composted	NMVOC	NH_3
1990	6.775	NE	0.002
1995	8,900	NE	0.002
2000	19.010	NE	0.005
2005	93,578	0.001	0.022
2010	195,002	0.004	0.047
2011	133,383	0.004	0.032
2012	148,362	0.004	0.036
2013	205,399	0.004	0.049
2014	181,324	0.004	0.044
2015	193,136	0.003	0.046
2016	261,604	0.003	0.063
2017	232,756	0.003	0.056
2018	245,094	0.003	0.059
2019	222.807	0.009	0.053

Table 6.6 Emissions from anaerobic digestion at biogas facilities in the period of 2011-2019

Year	NO_x	CO	NMVOC	SO_2	NH_3	TSP
	kt		t			
2011	0.002	0.001	0.077	0.068	0.344	0.002
2012	0.002	0.001	0.077	0.068	0.344	0.002
2013	0.008	0.008	0.676	0.348	0.344	0.011
2014	0.007	0.008	0.590	0.290	0.344	0.012
2015	0.008	0.008	1.498	4.644	0.344	0.017
2016	0.006	0.006	0.499	0.216	0.344	0.008
2017	0.007	0.007	0.554	0.201	NE	0.046
2018	0.001	0.001	0.052	0.018	NE	0.035
2019	0.001	0.000	0.041	2.476	NE	NE

6.4.2. Methodological Issues

Point sources emissions are based on operator reports. In 2019 there were reports from 3 anaerobic digestion operators and 7 composting operators.

Additional data to calculate diffuse sources emission of NH_3 in compost production sector is obtained from the waste management information system JATS in ESTEA. Different waste codes for wood, sludge, paper and organic wastes are taken into account. For these calculations, the Tier 2 method is used. Default emission factor for NH_3 is taken from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 (see Table 6.7).

Table 6.7 Emission factor for composting

Pollutant	Unit	Value
NH_3	kg/Mg waste	0.24

6.4.3. Source-Specific QA/QC and Verification

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

6.4.4. Source-Specific Planned Improvements

It is planned to check in more detail the data reported by point sources, specify activity data and make recalculations, if necessary.

6.5. Waste Incineration (NFR 5C)

6.5.1. Source Category Description

This sector includes the volume reduction, by combustion, of different kind of wastes. In Estonia, the following waste treatments take place: municipal, industrial and clinical waste incineration, cremation, clinical and open burning of waste.

In 2013 Eesti Energia finished building the modern and efficient waste-to-energy power unit at the Iru Power Plant to generate heat and electricity from mixed municipal solid waste (MSW). With the completion of the Iru waste-to-energy unit, the large-scale depositing of mixed MSW in landfills decreased because for the first time the waste that previously went into landfills could be used as a fuel. The Iru waste-to-energy unit is a new solution for Estonia, for both energy production and waste handling. Because of mixed MSW is incinerated to generate heat and electricity, all the emissions that occur in the process are reported in the combustion sector (NFR source category 1A1a).

Table 6.8 will give overview of emissions from industrial waste incineration in the period of 1990-2019.

Table 6.8 Emissions from industrial waste incineration in the period of 2000-2019

Year	NO_x	NMVOC	SO_2	CO	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC
	kt				t				
2000	NA	NA	NA	NA	NE	NA	NA	NA	NA
2005	NA	NA	NA	NA	NE	NA	NA	NA	NA
2010	0.016	0.005	0.010	0.015	0.229	0.065	0.113	0.162	0.002
2011	0.014	0.028	0.010	0.015	0.108	0.324	0.402	0.583	0.011
2012	0.011	0.001	0.050	0.005	0.300	0.076	0.133	0.190	0.003
2013	0.006	0.001	0.039	0.002	0.137	0.031	0.053	0.076	0.001
2014	0.007	0.000	0.006	0.003	0.246	0.052	0.092	0.131	0.002
2015	0.004	0.000	0.019	0.001	0.110	0.032	0.055	0.079	0.001
2016	0.009	0.000	0.041	0.002	0.152	0.049	0.085	0.122	0.002
2017	0.007	0.001	0.000	0.002	0.123	0.045	0.078	0.112	0.002
2018	0.008	0.001	0.070	0.003	0.122	0.051	0.090	0.129	0.002
2019	0.011	0.001	0.071	0.003	0.141	0.064	0.113	0.161	0.002

Table 6.8 continues

Year	Pb	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F
	kg							g I-Teq
2000	NA	NA	NE	NE	NA	NE	NE	0.116
2005	NA	NA	NE	NE	NA	NE	NE	0.117
2010	NA	NA	NE	9.400	NA	NE	NE	0.255
2011	0.048	0.029	0.010	8.923	0.019	0.029	0.085	0.295
2012	NA	NA	NE	7.200	NA	NE	NE	0.140
2013	NA	NA	NE	9.500	NA	NE	NE	0.220
2014	NA	NA	NE	6.000	NA	NE	NE	0.250
2015	NA	NA	NE	4.100	NA	NE	NE	0.638
2016	NA	NA	NE	0.013	NA	NE	NE	0.639
2017	NA	NA	NE	0.013	NA	NE	NE	0.802
2018	0.767	0.014	0.030	0.120	0.015	NE	NE	0.348
2019	0.003	NA	NE	0.000	NA	NE	NE	0.342

The Table 6.9 will give an overview of dioxins emissions from clinical waste incineration in the period of 1990-2019.

Table 6.9 PCDD/F emissions from clinical waste incineration in the period of 1990-2019 (g I-TEQ)

Year	PCDD/F
1990	0.470
1995	0.430
2000	0.280
2005	0.520
2010	0.066
2011	0.066
2012	0.068
2013	0.017
2014	0.073
2015	0.085
2016	0.086
2017	0.109
2018	0.114
2019	0.115

The first crematorium was established in Estonia in 1993. By the year 2019 there were already 9 crematoriums. As in 1993 there were only 39 cremations then in 2019 the number of cremations was over 8,500 which is about 55.6% of deceased people in that year. For pollutants emissions calculation the EMEP/EEA Guidebook 2019 Tier 1 emission factors are used and calculated emissions are presented in the following Table 6.10.

Table 6.10 Pollutants emissions from cremation in the period of 1993-2019

Year	Number of cremations	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
		t								
1993	39	0.032	0.001	0.004	NA	NR	NR	0.002	NR	0.005
1995	876	0.723	0.011	0.099	NA	NR	NR	0.034	NR	0.123
2000	3,063	2.527	0.040	0.346	NA	0.106	0.106	0.118	NE	0.429
2005	4,768	3.934	0.062	0.539	NA	0.165	0.165	0.184	NE	0.668
2010	6,211	5.124	0.081	0.702	1.619	0.216	0.216	0.239	NE	0.870
2011	6,816	5.623	0.089	0.770	1.678	0.237	0.237	0.263	NE	0.954
2012	6,969*	5.749	0.091	0.787	0.004	0.242	0.242	0.269	NE	0.976
2013	7,404*	6.108	0.096	0.837	0.007	0.257	0.257	0.285	NE	1.037
2014	7,616*	6.283	0.099	0.861	0.007	0.264	0.264	0.294	NE	1.066
2015	7,824*	6.455	0.102	0.884	0.013	0.271	0.271	0.302	NE	1.095
2016	7,861*	6.485	0.102	0.888	0.008	0.273	0.273	0.303	NE	1.101
2017	8,065*	6.654	0.105	0.911	0.008	0.280	0.280	0.311	NE	1.129
2018	8,752	7.220	0.114	0.989	0.008	0.304	0.304	0.337	NE	1.225
2019	8,570	7.070	0.111	0.968	0.056	0.297	0.297	0.330	NE	1.200

** Estimated number*

Table 6.10 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	kg								
1993	0.001	0.000	0.058	0.001	0.001	0.000	0.001	0.001	0.006
1995	0.026	0.004	1.305	0.012	0.012	0.011	0.015	0.017	0.140
2000	0.092	0.015	4.564	0.042	0.042	0.038	0.053	0.061	0.490
2005	0.143	0.024	7.104	0.065	0.065	0.059	0.083	0.094	0.763
2010	0.187	0.031	9.254	0.085	0.084	0.077	0.108	0.123	0.995
2011	0.205	0.034	10.156	0.093	0.092	0.085	0.118	0.135	1.091
2012	0.209	0.035	10.384	0.095	0.094	0.087	0.121	0.138	1.116
2013	0.222	0.037	11.032	0.101	0.100	0.092	0.128	0.146	1.186
2014	0.229	0.038	11.348	0.104	0.103	0.095	0.132	0.151	1.219
2015	0.235	0.039	11.658	0.106	0.106	0.097	0.136	0.155	1.253

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	kg								
2016	0.236	0.040	11.713	0.107	0.107	0.098	0.136	0.155	1.259
2017	0.242	0.041	12.017	0.110	0.109	0.100	0.140	0.160	1.291
2018	0.263	0.044	13.040	0.119	0.119	0.109	0.152	0.173	1.401
2019	0.257	0.043	12.769	0.117	0.116	0.107	0.149	0.170	1.372

Table 6.10 continues

Year	PCDD/F	PAHs				HCB	PCBs
		B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p		
	mg I-TEQ	g					
1993	0.001	0.001	0.000	0.000	0.000	0.006	0.016
1995	0.024	0.012	0.006	0.006	0.006	0.131	0.359
2000	0.083	0.040	0.022	0.020	0.021	0.459	1.256
2005	0.129	0.063	0.034	0.031	0.033	0.715	1.955
2010	0.168	0.082	0.045	0.040	0.043	0.932	2.547
2011	0.184	0.090	0.049	0.044	0.048	1.022	2.795
2012	0.188	0.092	0.050	0.045	0.049	1.045	2.857
2013	0.200	0.098	0.053	0.048	0.052	1.111	3.036
2014	0.206	0.101	0.055	0.049	0.053	1.142	3.123
2015	0.211	0.103	0.056	0.050	0.055	1.174	3.208
2016	0.212	0.104	0.057	0.051	0.055	1.179	3.223
2017	0.218	0.106	0.058	0.052	0.056	1.210	3.307
2018	0.236	0.116	0.063	0.056	0.061	1.313	3.588
2019	0.231	0.113	0.062	0.055	0.060	1.286	3.514

This chapter also covers emissions from open waste burning in households. This is a poorly quantified sector. Uncontrolled domestic waste burning should include all instances where waste is burned with no pollution controls and therefore includes burning in the open: in piles, in barrels or in home fires. Activity data and emissions are shown in the Tables 6.11-6.12. The share of this sector into total emission for all pollutants is not significant compared to other pollution sources.

Table 6.11 Amount of domestic waste burned in the period of 1990- 2019 (tonnes)

Year	Total MSW	MSW burned
1990	382,150.6	7643.0
1995	522,097.2	10,441.9
2000	570,582.4	11,411.6
2005	465,437.9	4654.4
2010	289,423.3	2894.2
2011	292,716.2	2927.2
2012	277,826.1	2778.3
2013	294,720.2	2947.2
2014	304,835.4	3048.4
2015	317,428.8	3174.3
2016	324,850.5	3248.5
2017	327,633.5	3276.3
2018	344,221.0	3442.2
2019	348,715.7	3487.2

Table 6.12 Pollutants emissions from domestic waste burning in the period of 1990-2019

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	t							
1990	13.757	0.153	12.993	NR	NR	139.867	NR	5.350
1995	18.795	0.209	17.751	NR	NR	191.088	NR	7.309
2000	20.541	0.228	19.400	104.987	156.340	208.833	3.675	7.988
2005	8.378	0.093	7.912	42.820	63.765	85.175	1.499	3.258
2010	5.210	0.058	4.920	26.627	39.651	52.964	0.932	2.026
2011	5.269	0.059	4.976	26.930	40.102	53.567	0.943	2.049
2012	5.001	0.056	4.723	25.560	38.062	50.842	0.895	1.945
2013	5.305	0.059	5.010	27.114	40.377	53.934	0.949	2.063
2014	5.487	0.061	5.182	28.045	41.762	55.785	0.982	2.134
2015	5.714	0.063	5.396	29.203	43.488	58.089	1.022	2.222
2016	5.847	0.065	5.522	29.886	44.505	59.448	1.046	2.274
2017	5.897	0.066	5.570	30.142	44.886	59.957	1.055	2.293
2018	6.196	0.069	5.852	31.668	47.158	62.992	1.108	2.410
2019	6.277	0.070	5.928	32.082	47.774	63.815	1.123	2.441

Table 6.12 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	kg							
1990	794.873	25.986	21.400	16.356	1.414	0.711	0.917	6.879
1995	1,085.962	35.503	29.237	22.346	1.932	0.971	1.253	9.398
2000	1,186.811	38.800	31.953	24.421	2.111	1.061	1.369	10.270
2005	484.055	15.825	13.032	9.960	0.861	0.433	0.559	4.189
2010	301.000	9.840	8.104	6.194	0.535	0.269	0.347	2.605
2011	304.425	9.952	8.196	6.264	0.542	0.272	0.351	2.634
2012	288.939	9.446	7.779	5.945	0.514	0.258	0.333	2.500
2013	306.509	10.020	8.252	6.307	0.545	0.274	0.354	2.652
2014	317.029	10.364	8.535	6.523	0.564	0.283	0.366	2.744
2015	330.126	10.793	8.888	6.793	0.587	0.295	0.381	2.857
2016	337.844	11.045	9.096	6.952	0.601	0.302	0.390	2.924
2017	340.739	11.140	9.174	7.011	0.606	0.305	0.393	2.949
2018	357.990	11.704	9.638	7.366	0.637	0.320	0.413	3.098
2019	362.664	11.856	9.764	7.463	0.645	0.324	0.418	3.138

Table 6.12 continues

Year	PCDD/ F	B(a)p	B(b)f	B(k)f	HCB	PCB
	g I-TEQ	kg				
1990	0.306	0.032	0.024	0.024	0.015	0.041
1995	0.418	0.044	0.033	0.032	0.021	0.055
2000	0.456	0.048	0.037	0.035	0.023	0.060
2005	0.186	0.020	0.015	0.014	0.009	0.025
2010	0.116	0.012	0.009	0.009	0.006	0.015
2011	0.117	0.012	0.009	0.009	0.006	0.016
2012	0.111	0.012	0.009	0.009	0.006	0.015
2013	0.118	0.012	0.009	0.009	0.006	0.016
2014	0.122	0.013	0.010	0.009	0.006	0.016
2015	0.127	0.013	0.010	0.010	0.006	0.017
2016	0.130	0.014	0.010	0.010	0.006	0.017
2017	0.131	0.014	0.010	0.010	0.007	0.017
2018	0.138	0.014	0.011	0.011	0.007	0.018
2019	0.139	0.015	0.011	0.011	0.007	0.018

6.5.2. Methodological Issues

Emissions from clinical and industrial 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.

In addition to the facility data, PCDD/F emissions from clinical and industrial waste incineration are calculated. In these calculations, data from the waste management information system JATS was used.

UNEP Standardized Toolkit emission factors were used in the calculation of dioxins emissions from clinical and industrial waste incineration:

- Clinical waste incineration 525 µg/Mg of waste;
- Industrial waste incineration 350 µg/Mg of waste.

The pollutant emissions from open domestic waste burning are calculated based on an expert judgement about the amount of burned waste (before 2004 - 2% from the total amount of municipal waste and since 2004 – 1% of MSW) and the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 emission factors. Unfortunately, there is no emission factor applicable for this category in the Guidebook and therefore the calculation method is applied for uncontrolled municipal waste incineration (NFR source category 5C1a). Emission factors are presented in mass per mass of waste burned (see Table 6.13).

Table 6.13 Emission factors for domestic waste incineration

Pollutant	Unit	Value
NO_X	kg/Mg waste	1.8
NMVOC	kg/Mg waste	0.02
SO_2	kg/Mg waste	1.7
CO	kg/Mg waste	0.7
TSP	kg/Mg waste	18.3
PM_{10}	kg/Mg waste	13.7
$PM_{2.5}$	kg/Mg waste	9.2
BC	kg/Mg waste	0.322
Pb	g/Mg waste	104.0
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
PCDD/F	µg/Mg waste	40.0
B(a)p	mg/Mg waste	4.2
B(b)f	mg/Mg waste	3.2
B(k)f	mg/Mg waste	3.1
HCB	g/Mg waste	0.002
PCB	mg/Mg waste	5.3

6.5.3. Source-Specific QA/QC and Verification

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

6.5.4. Source-Specific Planned Improvements

It is planned to specify activity data and make recalculations, if necessary.

6.6. Waste Water Handling (NFR 5D)

6.6.1. Source Category Description

This chapter covers emissions from domestic and industrial wastewater handling (see Tables 6.14-6.15). In general, emissions of NO_X, NMVOC, SO_X, NH_3 and CO occur from waste water treatment plants, but are largely insignificant in terms of total national emissions.

Table 6.14 Emissions from domestic wastewater handling in the period of 1994-2019

Year	Wastewater handled	NO_X	NMVOC	SO_X	NH_3
	thousand m^3	t			
1994	1,961.8	NA	29.427	NA	NE
1995	1,849.0	NA	27.735	NA	NE
2000	1,495.2	NA	22.428	NA	NE
2005	1,619.7	NA	24.296	NA	NE

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Year	Wastewater handled	NO_x	NMVOC	SO_x	NH_3
	thousand m^3	t			
2010	1,899.4	0.128	28.490	0.068	0.077
2011	1,933.0	0.128	28.995	0.068	0.014
2012	1,698.5	0.128	25.478	0.068	0.014
2013	1,795.7	0.128	26.936	0.068	0.173
2014	1,762.1	0.128	26.432	0.068	0.032
2015	1,641.7	0.128	24.625	0.068	0.042
2016	1,820.1	0.128	27.301	0.068	0.191
2017	1,870.6	NE	28.059	NE	NE
2018	1,658.8	NE	24.882	NE	NE
2019	1,065.6	NE	15.983	NE	0.002

Table 6.15 Emissions from industrial wastewater handling in the period of 1994-2019 (tonnes)

Year	NO_x	NMVOC	SO_x	NH_3
1994	NA	IE	NA	NE
1995	NA	IE	NA	NE
2000	NA	IE	NA	NE
2005	NA	IE	NA	NE
2010	0.441	6.216	0.126	0.426
2011	0.444	4.145	0.124	0.229
2012	0.441	4.145	0.125	0.318
2013	1.236	1.144	1.763	0.149
2014	1.486	1.098	2.183	0.134
2015	0.317	0.883	0.056	0.530
2016	1.085	4.539	1.833	0.522
2017	1.205	8.211	1.380	0.949
2018	0.893	1.370	0.321	1.307
2019	0.554	0.984	0.125	1.196

6.6.2. Methodological Issues

NO_x, NMVOC, SO_x and NH_3 emissions from waste water handling are based on data from facilities.

In 2019 the annual reports were received from 9 operators.

In addition to the facility data, NMVOC emissions from diffuse sources are based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 Tier 2 method, whereby emissions are calculated using a default emission factor (NMVOC 15 mg/m^3 waste water handled). In this calculation, data from Statistics Estonia was used. Data is available from the year 1994 and those NMVOC emissions are reported under NFR source category 5D1. It is assumed that diffuse sources NMVOC emissions from industrial wastewater handling for the years 1994 to 2007 are already included in the domestic wastewater handling NMVOC emissions for the same period.

6.7. Other Waste (NFR 5E)

6.7.1. Source Category Description

This chapter covers emissions from other waste sector, which includes data from facilities (3 operators in 2019) and from car fires, detached and undetached house fires, apartment and industrial building fires. Detailed data about fires is obtained from the Estonian Rescue Board and is available since 1998 (see Figure 6.2).

Pollutants emissions are presented in the following Table 6.16.

Table 6.16 Emissions from other waste in the period of 1998-2019

Year	NO_x	NMVOC	SO_x	NH_3	CO	$PM_{2.5}$	PM_{10}	TSP
	t					kt		
1998	NE	NE	NE	NE	NE	NR	NR	0.209
2000	NE	NE	NE	NE	NE	0.200	0.200	0.200
2005	NE	NE	NE	NE	NE	0.170	0.170	0.170
2010	0.475	5.035	NE	NE	0.475	0.099	0.099	0.099
2011	1.329	6.022	0.068	NE	1.444	0.091	0.091	0.091
2012	3.534	6.786	0.276	1.280	3.727	0.091	0.091	0.091
2013	1.797	4.878	0.018	1.137	0.247	0.075	0.075	0.075
2014	0.317	3.523	NE	1.780	NE	0.083	0.083	0.083
2015	0.388	2.727	NE	0.165	NE	0.065	0.065	0.065
2016	0.135	5.592	NE	0.009	0.112	0.067	0.067	0.067
2017	NE	3.113	NE	NE	NE	0.055	0.055	0.055
2018	NE	6.354	NE	NE	NE	0.061	0.061	0.061
2019	NE	14.730	NE	NE	NE	0.055	0.055	0.055

Table 6.16 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
	kg							
1998	0.611	1.230	1.230	1.947	1.857	4.318	NE	NE
2000	0.583	1.175	1.175	1.860	1.775	4.126	NE	NE
2005	0.496	0.998	0.998	1.580	1.508	3.505	NE	NE
2010	0.288	0.580	0.580	0.919	0.877	2.038	NE	NE
2011	0.264	0.532	0.532	0.842	0.803	1.867	NE	NE
2012	0.865	0.531	0.690	0.840	0.802	1.865	0.0007	0.0010
2013	0.906	0.497	0.581	0.689	0.658	1.529	0.0004	0.0006
2014	0.217	0.439	0.439	0.771	0.735	1.710	NE	NE
2015	0.189	0.380	0.380	0.602	0.575	1.336	NE	NE
2016	0.195	0.392	0.392	0.621	0.593	1.378	NE	NE
2017	0.160	0.322	0.322	0.510	0.487	1.132	NE	NE
2018	0.178	0.358	0.358	0.567	0.541	1.259	NE	NE
2019	0.158	0.319	0.319	0.506	0.483	1.122	NE	NE

Table 6.16 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p
	g I-TEQ	g			
1998	2.101	NE	NE	NE	NE
2000	2.012	NE	NE	NE	NE
2005	1.711	NE	NE	NE	NE
2010	0.999	NE	NE	NE	NE
2011	0.920	NE	NE	NE	NE
2012	0.919	1.100	1.400	0.900	0.500
2013	0.757	0.553	0.659	0.425	0.234
2014	0.843	NE	NE	NE	NE
2015	0.662	NE	NE	NE	NE
2016	0.684	NE	NE	NE	NE
2017	0.563	NE	NE	NE	NE
2018	0.625	NE	NE	NE	NE
2019	0.559	NE	NE	NE	NE

6.7.2. Methodological Issues

Emissions from the other waste sector are based on data from facilities and additional calculations.

In addition to the facility data, emissions of particulate matter, heavy metals and dioxins are calculated according to the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 Tier 2 method default emission factors (see Table 6.17). In these calculations, data from the Estonian Rescue Board were used.

Table 6.17 Emission factors for unwanted fires in cars and various types of houses

Category	$PM_{2.5}$	PM_{10}	TSP	Pb	Cd	Hg	As	Cr	Cu	PCDD/F
	kg/fire			mg/fire						µg/fire
Car fire	2.3	2.3	2.3							48
Detached house fire	143.82	143.82	143.82	420	850	850	1,350	1,290	2,990	1,440
Undetached house fire	61.62	61.62	61.62	180	360	360	580	550	1,280	620
Apartment building fire	43.78	43.78	43.78	130	260	260	410	390	910	440
Industrial building fire	27.23	27.23	27.23	80	160	160	250	240	570	270

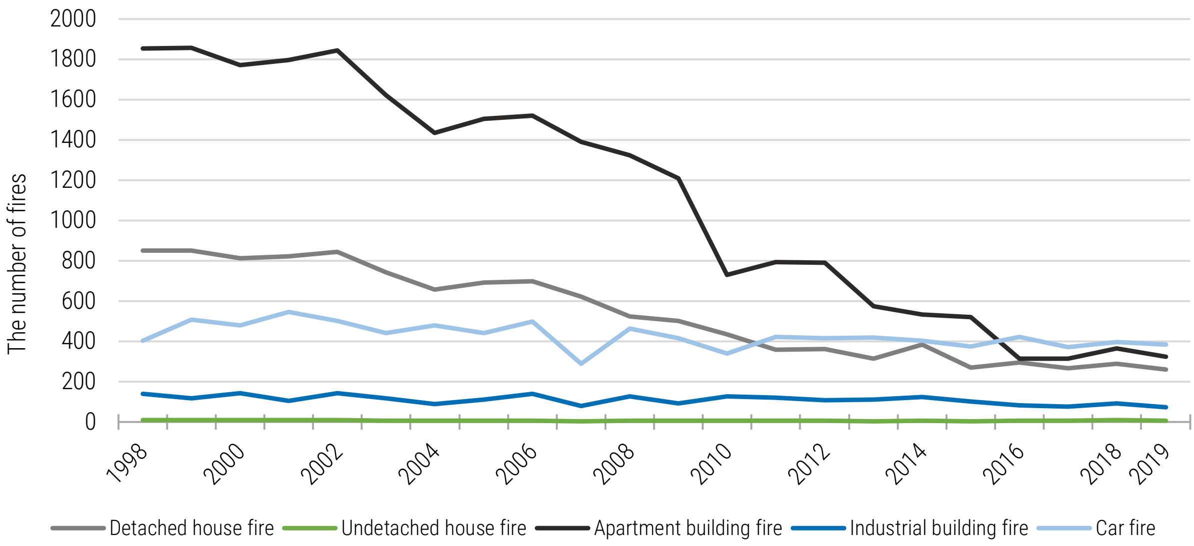

Figure 6.2 The number of fires according to the Estonian Rescue Board in the period of 1998-2019

6.7.3. Source-Specific QA/QC and Verification

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

6.7.4. Source-Specific Planned Improvements

Specify activity data and make recalculations if necessary.

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. Nevertheless it should be noted that emissions of NMVOC from this sector exceeds the anthropogenic emissions by 67%.

Table 7.1 Natural sources

NFR	Source	Description	Emissions reported
11	B. Forest fires	Includes emissions from naturally or man-induced burning of managed and non-managed forests	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO
	C. Other natutral emissions (please specify in the IIR)	Includes all types of foliar forest emissions: managed and non-managed, deciduous and coniferous.	NMVOC

7.2. Forest Fires (NFR 11B)

7.2.1. Source Category Description

A forest fire is an uncontrolled fire occurring in nature. Many forest fires are due to human activity.

The number of forest fires varies from year to year, and quite a long time may elapse between forest fires that are considered to be large. Climatic conditions are the factor that has greatest impact on the extent of forest fires. The forest is most vulnerable in spring and summer seasons when there are long dry spells. Weather conditions such as precipitation and wind, as well as the layout of the terrain, are important factors in determining the size of the forest fire (see Figure 7.1). The figures it is clear there is a tendency of forest fires depending on weather conditions - in the years with the highest temperature and lower precipitations amount the greatest number of fires.

Table 7.2 Pollutant emissions from forest fires in the period of 1990–2019

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.019	0.058	0.004	0.004	0.215	0.263	0.406	0.019	0.582
1995	0.019	0.056	0.004	0.004	0.210	0.257	0.397	0.019	0.558
2000	0.068	0.205	0.014	0.014	0.741	0.905	1.399	0.067	2.051
2005	0.009	0.026	0.002	0.002	0.098	0.120	0.185	0.009	0.260
2010	0.002	0.007	0.000	0.000	0.030	0.037	0.057	0.003	0.074
2011	0.002	0.006	0.000	0.000	0.024	0.029	0.045	0.002	0.058
2012	0.000	0.001	0.000	0.000	0.003	0.004	0.006	0.000	0.008
2013	0.008	0.024	0.002	0.002	0.099	0.121	0.187	0.009	0.236
2014	0.008	0.023	0.002	0.002	0.098	0.120	0.185	0.009	0.233
2015	0.008	0.025	0.002	0.002	0.105	0.129	0.199	0.009	0.249
2016	0.012	0.037	0.002	0.002	0.156	0.191	0.294	0.014	0.369
2017	0.003	0.010	0.001	0.001	0.042	0.051	0.079	0.004	0.099
2018	0.034	0.101	0.007	0.007	0.424	0.519	0.802	0.038	1.015
2019	0.005	0.015	0.001	0.001	0.062	0.076	0.118	0.006	0.150

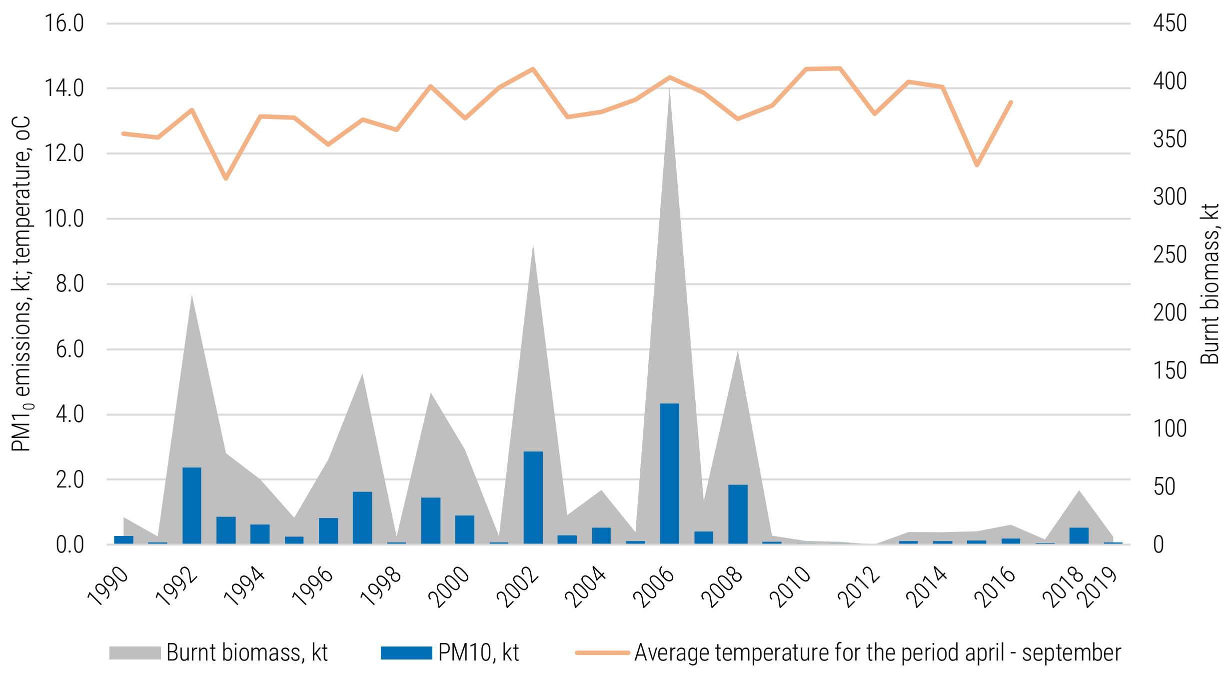

Figure 7.1 Burnt biomass, particulates emission and average temperature in the period 1990-2019

This year submission, preliminary data from the Forest Department on the area of the burned forest were used. All forest fires in 2017 began with a direct or indirect human activity. Natural factors (lightning) did not cause any forest fires this year. 16% of forest fires in 2017 were caused by the carelessness or negligence of forest visitors (campers, children, etc.). These fires were mainly caused due to smoking and campfires. Other causes of fires in 2017 were transport and power transmission lines. If we analyse the causes of fires in the period of 1999–2017, it appears that, on average, 1.4% of forest fires started due to natural factors (lightning), and the rest of the forest fires were, to a greater or lesser extent, the result of human activity.[35]

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 2018, the area of burned forest decreased in 2019 by about 7 times, which accordingly led to an decrease in pollutants emissions.

The emissions of NO_x, NMVOC, SO_x, NH_3 and CO are calculated using EMEP/EEA Guidebook 2019 Tier 1 emission factors (see Table 7.3) and burnt forest area (1990–2019) received from the Yearbook Forest 2017 (see Table 7.4).

The emissions of particulates are calculated on the base of EMEP/EEA Guidebook 2019 Tier 1 emission factors and biomass burnt. Data about biomass amount are available in statistical database only for the years 1990-2019. Biomass statistics changed in the 2021 reporting year, resulting in the recalculation of particle emissions.

[35] Yearbook Forest 2017, Estonian Environment Agency, 2018, https://www.keskkonnaagentuur.ee/et/aastaraamat-mets-2017

Table 7.3 Tier 1 emission factors for category 11B Forest fires

Pollutant	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
Unit	kg/ha area burned	kg/ha area burned	kg/ha area burned	kg/ha area burned	g/kg wood burned	g/kg wood burned	g/kg wood burned	g/kg wood burned	kg/ha area burned
Value	100.000	300.000	20.000	20.000	9.000	11.000	17.000	0.81	3000.000

Activity Data

Table 7.4 Forest burnt area and burnt biomass in the period 1990-2019

Year	Forest burnt area	Burnt biomass
	ha	t
1990	194.0	23,881.3
1995	185.9	23,381.3
2000	683.8	82,305.6
2005	86.5	10,889.3
2006	3,095.6	394,486.3
2007	292.4	37,668.0
2008	1,279.8	167,847.2
2009	59.3	7,925.5
2010	24.8	3,352.4
2011	19.3	2,650.4
2012	2.5	346.9
2013	78.5	11,015.3
2014	77.8	10,896.6
2015	83.1	11,684.1

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

Improve the activity data (burnt biomass) for the 1990-1999.

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 in the period of 1990–2019 (kt)

Year	NMVOC
1990	35.438
1995	34.730
2000	39.621
2005	38.348
2010	37.313
2011	37.821
2012	37.889
2013	38.541
2014	39.312
2015	39.840
2016	40.62
2017	41.18
2018	40.98
2019	41.13
Trend 1990-2019, %	16.1

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:

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;
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 2016.

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 1990-2019. These data were used for calculating the total emission. Information on permanent grasslands is available for the years 2005-2019. There is no information in the statistical database for the years 1990-2000. For calculating the total emission, areas were calculated by using data from CORINE Land Cover 1990 and 2000.

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

Table 7.7 Activity data used for NMVOC emission calculation in 1990-2019, 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	707.1	366.1	616.8	116.6	64.8	181.3	35.8
2005	692.0	360.7	649.9	110.7	64.6	193.5	35.3
2010	711.0	331.9	645.6	111.7	65.3	178.6	35.9
2011	692.7	338.2	665.1	116.0	67.9	175.8	33.5
2012	690.6	339.5	664.0	114.9	70.7	185.8	35.1
2013	699.2	343.2	661.0	113.0	70.7	192.3	35.4
2014	707.0	360.4	652.0	116.4	68.9	194.9	35.4
2015	701.8	364.5	654.2	120.2	72.3	197.8	34.8
2016	697.8	371.8	642.1	124	75.1	196.2	35.5
2017	692.9	377.8	648.8	129	78.3	194	36.6
2018	688.5	378.9	641.5	128.8	79.4	196.3	35.4
2019	683.4	380.4	635.8	131.2	81.6	195.6	34.1

Table 7.8 Activity data used for NMVOC emission calculation in 1990-2019, 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
2011	296.949	162.812
2012	290.473	191.529
2013	311.032	218.605
2014	332.949	197.579
2015	351.354	269.835
2016	330.678	259.102
2017	330.678	259.102
2018	330.678	259.102
2019	351.354	269.835

7.3.3. Source-Specific QA/QC and Verification

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

7.3.4. Sources-Specific Planned Improvements

Improve data quality trough calculating activity data for the 1990s by using data from CORINE Land Cover or other possible sources.

Source: www.drivelayer.com

8. RECALCULATIONS AND IMPROVEMENTS

The latest recalculations in the emission inventory were done for the time period from 1990 to 2018. The reason for the recalculations is specified in the Summary.

The main objective of recalculation is to improve the emissions inventory and the quality of reports.

The following changes have been carried out in comparison with the last year's report.

8.1. Energy Sector (NFR 1)

8.1.1. Stationary Combustion in Energy Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2021 and 2020 are made by using exact calculation numbers.

1A1a Public electricity and heat production

In comparison with the previous submission, the emissions of all POPs substances from NFR 1A1a were recalculated for the period 1990-2018.

The reason for the recalculation was the TERT recommendation to use Tier 2 method for POPs calculating for key source.

Before the calculations, an analysis of the data of the enterprises submitting the reports was carried out. Reports includes data on the number of boilers, their capacity and the amount of fuel burned. Each fuel was analyzed for each NFR with a distribution by capacity <1 MW ,>1<50 and >50. Fuel data for large combustion plants are the same as the LCP report. Emissions from oil shale and semi-coke gas are calculated based on fuel data provided by all oil shale power plants and national emission factors. Calculations for shale oil production, waste incineration and mineral products are also were carried out separately. The results are reflected in the total emissions.

The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2.

The differences in the public electricity and heat production sector emissions between the 2020 and 2021 submissions are presented in Table 8.1.

Table 8.1 The differences in the sector NFR 1A1a POPs emissions for 1990-2018 between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	2.330	1.526	-34.5	2.000	1.301	-35.0	0.020	0.133	565.6	5.244	1.712	-67.4
1991	2.150	1.499	-30.3	2.030	1.243	-38.8	0.020	0.120	501.0	5.456	1.620	-70.3
1992	1.800	1.364	-24.2	1.750	1.047	-40.2	0.020	0.104	420.3	3.818	1.534	-59.8
1993	1.300	0.917	-29.4	1.310	0.738	-43.6	0.010	0.081	714.3	3.260	1.069	-67.2
1994	1.340	1.073	-19.9	1.600	0.754	-52.9	0.020	0.088	339.5	3.505	1.076	-69.3
1995	1.280	1.150	-10.2	1.780	0.690	-61.2	0.030	0.095	216.2	2.724	1.092	-59.9
1996	1.370	1.147	-16.3	1.840	0.670	-63.6	0.030	0.095	216.2	3.124	1.079	-65.5
1997	1.330	1.061	-20.2	1.790	0.584	-67.4	0.030	0.096	219.6	2.978	0.951	-68.1
1998	1.210	1.077	-11.0	1.930	0.565	-70.7	0.040	0.094	135.6	3.243	0.803	-75.2
1999	1.040	0.978	-5.9	1.720	0.525	-69.5	0.040	0.088	119.7	2.874	0.714	-75.2
2000	0.770	0.694	-9.8	1.230	0.305	-75.2	0.030	0.084	181.2	1.689	0.569	-66.3
2001	0.710	0.601	-15.4	1.050	0.240	-77.1	0.020	0.079	295.1	1.551	0.582	-62.5
2002	0.710	0.565	-20.4	1.000	0.224	-77.6	0.020	0.076	281.5	1.549	0.624	-59.7
2003	1.068	0.573	-46.3	1.059	0.231	-78.2	0.024	0.090	276.0	1.985	0.619	-68.8
2004	0.620	0.730	17.7	1.340	0.301	-77.5	0.024	0.090	274.9	1.767	0.821	-53.5

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Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2005	0.514	0.743	44.5	1.454	0.308	-78.8	0.021	0.090	340.6	1.698	0.761	-55.2
2006	0.400	0.586	46.5	1.080	0.235	-78.2	0.020	0.081	306.9	1.427	0.804	-43.7
2007	1.840	0.455	-75.3	0.840	0.163	-80.6	0.020	0.100	399.3	1.016	0.685	-32.5
2008	2.252	2.258	0.3	1.022	0.171	-83.3	0.021	0.089	322.1	1.380	0.612	-55.6
2009	2.167	2.328	7.5	1.853	0.219	-88.2	0.046	0.093	101.3	2.063	0.642	-68.9
2010	2.958	2.293	-22.5	2.561	0.201	-92.1	0.067	0.139	108.7	2.812	0.697	-75.2
2011	3.106	3.426	10.3	2.153	0.180	-91.6	0.056	0.147	164.9	2.446	0.698	-71.5
2012	1.699	2.088	22.9	2.297	0.191	-91.7	0.059	0.146	146.7	2.487	0.643	-74.1
2013	0.803	1.037	29.1	2.498	0.226	-91.0	0.077	0.141	83.1	2.688	0.672	-75.0
2014	1.118	1.364	22.0	2.756	0.231	-91.6	0.079	0.139	76.4	3.120	0.662	-78.8
2015	1.012	1.204	18.9	2.583	0.195	-92.5	0.073	0.119	62.2	2.812	0.516	-81.7
2016	1.021	1.347	32.0	2.775	0.242	-91.3	0.078	0.140	79.2	2.960	0.586	-80.2
2017	0.983	1.420	44.5	3.108	0.318	-89.8	0.088	0.152	71.6	3.283	0.682	-79.2
2018	0.896	1.178	31.4	3.417	0.234	-93.2	0.100	0.151	50.5	3.541	0.584	-83.5

1A1c Manufacture of solid fuels and other energy industries

In comparison with the 2020 submission, POPs emissions of the sector 1A1c for 1990–2018 have been recalculated.

The differences in the emissions from the manufacture of solid fuels and other energy industries between the 2020 and 2021 submissions are presented in Table 8.2.

Also added solid fuel use data for the period 1990 -1992, calculated by extrapolation using shale oil production data (Table 8.3).

Table 8.2 The differences in the sector NFR 1A1c POPs emissions for 1990-2018 between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	NA	0.052	100.0	NA	0.021	100.0	NA	0.0003	100.0	NA	0.079	100.0
1991	NA	0.034	100.0	NA	0.013	100.0	NA	0.0002	100.0	NA	0.049	100.0
1992	NA	0.038	100.0	NA	0.015	100.0	NA	0.0002	100.0	NA	0.055	100.0
1993	0.020	0.051	155.3	0.090	0.020	-77.4	NA	0.0003	100.0	NA	0.077	100.0
1994	0.020	0.048	140.8	0.080	0.019	-76.0	NA	0.0003	100.0	NA	0.072	100.0
1995	0.020	0.054	170.6	0.090	0.022	-75.9	NA	0.0003	100.0	NA	0.082	100.0
1996	0.030	0.061	102.5	0.110	0.025	-77.7	NA	0.0003	100.0	NA	0.093	100.0
1997	0.030	0.067	123.6	0.121	0.027	-77.4	NA	0.0004	100.0	NA	0.103	100.0
1998	0.030	0.058	93.1	0.110	0.024	-78.1	NA	0.0003	100.0	NA	0.091	100.0
1999	0.030	0.059	97.7	0.113	0.025	-77.5	NA	0.0004	100.0	NA	0.096	100.0
2000	0.040	0.079	97.1	0.140	0.033	-76.4	NA	0.0006	100.0	0.010	0.119	1 094.1
2001	0.040	0.092	128.9	0.150	0.038	-74.6	NA	0.0009	100.0	0.010	0.131	1 210.4
2002	0.040	0.090	123.8	0.170	0.037	-78.2	NA	0.0009	100.0	0.010	0.129	1 185.0
2003	0.076	0.083	8.8	0.152	0.034	-77.6	0.0080	0.0007	-91.7	0.146	0.122	-16.6
2004	0.030	0.105	250.3	0.200	0.041	-79.7	0.0300	0.0025	-91.8	0.120	0.093	-22.1
2005	0.050	0.108	116.7	0.200	0.040	-79.8	0.0100	0.0032	-67.8	0.130	0.070	-46.0
2006	0.050	0.111	121.9	0.200	0.042	-79.1	0.0000	0.0030	100.0	0.120	0.081	-32.1
2007	0.030	0.115	282.0	0.180	0.045	-75.2	0.0000	0.0025	100.0	0.080	0.108	35.4
2008	0.012	0.069	485.9	0.044	0.024	-47.0	0.0004	0.0024	492.3	0.034	0.026	-22.6
2009	0.017	0.042	137.6	0.067	0.014	-79.9	0.0012	0.0011	-12.5	0.037	0.022	-39.2
2010	0.019	0.046	138.8	0.074	0.015	-80.0	0.0014	0.0012	-15.5	0.056	0.022	-60.2
2011	0.014	0.025	72.7	0.031	0.007	-78.9	0.0005	0.0004	-11.9	0.026	0.012	-53.4
2012	0.008	0.013	48.4	0.006	0.001	-76.1	0.0001	0.0001	-20.9	0.014	0.000	-100.0
2013	0.008	0.011	39.2	0.002	0.001	-68.5	0.0000	0.0000	-23.5	0.007	0.000	-100.0

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2014	0.009	0.012	32.6	0.001	0.000	-67.6	0.0000	0.0000	-20.0	0.005	0.000	-100.0
2015	0.011	0.013	25.2	0.001	0.000	-68.0	0.0000	0.0000	-20.0	0.004	0.000	-100.0
2016	0.010	0.012	19.2	0.001	0.000	-67.5	0.0000	0.0000	-20.0	0.005	0.000	-100.0
2017	0.021	0.019	-10.6	0.008	0.002	-80.2	0.0002	0.0002	-20.9	0.012	0.000	-100.0
2018	0.016	0.021	33.3	0.010	0.002	-80.2	0.0003	0.0002	-21.3	0.015	0.000	-100.0

Table 8.3 NFR 1A1c Activity data for period 1990-1992

Year	Solid Fuels		
	2020	2021	%
1990	NA	463.17	100
1991	NA	286.93	100
1992	NA	326.17	100

1A2a Stationary combustion in manufacturing industries and construction: Iron and steel

The Cd, Hg and As emissions for the years were calculated by extrapolation and presented in Table 8.4.

Table 8.4 The differences in the sector NFR 1A2a heavy metals emissions (t) between 2020 and 2021 submissions

Year	Cd			Hg			As		
	2020	2021	%	2020	2021	%	2020	2021	%
2010	NA	0.000011	100	NA	0.000001	100			
2016	NA	0.000011	100	NA	0.000008	100	NA	0.000002	100

1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals

In 2021 year submission emissions of Cd, Hg, Cr, Ni and Zn have been additionally calculated for the period between 2010–2012 and 2015–2018. Emissions for the 2010–2012 calculated by extrapolation, but for the emission calculation for the years 2015-2018 were used natural gas consumption in this sector. The results are presented in Table 8.5.

Table 8.5 The differences in the sector NFR 1A2b heavy metals emissions (t) between 2020 and 2021 submissions

Year	Cd			Hg			Cr			Ni			Zn		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2010	NA	0.000018	100	NA	0.000002	100	NA	0.000	100	NA	0.000156	100	NA	0.003275	100
2011	NA	0.000012	100	NA	0.000001	100	NA	0.000094	100	NA	0.000098	100	NA	0.002061	100
2012	NA	0.000002	100	NA	0.000000	100	NA	0.000018	100	NA	0.000019	100	NA	0.000397	100
2015	NA	0.00000002	100	NA	0.00001	100	NA	0.0000001	100	NA	0.00000003	100	NA	0.0000001	100
2016	NA	0.00000002	100	NA	0.00001	100	NA	0.0000001	100	NA	0.00000003	100	NA	0.0000001	100
2017	NA	0.00000003	100	NA	0.00001	100	NA	0.0000001	100	NA	0.00000006	100	NA	0.0000002	100
2018	NA	0.00000003	100	NA	0.00001	100	NA	0.0000001	100	NA	0.00000007	100	NA	0.0000002	100

1A2c Stationary combustion in manufacturing industries and construction: Chemicals

The method of extrapolation was used for the Cd and Hg emissions calculation for 2012 and 2014–2018. The results are shown in table 8.6

Table 8.6 The differences in the sector NFR 1A2c heavy metals emissions (t) between 2020 and 2021 submissions

Year	Cd			Hg		
	2020	2021	%	2020	2021	%
2012	NA	0.00043	100	NA	0.00011	100
2014	NA	0.00057	100	NA	0.00014	100
2015	NA	0.00045	100	NA	0.00011	100
2016	NA	0.00034	100	NA	0.00009	100
2017	NA	0.00023	100	NA	0.00006	100
2018	NA	0.00011	100	NA	0.00003	100

1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals

In comparison with the previous submission, the emissions of Hg and As were calculated by extrapolation for 2004–2005.

The differences in the emissions from the Stationary combustion in manufacturing industries and construction between the 2020 and 2021 submissions are presented in Table 8.7.

Table 8.7 The differences in the sector NFR 1A2f Hg and As emissions (t) for 2004-2005 between 2020 and 2021 submissions

Year	Hg			As		
	2020	2021	%	2020	2021	%
2004	0.000	0.006467	100			
2005	0.000	0.004534	100	0.000	0.004007	100

1A2giii Stationary combustion in manufacturing industries and construction: Other

First, in comparison with the previous submission, the emissions of POPs from NFR 1A2gviii were recalculated for period 1990–2018.

The reason for the recalculation was the TERT recommendation to use Tier 2 method for POPs calculating.

The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2.

Secondly, SO_2 emissions from combustion processes for 2001 were moved from NFR 2A6 and for 2001–2003 from NFR 2B10a to NFR 1A2gviii.

The differences in the emissions of stationary combustion in manufacturing industries and construction (other) between the 2020 and 2021 submissions are presented in Table 8.8 and 8.9.

Table 8.8 The differences in the sector NFR 1A2gviii POPs emissions for 1990–2018 between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	1.440	1.773	23.1	0.741	0.406	-45.3	0.064	0.007	-88.9	2.000	0.373	-81.4
1991	1.430	1.739	21.6	0.720	0.395	-45.2	0.062	0.007	-88.8	1.900	0.361	-81.0
1992	1.080	1.226	13.5	0.401	0.202	-49.5	0.042	0.005	-88.5	1.100	0.188	-82.9
1993	0.930	1.020	9.7	0.283	0.111	-60.8	0.030	0.004	-87.3	1.320	0.051	-96.1
1994	0.950	1.023	7.7	0.282	0.093	-66.9	0.043	0.006	-86.7	1.330	0.065	-95.1
1995	0.920	0.986	7.2	0.213	0.082	-61.4	0.046	0.007	-84.9	1.030	0.073	-93.0
1996	0.910	0.959	5.4	0.324	0.101	-68.9	0.048	0.007	-85.4	1.140	0.083	-92.7
1997	0.660	0.724	9.6	0.266	0.097	-63.7	0.052	0.007	-87.3	0.890	0.105	-88.2
1998	0.340	0.373	9.7	0.247	0.083	-66.4	0.053	0.007	-87.7	0.720	0.110	-84.7
1999	0.440	0.471	7.0	0.194	0.073	-62.6	0.047	0.006	-86.7	0.400	0.096	-75.9

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2000	0.530	0.670	26.4	0.386	0.106	-72.4	0.060	0.011	-81.1	0.380	0.110	-71.0
2001	0.760	0.992	30.6	0.764	0.178	-76.7	0.081	0.021	-74.4	1.920	0.118	-93.9
2002	0.720	0.967	34.3	0.873	0.197	-77.5	0.068	0.023	-66.4	1.780	0.128	-92.8
2003	0.774	0.934	20.7	1.158	0.249	-78.5	0.065	0.029	-54.7	2.119	0.133	-93.7
2004	0.800	1.043	30.4	1.254	0.275	-78.1	0.090	0.032	-64.3	1.350	0.155	-88.5
2005	0.595	0.944	58.7	1.056	0.236	-77.6	0.082	0.027	-66.7	1.175	0.149	-87.3
2006	0.790	0.869	10.0	0.867	0.206	-76.2	0.074	0.023	-69.8	0.990	0.155	-84.3
2007	0.930	0.769	-17.3	0.683	0.192	-71.9	0.094	0.020	-78.3	0.440	0.211	-52.1
2008	0.600	0.574	-4.4	1.051	0.256	-75.7	0.107	0.029	-73.2	1.040	0.220	-78.9
2009	0.171	0.428	150.9	0.658	0.182	-72.4	0.049	0.020	-58.2	0.670	0.111	-83.4
2010	0.246	0.536	118.1	0.822	0.215	-73.9	0.068	0.027	-60.8	0.940	0.108	-88.5
2011	0.222	0.557	151.4	0.847	0.205	-75.8	0.077	0.030	-60.8	0.835	0.094	-88.7
2012	0.216	0.398	84.5	0.793	0.149	-81.2	0.080	0.022	-72.6	0.753	0.104	-86.2
2013	0.259	0.601	131.6	0.904	0.210	-76.8	0.078	0.033	-58.0	0.886	0.094	-89.4
2014	0.222	0.553	149.0	0.780	0.206	-73.6	0.023	0.029	29.9	0.779	0.117	-84.9
2015	0.314	0.740	135.8	1.168	0.258	-77.9	0.035	0.037	7.1	1.145	0.058	-94.9
2016	0.250	0.630	151.8	0.928	0.225	-75.8	0.028	0.032	12.4	0.949	0.047	-95.1
2017	0.520	1.020	96.1	1.397	0.306	-78.1	0.043	0.045	5.0	1.369	0.064	-95.3
2018	0.491	0.909	85.1	1.262	0.281	-77.7	0.039	0.041	4.6	1.240	0.065	-94.8

Table 8.9 The differences in the sector NFR 1A2gviii SO_2 emissions between 2020 and 2021 submissions.

Year	SO_x		
	2020	2021	%
2001	11.390	11.400	0.09
2003	8.199	8.209	0.12
2004	9.433	9.443	0.11

1A4ai Commercial/institutional: Stationary

In comparison with the previous submission, the emissions of POPs from NFR 1A4ai were recalculated for 1990–2018.

The reason for the recalculation was the TERT recommendation to use Tier 2 method for POPs calculating.

The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2.

The differences in the emissions of stationary combustion in the commercial/institutional sector between the 2019 and 2020 submissions are presented in Table 8.10.

Table 8.10 The differences in the sector NFR 1A4ai POPs emissions for 1990–2018 between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	0.020	0.065	223.6	0.110	0.043	-61.2	0.002	0.002	-20.0	0.250	0.011	-95.6
1991	0.020	0.030	52.2	0.110	0.047	-57.4	0.002	0.002	-19.9	0.240	0.015	-93.8
1992	0.020	0.017	-12.8	0.100	0.034	-66.0	0.003	0.002	-20.1	0.230	0.007	-96.9
1993	0.000	0.010	100.0	0.035	0.013	-61.9	0.000	0.000	-19.0	0.080	0.001	-98.5
1994	0.010	0.013	27.3	0.050	0.020	-60.8	0.001	0.001	-18.7	0.110	0.005	-95.5
1995	0.010	0.011	9.4	0.040	0.017	-56.8	0.001	0.000	-48.0	0.110	0.002	-97.8
1996	0.010	0.011	8.2	0.040	0.016	-60.0	0.000	0.000	-19.2	0.100	0.002	-98.1
1997	0.010	0.012	17.9	0.040	0.018	-56.1	0.001	0.000	-18.9	0.110	0.002	-98.1
1998	0.010	0.015	45.5	0.040	0.021	-48.5	0.000	0.000	-16.9	0.120	0.003	-97.3
1999	0.010	0.012	21.5	0.050	0.019	-61.7	0.001	0.001	-19.7	0.110	0.004	-96.1

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Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2000	0.020	0.047	136.8	0.099	0.059	-40.8	0.001	0.001	-15.6	0.190	0.025	-86.6
2001	0.030	0.098	227.6	0.184	0.117	-36.5	0.003	0.002	-12.9	0.330	0.059	-82.1
2002	0.040	0.090	124.0	0.208	0.112	-46.3	0.004	0.003	-17.5	0.370	0.056	-85.0
2003	0.060	0.089	48.8	0.195	0.105	-46.2	0.003	0.003	-15.7	0.266	0.061	-77.2
2004	0.030	0.086	187.5	0.160	0.098	-38.7	0.003	0.002	-14.5	0.200	0.060	-69.9
2005	0.040	0.132	229.9	0.174	0.105	-39.8	0.003	0.002	-15.1	0.190	0.067	-64.8
2006	0.040	0.064	60.1	0.167	0.080	-51.9	0.003	0.003	-17.1	0.190	0.042	-77.8
2007	0.030	0.064	111.7	0.168	0.090	-46.2	0.005	0.004	-19.2	0.170	0.042	-75.1
2008	0.022	0.040	79.5	0.134	0.055	-58.6	0.002	0.002	22.9	0.203	0.024	-88.0
2009	0.024	0.036	52.0	0.125	0.051	-59.1	0.003	0.002	-8.4	0.172	0.022	-87.0
2010	0.033	0.035	4.1	0.162	0.058	-64.0	0.002	0.003	40.5	0.249	0.019	-92.2
2011	0.010	0.024	140.8	0.120	0.041	-65.6	0.002	0.003	48.1	0.183	0.014	-92.4
2012	0.022	0.025	11.4	0.096	0.037	-61.2	0.003	0.002	-27.8	0.124	0.014	-88.7
2013	0.031	0.018	-43.2	0.121	0.035	-70.8	0.002	0.003	27.5	0.185	0.010	-94.4
2014	0.051	0.021	-59.3	0.211	0.054	-74.5	0.006	0.005	-18.5	0.217	0.013	-94.0
2015	0.046	0.014	-69.6	0.171	0.041	-76.3	0.004	0.004	-5.8	0.178	0.008	-95.4
2016	0.045	0.099	120.2	0.182	0.043	-76.2	0.004	0.004	4.5	0.193	0.009	-95.5
2017	0.044	0.106	144.0	0.203	0.042	-79.2	0.005	0.005	-6.8	0.231	0.004	-98.3
2018	0.050	0.115	127.6	0.208	0.051	-75.3	0.006	0.005	-20.6	0.204	0.013	-93.7

1A4bi Residential: Stationary

Compared with the previous submission, the emissions of all pollutants from NFR 1A4bi were recalculated for 1990–2018.

The first reason for the recalculation is the correction of the energy balance data in 2020.

Secondly, previous reports did not include emissions from combustion of peat briquettes in the period 1990 – 1998.

The differences in the residential sector emissions and activities data between the submissions for 2020 and 2021 are presented in Table 8.11 and 8.11a.

Table 8.11 The differences in the sector NFR 1A4bi emissions (kt; HMs in t) for 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NMVOC			SO_x			NH_3		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	4.217	4.385	4.0	4.331	5.797	33.9	3.011	5.370	78.4	0.025	0.025	-0.4
1991	3.995	4.349	8.9	4.267	5.785	35.6	3.065	5.283	72.4	0.023	0.025	5.2
1992	3.409	4.101	20.3	2.874	4.363	51.8	1.019	2.747	169.5	0.022	0.025	17.3
1993	3.484	4.056	16.4	2.737	3.928	43.5	0.634	1.982	212.5	0.022	0.025	14.1
1994	5.302	5.441	2.6	3.803	4.497	18.2	0.238	1.273	434.8	0.035	0.035	1.2
1995	9.728	9.905	1.8	7.243	8.083	11.6	0.693	1.947	181.1	0.064	0.065	0.8
1996	11.085	11.281	1.8	8.416	9.322	10.8	1.121	2.484	121.6	0.074	0.074	0.8
1997	11.259	11.358	0.9	8.545	8.999	5.3	1.152	1.842	60.0	0.076	0.076	0.4
1998	8.588	8.639	0.6	6.453	6.681	3.5	0.868	1.213	39.7	0.058	0.059	0.2
1999	8.144	8.146	0.0	6.371	6.378	0.1	1.367	1.373	0.5	0.056	0.056	0.0
2000	7.986	7.992	0.1	6.128	6.139	0.2	1.148	1.168	1.8	0.055	0.055	0.0
2001	7.498	7.529	0.4	5.657	5.657	0.0	0.891	0.947	6.3	0.053	0.053	0.0
2002	7.237	6.833	-5.6	5.497	5.216	-5.1	1.023	1.018	-0.5	0.052	0.049	-5.6
2003	7.197	7.200	0.0	5.344	5.345	0.0	0.784	0.782	-0.2	0.053	0.053	0.0
2004	6.895	6.785	-1.6	5.221	5.142	-1.5	0.974	0.968	-0.5	0.052	0.051	-1.6
2005	5.699	5.701	0.0	4.295	4.298	0.1	0.856	0.860	0.4	0.043	0.043	0.0
2006	5.429	5.432	0.0	4.030	4.031	0.0	0.715	0.718	0.4	0.042	0.042	0.0
2007	6.815	6.817	0.0	4.900	4.901	0.0	0.541	0.545	0.7	0.054	0.054	0.0
2008	6.794	6.793	0.0	4.886	4.888	0.0	0.575	0.577	0.5	0.054	0.054	0.0
2009	6.936	6.934	0.0	4.939	4.935	-0.1	0.463	0.455	-1.7	0.057	0.057	0.0

Year	NO_x			NMVOC			SO_x			NH_3		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2010	6.891	6.903	0.2	4.926	4.934	0.2	0.490	0.491	0.2	0.057	0.057	0.2
2011	5.714	5.686	-0.5	4.109	4.084	-0.6	0.529	0.518	-2.2	0.049	0.048	-0.5
2012	5.858	5.862	0.1	4.127	4.129	0.1	0.498	0.504	1.3	0.051	0.051	0.0
2013	5.413	5.382	-0.6	3.800	3.778	-0.6	0.484	0.485	0.3	0.048	0.048	-0.7
2014	5.161	5.161	0.0	3.609	3.601	-0.2	0.453	0.438	-3.2	0.047	0.047	0.0
2015	4.896	4.891	-0.1	3.369	3.364	-0.2	0.364	0.352	-3.2	0.045	0.045	0.0
2016	5.026	5.030	0.1	3.410	3.408	-0.1	0.275	0.273	-0.6	0.047	0.047	0.0
2017	4.952	4.954	0.0	3.367	3.359	-0.2	0.287	0.274	-4.5	0.047	0.047	0.0
2018	4.818	4.865	1.0	3.256	3.281	0.8	0.240	0.247	3.0	0.046	0.047	0.8

Table 8.11 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	NR	NR		NR	NR		NR	NR		3.267	4.420	35.3
1991	NR	NR		NR	NR		NR	NR		3.277	4.446	35.7
1992	NR	NR		NR	NR		NR	NR		2.248	3.345	48.8
1993	NR	NR		NR	NR		NR	NR		2.125	3.001	41.2
1994	NR	NR		NR	NR		NR	NR		2.756	3.294	19.5
1995	NR	NR		NR	NR		NR	NR		4.911	5.563	13.3
1996	NR	NR		NR	NR		NR	NR		5.661	6.365	12.4
1997	NR	NR		NR	NR		NR	NR		5.741	6.097	6.2
1998	NR	NR		NR	NR		NR	NR		4.449	4.628	4.0
1999	NR	NR		NR	NR		NR	NR		4.453	4.458	0.1
2000	3.829	3.837	0.2	3.971	3.979	0.2	1.486	1.486	0.04	4.297	4.305	0.2
2001	3.529	3.529	0.0	3.662	3.661	0.0	1.389	1.389	0.01	3.961	3.961	0.0
2002	3.427	3.277	-4.4	3.555	3.400	-4.4	1.331	1.257	-5.54	3.847	3.679	-4.3
2003	3.283	3.284	0.0	3.407	3.408	0.0	1.313	1.313	0.00	3.685	3.686	0.0
2004	3.215	3.173	-1.3	3.336	3.293	-1.3	1.250	1.230	-1.62	3.610	3.563	-1.3
2005	2.685	2.687	0.1	2.787	2.789	0.1	1.020	1.020	0.01	3.017	3.019	0.1
2006	2.531	2.531	0.0	2.628	2.628	0.0	0.966	0.966	0.00	2.845	2.846	0.0
2007	2.965	2.965	0.0	3.076	3.077	0.0	1.209	1.209	0.00	3.328	3.329	0.0
2008	2.948	2.949	0.1	3.059	3.061	0.1	1.196	1.196	0.01	3.310	3.312	0.1
2009	2.940	2.937	-0.1	3.050	3.047	-0.1	1.213	1.213	-0.02	3.301	3.297	-0.1
2010	2.897	2.902	0.1	3.006	3.011	0.1	1.191	1.193	0.16	3.254	3.258	0.1
2011	2.528	2.514	-0.6	2.625	2.611	-0.6	1.000	0.995	-0.52	2.844	2.828	-0.6
2012	2.573	2.575	0.1	2.671	2.673	0.1	1.026	1.027	0.01	2.894	2.896	0.1
2013	2.342	2.331	-0.5	2.431	2.420	-0.5	0.914	0.909	-0.64	2.634	2.622	-0.5
2014	2.338	2.332	-0.3	2.429	2.423	-0.3	0.918	0.917	-0.05	2.635	2.628	-0.3
2015	2.230	2.226	-0.2	2.316	2.312	-0.2	0.880	0.880	-0.03	2.514	2.509	-0.2
2016	2.282	2.281	-0.1	2.371	2.369	-0.1	0.920	0.920	-0.01	2.574	2.572	-0.1
2017	2.306	2.301	-0.2	2.397	2.391	-0.2	0.929	0.929	-0.04	2.604	2.597	-0.2
2018	2.241	2.252	0.5	2.328	2.339	0.5	0.903	0.909	0.69	2.530	2.542	0.5

Table 8.11 continues

Year	CO			Pb			Cd			Hg			As		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	61.072	74.688	22.30	2.321	2.706	16.6	0.131	0.132	0.6	0.066	0.080	21.3	0.045	0.053	16.1
1991	59.246	74.466	25.69	2.503	2.873	14.8	0.132	0.137	3.6	0.072	0.085	18.8	0.049	0.056	14.1
1992	44.588	61.675	38.32	2.335	2.641	13.1	0.130	0.143	9.4	0.064	0.075	17.1	0.046	0.052	11.9
1993	43.747	57.545	31.54	2.384	2.626	10.2	0.136	0.146	7.6	0.064	0.073	13.3	0.047	0.052	9.2
1994	64.241	71.079	10.64	2.502	2.676	6.9	0.178	0.179	1.0	0.067	0.073	9.5	0.049	0.052	6.6
1995	121.652	129.936	6.81	2.862	3.072	7.4	0.274	0.276	0.8	0.076	0.083	10.2	0.054	0.057	7.4
1996	140.656	149.608	6.36	3.014	3.243	7.6	0.308	0.311	0.8	0.080	0.088	10.6	0.056	0.060	7.7
1997	143.437	147.920	3.13	3.068	3.185	3.8	0.319	0.320	0.4	0.081	0.086	5.3	0.056	0.059	3.9

Year	CO			Pb			Cd			Hg			As		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1998	108.950	111.196	2.06	2.955	3.015	2.0	0.267	0.267	0.2	0.078	0.081	2.8	0.056	0.057	2.0
1999	105.683	105.747	0.06	3.057	3.059	0.1	0.262	0.262	0.0	0.082	0.082	0.1	0.058	0.058	0.1
2000	103.094	103.198	0.10	3.126	3.129	0.1	0.267	0.267	0.0	0.084	0.084	0.1	0.059	0.059	0.1
2001	96.718	96.717	0.00	2.969	2.969	0.0	0.260	0.260	0.0	0.079	0.079	0.0	0.056	0.056	0.0
2002	94.230	89.150	-5.39	2.874	2.854	-0.7	0.257	0.247	-4.0	0.077	0.076	-0.5	0.054	0.054	-0.2
2003	93.622	93.633	0.01	2.749	2.749	0.0	0.262	0.262	0.0	0.073	0.073	0.0	0.051	0.051	0.0
2004	91.141	89.698	-1.58	2.681	2.674	-0.2	0.258	0.255	-1.2	0.072	0.071	-0.2	0.050	0.050	-0.1
2005	75.642	75.669	0.04	2.508	2.509	0.0	0.229	0.229	0.0	0.067	0.067	0.1	0.047	0.047	0.0
2006	71.926	71.929	0.00	2.558	2.558	0.0	0.228	0.228	0.0	0.068	0.068	0.0	0.048	0.048	0.0
2007	89.816	89.822	0.01	2.668	2.668	0.0	0.278	0.278	0.0	0.070	0.070	0.0	0.049	0.049	0.0
2008	90.063	90.084	0.02	2.703	2.703	0.0	0.284	0.284	0.0	0.071	0.071	0.0	0.050	0.050	0.0
2009	92.335	92.293	-0.05	2.698	2.697	0.0	0.296	0.296	0.0	0.070	0.070	-0.1	0.049	0.049	-0.1
2010	92.649	92.793	0.16	2.675	2.676	0.0	0.301	0.301	0.1	0.070	0.070	0.0	0.049	0.049	0.0
2011	77.671	77.236	-0.56	2.653	2.649	-0.1	0.271	0.270	-0.4	0.070	0.070	-0.2	0.049	0.049	-0.1
2012	79.365	79.390	0.03	2.702	2.703	0.0	0.285	0.285	0.0	0.071	0.071	0.1	0.050	0.050	0.0
2013	74.100	73.640	-0.62	2.711	2.709	-0.1	0.278	0.277	-0.5	0.071	0.071	0.0	0.050	0.050	0.0
2014	70.989	70.909	-0.11	2.694	2.691	-0.1	0.276	0.276	0.0	0.071	0.071	-0.2	0.050	0.050	-0.1
2015	67.215	67.165	-0.07	2.661	2.660	-0.1	0.270	0.270	0.0	0.070	0.070	-0.1	0.049	0.049	-0.1
2016	69.131	69.114	-0.02	2.673	2.673	0.0	0.282	0.282	0.0	0.070	0.070	0.0	0.049	0.049	0.0
2017	68.733	68.663	-0.10	2.686	2.684	-0.1	0.286	0.286	0.0	0.070	0.070	-0.1	0.050	0.050	-0.1
2018	67.244	67.796	0.82	2.687	2.690	0.1	0.286	0.288	0.6	0.070	0.070	0.1	0.050	0.050	0.0

Table 8.11 continues

Year	Cr			Cu			Ni			Se			Zn		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	0.166	0.196	17.9	0.112	0.182	61.6	0.056	0.095	68.9	0.008	0.013	59.7	3.540	4.121	16.4
1991	0.160	0.195	21.8	0.115	0.182	58.1	0.058	0.095	63.3	0.009	0.014	56.7	3.412	4.117	20.6
1992	0.126	0.169	33.7	0.057	0.113	98.1	0.027	0.057	112.7	0.004	0.009	95.2	2.712	3.601	32.8
1993	0.126	0.161	27.5	0.047	0.092	93.6	0.021	0.045	112.1	0.004	0.007	90.2	2.717	3.442	26.7
1994	0.188	0.204	8.4	0.053	0.084	59.1	0.020	0.038	85.5	0.004	0.007	54.4	4.112	4.427	7.6
1995	0.356	0.375	5.4	0.106	0.144	35.7	0.040	0.061	52.1	0.009	0.011	32.8	7.843	8.224	4.9
1996	0.420	0.441	5.0	0.132	0.173	31.1	0.052	0.075	44.5	0.011	0.014	28.9	9.251	9.671	4.5
1997	0.439	0.449	2.4	0.138	0.158	15.2	0.054	0.065	21.8	0.011	0.013	14.2	9.657	9.870	2.2
1998	0.341	0.347	1.6	0.106	0.117	10.0	0.042	0.048	14.3	0.009	0.009	9.5	7.500	7.608	1.4
1999	0.337	0.337	0.0	0.117	0.118	0.3	0.049	0.049	0.3	0.009	0.009	0.2	7.381	7.384	0.0
2000	0.338	0.338	0.1	0.112	0.113	0.4	0.046	0.046	0.6	0.009	0.009	0.4	7.407	7.412	0.1
2001	0.329	0.329	0.0	0.104	0.104	0.0	0.042	0.042	-0.1	0.008	0.008	-0.1	7.216	7.217	0.0
2002	0.331	0.313	-5.5	0.107	0.103	-4.2	0.044	0.042	-3.3	0.009	0.008	-4.3	7.271	6.866	-5.6
2003	0.344	0.344	0.0	0.105	0.105	0.0	0.041	0.041	0.1	0.009	0.009	0.1	7.562	7.563	0.0
2004	0.346	0.340	-1.6	0.111	0.109	-1.3	0.045	0.044	-1.1	0.009	0.009	-1.3	7.601	7.477	-1.6
2005	0.298	0.298	0.0	0.096	0.096	0.1	0.039	0.039	0.2	0.008	0.008	0.2	6.554	6.555	0.0
2006	0.291	0.291	0.0	0.090	0.090	0.0	0.036	0.036	0.0	0.007	0.007	0.0	6.389	6.389	0.0
2007	0.374	0.374	0.0	0.106	0.106	0.0	0.040	0.040	0.0	0.009	0.009	0.0	8.240	8.240	0.0
2008	0.383	0.383	0.0	0.109	0.110	0.1	0.041	0.041	0.2	0.009	0.009	0.1	8.451	8.452	0.0
2009	0.403	0.403	0.0	0.112	0.111	-0.2	0.041	0.041	-0.3	0.009	0.009	-0.2	8.905	8.903	0.0
2010	0.415	0.416	0.2	0.115	0.116	0.2	0.042	0.042	0.2	0.010	0.010	0.2	9.162	9.176	0.2
2011	0.362	0.360	-0.5	0.103	0.103	-0.7	0.039	0.039	-0.8	0.009	0.008	-0.7	7.977	7.934	-0.5
2012	0.383	0.383	0.0	0.108	0.108	0.1	0.040	0.040	0.2	0.009	0.009	0.1	8.454	8.455	0.0
2013	0.371	0.368	-0.6	0.105	0.104	-0.5	0.039	0.039	-0.4	0.009	0.009	-0.5	8.174	8.121	-0.6
2014	0.366	0.366	-0.1	0.103	0.102	-0.4	0.038	0.038	-0.7	0.008	0.008	-0.5	8.063	8.058	-0.1
2015	0.355	0.354	0.0	0.097	0.097	-0.3	0.036	0.035	-0.5	0.008	0.008	-0.3	7.818	7.815	0.0
2016	0.375	0.374	0.0	0.100	0.100	-0.1	0.036	0.036	-0.2	0.008	0.008	-0.1	8.266	8.264	0.0
2017	0.381	0.381	-0.1	0.102	0.102	-0.4	0.037	0.036	-0.7	0.008	0.008	-0.5	8.413	8.408	-0.1
2018	0.381	0.384	0.8	0.101	0.102	0.7	0.036	0.036	0.4	0.008	0.008	0.6	8.401	8.471	0.8

Table 8.11 continues

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	3.130	5.292	69.1	5.151	7.214	40.1	0.093	0.092	-1.89	0.601	1.142	90.1
1991	3.231	5.298	63.9	5.108	7.201	41.0	0.089	0.092	3.29	0.638	1.147	79.7
1992	1.446	3.139	117.0	3.216	5.180	61.0	0.085	0.097	14.30	0.206	0.604	192.3
1993	1.114	2.450	119.9	2.963	4.531	52.9	0.088	0.098	11.62	0.119	0.432	261.7
1994	1.094	2.059	88.1	4.033	4.999	23.9	0.132	0.133	0.66	0.024	0.264	995.3
1995	2.283	3.452	51.2	7.817	8.989	15.0	0.236	0.237	0.45	0.106	0.397	274.0
1996	2.858	4.122	44.2	9.126	10.399	13.9	0.269	0.270	0.47	0.190	0.507	166.7
1997	2.911	3.550	22.0	9.240	9.884	7.0	0.276	0.276	0.22	0.199	0.361	81.5
1998	2.173	2.496	14.9	6.923	7.249	4.7	0.215	0.215	0.14	0.144	0.227	57.2
1999	2.500	2.509	0.4	6.921	6.930	0.1	0.204	0.204	0.00	0.258	0.260	0.9
2000	2.273	2.288	0.7	6.585	6.601	0.2	0.204	0.204	0.01	0.209	0.213	1.9
2001	1.988	1.987	-0.1	6.009	6.007	0.0	0.195	0.195	0.01	0.161	0.160	-0.4
2002	2.013	1.946	-3.3	5.835	5.547	-4.9	0.190	0.180	-5.31	0.186	0.188	1.2
2003	1.784	1.785	0.1	5.548	5.549	0.0	0.192	0.192	0.00	0.130	0.130	0.3
2004	1.908	1.888	-1.1	5.453	5.373	-1.5	0.186	0.184	-1.56	0.186	0.186	0.0
2005	1.599	1.603	0.3	4.450	4.454	0.1	0.157	0.157	0.00	0.166	0.167	0.7
2006	1.418	1.418	0.0	4.100	4.100	0.0	0.152	0.152	0.00	0.131	0.131	0.1
2007	1.469	1.470	0.1	4.855	4.856	0.0	0.193	0.193	0.00	0.076	0.077	0.3
2008	1.472	1.475	0.2	4.796	4.799	0.1	0.194	0.194	0.00	0.082	0.083	1.1
2009	1.388	1.381	-0.5	4.742	4.735	-0.1	0.201	0.201	0.00	0.054	0.052	-3.4
2010	1.390	1.392	0.2	4.653	4.661	0.2	0.201	0.201	0.15	0.062	0.062	0.4
2011	1.226	1.213	-1.0	3.841	3.813	-0.7	0.171	0.170	-0.48	0.079	0.077	-2.9
2012	1.215	1.219	0.3	3.876	3.880	0.1	0.179	0.179	0.00	0.070	0.071	1.6
2013	1.125	1.123	-0.2	3.516	3.497	-0.5	0.170	0.169	-0.62	0.069	0.070	1.4
2014	1.048	1.035	-1.2	3.279	3.265	-0.4	0.164	0.164	-0.01	0.062	0.059	-6.2
2015	0.923	0.915	-0.9	3.012	3.003	-0.3	0.159	0.159	-0.01	0.039	0.037	-6.1
2016	0.855	0.852	-0.4	2.957	2.954	-0.1	0.164	0.164	0.00	0.015	0.014	-6.2
2017	0.847	0.835	-1.4	2.879	2.866	-0.4	0.164	0.164	-0.01	0.019	0.015	-18.9
2018	0.789	0.789	0.1	2.734	2.750	0.6	0.162	0.164	0.78	0.010	0.008	-17.7

Table 8.11a The differences in the sector NFR 1A4bi activities data (PJ) for 1990–2018 between 2020 and 2021 submissions (%)

Year	Liquid fuels			Solid fuels			Biomass			Gaseous fuels		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	3.46	3.46	0.1	3.53	6.72	90.2	5.34	5.09	-4.7	2.12	2.38	12.64
1991	2.81	2.86	1.6	3.75	6.74	79.8	5.00	5.07	1.5	2.74	2.87	4.62
1992	0.74	0.77	4.0	1.21	3.55	192.6	4.73	5.45	15.2	2.35	2.35	-0.02
1993	0.41	0.36	-11.9	0.70	2.54	262.3	4.96	5.58	12.4	2.59	2.59	0.00
1994	0.32	0.37	13.0	0.14	1.55	1 014.6	7.82	7.93	1.4	2.85	2.76	-3.17
1995	0.27	0.36	33.1	0.62	2.33	276.2	15.01	15.01	0.00	2.00	2.00	-0.05
1996	0.63	0.62	-0.4	1.11	2.98	167.6	17.54	17.55	0.05	1.54	1.54	-0.01
1997	0.57	0.57	-0.6	1.16	2.12	81.9	18.31	18.31	0.01	1.53	1.53	0.01
1998	0.67	0.67	0.2	0.84	1.33	57.5	14.24	14.24	0.00	1.82	1.82	0.00
1999	0.87	0.88	0.2	1.51	1.53	0.9	13.71	13.71	0.00	1.74	1.76	0.92
2000	0.85	0.88	2.6	1.23	1.25	1.9	13.89	13.89	0.00	1.76	1.77	0.65
2001	0.55	1.01	83.6	0.94	0.94	-0.4	13.64	13.64	0.04	1.75	1.73	-1.08
2002	0.68	0.65	-4.1	1.09	1.10	1.2	13.69	12.89	-5.8	1.54	1.54	-0.09
2003	0.62	0.61	-1.3	0.76	0.76	0.3	14.29	14.40	0.8	1.51	1.56	3.53
2004	0.43	0.44	3.5	1.09	1.09	0.0	14.27	14.09	-1.3	1.62	1.62	-0.09
2005	0.37	0.39	6.1	0.97	0.98	0.7	12.25	12.34	0.7	1.87	1.88	0.63
2006	0.40	0.43	9.0	0.77	0.77	0.1	11.95	12.11	1.4	1.91	1.91	0.24
2007	0.34	0.34	2.0	0.45	0.45	0.3	15.67	15.86	1.2	2.03	2.05	0.58
2008	0.45	0.43	-4.1	0.48	0.48	1.1	16.26	16.26	0.0	2.06	2.06	-0.18

Year	Liquid fuels			Solid fuels			Biomass			Gaseous fuels		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2009	0.37	0.35	-6.2	0.31	0.30	-3.5	16.75	17.22	2.8	2.10	2.12	0.92
2010	0.33	0.35	4.9	0.36	0.36	0.4	17.70	17.73	0.2	2.30	2.30	0.00
2011	0.38	0.39	3.6	0.46	0.45	-2.9	14.54	15.26	5.0	2.14	2.16	1.36
2012	0.33	0.35	5.3	0.41	0.41	1.6	16.30	16.30	0.0	2.29	2.32	1.00
2013	0.31	0.31	-1.2	0.41	0.41	1.4	15.75	15.64	-0.7	2.14	2.19	2.53
2014	0.35	0.35	0.1	0.37	0.34	-6.3	15.55	15.55	0.00	2.14	2.19	2.39
2015	0.44	0.40	-8.7	0.23	0.22	-6.1	15.13	15.13	0.00	2.08	2.07	-0.67
2016	0.41	0.45	8.0	0.09	0.08	-6.4	16.07	16.07	0.00	2.37	2.42	2.37
2017	0.38	0.40	5.9	0.11	0.09	-19.3	16.35	16.35	0.00	2.25	2.32	3.02
2018	0.27	0.36	31.0	0.05	0.04	-18.5	16.35	16.50	0.94	2.25	2.30	2.27

1A4ci Agriculture/Forestry/Fishing: Stationary

In comparison with the previous submission, the emissions of POPs from NFR 1A4ai were recalculated for 1990–2018.

The reason for the recalculation was the TERT recommendation to use Tier 2 method for POPs calculating.

The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2.

The differences in the emissions of stationary combustion in the commercial/institutional sector between the 2020 and 2021 submissions are presented in Table 8.12.

Table 8.12 The differences in the sector NFR 1A4ci POPs emissions for 1990–2018 between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PAHs total, t			HCB, kg			PCB, kg		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
1990	0.020	0.051	152.6	0.100	0.050	-50.2	NA	0.001	100.0	0.220	0.028	-87.1
1991	0.020	0.057	184.0	0.100	0.053	-46.5	NA	0.001	100.0	0.240	0.032	-86.5
1992	0.020	0.046	131.2	0.090	0.041	-54.6	NA	0.001	100.0	0.200	0.016	-91.8
1993	0.020	0.052	100.0	0.100	0.041	-58.9	NA	0.002	100.0	0.220	0.009	-96.1
1994	0.010	0.027	174.2	0.050	0.030	-39.6	NA	0.001	100.0	0.120	0.008	-93.5
1995	0.010	0.019	86.9	0.040	0.021	-47.4	NA	0.001	100.0	0.090	0.005	-94.7
1996	0.010	0.027	173.8	0.050	0.032	-36.9	NA	0.001	100.0	0.100	0.010	-90.5
1997	0.010	0.025	154.8	0.040	0.024	-39.3	NA	0.000	100.0	0.070	0.011	-84.2
1998	0.010	0.025	150.4	0.040	0.023	-42.7	NA	0.000	100.0	0.060	0.011	-81.6
1999	0.010	0.020	97.7	0.040	0.012	-68.8	NA	0.001	100.0	0.070	0.002	-97.1
2000	0.010	0.028	183.4	0.054	0.013	-76.4	NA	0.001	100.0	0.080	0.002	-97.2
2001	0.030	0.060	98.4	0.116	0.027	-77.0	0.010	0.003	-72.6	0.180	0.004	-97.8
2002	0.010	0.017	70.5	0.034	0.009	-72.9	NA	0.001	100.0	0.060	0.005	-91.9
2003	0.011	0.016	45.8	0.028	0.007	-75.9	NA	0.001	100.0	0.056	0.005	-91.4
2004	0.010	0.017	70.0	0.033	0.007	-78.2	NA	0.001	100.0	0.060	0.005	-92.2
2005	0.010	0.020	99.0	0.033	0.008	-75.8	NA	0.001	100.0	0.070	0.005	-93.4
2006	0.020	0.037	84.9	0.068	0.014	-79.6	0.000	0.002	100.0	0.160	0.000	-100.0
2007	0.000	0.011	100.0	0.022	0.005	-74.9	0.000	0.000	100.0	0.000	0.005	100.0
2008	0.002	0.010	534.4	0.020	0.006	-68.6	0.000	0.000	118.5	0.040	0.000	-99.9
2009	0.002	0.012	640.8	0.024	0.007	-72.0	0.000	0.001	208.9	0.041	0.000	-100.0
2010	0.001	0.010	749.1	0.018	0.006	-68.0	0.000	0.000	272.0	0.038	0.000	-100.0
2011	0.001	0.009	554.6	0.015	0.006	-56.7	0.000	0.000	163.6	0.031	0.000	-99.9
2012	0.002	0.007	229.3	0.009	0.007	-22.8	0.000	0.000	13.2	0.015	0.000	-97.9
2013	0.012	0.026	105.4	0.041	0.012	-71.0	0.000	0.001	294.4	0.086	0.006	-93.3
2014	0.003	0.009	157.1	0.015	0.005	-64.3	0.000	0.000	-8.5	0.019	0.001	-96.1
2015	0.004	0.015	266.6	0.026	0.009	-66.9	0.000	0.001	24.3	0.033	0.003	-90.3
2016	0.005	0.026	400.0	0.048	0.013	-72.6	0.001	0.001	10.4	0.046	0.021	-54.9
2017	0.016	0.035	123.2	0.066	0.017	-74.9	0.001	0.001	115.7	0.108	0.008	-92.6
2018	0.007	0.018	157.2	0.032	0.019	-41.4	0.001	0.001	-19.0	0.070	0.002	-97.8

1B2c Venting and flaring (oil, gas, combined oil and gas)

In comparison with the previous submission, the emissions of Cd and Hg for 2013-2017 were additionally calculated by extrapolation. Also the emissions of main pollutants and heavy metals from flaring of one terminal were reallocated from NFR 5C1bi to NFR 1B2c for the year 2018. The differences in the fugitive emissions from the solid fuels sector between the submissions for 2020 and 2021 are presented in Tables 8.13 and 8.14.

Table 8.13 The differences in the sector NFR 1B2c Cd and Hg emissions (t) for 2013–2017 between 2020 and 2021 submissions

Year	Cd			Hg		
	2020	2021	%	2020	2021	%
2013	NA	0.000000147	100	NA	0.00000012	100
2014	NA	0.000000147	100	NA	0.00000011	100
2015	NA	0.000000141	100	NA	0.00000011	100
2016	NA	0.00000013	100	NA	0.0000001	100
2017	NA	1.26833E-07	100	NA	0.0000001	100

Table 8.14 The differences in the sector NFR 1B2c emissions (kt, heavy metals in t) for 2018 between 2020 and 2021 submissions

Substance	2020	2021	%
NOx (as NO2)	0.000063	0.00029	360.3
NMVOC	0.000006	0.00001	66.7
SOx (as SO2)	0.00003	0.000138	360.0
PM2.5	0.000042	0.000194	361.9
PM10	0.000052	0.00024	361.5
TSP	0.000063	0.00029	360.3
BC	0.00001	0.000047	370.0
CO	0.000063	0.00029	360.3
Pb	0.000006	0.000029	383.3
Cd	0	0.00000012	100.0
Hg	0	0.00000009	100.0
As	0.000004	0.000018	350.0
Cr	0.000001	0.000006	500.0
Cu	0.000007	0.000032	357.1
Ni	0.000003	0.000012	300.0
Zn	0.000004	0.000018	350.0

1B2aiv Fugitive emissions oil: Refining and storage

Compared with last year's report, the emissions of NO_x and particulates were additionally calculated by extrapolation for years 2010, 2015-2018. The differences in the emissions of the oil refining and storage sector between the submissions for 2020 and 2021 are presented in Table 8.15.

Table 8.15 The differences in the sector NFR 1B2aiv emissions (kt) between 2020 and 2021 submissions

Year	NO_x			$PM_{2.5}$			PM_{10}			TSP			BC		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2002				NA	0.010	100	NA	0.023	100	NA	0.037	100			
2003				NA	0.009	100	NA	0.021	100	NA	0.033	100			
2004				NA	0.008	100	NA	0.019	100	NA	0.030	100			
2005				NA	0.007	100	NA	0.016	100	NA	0.027	100			

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Year	NO_x			$PM_{2.5}$			PM_{10}			TSP			BC		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2006				NA	0.006	100	NA	0.014	100	NA	0.023	100			
2007				NA	0.005	100	NA	0.012	100	NA	0.020	100	NA	0.038	100
2010	NA	0.003	100												
2015	NA	0.001	100												
2016	NA	0.001	100												
2017	NA	0.001	100												
2018	NA	0.001	100												

8.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2020 and 2021 are made by using exact calculation numbers.

1A2gvii Industrial machinery

In the industrial machinery sector, NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO emissions have been recalculated for the period between 1990-2018. For calculating emissions from industrial machinery, Tier 2 methodology was used instead that of of Tier 1 for the first time.

According to an observation which was made by the expert team following the 2020 review ('A comprehensive technical review of national emission inventories'), main pollutants as well as particulate matter emission factors and emission calculations were checked for the industrial machinery sector. There was an underestimation of emissions for the period 1990–2006 and overestimation for the years between 2007 and 2018.

Table 8.16 provides an overview of emission factors that have changed, where Tier 1 emission factors were used to calculate emissions in the 2020 submission and emission factors in the Tier 2 methodology described in the EMEP/EEA Guidebook being used in the 2021 submission. It should be noted that implied emission factors vary every year. Emissions were calculated for each year using a share of various engine technologies in use in any particular inventory year.

The differences in the industrial machinery sector emissions between the submissions for 2020 and 2021 are presented in Table 8.17.

Table 8.16 Emission factors for the industrial machinery sector (g/t)

Fuel	Pollutant	Tier 2									Tier 1
		<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V	
Diesel	NO_x	26,552	33,942	43,552	31,077	22,101	15,653	11,933	1,570	7,663	32,629
	NMVOC	8,077	6,962	5,851	1,725	1,587	1,470	625	536	930	3,377
	NH_3	7	7	8	8	8	8	8	8	8	8
	PM	6,207	4,308	3,642	1,005	1,034	950	98	98	116	2,104
	BC	3,414	2,369	2,001	800	825	758,	78	78	56	1,306
	CO	20,690	18,890	16,258	6,639	7,135	6,826	6,445	6,019	7,352	10,774
Gasoline 4-stroke	NO_x	2,429	5,743	7,129	7,088	6,676				5,354	7,117
	NMVOC	20,182	25,852	19,082	18,469	16,126				13,293	18,893
	NH_3	4	4	4	4	4				4	4
	PM	148	147	157	159	159				159	157
	BC	7	7	8	8	8				8	8
	CO	1,214,855	836,966	768,445	774,457	804,157				778,282	770,368

Table 8.17 The differences in the sector NFR1A2gvii emissions for 1990-2018 between 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	5.329	5.362	0.6	0.660	1.309	98.2	1.320	1.158	-12.3
1991	5.445	5.676	4.2	0.636	1.257	97.7	1.344	1.193	-11.3
1992	2.958	3.172	7.2	0.361	0.689	91.0	0.732	0.658	-10.1
1993	2.700	2.976	10.2	0.334	0.622	86.2	0.669	0.608	-9.0
1994	2.721	3.083	13.3	0.300	0.573	91.1	0.669	0.616	-8.1
1995	0.635	0.737	16.0	0.084	0.146	74.5	0.158	0.147	-6.8
1996	1.226	1.458	18.9	0.145	0.260	79.0	0.303	0.285	-5.8
1997	1.144	1.392	21.7	0.137	0.239	75.2	0.283	0.269	-4.7
1998	0.954	1.186	24.2	0.135	0.217	60.7	0.239	0.230	-3.6
1999	0.558	0.695	24.7	0.076	0.118	55.2	0.139	0.136	-2.5
2000	0.496	0.616	24.4	0.069	0.102	46.7	0.124	0.122	-1.7
2001	0.670	0.822	22.7	0.069	0.106	53.0	0.164	0.162	-1.3
2002	0.700	0.838	19.7	0.091	0.122	34.5	0.174	0.172	-1.0
2003	1.006	1.162	15.5	0.177	0.211	19.6	0.256	0.254	-0.7
2004	0.855	0.952	11.3	0.107	0.128	19.6	0.212	0.211	-0.6
2005	0.855	0.911	6.5	0.107	0.118	10.7	0.212	0.211	-0.4
2006	1.019	1.032	1.3	0.124	0.125	1.5	0.252	0.251	-0.3
2007	1.051	0.990	-5.8	0.127	0.115	-9.3	0.260	0.260	-0.2
2008	0.948	0.830	-12.4	0.103	0.083	-19.8	0.233	0.233	-0.1
2009	0.823	0.679	-17.5	0.103	0.080	-22.3	0.204	0.204	0.0
2010	1.019	0.794	-22.0	0.124	0.091	-26.3	0.252	0.252	0.0
2011	0.671	0.491	-26.8	0.074	0.051	-31.8	0.165	0.165	0.0
2012	0.888	0.611	-31.3	0.110	0.074	-32.9	0.220	0.220	0.0
2013	0.655	0.424	-35.2	0.075	0.045	-39.2	0.161	0.161	0.0
2014	1.007	0.613	-39.2	0.122	0.072	-41.5	0.249	0.249	0.0
2015	1.112	0.618	-44.4	0.126	0.066	-47.6	0.274	0.274	0.0
2016	1.049	0.545	-48.1	0.181	0.113	-37.8	0.266	0.266	0.0
2017	1.106	0.526	-52.5	0.187	0.110	-41.1	0.280	0.280	0.0
2018	1.812	0.763	-57.9	0.188	0.085	-54.5	0.444	0.440	-0.9

Table 8.17 continues

Year	PM			BC			CO		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.342	0.743	117.3	NR	NR	NR	6.368	8.124	27.6
1991	0.350	0.738	110.8	NR	NR	NR	4.870	6.435	32.1
1992	0.190	0.391	106.1	NR	NR	NR	3.281	4.122	25.6
1993	0.173	0.349	101.7	NR	NR	NR	3.196	3.923	22.8
1994	0.175	0.346	97.7	NR	NR	NR	1.667	2.298	37.9
1995	0.041	0.079	93.5	NR	NR	NR	0.978	1.131	15.7
1996	0.079	0.150	89.9	NR	NR	NR	1.173	1.438	22.6
1997	0.073	0.137	86.3	NR	NR	NR	1.146	1.380	20.4
1998	0.061	0.111	82.6	NR	NR	NR	1.851	2.035	9.9
1999	0.036	0.061	72.0	NR	NR	NR	0.952	1.045	9.7
2000	0.032	0.051	62.3	0.020	0.029	46.2	0.932	1.002	7.6
2001	0.043	0.066	52.2	0.027	0.037	38.4	0.221	0.301	36.2
2002	0.045	0.064	42.2	0.028	0.036	31.1	0.999	1.064	6.5
2003	0.064	0.084	32.4	0.039	0.049	23.9	3.404	3.469	1.9
2004	0.055	0.067	23.0	0.034	0.040	16.9	1.050	1.093	4.1
2005	0.055	0.062	12.5	0.034	0.037	9.2	1.050	1.074	2.2
2006	0.065	0.066	1.6	0.040	0.041	1.2	1.104	1.108	0.4
2007	0.067	0.060	-10.6	0.042	0.039	-7.9	1.115	1.094	-1.9
2008	0.061	0.049	-20.4	0.038	0.032	-15.2	0.526	0.485	-7.8

Year	PM			BC			CO		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
2009	0.053	0.039	-25.3	0.033	0.026	-19.0	1.040	1.007	-3.1
2010	0.065	0.047	-28.6	0.040	0.032	-21.5	1.104	1.059	-4.1
2011	0.043	0.029	-32.2	0.027	0.020	-24.3	0.417	0.375	-9.9
2012	0.057	0.036	-36.8	0.035	0.025	-29.0	1.061	1.019	-4.0
2013	0.042	0.024	-42.3	0.026	0.017	-34.5	0.501	0.456	-8.9
2014	0.065	0.034	-47.9	0.040	0.024	-40.1	1.101	1.039	-5.6
2015	0.072	0.034	-52.9	0.044	0.024	-45.3	0.822	0.731	-11.0
2016	0.066	0.029	-57.1	0.041	0.020	-50.2	3.419	3.443	0.7
2017	0.070	0.026	-62.3	0.043	0.019	-55.5	3.437	3.449	0.3
2018	0.117	0.038	-67.3	0.073	0.029	-60.6	0.598	1.182	97.6

1A3b Road transport

All emissions from road transport have been recalculated for the period between 1990-2018. Recalculations entail taking into use an improved new edition (version 5.4.36) of the COPERT 5 programme for emission calculations. Therefore there was a need to correct vehicle mileages to a small extent in order to maintain a balance between calculated and statistical fuel consumption levels as calculated by COPERT 5. These small changes have led to a minor change in total emissions.

In addition, LPG and CNG vehicles were included in the emission calculation for the period 1990–2018. However, emissions from LPG and CNG vehicles constitute a small fraction of the total emissions from the road transport sector.

In comparison to the previous submission, the emissions have change to a small extent (except heavy metals emissions, PCDD/PCDF and B(a)p). Heavy metals emissions which are related to lubricant consumption in 4-stroke engines are reported under NFR 2G in accordance with the EMEP/EEA Guidebook 2019.

The differences in road transport emissions between the submissions for 2020 and 2021 are presented in Table 8.18.

Table 8.18 The differences in road transport emissions between the 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x			NH_3		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	25.102	25.109	0.0	17.493	17.495	0.0	3.213	3.213	0.0	0.015	0.016	4.9
1991	22.919	22.926	0.0	16.831	16.834	0.0	2.923	2.923	0.0	0.014	0.015	5.6
1992	11.166	11.174	0.1	8.711	8.714	0.0	1.577	1.577	0.0	0.007	0.007	6.3
1993	12.296	12.305	0.1	9.033	9.037	0.0	1.853	1.853	0.0	0.010	0.011	5.4
1994	15.880	15.891	0.1	11.603	11.609	0.0	2.343	2.343	0.0	0.019	0.020	4.0
1995	15.596	15.609	0.1	10.777	10.783	0.1	2.591	2.591	0.0	0.025	0.026	2.9
1996	16.102	16.119	0.1	11.333	11.345	0.1	2.554	2.554	0.0	0.032	0.033	1.4
1997	17.074	17.091	0.1	12.116	12.128	0.1	2.693	2.693	0.0	0.043	0.043	1.2
1998	17.675	17.694	0.1	11.232	11.245	0.1	2.897	2.897	0.0	0.043	0.043	0.8
1999	15.381	15.399	0.1	10.352	10.365	0.1	2.581	2.581	0.0	0.053	0.054	0.9
2000	15.132	15.154	0.1	10.152	10.167	0.1	2.553	2.553	0.0	0.095	0.095	0.5
2001	16.574	16.598	0.1	9.273	9.290	0.2	0.579	0.579	0.0	0.120	0.120	-0.2
2002	15.945	15.970	0.2	7.900	7.917	0.2	0.601	0.601	0.0	0.125	0.125	-0.2
2003	13.732	13.756	0.2	6.349	6.366	0.3	0.293	0.293	0.0	0.137	0.137	-0.1
2004	13.320	13.345	0.2	5.454	5.471	0.3	0.267	0.267	0.0	0.139	0.208	49.3
2005	13.200	13.228	0.2	5.257	5.276	0.4	0.063	0.063	-0.1	0.198	0.198	-0.2
2006	13.186	13.216	0.2	5.127	5.149	0.4	0.036	0.036	-0.5	0.230	0.229	-0.1
2007	12.798	12.819	0.2	4.767	4.781	0.3	0.037	0.037	-0.2	0.245	0.244	-0.1
2008	11.182	11.210	0.3	3.927	3.946	0.5	0.036	0.036	-1.5	0.243	0.242	-0.1
2009	9.465	9.493	0.3	3.441	3.462	0.6	0.012	0.011	-0.6	0.219	0.218	-0.2
2010	9.654	9.676	0.2	3.084	3.101	0.6	0.006	0.006	-2.7	0.202	0.202	-0.1

Year	NOx			NMVOC			SOx			NH3		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	kt	kt	%	kt	kt	%	kt	kt	%
2011	9.772	9.790	0.2	2.602	2.619	0.7	0.008	0.008	1.8	0.194	0.194	0.0
2012	9.451	9.477	0.3	2.535	2.552	0.7	0.009	0.009	-1.2	0.182	0.183	0.5
2013	8.882	8.890	0.1	2.213	2.236	1.1	0.008	0.008	-1.1	0.157	0.158	0.6
2014	8.360	8.362	0.0	1.739	1.764	1.5	0.008	0.007	-1.9	0.148	0.150	1.3
2015	8.244	8.255	0.1	1.663	1.695	1.9	0.009	0.009	-0.8	0.149	0.153	2.9
2016	7.852	7.863	0.1	1.635	1.672	2.2	0.008	0.007	-0.7	0.146	0.152	4.0
2017	7.506	7.450	-0.7	1.460	1.460	0.0	0.009	0.009	-0.4	0.144	0.145	1.0
2018	7.215	7.111	-1.4	1.381	1.381	0.0	0.010	0.009	-4.9	0.136	0.138	1.2

Table 8.18 continues

Year	PM2.5			PM10			TSP			BC		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	kt	kt	%	kt	kt	%	kt	kt	%
1990	NR	NR	NR	NR	NR	NR	1.001	1.001	0.0	NR	NR	NR
1991	NR	NR	NR	NR	NR	NR	0.939	0.939	0.0	NR	NR	NR
1992	NR	NR	NR	NR	NR	NR	0.499	0.499	0.0	NR	NR	NR
1993	NR	NR	NR	NR	NR	NR	0.594	0.594	0.0	NR	NR	NR
1994	NR	NR	NR	NR	NR	NR	0.766	0.766	0.0	NR	NR	NR
1995	NR	NR	NR	NR	NR	NR	0.803	0.802	-0.1	NR	NR	NR
1996	NR	NR	NR	NR	NR	NR	0.769	0.769	0.0	NR	NR	NR
1997	NR	NR	NR	NR	NR	NR	0.813	0.814	0.0	NR	NR	NR
1998	NR	NR	NR	NR	NR	NR	0.811	0.811	0.0	NR	NR	NR
1999	NR	NR	NR	NR	NR	NR	0.752	0.752	0.0	NR	NR	NR
2000	0.709	0.709	0.0	0.795	0.795	0.0	0.899	0.900	0.1	0.362	0.341	-5.8
2001	0.583	0.583	0.0	0.689	0.689	0.1	0.817	0.817	0.1	0.297	0.271	-8.8
2002	0.652	0.652	0.0	0.760	0.761	0.1	0.892	0.892	0.1	0.342	0.315	-7.9
2003	0.597	0.598	0.0	0.701	0.702	0.1	0.827	0.828	0.1	0.321	0.295	-8.2
2004	0.678	0.679	0.0	0.787	0.787	0.1	0.917	0.918	0.1	0.366	0.339	-7.5
2005	0.656	0.657	0.1	0.767	0.768	0.1	0.901	0.902	0.1	0.359	0.331	-7.9
2006	0.634	0.634	0.1	0.754	0.755	0.1	0.899	0.901	0.1	0.352	0.321	-8.7
2007	0.623	0.623	0.1	0.749	0.750	0.1	0.903	0.904	0.1	0.350	0.318	-9.3
2008	0.533	0.534	0.1	0.655	0.656	0.1	0.802	0.804	0.2	0.298	0.267	-10.4
2009	0.466	0.467	0.1	0.578	0.579	0.2	0.714	0.715	0.2	0.268	0.240	-10.6
2010	0.473	0.474	0.1	0.590	0.591	0.2	0.732	0.733	0.2	0.276	0.247	-10.7
2011	0.472	0.473	0.1	0.594	0.595	0.2	0.742	0.743	0.2	0.276	0.245	-11.1
2012	0.469	0.470	0.2	0.593	0.594	0.2	0.743	0.745	0.3	0.278	0.247	-11.2
2013	0.442	0.443	0.2	0.563	0.564	0.3	0.709	0.711	0.4	0.263	0.232	-11.6
2014	0.414	0.415	0.3	0.537	0.539	0.4	0.685	0.689	0.5	0.243	0.212	-12.8
2015	0.412	0.413	0.4	0.538	0.541	0.5	0.690	0.695	0.6	0.241	0.209	-13.3
2016	0.403	0.405	0.5	0.533	0.536	0.7	0.688	0.694	0.8	0.233	0.200	-14.2
2017	0.389	0.390	0.2	0.523	0.525	0.3	0.684	0.686	0.3	0.219	0.187	-14.9
2018	0.382	0.383	0.3	0.520	0.522	0.4	0.686	0.689	0.4	0.214	0.178	-16.7

Table 8.18 continues

Year	CO			Pb			Cd			Hg		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	t	t	%	t	t	%	t	t	%
1990	120.377	120.400	0.0	73.240	73.240	0.0	0.007	0.001	-80.7	0.005	0.005	0.0
1991	119.503	119.532	0.0	65.671	65.672	0.0	0.006	0.001	-81.6	0.005	0.005	0.0
1992	48.423	48.445	0.0	30.713	30.713	0.0	0.003	0.001	-80.0	0.002	0.002	0.0
1993	54.088	54.115	0.0	32.856	32.856	0.0	0.003	0.001	-80.3	0.003	0.003	0.0
1994	71.927	71.972	0.1	42.059	42.060	0.0	0.004	0.001	-81.9	0.003	0.003	0.0
1995	61.594	61.653	0.1	23.654	23.655	0.0	0.004	0.001	-82.1	0.003	0.003	0.0
1996	72.266	72.356	0.1	20.546	20.547	0.0	0.004	0.001	-82.1	0.003	0.003	0.0

Year	CO			Pb			Cd			Hg		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	t	t	%	t	t	%	t	t	%
1997	76.346	76.434	0.1	8.812	8.812	0.0	0.005	0.001	-82.0	0.004	0.004	0.0
1998	79.358	79.474	0.1	6.621	6.622	0.0	0.005	0.001	-81.4	0.004	0.004	0.0
1999	71.252	71.355	0.1	6.674	6.674	0.0	0.004	0.001	-81.8	0.003	0.003	0.0
2000	66.293	66.403	0.2	4.900	4.900	0.0	0.004	0.001	-81.6	0.003	0.003	0.0
2001	70.365	70.479	0.2	5.879	5.880	0.0	0.006	0.001	-82.1	0.004	0.004	0.0
2002	58.952	59.061	0.2	5.423	5.424	0.0	0.006	0.001	-81.8	0.004	0.004	0.0
2003	48.555	48.661	0.2	2.119	2.119	0.0	0.006	0.001	-82.2	0.004	0.004	0.0
2004	41.461	41.562	0.2	2.058	2.059	0.0	0.006	0.001	-82.3	0.004	0.004	0.0
2005	39.219	39.332	0.3	2.104	2.105	0.0	0.006	0.001	-82.6	0.004	0.004	-0.1
2006	37.931	38.054	0.3	1.439	1.440	0.0	0.007	0.001	-82.8	0.005	0.005	-0.3
2007	34.898	34.981	0.2	1.511	1.511	0.0	0.007	0.001	-82.9	0.005	0.005	-0.1
2008	28.983	29.088	0.4	1.495	1.482	-0.9	0.007	0.001	-82.9	0.005	0.005	-1.3
2009	25.681	25.793	0.4	1.363	1.363	0.0	0.006	0.001	-83.3	0.004	0.004	-0.5
2010	23.063	23.146	0.4	0.259	0.258	-0.3	0.006	0.001	-82.9	0.004	0.004	-2.9
2011	19.282	19.369	0.5	0.266	0.266	-0.1	0.007	0.001	-82.8	0.004	0.004	0.6
2012	18.050	18.103	0.3	0.268	0.268	0.0	0.007	0.001	-82.9	0.005	0.004	-1.7
2013	15.109	15.266	1.0	0.261	0.262	0.2	0.007	0.001	-83.2	0.004	0.004	-1.5
2014	12.868	13.041	1.3	0.235	0.237	0.8	0.007	0.001	-83.3	0.004	0.004	-2.5
2015	12.725	12.945	1.7	0.241	0.244	1.0	0.007	0.001	-83.5	0.005	0.004	-1.2
2016	12.810	13.083	2.1	0.248	0.251	1.3	0.008	0.001	-83.6	0.005	0.005	-1.0
2017	11.697	11.732	0.3	0.257	0.259	0.5	0.008	0.001	-83.8	0.005	0.005	-0.6
2018	10.890	10.949	0.5	0.266	0.268	0.8	0.001	0.001	0.4	0.005	0.005	-4.9

Table 8.18 continues

Year	As			Cr			Cu			Ni		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
1990	0.000	0.003	1,778.6	0.124	0.102	-18.2	3.035	2.120	-30.1	0.054	0.016	-69.8
1991	0.000	0.003	1,735.5	0.111	0.090	-19.3	2.733	1.866	-31.7	0.050	0.014	-71.2
1992	0.000	0.001	1,847.3	0.056	0.047	-17.4	1.368	0.971	-29.0	0.024	0.007	-68.8
1993	0.000	0.002	1,873.8	0.062	0.051	-17.7	1.510	1.064	-29.5	0.026	0.008	-69.3
1994	0.000	0.002	1,837.7	0.078	0.063	-19.4	1.930	1.312	-32.0	0.035	0.010	-71.6
1995	0.000	0.002	1,876.5	0.074	0.059	-19.5	1.817	1.232	-32.2	0.034	0.009	-71.9
1996	0.000	0.002	1,803.1	0.076	0.061	-19.7	1.865	1.260	-32.5	0.035	0.010	-71.9
1997	0.000	0.002	1,779.2	0.083	0.067	-19.6	2.042	1.382	-32.3	0.038	0.011	-71.8
1998	0.000	0.002	1,839.5	0.084	0.068	-18.9	2.061	1.417	-31.3	0.037	0.011	-70.9
1999	0.000	0.002	1,800.2	0.078	0.063	-19.4	1.906	1.296	-32.0	0.035	0.010	-71.5
2000	0.000	0.002	1,846.3	0.079	0.064	-19.2	1.947	1.330	-31.7	0.036	0.010	-71.3
2001	0.000	0.002	1,872.7	0.098	0.079	-19.7	2.420	1.637	-32.4	0.045	0.013	-71.9
2002	0.000	0.003	1,974.5	0.101	0.081	-19.3	2.474	1.683	-32.0	0.045	0.013	-71.6
2003	0.000	0.002	1,974.3	0.097	0.078	-19.7	2.389	1.612	-32.5	0.044	0.012	-72.1
2004	0.000	0.003	2,062.3	0.101	0.081	-19.8	2.499	1.683	-32.7	0.046	0.013	-72.3
2005	0.000	0.003	2,041.8	0.104	0.083	-20.2	2.576	1.721	-33.2	0.048	0.013	-72.8
2006	0.000	0.003	2,054.4	0.113	0.090	-20.4	2.801	1.861	-33.6	0.053	0.014	-73.1
2007	0.000	0.003	2,059.8	0.120	0.095	-20.6	2.967	1.966	-33.7	0.056	0.015	-73.2
2008	0.000	0.003	2,031.9	0.116	0.092	-20.5	2.862	1.902	-33.6	0.054	0.015	-73.2
2009	0.000	0.003	2,049.0	0.106	0.084	-20.9	2.647	1.743	-34.2	0.051	0.013	-73.7
2010	0.000	0.003	2,146.1	0.110	0.088	-20.4	2.725	1.815	-33.4	0.051	0.014	-73.1
2011	0.000	0.003	2,294.3	0.114	0.091	-20.1	2.827	1.889	-33.2	0.053	0.014	-73.0
2012	0.000	0.003	2,332.7	0.116	0.093	-20.2	2.881	1.922	-33.3	0.054	0.015	-73.2
2013	0.000	0.003	2,369.4	0.115	0.091	-20.4	2.840	1.884	-33.7	0.054	0.014	-73.6
2014	0.000	0.003	2,372.2	0.117	0.093	-20.5	2.898	1.920	-33.7	0.055	0.014	-73.7
2015	0.000	0.003	2,400.9	0.120	0.096	-20.6	2.996	1.975	-34.1	0.057	0.015	-74.1
2016	0.000	0.003	2,373.8	0.124	0.098	-20.7	3.095	2.036	-34.2	0.060	0.015	-74.2
2017	0.000	0.003	2,387.2	0.129	0.101	-21.3	3.214	2.096	-34.8	0.062	0.016	-74.5

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Year	As 2020 t	As 2021 t	As Difference %	Cr 2020 t	Cr 2021 t	Cr Difference %	Cu 2020 t	Cu 2021 t	Cu Difference %	Ni 2020 t	Ni 2021 t	Ni Difference %
2018	0.000	0.003	2,430.7	0.104	0.105	0.5	2.152	2.169	0.8	0.016	0.016	0.5

Table 8.18 continues

Year	Se 2020 t	Se 2021 t	Se Difference %	Zn 2020 t	Zn 2021 t	Zn Difference %	PCDD/PCDF 2020 g	PCDD/PCDF 2021 g	PCDD/PCDF Difference %	B(a)p 2020 t	B(a)p 2021 t	B(a)p Difference %
1990	0.007	0.002	-72.5	1.310	0.780	-40.4	0.329	0.283	-13.8	0.006	0.006	10.5
1991	0.007	0.002	-73.5	1.204	0.703	-41.6	0.304	0.256	-15.7	0.005	0.006	10.2
1992	0.003	0.001	-71.7	0.584	0.353	-39.4	0.150	0.125	-16.8	0.003	0.003	10.2
1993	0.004	0.001	-72.1	0.647	0.389	-39.9	0.169	0.136	-19.5	0.003	0.003	9.8
1994	0.005	0.001	-73.7	0.853	0.495	-41.9	0.220	0.173	-21.6	0.004	0.004	9.5
1995	0.005	0.001	-73.7	0.810	0.471	-41.9	0.213	0.164	-22.7	0.004	0.004	9.1
1996	0.005	0.001	-73.7	0.835	0.484	-42.0	0.213	0.177	-16.9	0.004	0.004	10.1
1997	0.005	0.001	-73.7	0.912	0.530	-41.9	0.233	0.195	-16.4	0.004	0.004	10.1
1998	0.005	0.001	-72.9	0.910	0.537	-41.0	0.229	0.199	-13.1	0.004	0.004	10.7
1999	0.005	0.001	-73.4	0.849	0.496	-41.5	0.217	0.183	-15.9	0.004	0.004	10.2
2000	0.005	0.001	-73.2	0.864	0.507	-41.3	0.221	0.195	-11.8	0.004	0.004	10.7
2001	0.006	0.002	-73.6	1.086	0.633	-41.8	0.280	0.250	-10.5	0.005	0.005	9.9
2002	0.006	0.002	-73.2	1.111	0.653	-41.2	0.289	0.255	-11.5	0.005	0.006	9.3
2003	0.006	0.002	-73.5	1.082	0.631	-41.6	0.284	0.254	-10.5	0.005	0.006	8.9
2004	0.006	0.002	-73.6	1.133	0.660	-41.7	0.299	0.256	-14.4	0.006	0.007	8.4
2005	0.007	0.002	-73.8	1.180	0.684	-42.0	0.311	0.270	-13.0	0.007	0.007	8.2
2006	0.007	0.002	-74.1	1.287	0.742	-42.3	0.343	0.312	-9.0	0.007	0.008	7.9
2007	0.008	0.002	-74.2	1.365	0.785	-42.5	0.364	0.338	-7.2	0.008	0.009	7.6
2008	0.008	0.002	-74.4	1.304	0.747	-42.7	0.332	0.315	-5.2	0.007	0.008	7.8
2009	0.007	0.002	-74.8	1.213	0.689	-43.2	0.315	0.302	-4.3	0.007	0.008	7.4
2010	0.007	0.002	-74.3	1.238	0.710	-42.6	0.321	0.310	-3.5	0.008	0.008	7.3
2011	0.007	0.002	-74.2	1.282	0.738	-42.4	0.331	0.321	-2.9	0.008	0.009	7.1
2012	0.008	0.002	-74.3	1.309	0.752	-42.5	0.327	0.320	-2.1	0.009	0.009	6.7
2013	0.008	0.002	-74.6	1.295	0.740	-42.9	0.312	0.306	-1.6	0.009	0.010	6.5
2014	0.008	0.002	-74.7	1.325	0.756	-42.9	0.298	0.294	-1.3	0.009	0.010	6.5
2015	0.008	0.002	-75.0	1.375	0.779	-43.3	0.309	0.307	-0.8	0.010	0.011	6.2
2016	0.008	0.002	-75.1	1.427	0.809	-43.3	0.293	0.290	-0.9	0.011	0.011	6.2
2017	0.009	0.002	-75.3	1.485	0.835	-43.8	0.279	0.276	-1.0	0.011	0.011	6.3
2018	0.002	0.002	0.4	0.861	0.866	0.6	0.268	0.266	-1.0	0.011	0.012	6.4

Table 8.18 continues

Year	B(b)f 2020 t	B(b)f 2021 t	B(b)f Difference %	B(k)f 2020 t	B(k)f 2021 t	B(k)f Difference %	I(1,2,3-cd)p 2020 g	I(1,2,3-cd)p 2021 g	I(1,2,3-cd)p Difference %	Total PAHs 2020 t	Total PAHs 2021 t	Total PAHs Difference %
1990	0.015	0.015	0.3	0.013	0.013	0.6	0.009	0.010	2.9	0.043	0.044	2.3
1991	0.013	0.013	0.3	0.010	0.010	0.6	0.009	0.009	2.7	0.037	0.038	2.3
1992	0.007	0.007	0.3	0.006	0.006	0.5	0.004	0.004	3.0	0.020	0.021	2.2
1993	0.008	0.008	0.3	0.007	0.007	0.5	0.005	0.005	2.9	0.022	0.023	2.2
1994	0.009	0.009	0.3	0.007	0.007	0.6	0.006	0.006	2.7	0.027	0.028	2.3
1995	0.009	0.009	0.0	0.007	0.007	0.2	0.006	0.006	2.5	0.026	0.027	2.0
1996	0.009	0.009	0.3	0.007	0.007	0.6	0.006	0.006	2.8	0.026	0.026	2.3
1997	0.010	0.010	0.3	0.008	0.008	0.6	0.006	0.007	2.8	0.028	0.029	2.3
1998	0.010	0.010	0.3	0.009	0.009	0.5	0.006	0.006	3.0	0.029	0.030	2.3
1999	0.009	0.009	0.3	0.008	0.008	0.6	0.006	0.006	2.9	0.026	0.027	2.4
2000	0.009	0.009	0.3	0.008	0.008	0.6	0.006	0.006	3.1	0.026	0.026	2.5
2001	0.011	0.011	0.3	0.009	0.009	0.6	0.007	0.007	3.0	0.032	0.033	2.5
2002	0.012	0.012	0.3	0.010	0.010	0.5	0.007	0.007	3.0	0.034	0.035	2.4
2003	0.011	0.011	0.3	0.009	0.010	0.5	0.007	0.007	3.0	0.033	0.034	2.4

Year	B(b)f			B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	g	g	%	t	t	%
2004	0.012	0.012	0.3	0.010	0.010	0.5	0.007	0.008	2.9	0.035	0.036	2.3
2005	0.012	0.012	0.3	0.010	0.010	0.5	0.008	0.008	2.9	0.037	0.037	2.3
2006	0.013	0.013	0.3	0.011	0.011	0.5	0.009	0.009	2.8	0.040	0.041	2.3
2007	0.014	0.014	0.3	0.012	0.012	0.5	0.009	0.009	2.8	0.043	0.044	2.3
2008	0.013	0.013	0.3	0.011	0.011	0.5	0.008	0.009	2.9	0.040	0.041	2.3
2009	0.012	0.012	0.3	0.010	0.011	0.5	0.008	0.008	2.8	0.038	0.039	2.2
2010	0.013	0.013	0.3	0.012	0.012	0.5	0.008	0.008	2.8	0.040	0.041	2.2
2011	0.014	0.014	0.3	0.012	0.013	0.5	0.009	0.009	2.8	0.043	0.044	2.1
2012	0.014	0.014	0.3	0.013	0.013	0.5	0.009	0.009	2.7	0.045	0.046	2.1
2013	0.014	0.014	0.3	0.013	0.013	0.5	0.009	0.010	2.6	0.046	0.047	2.1
2014	0.015	0.015	0.4	0.013	0.013	0.6	0.010	0.010	2.6	0.046	0.047	2.1
2015	0.015	0.015	0.4	0.014	0.014	0.7	0.010	0.011	2.6	0.049	0.050	2.1
2016	0.016	0.016	0.5	0.014	0.014	0.8	0.011	0.011	2.6	0.050	0.052	2.2
2017	0.016	0.016	0.6	0.014	0.014	0.8	0.011	0.011	2.6	0.051	0.052	2.3
2018	0.016	0.016	0.6	0.014	0.014	0.9	0.011	0.012	2.8	0.053	0.054	2.4

Table 8.18 continues

Year	HCB			PCBs		
	2020	2021	Difference	2020	2021	Difference
	g	g	%	g	g	%
1990	0.201	0.201	0.0	0.075	0.072	-4.0
1991	0.193	0.193	0.0	0.066	0.064	-3.0
1992	0.085	0.085	0.0	0.035	0.034	-2.9
1993	0.093	0.093	0.0	0.038	0.036	-5.3
1994	0.130	0.130	0.2	0.039	0.037	-4.6
1995	0.123	0.123	0.2	0.037	0.035	-4.9
1996	0.135	0.136	1.0	0.038	0.037	-1.8
1997	0.150	0.150	0.3	0.042	0.042	1.0
1998	0.148	0.149	0.9	0.043	0.042	-1.6
1999	0.142	0.142	0.3	0.040	0.039	-1.5
2000	0.160	0.161	0.3	0.041	0.042	1.2
2001	0.220	0.221	0.5	0.054	0.053	-1.9
2002	0.226	0.226	0.0	0.056	0.054	-3.6
2003	0.234	0.235	0.4	0.054	0.054	0.0
2004	0.235	0.235	0.0	0.056	0.054	-3.6
2005	0.251	0.252	0.5	0.058	0.056	-2.9
2006	0.295	0.296	0.3	0.063	0.065	3.2
2007	0.323	0.324	0.3	0.068	0.070	2.9
2008	0.303	0.303	0.0	0.065	0.064	-1.5
2009	0.295	0.295	0.0	0.061	0.062	1.6
2010	0.303	0.304	0.3	0.061	0.062	1.6
2011	0.313	0.314	0.3	0.063	0.065	3.2
2012	0.312	0.313	0.3	0.061	0.064	4.1
2013	0.298	0.299	0.3	0.058	0.061	4.3
2014	0.285	0.286	0.4	0.060	0.058	-2.7
2015	0.298	0.299	0.3	0.062	0.061	-1.6
2016	0.281	0.282	0.4	0.063	0.058	-7.9
2017	0.269	0.269	0.0	0.064	0.055	-14.1
2018	0.258	0.259	0.4	0.065	0.053	-18.5

1A3c Railways

In the railway sector, all emissions have been recalculated for the years 2012-2014 and 2018 due to the correction of statistical fuel consumption (see Table 8.19).

The differences in the railway sector emissions between the submissions for 2020 and 2021 are presented in Table 8.20.

Table 8.19 The differences in fuel consumption in the railway sector between the 2020 and 2021 (kt)

Year	Diesel		Petrol	
	2020	2021	2020	2021
2012	30	30	0.163	0
2013	26	26	0.116	0
2014	20	20	0.047	0
2018	8	14.641	0	0

Table 8.20 The differences in the sector NFR 1A3c emissions between the 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x			NH_3		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 t	2021 t	Difference %	2020 t	2021 t	Difference %
2012	1.581	1.572	-0.5	0.140	0.140	-0.5	0.603	0.600	-0.5	0.211	0.210	-0.5
2013	1.368	1.362	-0.4	0.121	0.121	-0.4	0.522	0.520	-0.4	0.183	0.182	-0.4
2014	1.050	1.048	-0.2	0.093	0.093	-0.2	0.401	0.400	-0.2	0.140	0.140	-0.2
2018	0.419	0.767	83.0	0.037	0.068	83.0	0.160	0.293	83.0	0.056	0.102	83.0

Table 8.20 continues

Year	$PM_{2.5}$			PM_{10}			TSP			BC		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
2012	0.041	0.041	-0.5	0.043	0.043	-0.5	0.046	0.046	-0.5	0.027	0.027	-0.5
2013	0.036	0.036	-0.4	0.038	0.037	-0.4	0.040	0.040	-0.4	0.023	0.023	-0.4
2014	0.027	0.027	-0.2	0.029	0.029	-0.2	0.030	0.030	-0.2	0.018	0.018	-0.4
2018	0.011	0.020	83.0	0.012	0.021	83.0	0.012	0.022	83.0	0.007	0.013	83.0

Table 8.20 continues

Year	CO			Cd			Cr			Cu		
	2020 kt	2021 kt	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 t	2021 t	Difference %
2012	0.323	0.321	-0.5	0.302	0.300	-0.5	1.508	1.500	-0.5	0.051	0.051	-0.5
2013	0.279	0.278	-0.4	0.261	0.260	-0.4	1.306	1.300	-0.4	0.044	0.044	-0.4
2014	0.215	0.214	-0.2	0.200	0.200	-0.2	1.002	1.000	-0.2	0.034	0.034	-0.2
2018	0.086	0.157	83.0	0.080	0.146	83.0	0.400	0.732	83.0	0.014	0.025	83.0

Table 8.20 continues

Year	Ni			Se			Zn			B(a)p		
	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 t	2021 t	Difference %	2020 kg	2021 kg	Difference %
2012	2.111	2.100	-0.5	0.302	0.300	-0.5	0.030	0.030	-0.5	0.905	0.900	-0.5
2013	1.828	1.820	-0.4	0.261	0.260	-0.4	0.026	0.026	-0.4	0.783	0.780	-0.4
2014	1.403	1.400	-0.2	0.200	0.200	-0.2	0.020	0.020	-0.2	0.601	0.600	-0.2
2018	0.560	1.025	83.0	0.080	0.146	83.0	0.008	0.015	83.0	0.240	0.439	83.0

Table 8.20 continues

Year	B(b)f			B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %
2012	1.508	1.500	-0.5	1.038	1.032	-0.5	0.238	0.237	-0.5	3.689	3.669	-0.5
2013	1.306	1.300	-0.4	0.898	0.894	-0.4	0.206	0.205	-0.4	3.194	3.180	-0.4
2014	1.002	1.000	-0.2	0.690	0.688	-0.2	0.158	0.158	-0.2	2.452	2.446	-0.2
2018	0.400	0.732	83.0	0.275	0.504	83.0	0.063	0.116	83.0	0.978	1.791	83.0

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1A3dii National navigation (shipping)

In the national navigation sector, emissions have been recalculated for the period between 1990-2018 due to the correction of statistical fuel consumption and emission factors for heavy metals (Cu, Se) and PAHs (see Tables 8.21-8.22).

The differences in the national navigation sector emissions between the 2020 and 2021 submissions are presented in Tables 8.23-8.24.

Table 8.21 The differences in fuel consumption in the national navigation sector between 2020 and 2021 (kt)

Year	Diesel		Light fuel oil		Petrol	
	2020	2021	2020	2021	2020	2021
1991	7	6	0	0	0	0
1999	5	5	0.256	0	0	0
2012	4	4	0.395	0	0	0
2013	4	4	0.419	0	0	0
2014	6	6	0.395	0	0	0
2015	6	6	0.395	0	0.205	0
2016	5	5	0.395	0	0.272	0
2018	5	6.423	0	0	0	0

Table 8.22 Emission factors for the national navigation sector (g/t)

Year	Diesel	
	2020	2021
Cu	0.88	0.20
Se	0.1	0.01
B(a)p	NE	0.002
B(b)f	NE	0.01
B(k)f	NE	0.01
I(1,2,3-cd)o	NE	0.001

Table 8.23 The differences in national navigation emissions between the 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x			$PM_{2.5}$		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1991	0.550	0.471	-14.3	0.020	0.017	-14.3	0.070	0.060	-14.3	NR	NR	NR
1999	0.413	0.393	-4.9	0.015	0.014	-4.9	0.053	0.050	-4.9	NR	NR	NR
2012	0.345	0.314	-9.0	0.012	0.011	-9.0	0.009	0.008	-9.0	0.006	0.006	-9.0
2013	0.347	0.314	-9.5	0.012	0.011	-9.5	0.009	0.008	-9.5	0.006	0.006	-9.5
2014	0.502	0.471	-6.2	0.018	0.017	-6.2	0.013	0.012	-6.2	0.009	0.008	-6.2
2015	0.504	0.471	-6.5	0.055	0.017	-69.5	0.013	0.012	-6.2	0.011	0.008	-22.9
2016	0.426	0.393	-7.9	0.065	0.014	-78.3	0.011	0.010	-7.4	0.010	0.007	-31.0
2018	0.393	0.504	28.5	0.014	0.018	28.5	0.010	0.013	28.5	0.007	0.009	28.5

Table 8.23 continues

Year	PM_{10}=TSP			BC			CO			Pb		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kg	2021 kg	Difference %
1991	0.011	0.009	-14.3	0.003	0.003	-14.3	0.052	0.044	-14.3	0.910	0.780	-14.3
1999	0.008	0.008	-4.9	0.002	0.002	-4.9	0.039	0.037	-4.9	0.683	0.650	-4.9
2012	0.007	0.006	-9.0	0.002	0.002	-9.0	0.033	0.030	-9.0	0.571	0.520	-9.0
2013	0.007	0.006	-9.5	0.002	0.002	-9.5	0.033	0.030	-9.5	0.574	0.520	-9.5
2014	0.010	0.009	-6.2	0.003	0.003	-6.2	0.047	0.044	-6.2	0.831	0.780	-6.2
2015	0.012	0.009	-22.0	0.003	0.003	-9.2	0.165	0.044	-73.1	0.831	0.780	-6.2
2016	0.011	0.008	-29.8	0.003	0.002	-11.9	0.196	0.037	-81.1	0.701	0.650	-7.3
2018	0.008	0.010	28.5	0.002	0.003	28.5	0.037	0.048	28.5	0.650	0.835	28.5

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Table 8.23 continues

Year	Cd			Hg			As			Cr		
	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %
1991	0.070	0.060	-14.3	0.210	0.180	-14.3	0.280	0.240	-14.3	0.350	0.300	-14.3
1999	0.053	0.050	-4.9	0.158	0.150	-4.9	0.210	0.200	-4.9	0.263	0.250	-4.9
2012	0.044	0.040	-9.0	0.132	0.120	-9.0	0.176	0.160	-9.0	0.220	0.200	-9.0
2013	0.044	0.040	-9.5	0.133	0.120	-9.5	0.177	0.160	-9.5	0.221	0.200	-9.5
2014	0.064	0.060	-6.2	0.192	0.180	-6.2	0.256	0.240	-6.2	0.320	0.300	-6.2
2015	0.064	0.060	-6.2	0.192	0.180	-6.2	0.256	0.240	-6.2	0.320	0.300	-6.2
2016	0.054	0.050	-7.3	0.162	0.150	-7.3	0.216	0.200	-7.3	0.270	0.250	-7.3
2018	0.050	0.064	28.5	0.150	0.193	28.5	0.200	0.257	28.5	0.250	0.321	28.5

Table 8.23 continues

Year	Ni			Zn			PCDD/PCDF			HCB		
	2020 t	2021 t	Difference %	2020 t	2021 t	Difference %	2020 g	2021 g	Difference %	2020 g	2021 g	Difference %
1991	0.007	0.006	-14.3	0.008	0.007	-14.3	0.001	0.001	-14.3	0.560	0.480	-14.3
1999	0.005	0.005	-4.9	0.006	0.006	-4.9	0.001	0.001	-4.9	0.420	0.400	-4.9
2012	0.004	0.004	-9.0	0.005	0.005	-9.0	0.001	0.001	-9.0	0.352	0.320	-9.0
2013	0.004	0.004	-9.5	0.005	0.005	-9.5	0.001	0.001	-9.5	0.354	0.320	-9.5
2014	0.006	0.006	-6.2	0.008	0.007	-6.2	0.001	0.001	-6.2	0.512	0.480	-6.2
2015	0.006	0.006	-6.2	0.008	0.007	-6.2	0.001	0.001	-6.2	0.512	0.480	-6.2
2016	0.005	0.005	-7.3	0.006	0.006	-7.3	0.001	0.001	-7.3	0.432	0.400	-7.3
2018	0.005	0.006	28.5	0.006	0.008	28.5	0.001	0.001	28.5	0.400	0.514	28.5

Table 8.23 continues

Year	PCB		
	2020 g	2021 g	Difference %
1991	0.266	0.228	-14.3
1999	0.200	0.190	-4.9
2012	0.167	0.152	-9.0
2013	0.168	0.152	-9.5
2014	0.243	0.228	-6.2
2015	0.243	0.228	-6.2
2016	0.205	0.190	-7.3
2018	0.190	0.244	28.5

Table 8.24 The differences of Cu, Se and PAHs emissions in the sector NFR 1A3dii for 1990-2018 between 2020 and 2021 submissions

Year	Cu			Se			B(a)p			B(b)f		
	2020 t	2021 t	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %	2020 kg	2021 kg	Difference %
1990	0.006	0.001	-77.3	0.700	0.070	-90.0	NE	0.014	100.0	NE	0.070	100.0
1991	0.006	0.001	-80.5	0.700	0.060	-91.4	NE	0.012	100.0	NE	0.060	100.0
1992	0.004	0.001	-77.3	0.500	0.050	-90.0	NE	0.010	100.0	NE	0.050	100.0
1993	0.004	0.001	-77.3	0.500	0.050	-90.0	NE	0.010	100.0	NE	0.050	100.0
1994	0.004	0.001	-77.3	0.400	0.040	-90.0	NE	0.008	100.0	NE	0.040	100.0
1995	0.004	0.001	-77.3	0.400	0.040	-90.0	NE	0.008	100.0	NE	0.040	100.0
1996	0.006	0.001	-77.3	0.700	0.070	-90.0	NE	0.014	100.0	NE	0.070	100.0
1997	0.005	0.001	-77.3	0.600	0.060	-90.0	NE	0.012	100.0	NE	0.060	100.0
1998	0.005	0.001	-77.3	0.600	0.060	-90.0	NE	0.012	100.0	NE	0.060	100.0
1999	0.005	0.001	-78.4	0.526	0.050	-90.5	NE	0.010	100.0	NE	0.050	100.0
2000	0.006	0.001	-77.3	0.700	0.070	-90.0	NE	0.014	100.0	NE	0.070	100.0
2001	0.006	0.001	-77.3	0.700	0.070	-90.0	NE	0.014	100.0	NE	0.070	100.0

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Year	Cu			Se			B(a)p			B(b)f		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	kg	kg	%	kg	kg	%	kg	kg	%
2002	0.010	0.002	-77.3	1.100	0.110	-90.0	NE	0.022	100.0	NE	0.110	100.0
2003	0.008	0.002	-77.3	0.900	0.090	-90.0	NE	0.018	100.0	NE	0.090	100.0
2004	0.007	0.002	-77.3	0.800	0.080	-90.0	NE	0.016	100.0	NE	0.080	100.0
2005	0.007	0.002	-77.3	0.800	0.080	-90.0	NE	0.016	100.0	NE	0.080	100.0
2006	0.010	0.002	-77.3	1.100	0.110	-90.0	NE	0.022	100.0	NE	0.110	100.0
2007	0.015	0.003	-77.3	1.700	0.170	-90.0	NE	0.034	100.0	NE	0.170	100.0
2008	0.018	0.004	-77.3	2.000	0.200	-90.0	NE	0.040	100.0	NE	0.200	100.0
2009	0.007	0.002	-77.3	0.800	0.080	-90.0	NE	0.016	100.0	NE	0.080	100.0
2010	0.007	0.002	-77.3	0.800	0.080	-90.0	NE	0.016	100.0	NE	0.080	100.0
2011	0.004	0.001	-77.3	0.500	0.050	-90.0	NE	0.010	100.0	NE	0.050	100.0
2012	0.004	0.001	-79.3	0.440	0.040	-90.9	NE	0.008	100.0	NE	0.040	100.0
2013	0.004	0.001	-79.4	0.442	0.040	-90.9	NE	0.008	100.0	NE	0.040	100.0
2014	0.006	0.001	-78.7	0.640	0.060	-90.6	NE	0.012	100.0	NE	0.060	100.0
2015	0.006	0.001	-78.7	0.640	0.060	-90.6	NE	0.012	100.0	NE	0.060	100.0
2016	0.005	0.001	-78.9	0.540	0.050	-90.7	NE	0.010	100.0	NE	0.050	100.0
2017	0.006	0.001	-77.3	0.655	0.065	-90.0	NE	0.013	100.0	NE	0.065	100.0
2018	0.004	0.001	-70.8	0.500	0.064	-87.2	NE	0.013	100.0	NE	0.064	100.0

Table 8.24 continues

Year	B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kg	kg	%	kg	kg	%	kg	kg	%
1990	NE	0.070	100.0	NE	0.007	100.0	NE	0.161	100.0
1991	NE	0.060	100.0	NE	0.006	100.0	NE	0.138	100.0
1992	NE	0.050	100.0	NE	0.005	100.0	NE	0.115	100.0
1993	NE	0.050	100.0	NE	0.005	100.0	NE	0.115	100.0
1994	NE	0.040	100.0	NE	0.004	100.0	NE	0.092	100.0
1995	NE	0.040	100.0	NE	0.004	100.0	NE	0.092	100.0
1996	NE	0.070	100.0	NE	0.007	100.0	NE	0.161	100.0
1997	NE	0.060	100.0	NE	0.006	100.0	NE	0.138	100.0
1998	NE	0.060	100.0	NE	0.006	100.0	NE	0.138	100.0
1999	NE	0.050	100.0	NE	0.005	100.0	NE	0.115	100.0
2000	NE	0.070	100.0	NE	0.007	100.0	NE	0.161	100.0
2001	NE	0.070	100.0	NE	0.007	100.0	NE	0.161	100.0
2002	NE	0.110	100.0	NE	0.011	100.0	NE	0.253	100.0
2003	NE	0.090	100.0	NE	0.009	100.0	NE	0.207	100.0
2004	NE	0.080	100.0	NE	0.008	100.0	NE	0.184	100.0
2005	NE	0.080	100.0	NE	0.008	100.0	NE	0.184	100.0
2006	NE	0.110	100.0	NE	0.011	100.0	NE	0.253	100.0
2007	NE	0.170	100.0	NE	0.017	100.0	NE	0.391	100.0
2008	NE	0.200	100.0	NE	0.020	100.0	NE	0.460	100.0
2009	NE	0.080	100.0	NE	0.008	100.0	NE	0.184	100.0
2010	NE	0.080	100.0	NE	0.008	100.0	NE	0.184	100.0
2011	NE	0.050	100.0	NE	0.005	100.0	NE	0.115	100.0
2012	NE	0.040	100.0	NE	0.004	100.0	NE	0.092	100.0
2013	NE	0.040	100.0	NE	0.004	100.0	NE	0.092	100.0
2014	NE	0.060	100.0	NE	0.006	100.0	NE	0.138	100.0
2015	NE	0.060	100.0	NE	0.006	100.0	NE	0.138	100.0
2016	NE	0.050	100.0	NE	0.005	100.0	NE	0.115	100.0
2017	NE	0.065	100.0	NE	0.007	100.0	NE	0.151	100.0
2018	NE	0.064	100.0	NE	0.006	100.0	NE	0.148	100.0

1A4aii Commercial/institutional sector

In the commercial and institutional machinery sector, NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO emissions have been recalculated for the period between 1990-2018. For calculating emissions from industrial machinery, Tier 2 methodology was used instead that of Tier 1 for the first time.

According to an observation which was made by the expert team following the 2020 review ('A comprehensive technical review of national emission inventories'), main pollutants as well as particulate matter emission factors and emission calculations were checked for the commercial and institutional machinery sector. There was an underestimation of emissions for the period 1990–2006 and overestimation for the years between 2007 and 2018.

Table 8.25 provides an overview of emission factors that have changed, where Tier 1 emission factors were used to calculate emissions in the 2020 submission and emission factors in the Tier 2 methodology described in the EMEP/EEA Guidebook being used in the 2021 submission. It should be noted that implied emission factors vary every year. Emissions were calculated for each year using a share of various engine technologies in use in any particular inventory year.

The differences in the commercial and institutional machinery sector emissions between the submissions for 2020 and 2021 are presented in Table 8.26.

Table 8.25 Emission factors for the sector NFR 1A4aii (g/t)

Fuel	Pollutant	Tier 2									Tier 1
		<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V	
Diesel	NO_x	26,552	33,942	43,552	31,077	22,101	15,653	11,933	1,57	7,663	32,629
	NMVOC	8,077	6,962	5,851	1,725	1,587	1,47	625	536	930	3,377
	NH_3	7	7	8	8	8	8	8	8	8	8
	PM	6,207	4,308	3,642	1,005	1,034	950	98	98	116	2,104
	BC	3,414	2,369	2,001	800	825	758	78	78	56	1,306
	CO	20,690	18,890	16,258	6,639	7,135	6,826	6,445	6,019	7,352	10,774
Petrol 2-stroke	NO_x	1,050	1,682	1,852	3,445	2,495				2,490	2,765
	NMVOC	298,703	258,562	229,630	225,579	113,157				111,450	227,289
	NH_3	2	3	3	4	4				4	3
	PM	7,037	4,786	3,869	3,683	4,299				4,278	3,762
	BC	352	239	193	184	215				214	188
	CO	754,523	699,494	621,083	620,519	695,237				694,870	620,793

Table 8.26 The differences in the sector NFR1 A4aii emissions for 1990-2018 between 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.397	0.398	0.2	0.495	0.603	21.7	0.102	0.090	-11.8
1991	0.495	0.514	3.9	0.505	0.605	19.7	0.126	0.112	-10.9
1992	0.359	0.385	7.4	0.037	0.075	103.0	0.088	0.079	-10.3
1993	0.101	0.110	9.2	0.237	0.254	6.8	0.027	0.025	-8.2
1994	0.131	0.148	13.3	0.014	0.026	96.1	0.032	0.029	-8.1
1995	0.296	0.343	15.8	0.258	0.290	12.5	0.075	0.070	-6.7
1996	0.163	0.194	19.1	0.017	0.032	89.5	0.040	0.038	-5.9
1997	0.131	0.159	21.9	0.014	0.025	86.3	0.032	0.030	-4.8
1998	0.186	0.231	24.1	0.159	0.177	11.2	0.047	0.045	-3.6
1999	0.182	0.227	24.5	0.135	0.150	10.9	0.046	0.045	-2.5
2000	0.180	0.224	24.2	0.145	0.158	9.0	0.045	0.045	-1.7
2001	0.177	0.216	22.2	0.153	0.164	7.2	0.045	0.044	-1.2
2002	0.112	0.133	18.4	0.270	0.277	2.8	0.030	0.030	-0.9
2003	0.172	0.199	15.3	0.204	0.212	3.8	0.044	0.044	-0.7

Year	NO_x			NMVOC			SO_x		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
2004	0.269	0.299	11.1	0.169	0.177	4.7	0.067	0.067	-0.6
2005	0.297	0.317	6.5	0.052	0.056	7.8	0.073	0.073	-0.4
2006	0.326	0.330	1.3	0.043	0.043	1.4	0.080	0.080	-0.2
2007	0.320	0.301	-5.8	0.033	0.030	-10.6	0.078	0.078	-0.2
2008	0.346	0.303	-12.5	0.036	0.028	-20.6	0.085	0.085	-0.1
2009	0.279	0.231	-17.4	0.204	0.166	-18.5	0.070	0.071	1.0
2010	0.439	0.342	-22.1	0.045	0.032	-29.6	0.108	0.108	0.0
2011	0.202	0.148	-26.8	0.058	0.034	-42.0	0.050	0.050	0.3
2012	0.201	0.138	-31.3	0.141	0.076	-45.9	0.051	0.051	1.0
2013	0.312	0.202	-35.3	0.058	0.032	-44.7	0.077	0.077	0.1
2014	0.262	0.159	-39.2	0.167	0.086	-48.3	0.066	0.066	0.9
2015	0.242	0.135	-44.3	0.143	0.072	-49.5	0.061	0.061	0.9
2016	0.156	0.080	-48.7	0.180	0.089	-50.2	0.040	0.041	1.8
2017	0.450	0.209	-53.5	0.237	0.114	-52.0	0.112	0.113	0.7
2018	0.436	0.186	-57.4	0.097	0.043	-55.9	0.108	0.108	0.2

Table 8.26 continues

Year	PM			BC			CO		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.033	0.065	96.9	NR	NR	NR	1.371	1.629	18.8
1991	0.039	0.076	93.5	NR	NR	NR	1.403	1.636	16.6
1992	0.023	0.048	106.4	NR	NR	NR	0.119	0.204	72.4
1993	0.010	0.017	66.2	NR	NR	NR	0.653	0.686	5.1
1994	0.008	0.017	97.8	NR	NR	NR	0.043	0.072	67.5
1995	0.023	0.041	79.0	NR	NR	NR	0.718	0.786	9.5
1996	0.011	0.020	90.0	NR	NR	NR	0.054	0.088	62.8
1997	0.008	0.016	86.5	NR	NR	NR	0.043	0.069	60.5
1998	0.014	0.024	70.1	NR	NR	NR	0.442	0.479	8.3
1999	0.014	0.022	62.4	NR	NR	NR	0.378	0.409	8.0
2000	0.014	0.021	53.5	0.007	0.011	45.6	0.404	0.430	6.4
2001	0.014	0.019	44.0	0.007	0.010	37.8	0.426	0.447	5.0
2002	0.011	0.014	27.4	0.005	0.006	29.8	0.742	0.753	1.5
2003	0.014	0.018	26.1	0.007	0.009	23.5	0.565	0.578	2.3
2004	0.020	0.024	20.7	0.011	0.013	16.8	0.476	0.490	3.0
2005	0.020	0.022	12.3	0.012	0.013	9.2	0.157	0.165	5.5
2006	0.021	0.022	1.6	0.013	0.013	1.2	0.132	0.134	1.0
2007	0.021	0.018	-10.6	0.013	0.012	-7.9	0.106	0.098	-7.1
2008	0.022	0.018	-20.4	0.014	0.012	-15.2	0.114	0.098	-13.8
2009	0.021	0.016	-21.3	0.011	0.009	-18.7	0.570	0.574	0.6
2010	0.028	0.020	-28.7	0.018	0.014	-21.5	0.145	0.117	-19.2
2011	0.014	0.009	-30.2	0.008	0.006	-24.2	0.168	0.166	-1.7
2012	0.015	0.010	-30.2	0.008	0.006	-28.5	0.394	0.416	5.5
2013	0.021	0.012	-41.2	0.012	0.008	-34.4	0.174	0.156	-10.4
2014	0.019	0.011	-40.5	0.011	0.006	-39.6	0.468	0.489	4.4
2015	0.017	0.010	-45.5	0.010	0.005	-44.7	0.402	0.416	3.5
2016	0.013	0.007	-42.3	0.006	0.003	-48.9	0.498	0.534	7.4
2017	0.032	0.014	-55.3	0.018	0.008	-54.9	0.668	0.680	1.8
2018	0.029	0.010	-64.4	0.017	0.007	-59.7	0.287	0.253	-11.9

1A4bii Household and gardening sector

In the household and gardening sector, NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO emissions have been recalculated for the period between 1990-2018. For calculating emissions from industrial machinery, Tier 2 methodology was used instead that of of Tier 1 for the first time.

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According to an observation which was made by the expert team following the 2020 review ('A comprehensive technical review of national emission inventories'), main pollutants as well as particulate matter emission factors and emission calculations were checked for the household and gardening sector. There was an underestimation of emissions for the period 1990–2006 and overestimation for the years between 2007 and 2018.

Table 8.27 provides an overview of emission factors that have changed, where Tier 1 emission factors were used to calculate emissions in the 2020 submission and emission factors in the Tier 2 methodology described in the EMEP/EEA Guidebook being used in the 2021 submission. It should be noted that implied emission factors vary every year. Emissions were calculated for each year using a share of various engine technologies in use in any particular inventory year.

The differences in the household and gardening sector emissions between the submissions for 2020 and 2021 are presented in Table 8.28.

Table 8.27 Emission factors for the sector NFR 1A4bii (g/t)

Fuel	Pollutant	Tier 2									Tier 1
		<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V	
Diesel	NO_x	26,552	33,942	43,552	31,077	22,101	15,653	11,933	1,57	7,663	32,629
	NMVOC	8,077	6,962	5,851	1,725	1,587	1,47	625	536	930	3,377
	NH_3	7	7	8	8	8	8	8	8	8	8
	PM	6,207	4,308	3,642	1,005	1,034	950	98	98	116	2,104
	BC	3,414	2,369	2,001	800	825	758	78	78	56	1,306
	CO	20,690	18,890	16,258	6,639	7,135	6,826	6,445	6,019	7,352	10,774
Petrol 2-stroke	NO_x	1,050	1,682	1,852	3,445	2,495				2,490	2,765
	NMVOC	298,703	258,562	229,630	225,579	113,157				111,450	227,289
	NH_3	2	3	3	4	4				4	3
	PM	7,037	4,786	3,869	3,683	4,299				4,278	3,762
	BC	352	239	193	184	215				214	188
	CO	754,523	699,494	621,083	620,519	695,237				694,870	620,793
Petrol 4-stroke	NO_x	2,429	5,743	7,129	7,088	6,676				5,354	7,117
	NMVOC	20,182	25,852	19,082	18,469	16,126				13,293	18,893
	NH_3	4	4	4	4	4				4	4
	PM	148	147	157	159	159				159	157
	BC	7	7	8	8	8				8	8
	CO	1,214,855	836,966	768,445	774,457	804,157				778,282	770,368

Table 8.28 The differences in the sector NFR1A4bii emissions for 1990-2018 between 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.006	0.005	-17.6	0.104	0.120	15.7	0.003	0.003	-1.5
1991	0.005	0.004	-22.3	0.117	0.131	11.7	0.003	0.003	0.0
1992	0.010	0.009	-6.8	0.126	0.136	8.3	0.005	0.005	-2.5
1993	0.015	0.015	0.5	0.138	0.144	4.8	0.006	0.006	-3.5
1994	0.023	0.025	7.1	0.127	0.133	4.4	0.008	0.008	-4.5
1995	0.035	0.037	7.6	0.254	0.262	3.4	0.013	0.013	-3.2
1996	0.032	0.034	5.0	0.360	0.369	2.6	0.015	0.014	-1.8
1997	0.040	0.043	9.2	0.383	0.392	2.4	0.017	0.017	-1.7
1998	0.028	0.032	13.8	0.220	0.225	2.2	0.011	0.011	-1.6
1999	0.038	0.042	11.9	0.357	0.363	1.6	0.016	0.016	-0.9
2000	0.047	0.053	11.3	0.463	0.470	1.5	0.020	0.020	-0.6
2001	0.052	0.056	8.5	0.572	0.579	1.3	0.023	0.023	-0.4
2002	0.051	0.054	7.8	0.530	0.537	1.3	0.022	0.022	-0.3
2003	0.054	0.058	6.3	0.523	0.529	1.2	0.023	0.023	-0.3

2004	0.054	0.056	4.3	0.471	0.477	1.2	0.022	0.022	-0.2
2005	0.056	0.057	3.0	0.447	0.450	0.6	0.022	0.022	2.2
2006	0.059	0.060	0.9	0.474	0.474	0.0	0.023	0.024	4.6
2007	0.065	0.063	-2.7	0.499	0.495	-0.8	0.025	0.027	6.9
2008	0.063	0.058	-7.1	0.509	0.493	-3.1	0.025	0.027	7.7
2009	0.060	0.053	-11.5	0.496	0.415	-16.4	0.024	0.026	7.9
2010	0.063	0.053	-16.2	0.477	0.335	-29.8	0.024	0.026	7.5
2011	0.052	0.042	-19.5	0.456	0.256	-43.9	0.021	0.023	8.4
2012	0.063	0.048	-23.8	0.475	0.263	-44.5	0.024	0.026	7.7
2013	0.061	0.044	-26.9	0.440	0.241	-45.2	0.023	0.025	7.6
2014	0.064	0.044	-30.1	0.450	0.244	-45.9	0.024	0.026	7.6
2015	0.065	0.043	-34.4	0.441	0.236	-46.5	0.024	0.026	7.4
2016	0.067	0.042	-37.6	0.460	0.244	-47.1	0.025	0.027	7.5
2017	0.068	0.040	-40.8	0.473	0.248	-47.6	0.025	0.027	7.5
2018	0.068	0.038	-43.5	0.473	0.248	-47.6	0.025	0.027	7.5

Table 8.28 continues

Year	PM			BC			CO		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.002	0.002	31.4	NR	NR	NR	0.585	0.646	10.5
1991	0.002	0.002	19.1	NR	NR	NR	0.661	0.714	8.1
1992	0.002	0.003	24.5	NR	NR	NR	0.711	0.753	5.9
1993	0.003	0.004	27.3	NR	NR	NR	0.775	0.804	3.6
1994	0.003	0.004	38.6	NR	NR	NR	0.715	0.736	2.9
1995	0.006	0.007	29.5	NR	NR	NR	1.427	1.456	2.0
1996	0.007	0.008	18.1	NR	NR	NR	2.030	2.058	1.4
1997	0.008	0.009	20.7	NR	NR	NR	2.157	2.178	1.0
1998	0.005	0.006	24.2	NR	NR	NR	1.237	1.245	0.6
1999	0.007	0.008	17.4	NR	NR	NR	2.011	2.016	0.3
2000	0.009	0.011	14.8	0.002	0.002	35.7	2.611	2.615	0.2
2001	0.011	0.012	11.1	0.002	0.002	28.3	3.223	3.225	0.1
2002	0.010	0.011	10.0	0.002	0.002	23.6	2.987	2.986	0.0
2003	0.010	0.011	8.9	0.002	0.002	18.9	2.946	2.945	0.0
2004	0.010	0.010	7.5	0.002	0.002	13.9	2.655	2.654	0.0
2005	0.009	0.010	4.2	0.002	0.002	7.7	2.517	2.516	0.0
2006	0.010	0.010	0.4	0.002	0.002	1.0	2.670	2.670	0.0
2007	0.011	0.010	-3.8	0.002	0.002	-6.7	2.811	2.817	0.2
2008	0.011	0.010	-5.9	0.002	0.002	-12.5	2.866	2.888	0.8
2009	0.010	0.010	-3.6	0.002	0.002	-14.6	2.795	2.870	2.7
2010	0.010	0.010	-2.0	0.002	0.002	-16.3	2.686	2.808	4.5
2011	0.009	0.010	2.4	0.002	0.001	-16.5	2.571	2.739	6.5
2012	0.010	0.010	-0.7	0.002	0.002	-21.6	2.672	2.851	6.7
2013	0.010	0.009	-2.8	0.002	0.002	-26.5	2.477	2.648	6.9
2014	0.010	0.010	-4.7	0.002	0.001	-31.5	2.533	2.714	7.2
2015	0.010	0.009	-6.9	0.002	0.001	-36.3	2.478	2.660	7.3
2016	0.010	0.010	-7.8	0.002	0.001	-40.2	2.590	2.782	7.4
2017	0.011	0.010	-9.1	0.002	0.001	-44.5	2.659	2.859	7.5
2018	0.011	0.010	-10.2	0.002	0.001	-48.1	2.659	2.859	7.5

1A4cii Agricultural machinery

In the agricultural sector, NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP and CO emissions have been recalculated for the period between 1990-2018. For calculating emissions from industrial machinery, Tier 2 methodology was used instead that of of Tier 1 for the first time.

According to an observation which was made by the expert team following the 2020 review ('A comprehensive technical review of national emission inventories'), main pollutants as well as particulate matter emission factors and emission calculations were checked for the agricultural sector. There was an underestimation of emissions for the period 1990–2006 and overestimation for the years between 2007 and 2018.

Table 8.29 provides an overview of emission factors that have changed, where Tier 1 emission factors were used to calculate emissions in the 2020 submission and emission factors in the Tier 2 methodology described in the EMEP/EEA Guidebook being used in the 2021 submission. It should be noted that implied emission factors vary every year. Emissions were calculated for each year using a share of various engine technologies in use in any particular inventory year.

The differences in the agricultural sector emissions between the submissions for 2020 and 2021 are presented in Table 8.30.

Table 8.29 Emission factors for the sector NFR 1A4cii (g/t)

Fuel	Pollutant	Tier 2									Tier 1
		<1981	1981-1990	1991-Stage I	Stage I	Stage II	Stage IIIA	Stage IIIB	Stage IV	Stage V	
Diesel (Agridulture)	NO_x	29,901	37,383	49,002	30,799	20,612	12,921	9,318	1,587	1,861	34,457
	NMVOC	7,760	6,439	4,493	1,544	1,181	1,173	544	530	526	3,542
	NH_3	7	7	8	8	8	8	8	8	8	8
	PM	5,861	4,047	1,974	947	624	550	99	99	59	1,913
	BC	3,221	2,221	1,074	727	483	416	74	73	9	1,111
	CO	19,804	17,566	14,147	6,463	6,104	6,035	6,087	6,024	6,077	11,469
Diesel (Forestry)	NO_x	33,028	44,030	49,963	31,344	20,593	12,845	9,454	1,586	1,915	28,471
	NMVOC	7,423	5,827	4,907	1,420	1,160	1,161	514	515	542	1,997
	NH_3	7	7	8	8	8	8	8	8	8	8
	PM	5,493	3,731	2,130	789	595	573	99	99	59	943
	BC	3,021	2,052	1,172	607	456	437	74	74	9	626
	CO	19,014	16,045	14,239	5,919	5,940	5,947	5,940	5,947	6,008	7,673
Petrol 4-stroke	NO_x	2,429	5,743	7,129	7,088	6,676				5,354	7,117
	NMVOC	20,182	25,852	19,082	18,469	16,126				13,293	18,893
	NH_3	4	4	4	4	4				4	4
	PM	148	147	157	159	159				159	157
	BC	7	7	8	8	8				8	8
	CO	1,214,855	836,966	768,445	774,457	804,157				778,282	770,368

Table 8.30 The differences in the sector NFR1A4cii emissions for 1990-2018 between 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	4.031	4.007	-0.6	0.837	1.380	64.9	0.990	0.878	-11.3
1991	3.880	4.005	3.2	0.681	1.122	64.9	0.937	0.837	-10.7
1992	2.914	3.098	6.3	0.599	0.924	54.3	0.715	0.647	-9.6
1993	2.531	2.780	9.8	0.383	0.613	59.9	0.604	0.548	-9.2
1994	1.296	1.465	13.0	0.151	0.253	67.6	0.303	0.277	-8.7
1995	1.076	1.244	15.7	0.128	0.208	61.9	0.252	0.232	-7.9
1996	1.209	1.427	18.0	0.160	0.244	53.0	0.285	0.265	-7.1
1997	1.114	1.340	20.3	0.150	0.223	48.6	0.263	0.246	-6.4
1998	1.148	1.405	22.4	0.153	0.223	45.6	0.271	0.255	-5.7
1999	0.544	0.672	23.5	0.074	0.104	41.5	0.129	0.122	-5.1
2000	0.835	1.041	24.7	0.103	0.146	41.5	0.196	0.187	-4.7
2001	0.627	0.781	24.6	0.082	0.111	34.9	0.148	0.142	-4.2
2002	2.331	2.882	23.6	0.257	0.333	29.5	0.544	0.523	-3.8
2003	2.388	2.833	18.6	0.280	0.337	20.2	0.559	0.540	-3.4
2004	2.224	2.527	13.7	0.282	0.317	12.3	0.523	0.508	-3.0
2005	2.015	2.154	6.9	0.207	0.209	0.8	0.468	0.457	-2.2

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Year	NO_x			NMVOC			SO_x		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
2006	1.986	2.063	3.9	0.209	0.211	1.2	0.462	0.450	-2.5
2007	2.060	2.021	-1.9	0.221	0.210	-5.0	0.479	0.468	-2.3
2008	2.009	1.854	-7.7	0.208	0.184	-11.7	0.467	0.457	-2.1
2009	1.819	1.582	-13.0	0.188	0.156	-17.4	0.423	0.415	-1.8
2010	1.987	1.527	-23.1	0.208	0.146	-29.9	0.462	0.456	-1.3
2011	2.653	2.051	-22.7	0.279	0.201	-27.9	0.617	0.608	-1.4
2012	2.550	1.933	-24.2	0.264	0.160	-39.4	0.592	0.592	0.0
2013	2.229	1.577	-29.2	0.235	0.133	-43.4	0.518	0.518	0.0
2014	3.249	2.118	-34.8	0.337	0.175	-48.1	0.755	0.755	0.0
2015	3.305	1.785	-46.0	0.345	0.152	-55.9	0.768	0.768	0.0
2016	2.646	1.323	-50.0	0.287	0.126	-56.3	0.616	0.616	0.0
2017	2.376	1.124	-52.7	0.262	0.114	-56.7	0.554	0.554	0.0
2018	2.271	0.985	-56.6	0.234	0.089	-62.1	0.527	0.527	0.0

Table 8.30 continues

Year	PM			BC			CO		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.218	0.535	145.1	NR	NR	NR	19.208	21.537	12.1
1991	0.212	0.495	133.6	NR	NR	NR	13.203	14.800	12.1
1992	0.158	0.350	121.5	NR	NR	NR	13.626	14.898	9.3
1993	0.139	0.294	111.9	NR	NR	NR	6.054	6.728	11.1
1994	0.072	0.145	102.6	NR	NR	NR	1.176	1.412	20.1
1995	0.059	0.115	93.4	NR	NR	NR	1.103	1.287	16.7
1996	0.067	0.123	84.9	NR	NR	NR	1.891	2.093	10.7
1997	0.061	0.109	77.0	NR	NR	NR	1.860	2.029	9.1
1998	0.063	0.107	69.7	NR	NR	NR	1.871	2.028	8.4
1999	0.030	0.049	62.1	NR	NR	NR	0.926	0.994	7.4
2000	0.046	0.072	55.0	0.027	0.039	46.8	1.022	1.119	9.5
2001	0.035	0.051	47.4	0.020	0.028	40.2	0.953	1.017	6.7
2002	0.129	0.166	28.3	0.075	0.092	23.2	1.520	1.697	11.6
2003	0.132	0.158	19.6	0.077	0.089	16.1	2.260	2.390	5.7
2004	0.123	0.137	11.7	0.071	0.078	9.4	3.009	3.085	2.5
2005	0.112	0.108	-3.8	0.065	0.063	-3.8	0.671	0.674	0.4
2006	0.110	0.108	-1.9	0.064	0.063	-2.1	0.860	0.869	1.1
2007	0.114	0.105	-8.3	0.066	0.061	-7.6	1.090	1.070	-1.9
2008	0.112	0.095	-14.7	0.065	0.056	-13.0	0.734	0.682	-7.1
2009	0.101	0.080	-20.6	0.059	0.048	-18.1	0.665	0.593	-10.8
2010	0.110	0.073	-33.6	0.064	0.045	-29.3	0.828	0.690	-16.7
2011	0.147	0.100	-32.0	0.085	0.061	-28.4	1.132	0.969	-14.4
2012	0.142	0.072	-49.2	0.082	0.045	-45.1	0.930	0.718	-22.9
2013	0.124	0.057	-53.7	0.072	0.036	-49.7	0.975	0.777	-20.3
2014	0.180	0.076	-57.7	0.105	0.048	-53.9	1.201	0.881	-26.6
2015	0.183	0.064	-65.3	0.106	0.041	-61.3	1.318	0.945	-28.3
2016	0.147	0.047	-67.8	0.085	0.030	-64.2	1.533	1.248	-18.6
2017	0.132	0.041	-69.2	0.076	0.026	-65.9	1.559	1.309	-16.0
2018	0.126	0.036	-71.7	0.073	0.023	-68.7	0.793	0.517	-34.9

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1A4ciii Agriculture/Forestry/Fishing: National fishing

In the national fishing sector, emissions have been recalculated for the period between 1990-2018 due to the correction of emission factors for BC, PAHs, heavy metals (Cu, Se) and PAHs (see Table 8.31).

The differences in the national fishing sector emissions between the 2020 and 2021 submissions are presented in Tables 8.32-8.33.

Table 8.31 Emission factors for the national navigation sector

Year	Unit	Diesel	
		2020	2021
BC	kg/t	0.434	0.465
Cu	g/t	0.88	0.20
Se	g/t	0.1	0.01
B(a)p	g/t	NE	0.002
B(b)f	g/t	NE	0.01
B(k)f	g/t	NE	0.01
I(1,2,3-cd)o	g/t	NE	0.001

Table 8.32 The differences in the sector NFR1A4ciii emissions for 1990-2018 between 2020 and 2021 submissions

Year	BC			Cu			Se			B(a)p		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	kg	kg	%	kg	kg	%	kg	kg	%
1990	NR	NR	NR	9.530	2.166	-77.3	1.083	0.108	-90.0	NE	0.022	100.0
1991	NR	NR	NR	9.320	2.118	-77.3	1.059	0.106	-90.0	NE	0.021	100.0
1992	NR	NR	NR	6.882	1.564	-77.3	0.782	0.078	-90.0	NE	0.016	100.0
1993	NR	NR	NR	6.115	1.390	-77.3	0.695	0.069	-90.0	NE	0.014	100.0
1994	NR	NR	NR	3.148	0.715	-77.3	0.358	0.036	-90.0	NE	0.007	100.0
1995	NR	NR	NR	2.620	0.595	-77.3	0.298	0.030	-90.0	NE	0.006	100.0
1996	NR	NR	NR	2.909	0.661	-77.3	0.331	0.033	-90.0	NE	0.007	100.0
1997	NR	NR	NR	2.699	0.613	-77.3	0.307	0.031	-90.0	NE	0.006	100.0
1998	NR	NR	NR	2.722	0.619	-77.3	0.309	0.031	-90.0	NE	0.006	100.0
1999	NR	NR	NR	1.238	0.281	-77.3	0.141	0.014	-90.0	NE	0.003	100.0
2000	0.865	0.926	7.0	1.725	0.392	-77.3	0.196	0.020	-90.0	NE	0.004	100.0
2001	1.748	1.872	7.1	3.516	0.799	-77.3	0.400	0.040	-90.0	NE	0.008	100.0
2002	2.257	2.417	7.1	4.547	1.033	-77.3	0.517	0.052	-90.0	NE	0.010	100.0
2003	2.944	3.151	7.0	5.880	1.336	-77.3	0.668	0.067	-90.0	NE	0.013	100.0
2004	2.067	2.213	7.1	4.147	0.942	-77.3	0.471	0.047	-90.0	NE	0.009	100.0
2005	1.821	1.952	7.1	3.693	0.839	-77.3	0.420	0.042	-90.0	NE	0.008	100.0
2006	0.929	0.995	7.1	1.874	0.426	-77.3	0.213	0.021	-90.0	NE	0.004	100.0
2007	0.915	0.980	7.1	1.847	0.420	-77.3	0.210	0.021	-90.0	NE	0.004	100.0
2008	1.891	2.026	7.1	3.833	0.871	-77.3	0.436	0.044	-90.0	NE	0.009	100.0
2009	2.473	2.649	7.1	4.984	1.133	-77.3	0.566	0.057	-90.0	NE	0.011	100.0
2010	1.490	1.596	7.1	3.015	0.685	-77.3	0.343	0.034	-90.0	NE	0.007	100.0
2011	0.792	0.847	7.0	1.572	0.357	-77.3	0.179	0.018	-90.0	NE	0.004	100.0
2012	0.845	0.904	7.0	1.682	0.382	-77.3	0.191	0.019	-90.0	NE	0.004	100.0
2013	0.485	0.520	7.1	0.972	0.221	-77.3	0.111	0.011	-90.0	NE	0.002	100.0
2014	0.237	0.254	7.1	0.480	0.109	-77.3	0.055	0.005	-90.0	NE	0.001	100.0
2015	0.301	0.323	7.1	0.610	0.139	-77.3	0.069	0.007	-90.0	NE	0.001	100.0
2016	0.659	0.705	6.9	1.297	0.295	-77.3	0.147	0.015	-90.0	NE	0.003	100.0
2017	0.553	0.593	7.1	1.122	0.255	-77.3	0.128	0.013	-90.0	NE	0.003	100.0
2018	0.273	0.292	7.1	0.553	0.126	-77.3	0.063	0.006	-90.0	NE	0.001	100.0

Table 8.32 continues

Year	B(b)f			B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kg	kg	%	kg	kg	%	kg	kg	%	kg	kg	%
1990	NE	0.108	100.0	NE	0.108	100.0	NE	0.011	100.0	NE	0.249	100.0
1991	NE	0.106	100.0	NE	0.106	100.0	NE	0.011	100.0	NE	0.244	100.0
1992	NE	0.078	100.0	NE	0.078	100.0	NE	0.008	100.0	NE	0.180	100.0
1993	NE	0.069	100.0	NE	0.069	100.0	NE	0.007	100.0	NE	0.160	100.0
1994	NE	0.036	100.0	NE	0.036	100.0	NE	0.004	100.0	NE	0.082	100.0

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Year	B(b)f			B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kg	kg	%	kg	kg	%	kg	kg	%	kg	kg	%
1995	NE	0.030	100.0	NE	0.030	100.0	NE	0.003	100.0	NE	0.068	100.0
1996	NE	0.033	100.0	NE	0.033	100.0	NE	0.003	100.0	NE	0.076	100.0
1997	NE	0.031	100.0	NE	0.031	100.0	NE	0.003	100.0	NE	0.071	100.0
1998	NE	0.031	100.0	NE	0.031	100.0	NE	0.003	100.0	NE	0.071	100.0
1999	NE	0.014	100.0	NE	0.014	100.0	NE	0.001	100.0	NE	0.032	100.0
2000	NE	0.020	100.0	NE	0.020	100.0	NE	0.002	100.0	NE	0.045	100.0
2001	NE	0.040	100.0	NE	0.040	100.0	NE	0.004	100.0	NE	0.092	100.0
2002	NE	0.052	100.0	NE	0.052	100.0	NE	0.005	100.0	NE	0.119	100.0
2003	NE	0.067	100.0	NE	0.067	100.0	NE	0.007	100.0	NE	0.154	100.0
2004	NE	0.047	100.0	NE	0.047	100.0	NE	0.005	100.0	NE	0.108	100.0
2005	NE	0.042	100.0	NE	0.042	100.0	NE	0.004	100.0	NE	0.097	100.0
2006	NE	0.021	100.0	NE	0.021	100.0	NE	0.002	100.0	NE	0.049	100.0
2007	NE	0.021	100.0	NE	0.021	100.0	NE	0.002	100.0	NE	0.048	100.0
2008	NE	0.044	100.0	NE	0.044	100.0	NE	0.004	100.0	NE	0.100	100.0
2009	NE	0.057	100.0	NE	0.057	100.0	NE	0.006	100.0	NE	0.130	100.0
2010	NE	0.034	100.0	NE	0.034	100.0	NE	0.003	100.0	NE	0.079	100.0
2011	NE	0.018	100.0	NE	0.018	100.0	NE	0.002	100.0	NE	0.041	100.0
2012	NE	0.019	100.0	NE	0.019	100.0	NE	0.002	100.0	NE	0.044	100.0
2013	NE	0.011	100.0	NE	0.011	100.0	NE	0.001	100.0	NE	0.025	100.0
2014	NE	0.005	100.0	NE	0.005	100.0	NE	0.001	100.0	NE	0.013	100.0
2015	NE	0.007	100.0	NE	0.007	100.0	NE	0.001	100.0	NE	0.016	100.0
2016	NE	0.015	100.0	NE	0.015	100.0	NE	0.001	100.0	NE	0.034	100.0
2017	NE	0.013	100.0	NE	0.013	100.0	NE	0.001	100.0	NE	0.029	100.0
2018	NE	0.006	100.0	NE	0.006	100.0	NE	0.001	100.0	NE	0.014	100.0

1A3di(i) International maritime navigation

In the international maritime navigation sector, emissions have been recalculated for the years 1990-1992 and 2018 due to the correction of statistical fuel consumption and emission factors for heavy metals (As, Cu, Se) and PAHs (see Tables 8.8.33-8.34).

The differences in the international maritime navigation sector emissions between the 2020 and 2021 submissions are presented in Tables 8.35-8.36.

Table 8.33 The differences in fuel consumption in the international maritime navigation sector between the 2020 and 2021 (kt)

Year	Bunker fuel oil		Light fuel oil		Diesel	
	2020	2021	2020	2021	2020	2021
1990	151	151	0	0	27	34
1991	177	177	0	0	33	41
1992	82	82	0	0	43	44
2018	140	140	157	157	0	0

Table 8.34 Emission factors for the national navigation sector

Year	Unit	Diesel	
		2020	2021
BC	Kg/t	0.434	0.465
Cu	g/t	0.88	0.20
Se	g/t	0.1	0.01
B(a)p	g/t	NE	0.002
B(b)f	g/t	NE	0.01
B(k)f	g/t	NE	0.01
I(1,2,3-cd)o	g/t	NE	0.001

Table 8.35 The differences in the sector NFR 1A3di(i) emissions between 2020 and 2021 submissions

Year	NO_x			NMVOC			SO_x			$PM_{2.5}$		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	kt	kt	%	kt	kt	%	kt	kt	%
1990	14.094	14.643	3.9	0.483	0.503	4.1	8.424	8.494	0.8	NR	NR	NR
1991	16.627	17.255	3.8	0.570	0.593	3.9	9.888	9.968	0.8	NR	NR	NR
1992	9.878	9.957	0.8	0.342	0.345	0.8	4.858	4.868	0.2	NR	NR	NR
2018	21.963	21.974	0.0	0.836	0.832	-0.4	4.514	4.514	0.0	0.999	0.995	-0.4

Table 8.35 continues

Year	PM_{10}=TSP			BC			CO			Pb		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	kt	kt	%	kt	kt	%	kt	kt	%	t	t	%
1990	0.977	0.987	1.1	NR	NR	NR	1.317	1.369	3.9	0.031	0.032	3.0
1991	1.147	1.159	1.0	NR	NR	NR	1.554	1.613	3.8	0.036	0.037	2.9
1992	0.573	0.574	0.3	NR	NR	NR	0.925	0.932	0.8	0.020	0.020	0.6
2018	1.065	1.061	-0.3	0.163	0.162	-0.3	2.198	2.198	0.0	0.046	0.046	0.0

Table 8.35 continues

Year	Cd			Hg			Cr			Ni		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
1990	0.003	0.003	2.1	0.004	0.004	5.5	0.110	0.110	0.3	4.859	4.866	0.1
1991	0.004	0.004	2.1	0.005	0.005	5.3	0.129	0.129	0.3	5.697	5.705	0.1
1992	0.002	0.002	0.5	0.003	0.003	1.0	0.061	0.061	0.1	2.667	2.668	0.0
2018	0.004	0.004	0.0	0.008	0.008	0.0	0.109	0.109	0.0	4.637	4.637	0.0

Table 8.35 continues

Year	Zn			PCDD/PCDF			HCB			PCB		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	g	g	%	kg	kg	%	kg	kg	%
1990	0.214	0.222	3.9	0.074	0.075	1.2	0.023	0.024	2.4	0.087	0.087	0.3
1991	0.252	0.262	3.8	0.087	0.089	1.2	0.027	0.028	2.3	0.102	0.102	0.3
1992	0.150	0.151	0.8	0.044	0.044	0.3	0.015	0.015	0.5	0.048	0.048	0.1
2018	0.356	0.356	0.0	0.086	0.086	0.0	0.032	0.032	0.0	0.086	0.086	0.0

Table 8.36 The differences of As, Cu, Se and PAHs emissions in NFR 1A3di(i) for the years 1990-2018 b between 2020 and 2021 submissions

Year	As			Cu			Se			B(a)p		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
1990	0.104	0.009	-91.4	0.213	0.037	-82.6	0.034	0.006	-81.5	NE	0.001	100.0
1991	0.122	0.010	-91.4	0.250	0.044	-82.6	0.040	0.007	-81.5	NE	0.001	100.0
1992	0.057	0.006	-89.8	0.140	0.025	-82.0	0.022	0.004	-82.7	NE	0.000	100.0
1993	0.058	0.007	-88.0	0.165	0.031	-81.4	0.024	0.004	-83.6	NE	0.001	100.0
1994	0.047	0.006	-87.6	0.138	0.026	-81.2	0.020	0.003	-83.8	NE	0.000	100.0
1995	0.036	0.004	-88.5	0.098	0.018	-81.6	0.015	0.002	-83.4	NE	0.000	100.0
1996	0.041	0.004	-89.5	0.103	0.019	-82.0	0.016	0.003	-83.0	NE	0.000	100.0
1997	0.050	0.005	-90.3	0.116	0.020	-82.4	0.018	0.003	-82.5	NE	0.000	100.0
1998	0.054	0.005	-90.6	0.124	0.022	-82.6	0.019	0.003	-82.4	NE	0.000	100.0
1999	0.053	0.005	-90.1	0.128	0.023	-82.3	0.020	0.003	-82.7	NE	0.000	100.0
2000	0.046	0.005	-89.3	0.118	0.021	-81.9	0.018	0.003	-83.1	NE	0.000	100.0
2001	0.041	0.005	-88.5	0.111	0.020	-81.6	0.016	0.003	-83.4	NE	0.000	100.0
2002	0.050	0.006	-89.0	0.132	0.024	-81.8	0.020	0.003	-83.2	NE	0.000	100.0
2003	0.049	0.005	-89.3	0.126	0.023	-81.9	0.019	0.003	-83.0	NE	0.000	100.0

Year	As			Cu			Se			B(a)p		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
2004	0.072	0.007	-90.1	0.173	0.031	-82.3	0.027	0.005	-82.7	NE	0.001	100.0
2005	0.054	0.006	-89.6	0.136	0.024	-82.0	0.021	0.004	-82.9	NE	0.000	100.0
2006	0.119	0.010	-91.2	0.255	0.043	-83.0	0.041	0.007	-82.0	NE	0.001	100.0
2007	0.152	0.012	-91.9	0.305	0.051	-83.4	0.050	0.009	-81.5	NE	0.001	100.0
2008	0.163	0.013	-92.2	0.315	0.052	-83.6	0.052	0.010	-81.3	NE	0.001	100.0
2009	0.147	0.011	-92.3	0.282	0.046	-83.7	0.047	0.009	-81.2	NE	0.001	100.0
2010	0.140	0.011	-92.1	0.275	0.045	-83.5	0.045	0.008	-81.4	NE	0.001	100.0
2011	0.116	0.009	-91.9	0.232	0.039	-83.4	0.038	0.007	-81.5	NE	0.001	100.0
2012	0.224	0.020	-91.2	0.482	0.082	-82.9	0.077	0.014	-82.0	NE	0.002	100.0
2013	0.268	0.021	-92.1	0.525	0.086	-83.5	0.086	0.016	-81.4	NE	0.002	100.0
2014	0.193	0.016	-91.7	0.395	0.066	-83.3	0.064	0.012	-81.7	NE	0.002	100.0
2015	0.143	0.014	-90.3	0.337	0.059	-82.4	0.052	0.009	-82.5	NE	0.001	100.0
2016	0.118	0.013	-89.2	0.306	0.056	-81.9	0.046	0.008	-83.1	NE	0.001	100.0
2017	0.145	0.015	-89.8	0.357	0.064	-82.1	0.055	0.009	-82.8	NE	0.001	100.0
2018	0.101	0.013	-86.9	0.313	0.059	-81.0	0.045	0.007	-84.1	NE	0.001	100.0

Table 8.36 continues

Year	B(b)f			B(k)f			I(1,2,3-cd)p			Total PAHs		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
1990	NE	0.005	100.0	NE	0.003	100.0	NE	0.001	100.0	NE	0.010	100.0
1991	NE	0.006	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.012	100.0
1992	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
1993	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.007	100.0
1994	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
1995	NE	0.002	100.0	NE	0.001	100.0	NE	0.000	100.0	NE	0.004	100.0
1996	NE	0.002	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.005	100.0
1997	NE	0.002	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.005	100.0
1998	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
1999	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
2000	NE	0.002	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.005	100.0
2001	NE	0.002	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.005	100.0
2002	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
2003	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.005	100.0
2004	NE	0.004	100.0	NE	0.003	100.0	NE	0.001	100.0	NE	0.008	100.0
2005	NE	0.003	100.0	NE	0.002	100.0	NE	0.001	100.0	NE	0.006	100.0
2006	NE	0.006	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.012	100.0
2007	NE	0.007	100.0	NE	0.005	100.0	NE	0.002	100.0	NE	0.015	100.0
2008	NE	0.007	100.0	NE	0.005	100.0	NE	0.002	100.0	NE	0.016	100.0
2009	NE	0.007	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.014	100.0
2010	NE	0.006	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.014	100.0
2011	NE	0.005	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.011	100.0
2012	NE	0.011	100.0	NE	0.007	100.0	NE	0.003	100.0	NE	0.023	100.0
2013	NE	0.012	100.0	NE	0.008	100.0	NE	0.004	100.0	NE	0.026	100.0
2014	NE	0.009	100.0	NE	0.006	100.0	NE	0.003	100.0	NE	0.019	100.0
2015	NE	0.007	100.0	NE	0.005	100.0	NE	0.002	100.0	NE	0.015	100.0
2016	NE	0.006	100.0	NE	0.004	100.0	NE	0.002	100.0	NE	0.013	100.0
2017	NE	0.007	100.0	NE	0.005	100.0	NE	0.002	100.0	NE	0.016	100.0
2018	NE	0.006	100.0	NE	0.004	100.0	NE	0.001	100.0	NE	0.013	100.0

8.2. Industry Sector (NFR 2)

8.2.1. Industrial Processes

2A6 Other mineral products

In comparison with the previous submission, the emissions of ammonia from refrigeration equipments were reallocated from NFR 2A6 to NFR 2L for the period 2001–2013. So2 emission related to fuel combustion, was reallocated to NFR 1A2gviii for 2001. The reason for this is incorrect SNAP activity codes for some facilities.

The differences in the emissions of the glass production sector between the submissions for 2020 and 2021 are presented in Table 8.37.

Table 8.37 The differences in the sector NFR 2A6 emissions (kt) for 2000–2003 between 2020 and 2021 submissions

Year	NH_3			SOx		
	2020	2021	%	2020	2021	%
2000	0.01	NA	-100			
2001	0.01	NA	-100	0.01	NA	-100
2002	0.01	NA	-100			
2003	0.01	NA	-100			

2B1 Ammonia production

Since inventory data for this activity are based on operator data and no data were provided for the periods 2002–2003 and 2005–2006, ammonia emissions were calculated using the extrapolation method.

The differences in the emissions of ammonia production between the submissions for 2020 and 2021 are presented in Table 8.38.

Table 8.38 The differences in the sector NFR 2B1 emissions (kt) between 2020 and 2021 submissions

Year	NH_3		
	2020	2021	%
2002	NA	0.01	100
2003	NA	0.01	100
2005	NA	0.01	100
2006	NA	0.01	100

2B10a Chemical industry: Other

Since inventory data for this activity are based on operators data and no NOx and CO data were provided for the some years in the period 1995–2014, emissions were calculated using the extrapolation method. Emission of SOx reallocated to NFR 1A2gviii.

The differences in the emissions of ammonia production between the submissions for 2020 and 2021 are presented in Table 8.39.

Table 8.39 The differences in the sector NFR 2B10a emissions (kt) between 2020 and 2021 submissions

Year	NO_x			SOx			CO		
	2020	2021	%	2020	2021	%	2020	2021	%
1995							NA	0.030	100
1996							NA	0.020	100
1999							NA	0.180	100
2001				0.010	NA	-100			
2003				0.010	NA	-100			
2004				0.010	NA	-100			
2010	NA	0.0000002	100						

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Year	NO_x			SOx			CO		
	2020	2021	%	2020	2021	%	2020	2021	%
2013	NA	0.0000600	100						
2014	NA	0.0001190	100						

2B10b Storage, handling and transport of chemical products

In comparison with the previous submission, the emissions of BC for 2018 were additionally calculated using the Guidebook 2019 EF (% of $PM_{2.5}$)

The differences in the BC emissions of storage, handling and transport of chemical products between the submissions for 2020 and 2021 are presented in Table 8.40.

Table 8.40 The differences in the sector NFR 2B10b emissions (kt) between 2020 and 2021 submissions

Year	BC		
	2020	2021	%
2018	NA	0.0000001	100

2C1 Iron and steel production

In comparison with the previous submission, the emissions of cadmium for 2000–2018 were additionally calculated using the Guidebook 2019 EF (0.02 g/Mg steel). Due to the lack of activity data, the calculation is based on the ratio of GB Cd emission factor to $PM_{2.5}$ emission factor. Then, emission of cadmium calculated using $PM_{2.5}$ emissions data and estimated ratio.

This year submission the particulates emissions for period 2009–2018 from mechanical treatment of copper pipes were mistakenly reallocated from the 2C7a sector to NFR 2C1. In the next reporting year, emissions will be accounted under 2C7c.

The differences in the emissions of Iron and steel production sector between the submissions for 2020 and 2021 are presented in Tables 8.41 and 8.42.

Table 8.41 The differences in the sector NFR 2C1 particulates emissions (kt) between 2020 and 2021 submissions

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2009	0.015	0.015	0.30	0.019	0.019	0.31	0.00005	0.00005	0.094	0.032	0.032	0.24
2010	0.017	0.017	0.01	0.022	0.022	0.01	0.00006	0.00006	0.000	0.037	0.037	0.01
2011	0.012	0.012	0.08	0.016	0.016	0.08	0.00004	0.00004	0.023	0.026	0.026	0.06
2012	0.013	0.013	0.13	0.017	0.017	0.14	0.00005	0.00005	0.043	0.028	0.028	0.10
2013	0.018	0.018	0.01	0.024	0.024	0.01	0.00007	0.00007	0.000	0.039	0.039	0.01
2014	0.023	0.023	0.02	0.029	0.029	0.02	0.00008	0.00008	0.012	0.049	0.049	0.02
2015	0.024	0.024	0.04	0.031	0.031	0.04	0.00009	0.00009	0.011	0.052	0.052	0.03
2016	0.038	0.038	0.04	0.049	0.049	0.04	0.00022	0.00022	0.009	0.082	0.082	0.03
2017	0.123	0.123	0.01	0.159	0.159	0.01	0.00074	0.00074	0.003	0.266	0.266	0.01
2018	0.027	0.027	0.04	0.035	0.035	0.04	0.00010	0.00010	0.010	0.058	0.058	0.03

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Table 8.42 The differences in the sector NFR 2C1 Cd emissions (t) between 2020 and 2021 submissions

Year	Cd		
	2020	2021	%
2000	NA	0.003	100
2001	NA	0.003	100
2002	NA	0.003	100
2003	NA	0.003	100
2004	NA	0.004	100
2005	NA	0.003	100
2006	NA	0.002	100
2007	NA	0.003	100
2008	NA	0.003	100
2009	NA	0.002	100
2010	NA	0.002	100
2011	NA	0.002	100
2012	NA	0.002	100
2013	NA	0.003	100
2014	NA	0.003	100
2015	NA	0.003	100
2016	NA	0.005	100
2017	NA	0.018	100
2018	NA	0.004	100

2C7a Copper production

This year submission the particulates emissions for period 2009–2018 from mechanical treatment of copper pipes were mistakenly reallocated from the 2C7a sector to NFR 2C1. In the next reporting year, emissions will be accounted under 2C7c.

The differences in the emissions of Iron and steel production sector between the submissions for 2020 and 2021 are presented in Tables 8.43

Table 8.43 The differences in the sector NFR 2C7a particulates emissions (kt) between 2020 and 2021 submissions

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2020	2021	%	2020	2021	%	2020	2021	%	2020	2021	%
2009	0.000045	NO	-100	0.000059	NO	-100	0.00000005	NO	-100	0.000076	NO	-100
2010	0.000002	NO	-100	0.000002	NO	-100	0.00000000	NO	-100	0.000003	NO	-100
2011	0.000010	NO	-100	0.000012	NO	-100	0.00000001	NO	-100	0.000016	NO	-100
2012	0.000017	NO	-100	0.000023	NO	-100	0.00000002	NO	-100	0.000029	NO	-100
2013	0.000002	NO	-100	0.000003	NO	-100	0.00000000	NO	-100	0.000004	NO	-100
2014	0.000005	NO	-100	0.000006	NO	-100	0.00000001	NO	-100	0.000008	NO	-100
2015	0.000010	NO	-100	0.000012	NO	-100	0.00000001	NO	-100	0.000016	NO	-100
2016	0.000016	NO	-100	0.000021	NO	-100	0.00000002	NO	-100	0.000027	NO	-100
2017	0.000015	NO	-100	0.000020	NO	-100	0.00000002	NO	-100	0.000026	NO	-100
2018	0.000011	NO	-100	0.000015	NO	-100	0.00000001	NO	-100	0.000019	NO	-100

2C7c Other metal production

This year submission, Zn emission for the period 2010–2018 was recalculated due to the usage of the wrong emission unit provided by one operator.

The differences in the emissions of Iron and steel production sector between the submissions for 2020 and 2021 are presented in Tables 8.44.

Table 8.44 The differences in the sector NFR 2C7c Zn emissions (t) between 2020 and 2021 submissions

Year	Zn		
	2020	2021	%
2010	0.0327	0.0357	9.2
2011	0.0361	0.0501	38.8
2012	0.0272	0.1102	305.7
2013	0.0336	0.1536	356.9
2014	0.0380	0.1640	331.4
2015	0.0374	0.1674	347.2
2016	0.0359	0.1615	349.8
2017	0.0359	0.1603	346.4
2018	0.0302	0.1417	368.9

2C3 Aluminium production

According to the TERT recommendation, this year submission PCDD/F and HCB emissions were additionally estimated for aluminium production sector. Calculations were carried out by using the Guidebook 2019 EF (Guidebook 2019, table 3.4, Chapter C.3) and operator activity data (Tables 8.45 and 8.46).

The differences in the emissions of aluminium production sector between the submissions for 2020 and 2021 are presented in Tables 8.47.

Table 8.45 PCDD/F and HCB EF for aluminium production

Substance	EF	Unit
PCDD/F	35	µg I-TEQ/Mg aluminium
HCB	5	g/Mg aluminium

Table 8.46 Aluminium production (Mg) for the period 2007–2018

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0.174	0.298	0.298	0.416	0.470	0.460	0.379	0.414	0.345	0.515	0.364	0.320

Table 8.47 The differences in the sector NFR 2C3 POPs emissions between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			HCB, kg		
	2020	2021	%	2020	2021	%
2007	NA	0.000006	100	NA	0.0009	100
2008	NA	0.000010	100	NA	0.0015	100
2009	NA	0.000010	100	NA	0.0015	100
2010	NA	0.000015	100	NA	0.0021	100
2011	NA	0.000017	100	NA	0.0024	100
2012	NA	0.000016	100	NA	0.0023	100
2013	NA	0.000013	100	NA	0.0019	100
2014	NA	0.000015	100	NA	0.0021	100
2015	NA	0.000012	100	NA	0.0017	100
2016	NA	0.000018	100	NA	0.0026	100
2017	NA	0.000013	100	NA	0.0018	100
2018	NA	0.000011	100	NA	0.0016	100

2C5 Lead production

According to the TERT recommendation, this year submission PCDD/F and PCB emissions were additionally estimated for secondary lead production sector. Calculations were carried out by using the Guidebook 2019 EF (Guidebook 2019, table 3.5, Chapter C.5) and recycling of old lead-acid batteries operator activity data (Tables 8.48 and 8.48a).

The differences in the emissions of lead production sector between the submissions for 2020 and 2021 are presented in Tables 8.49.

Table 8.48 PCDD/F and HCB EF for secondary production

Substance	EF	Unit
PCDD/F	3.2	µg I-TEQ/Mg lead
PCB	2.6	µg/Mg lead

Table 8.48a Lead production (Mg) for the period 2000–2018

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
6.754	6.754	6.754	6.754	6.754	3.377	3.856	4.335	4.814	5.293
2010	2011	2012	2013	2014	2015	2016	2017	2018	
7.184	7.840	8.046	7.581	8.588	8.638	8.635	8.958	8.140	

Table 8.49 The differences in the sector NFR 2C5 POPs emissions between 2020 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			PCB, kg		
	2020	2021	%	2020	2021	%
2000	NA	0.0216	100	NA	0.00002	100
2001	NA	0.0216	100	NA	0.00002	100
2002	NA	0.0216	100	NA	0.00002	100
2003	NA	0.0216	100	NA	0.00002	100
2004	NA	0.0216	100	NA	0.00002	100
2005	NA	0.0108	100	NA	0.00001	100
2006	NA	0.0123	100	NA	0.00001	100
2007	NA	0.0139	100	NA	0.00001	100
2008	NA	0.0154	100	NA	0.00001	100
2009	NA	0.0169	100	NA	0.00001	100
2010	NA	0.0230	100	NA	0.00002	100
2011	NA	0.0251	100	NA	0.00002	100
2012	NA	0.0257	100	NA	0.00002	100
2013	NA	0.0243	100	NA	0.00002	100
2014	NA	0.0275	100	NA	0.00002	100
2015	NA	0.0276	100	NA	0.00002	100
2016	NA	0.0276	100	NA	0.00002	100
2017	NA	0.0287	100	NA	0.00002	100
2018	NA	0.0260	100	NA	0.00002	100

2H2 Food and beverages industry

In comparison with the previous submission, the emissions of particulates were additionally calculated for 2007.

The differences in the emissions of lead production sector between the submissions for 2020 and 2021 are presented in Tables 8.50.

Table 8.50 The differences in the sector NFR 2H2 particulates emissions (kt) between 2020 and 2021 submissions

Year	$PM_{2.5}$			PM_{10}			TSP		
	2020	2021	%	2020	2021	%	2020	2021	%
2007	NA	0.00055	100	NA	0.00165	100	NA	0.005	100

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2L Other production, consumption, storage, transportation or handling of bulk products

In comparison with the previous submission, the emissions of ammonia from refrigeration equipments were reallocated from NFR 2A6 to NFR 2L for the period 2001–2013. Emissions of ammonia were additionally calculated for 1990-1999 by extrapolation by using of meat production statistical data.

The differences in the emissions of the other production, consumption, storage, transportation or handling of bulk products sector between the submissions for 2020 and 2021 are presented in Table 8.51.

Table 8.51 The differences in the sector NFR 2L ammonia emissions (kt) between 2020 and 2021 submissions

Year	NH_3		
	2020	2021	%
1990	NA	0.137	100
1991	NA	0.114	100
1992	NA	0.081	100
1993	NA	0.063	100
1994	NA	0.052	100
1995	NA	0.051	100
1996	NA	0.044	100
1997	NA	0.040	100
1998	NA	0.045	100
1999	NA	0.045	100
2000	0,03	0.040	33.3
2001	0,02	0.030	50.0
2002	0,02	0.030	50.0
2003	0,01	0.020	100.0

8.2.2. Solvent and Other Product Use

2D3a Domestic solvent use including fungicides

NMVOC emissions for the years 2017–2018 were recalculated due to the correction of statistical data for international trade and production of paints (see Table 8.52).

Table 8.52 The differences of NMVOC emissions in NFR 2D3a for the years 2017-2018 between 2020 and 2021 submissions

Year	2020	2021	Difference
	kt	kt	%
2017	3.210	3.219	0.27
2018	2.889	2.883	-0.20

2D3d Coating applications

NMVOC emission for the year 2018 was recalculated due to the correction of statistical data for international trade of paints (see Table 8.53).

Table 8.53 The differences of pollutants emissions in NFR 2D3d for the year 2018 between 2020 and 2021 submissions

Year	Pollutant	2020	2021	Difference
		kt	kt	%
2018	NMVOC	3.815	3.816	0.01
2014		0.000050	0.050000	99900.00
2015		0.000051	0.050978	99856.86

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2D3h Printing

NMVOC emission for the year 2018 was recalculated due to the correction of statistical data for international trade of printing ink (see Table 8.54).

Table 8.54 The difference of NMVOC emission in NFR 2D3h for the year 2018 between 2020 and 2021 submissions

Year	2020 kt	2021 kt	Difference %
2018	0.579	0.584	0.73

2G Other product use

TSP, Cd, Hg, As, Cu emissions for the years 1990–2018 and $PM_{2,5}$, BC emissions for the years 2000–2018 from the use of tobacco were recalculated due to the usage of EMEP/EEA Guidebook 2019 emission factor. In the previous submission, EMEP/EEA Guidebook 2016 emission factors were used.

In addition, NMVOC emissions for the years 1990–2018 from lubricant consumption in 4-stroke engines were calculated. EMEP/EEA Guidebook 2019 emission factors were used for calculating NMVOC emissions from the use of lubricants. Pb, Cd, Cr, Cu, Ni, Se, Zn emissions were relocated from NFR 1A3bi, 1A3bii, 1A3biii, and 1A3biv to NFR 2G (see Table 8.55).

Table 8.55 The differences (%) of pollutants emissions in NFR 2G for the years 1990-2018 between 2020 and 2021 submissions

Year	NMVOC			$PM_{2.5}$			TSP			BC		
	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %	2020 kt	2021 kt	Difference %
1990	0.020	0.053	163.49	NR	NR	--	0.113	0.135	19.95	NR	NR	--
1991	0.017	0.049	180.30	NR	NR	--	0.097	0.116	19.91	NR	NR	--
1992	0.009	0.023	166.48	NR	NR	--	0.049	0.058	19.73	NR	NR	--
1993	0.013	0.029	126.37	NR	NR	--	0.072	0.086	19.72	NR	NR	--
1994	0.011	0.033	201.35	NR	NR	--	0.063	0.076	19.51	NR	NR	--
1995	0.011	0.032	197.45	NR	NR	--	0.062	0.062	-0.24	NR	NR	--
1996	0.010	0.032	215.36	NR	NR	--	0.060	0.060	-0.16	NR	NR	--
1997	0.015	0.039	153.93	NR	NR	--	0.094	0.094	-0.19	NR	NR	--
1998	0.010	0.033	236.33	NR	NR	--	0.065	0.065	-0.31	NR	NR	--
1999	0,010	0.032	211.70	NR	NR	--	0.070	0.070	-0.26	NR	NR	--
2000	0.009	0.032	236.47	0.056	0.056	-0.3	0.060	0.060	-0.26	0.024	0.024	-0.30
2001	0.009	0.038	300.24	0.057	0.057	-0.4	0.062	0.062	-0.34	0.024	0.024	-0.40
2002	0.011	0.040	256.04	0.067	0.067	-0.4	0.073	0.073	-0.38	0.028	0.028	-0.45
2003	0.011	0.039	247.90	0.070	0.070	-0.4	0.077	0.077	-0.39	0.028	0.028	-0.48
2004	0.011	0.041	261.30	0.073	0.073	-0.6	0.084	0.084	-0.56	0.028	0.028	-0.74
2005	0.013	0.044	246.65	0.087	0.084	-3.4	0.107	0.104	-2.74	0.032	0.030	-4.17
2006	0.012	0.046	286.53	0.087	0.086	-0.7	0.109	0.109	-0.52	0.030	0.030	-0.86
2007	0.017	0.053	211.10	0.121	0.121	-0.7	0.150	0.149	-0.57	0.043	0.043	-0.90
2008	0.007	0.042	466.29	0.058	0.058	-0.7	0.076	0.076	-0.52	0.019	0.019	-0.95
2009	0.012	0.044	284.76	0.071	0.071	-0.8	0.079	0.078	-0.70	0.029	0.029	-0.85
2010	0.006	0.039	555.29	0.048	0.047	-0.6	0.064	0.063	-0.44	0.015	0.015	-0.85
2011	0.009	0.043	374.79	0.066	0.065	-0.9	0.083	0.082	-0.74	0.023	0.023	-1.21
2012	0.009	0.044	402.84	0.069	0.068	-0.9	0.092	0.091	-0.64	0.022	0.022	-1.21
2013	0.009	0.044	397.20	0.072	0.072	-0.7	0.098	0.097	-0.53	0.022	0.022	-1.06
2014	0.009	0.045	396.72	0.078	0.077	-0.7	0.108	0.107	-0.48	0.023	0.023	-1.02
2015	0.009	0.047	417.16	0.070	0.069	-0.9	0.091	0.090	-0.72	0.023	0.023	-1.30
2016	0.009	0.049	430.08	0.073	0.073	-0.9	0.098	0.097	-0.66	0.023	0.023	-1.26
2017	0.009	0.050	464.73	0.072	0.071	-1.3	0.097	0.096	-0.93	0.022	0.022	-1.83
2018	0.008	0.051	532.38	0.072	0.071	-1.2	0.103	0.102	-0.82	0.020	0.020	-1.87

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Table 8.55 continues

Year	Pb			Cd			Hg			AS		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	TSP	t	%
1990	0.002	0.002	1.960	0.022	0.032	43.86	0.011	0.013	20.00	0.011	0.013	19.99
1991	0.003	0.003	1.210	0.019	0.028	46.30	0.010	0.012	19.99	0.010	0.012	19.98
1992	0.005	0.005	0.360	0.010	0.014	44.26	0.005	0.006	20.00	0.005	0.006	19.96
1993	0.007	0.007	0.260	0.014	0.020	38.42	0.007	0.009	20.01	0.007	0.009	19.96
1994	0.011	0.011	0.230	0.012	0.018	49.31	0.006	0.007	20.02	0.006	0.007	19.94
1995	0.017	0.017	0.150	0.012	0.015	28.49	0.006	0.006	-0.25	0.006	0.006	-0.25
1996	0.023	0.023	0.110	0.011	0.015	31.16	0.006	0.006	-0.16	0.006	0.006	-0.18
1997	0.053	0.053	0.050	0.017	0.021	22.13	0.009	0.009	-0.21	0.009	0.009	-0.21
1998	0.071	0.071	0.040	0.011	0.015	33.73	0.005	0.005	-0.36	0.006	0.006	-0.36
1999	0.087	0.087	0.030	0.012	0.015	30.16	0.006	0.006	-0.31	0.006	0.006	-0.30
2000	0.054	0.054	0.050	0.011	0.014	33.89	0.005	0.005	-0.28	0.005	0.005	-0.28
2001	0.066	0.066	0.050	0.011	0.015	42.93	0.005	0.005	-0.40	0.005	0.005	-0.39
2002	0.077	0.077	0.040	0.013	0.017	36.49	0.006	0.006	-0.45	0.006	0.006	-0.44
2003	0.100	0.100	0.030	0.013	0.017	35.18	0.006	0.006	-0.49	0.007	0.006	-0.46
2004	0.150	0.150	0.020	0.013	0.018	36.59	0.006	0.006	-0.74	0.007	0.007	-0.72
2005	0.261	0.261	0.010	0.015	0.019	30.75	0.007	0.007	-4.15	0.007	0.007	-3.92
2006	0.305	0.305	0.010	0.014	0.019	39.27	0.007	0.007	-0.85	0.007	0.007	-0.80
2007	0.386	0.386	0.010	0.020	0.026	28.82	0.010	0.010	-0.89	0.010	0.010	-0.84
2008	0.245	0.246	0.020	0.009	0.014	63.59	0.004	0.004	-0.95	0.005	0.005	-0.87
2009	0.100	0.100	0.040	0.013	0.018	40.12	0.006	0.006	-0.84	0.007	0.007	-0.82
2010	0.217	0.217	0.020	0.007	0.012	75.56	0.003	0.003	-0.87	0.004	0.004	-0.79
2011	0.230	0.230	0.020	0.011	0.016	51.31	0.005	0.005	-1.21	0.005	0.005	-1.13
2012	0.309	0.309	0.010	0.010	0.016	54.33	0.005	0.005	-1.21	0.005	0.005	-1.10
2013	0.345	0.345	0.010	0.011	0.016	53.39	0.005	0.005	-1.05	0.006	0.005	-0.94
2014	0.406	0.406	0.010	0.011	0.017	52.89	0.005	0.005	-1.02	0.006	0.006	-0.90
2015	0.288	0.288	0.020	0.011	0.017	56.55	0.005	0.005	-1.28	0.006	0.005	-1.17
2016	0.334	0.334	0.010	0.011	0.017	57.96	0.005	0.005	-1.26	0.006	0.006	-1.14
2017	0.339	0.339	0.010	0.010	0.017	61.96	0.005	0.005	-1.82	0.005	0.005	-1.64
2018	0.413	0.413	0.010	0.010	0.017	69.75	0.005	0.004	-1.84	0.005	0.005	-1.61

Table 8.55 continues

Year	Cr			Cu			Ni			Zn		
	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference	2020	2021	Difference
	t	t	%	t	t	%	t	t	%	t	t	%
1990	0.0000	0.0226	56497.50	0.024	0.944	3896.46	0.0001	0.0376	49389.47	0.0007	0.5306	80287.73
1991	0.0001	0.0215	35086.89	0.021	0.892	4138.61	0.0001	0.0357	30383.76	0.0010	0.5029	49444.33
1992	0.0001	0.0099	10461.70	0.012	0.413	3260.97	0.0002	0.0165	9074.44	0.0016	0.2322	14762.68
1993	0.0001	0.0112	7660.42	0.018	0.468	2457.17	0.0003	0.0186	6614.08	0.0024	0.2610	10763.42
1994	0.0002	0.0155	6884.23	0.019	0.640	3331.24	0.0004	0.0258	5944.73	0.0037	0.3620	9690.40
1995	0.0003	0.0149	4263.05	0.022	0.611	2715.22	0.0007	0.0248	3680.79	0.0057	0.3466	5991.79
1996	0.0005	0.0154	3251.19	0.024	0.632	2485.46	0.0009	0.0258	2809.71	0.0077	0.3591	4577.71
1997	0.0011	0.0174	1544.52	0.047	0.709	1397.36	0.0020	0.0292	1333.71	0.0176	0.4008	2173.09
1998	0.0014	0.0174	1136.01	0.051	0.698	1268.84	0.0027	0.0292	981.49	0.0234	0.3977	1598.55
1999	0.0017	0.0168	875.97	0.061	0.672	1008.70	0.0033	0.0284	756.66	0.0287	0.3826	1232.72
2000	0.0011	0.0164	1421.47	0.041	0.661	1505.81	0.0021	0.0275	1227.25	0.0179	0.3766	1999.34
2001	0.0013	0.0207	1486.75	0.048	0.834	1650.09	0.0025	0.0348	1284.35	0.0218	0.4770	2092.40
2002	0.0015	0.0212	1274.33	0.056	0.851	1412.46	0.0030	0.0355	1100.84	0.0256	0.4855	1793.07
2003	0.0020	0.0213	969.55	0.069	0.851	1127.86	0.0038	0.0359	837.15	0.0332	0.4856	1363.76
2004	0.0030	0.0233	679.60	0.098	0.920	842.27	0.0057	0.0394	587.02	0.0497	0.5254	956.19
2005	0.0052	0.0264	410.25	0.162	1.023	532.96	0.0100	0.0453	354.30	0.0864	0.5850	577.12
2006	0.0061	0.0295	385.82	0.186	1.134	509.98	0.0117	0,0505	333.24	0.1011	0.6499	542.81
2007	0.0077	0.0326	323.94	0.238	1.246	423.92	0.0148	0,0561	279.78	0.1281	0.7116	455.73

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Year	Cr 2020 t	Cr 2021 t	Cr Difference %	Cu 2020 t	Cu 2021 t	Cu Difference %	Ni 2020 t	Ni 2021 t	Ni Difference %	Zn 2020 t	Zn 2021 t	Zn Difference %
2008	0.0049	0.0288	490.42	0.147	1.118	658.51	0.0094	0,0492	423.53	0.0814	0.6430	689.90
2009	0.0020	0.0246	1133.28	0.070	0.984	1314.50	0.0038	0,0413	978.98	0.0332	0.5625	1594.74
2010	0.0043	0.0270	525.14	0.130	1.049	709.19	0.0083	0,0460	453.48	0.0720	0.6039	738.73
2011	0.0046	0.0280	511.97	0.140	1.090	676.02	0.0088	0,0477	442.18	0.0763	0.6257	720.29
2012	0.0061	0.0302	391.15	0.185	1.159	527.56	0.0118	0,0517	337.85	0.1024	0.6661	550.33
2013	0.0069	0.0309	350.71	0.205	1.180	475.24	0.0132	0,0531	302.89	0.1143	0.6784	493.38
2014	0.0081	0.0328	306.62	0.240	1.243	418.00	0.0155	0,0566	264.81	0.1345	0.7148	431.35
2015	0.0057	0.0317	453.86	0.173	1.227	608.22	0.0110	0,0542	391.96	0.0955	0.7054	638.48
2016	0.0066	0.0338	409.30	0.199	1.300	552.58	0,0128	0,0579	353.49	0.1106	0.7475	575.82
2017	0.0068	0.0348	415.55	0.202	1.339	562.80	0,0130	0,0596	358.92	0.1125	0.7705	584.67
2018	0.0082	0.0375	356.13	0.243	1.428	488.31	0,0158	0,0644	307.61	0.1369	0.8229	501.06

8.3. Agriculture Sector (NFR 4)

8.3.1. Manure Management

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2021 and 2020 are made by using exact calculation numbers.

NO_x and NH_3 emissions from manure management are recalculated due to the updated emission factors in EMEP/EEA Guidebook 2019.

PM_{10} emissions from goats for the year 2005 and NMVOC emissions from other animals manure management for the year 2017 were corrected due to the mistake done by the inventory expert

3B1a Manure management - Dairy cattle

Table 8.56 The differences in dairy cattle manure management NO_x and NH_3 missions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.070	0.068	-3.5	2.291	2.829	23.5
1991	0.064	0.062	-3.5	2.097	2.590	23.5
1992	0.059	0.057	-3.5	1.930	2.384	23.5
1993	0.051	0.049	-3.5	1.691	2.089	23.6
1994	0.048	0.046	-3.5	1.581	1.954	23.6
1995	0.043	0.041	-3.5	1.399	1.729	23.6
1996	0.041	0.040	-3.5	1.355	1.673	23.5
1997	0.043	0.041	-3.4	1.385	1.711	23.5
1998	0.042	0.040	-3.4	1.351	1.668	23.5
1999	0.040	0.038	-3.3	1.274	1.572	23.4
2000	0.035	0.034	-3.4	1.127	1.391	23.4
2001	0.040	0.039	-3.3	1.280	1.578	23.3
2002	0.036	0.035	-3.3	1.155	1.424	23.3
2003	0.034	0.033	-3.3	1.282	1.573	22.7
2004	0.032	0.031	-3.3	1.424	1.740	22.2
2005	0.029	0.028	-3.3	1.545	1.882	21.8
2006	0.028	0.027	-3.2	1.692	2.055	21.5
2007	0.025	0.024	-3.1	1.739	2.108	21.2
2008	0.024	0.023	-3.1	1.854	2.244	21.1
2009	0.022	0.022	-3.0	1.920	2.321	20.9
2010	0.020	0.019	-3.0	2.017	2.435	20.7
2011	0.017	0.017	-3.0	2.088	2.517	20.6
2012	0.015	0.015	-3.0	2.205	2.655	20.4
2013	0.013	0.013	-3.1	2.358	2.836	20.3
2014	0.010	0.010	-3.1	2.403	2.887	20.1
2015	0.007	0.007	-3.2	2.357	2.853	21.1
2016	0.007	0.007	-3.2	2.303	2.788	21.1
2017	0.007	0.007	-3.1	2.311	2.810	21.6
2018	0.007	0.007	-3.1	2.300	2.781	20.9

3B1b Manure management - Non-dairy cattle

Table 8.57 The differences in non-dairy cattle manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.034	0.042	21.8	2.124	1.566	-26.3
1991	0.039	0.047	20.2	2.179	1.664	-23.6
1992	0.035	0.042	19.5	1.968	1.502	-23.7
1993	0.023	0.028	19.5	1.292	0.986	-23.7
1994	0.018	0.022	20.2	1.023	0.783	-23.5
1995	0.018	0.022	19.7	0.996	0.763	-23.4
1996	0.017	0.020	19.6	0.933	0.714	-23.5
1997	0.015	0.019	19.6	0.858	0.656	-23.5
1998	0.014	0.017	19.6	0.801	0.613	-23.5
1999	0.013	0.015	19.5	0.704	0.538	-23.7
2000	0.012	0.014	19.6	0.659	0.503	-23.6
2001	0.013	0.016	19.6	0.716	0.549	-23.4
2002	0.014	0.016	19.5	0.764	0.584	-23.6
2003	0.014	0.016	19.6	0.766	0.590	-23.0
2004	0.013	0.015	19.5	0.734	0.568	-22.6
2005	0.013	0.016	19.5	0.751	0.584	-22.2
2006	0.013	0.016	19.2	0.778	0.613	-21.2
2007	0.013	0.016	19.0	0.809	0.646	-20.2
2008	0.013	0.016	19.0	0.815	0.661	-19.0
2009	0.014	0.016	18.7	0.858	0.703	-18.0
2010	0.014	0.017	18.4	0.910	0.757	-16.8
2011	0.013	0.016	18.6	0.896	0.756	-15.6
2012	0.013	0.016	18.7	0.927	0.792	-14.6
2013	0.014	0.016	18.9	0.984	0.849	-13.7
2014	0.013	0.016	19.1	0.992	0.864	-12.9
2015	0.012	0.014	19.3	0.939	0.825	-12.1
2016	0.010	0.012	19.3	0.862	0.760	-11.8
2017	0.010	0.012	19.5	0.863	0.759	-12.1
2018	0.010	0.012	19.4	0.875	0.769	-12.1

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3B2 Manure management - Sheep

Table 8.58 The differences in sheep manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.001	0.002	50.4	0.222	0.063	-71.4
1991	0.001	0.002	50.0	0.227	0.065	-71.4
1992	0.001	0.002	50.0	0.195	0.056	-71.4
1993	0.000	0.001	48.9	0.078	0.022	-71.4
1994	0.001	0.001	48.2	0.096	0.028	-71.4
1995	0.000	0.001	48.9	0.078	0.022	-71.4
1996	0.000	0.001	48.6	0.060	0.017	-71.4
1997	0.000	0.000	46.9	0.055	0.016	-71.4
1998	0.000	0.000	48.1	0.046	0.013	-71.4
1999	0.000	0.000	50.0	0.045	0.013	-71.4
2000	0.000	0.000	48.1	0.047	0.013	-71.4
2001	0.000	0.000	48.1	0.046	0.013	-71.4
2002	0.000	0.000	50.0	0.048	0.014	-71.4
2003	0.000	0.000	48.3	0.050	0.014	-71.4
2004	0.000	0.001	51.3	0.068	0.019	-71.4
2005	0.000	0.001	48.9	0.078	0.022	-71.4
2006	0.001	0.001	50.9	0.096	0.027	-71.4
2007	0.001	0.001	50.8	0.114	0.032	-71.4
2008	0.001	0.001	49.3	0.126	0.036	-71.4
2009	0.001	0.001	50.7	0.128	0.036	-71.4
2010	0.001	0.001	49.4	0.134	0.038	-71.4
2011	0.001	0.001	48.7	0.132	0.038	-71.4
2012	0.001	0.001	50.7	0.127	0.036	-71.4
2013	0.001	0.001	49.3	0.116	0.033	-71.4
2014	0.001	0.001	50.7	0.120	0.034	-71.4
2015	0.001	0.001	50.7	0.120	0.034	-71.4
2016	0.001	0.001	48.6	0.128	0.037	-71.4
2017	0.001	0.001	49.2	0.113	0.032	-71.4
2018	0.001	0.001	49.2	0.102	0.029	-71.4

3B3 Manure management - swine

Table 8.59 The differences in swine manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.006	0.005	-8.8	2.308	2.533	9.7
1991	0.006	0.005	-8.5	2.132	2.333	9.4
1992	0.004	0.004	-8.5	1.443	1.576	9.2
1993	0.004	0.003	-8.8	1.147	1.255	9.5
1994	0.004	0.004	-8.4	1.230	1.342	9.0
1995	0.004	0.004	-8.6	1.198	1.302	8.7
1996	0.003	0.003	-9.2	0.805	0.878	9.0
1997	0.003	0.003	-9.1	0.840	0.921	9.5
1998	0.004	0.003	-9.3	0.895	0.980	9.5
1999	0.004	0.003	-11.2	0.852	0.947	11.1
2000	0.004	0.004	-11.8	0.920	1.034	12.3
2001	0.004	0.004	-12.3	1.005	1.143	13.8
2002	0.004	0.004	-10.7	0.994	1.112	11.8
2003	0.004	0.004	-11.3	0.984	1.107	12.6
2004	0.004	0.004	-11.0	0.944	1.064	12.7
2005	0.004	0.004	-10.8	0.955	1.077	12.8
2006	0.004	0.004	-10.7	0.949	1.069	12.6
2007	0.004	0.004	-10.2	1.027	1.137	10.7
2008	0.004	0.004	-9.2	0.956	1.078	12.7
2009	0.004	0.004	-10.2	0.938	1.057	12.8
2010	0.004	0.004	-10.7	0.951	1.073	12.8
2011	0.004	0.003	-10.3	0.918	1.042	13.6
2012	0.003	0.003	-8.2	0.901	1.025	13.8
2013	0.002	0.002	-6.6	0.845	0.963	14.1
2014	0.002	0.002	-4.6	0.828	0.951	14.8
2015	0.001	0.001	1.0	0.667	0.765	14.7
2016	0.001	0.001	2.2	0.610	0.686	12.5
2017	0.001	0.001	1.9	0.661	0.731	10.5
2018	0.001	0.001	2.8	0.660	0.719	8.9

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3B4d Manure management - goats

Table 8.60 The differences in goats manure management PM_{10} emissions (kt) for the year 2005 between 2020 and 2021 submissions (%)

Year	PM_{10}		
	Old	Recalc.	Difference
2005	0.000	0.000	-13.6

Table 8.61 The differences in goats manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.00002	0.00003	50	0.003	0.001	-71
1991	0.00002	0.00003	50	0.003	0.001	-71
1992	0.00003	0.00004	33	0.005	0.001	-71
1993	0.00002	0.00003	50	0.003	0.001	-71
1994	0.00002	0.00003	50	0.002	0.001	-71
1995	0.00002	0.00003	50	0.003	0.001	-71
1996	0.00002	0.00003	50	0.003	0.001	-71
1997	0.00002	0.00003	50	0.003	0.001	-71
1998	0.00002	0.00003	50	0.003	0.001	-71
1999	0.00003	0.00004	33	0.004	0.001	-71
2000	0.00003	0.00005	67	0.005	0.001	-71
2001	0.00004	0.00006	50	0.006	0.002	-71
2002	0.00004	0.00006	50	0.006	0.002	-71
2003	0.00004	0.00005	25	0.006	0.002	-71
2004	0.00003	0.00005	67	0.005	0.001	-71
2005	0.00003	0.00004	33	0.004	0.001	-71
2006	0.00003	0.00005	67	0.005	0.001	-71
2007	0.00004	0.00006	50	0.006	0.002	-71
2008	0.00004	0.00005	25	0.006	0.002	-71
2009	0.00004	0.00006	50	0.007	0.002	-71
2010	0.00004	0.00006	50	0.007	0.002	-71
2011	0.00004	0.00006	50	0.007	0.002	-71
2012	0.00005	0.00007	40	0.008	0.002	-71
2013	0.00005	0.00007	40	0.007	0.002	-71
2014	0.00004	0.00006	50	0.006	0.002	-71
2015	0.00004	0.00006	50	0.007	0.002	-71
2016	0.00005	0.00007	40	0.008	0.002	-71
2017	0.00005	0.00007	40	0.007	0.002	-71
2018	0.00005	0.00007	40	0.007	0.002	-71

3B4e Manure management - horses

Table 8.62 The differences in horses manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.002	0.002	24.3	0.127	0.060	-52.7
1991	0.002	0.002	24.2	0.115	0.055	-52.7
1992	0.001	0.002	24.1	0.098	0.046	-52.7
1993	0.001	0.001	23.8	0.077	0.036	-52.7
1994	0.001	0.001	23.8	0.074	0.035	-52.7
1995	0.001	0.001	23.7	0.068	0.032	-52.7
1996	0.001	0.001	23.5	0.062	0.029	-52.7
1997	0.001	0.001	23.5	0.062	0.029	-52.7
1998	0.001	0.001	24.1	0.058	0.027	-52.7
1999	0.001	0.001	24.1	0.058	0.027	-52.7
2000	0.001	0.001	23.5	0.062	0.029	-52.7
2001	0.001	0.001	24.3	0.081	0.039	-52.7
2002	0.001	0.001	24.3	0.078	0.037	-52.7
2003	0.001	0.001	23.9	0.086	0.041	-52.7
2004	0.001	0.001	24.3	0.075	0.036	-52.7
2005	0.001	0.001	23.7	0.071	0.034	-52.7
2006	0.001	0.001	24.2	0.073	0.034	-52.7
2007	0.001	0.001	24.3	0.078	0.037	-52.7
2008	0.001	0.001	24.3	0.078	0.037	-52.7
2009	0.001	0.001	23.9	0.080	0.038	-52.7
2010	0.001	0.002	24.1	0.101	0.048	-52.7
2011	0.001	0.002	24.4	0.096	0.046	-52.7
2012	0.001	0.002	24.0	0.092	0.043	-52.7
2013	0.001	0.002	24.4	0.093	0.044	-52.7
2014	0.001	0.002	24.4	0.093	0.044	-52.7
2015	0.001	0.002	24.4	0.093	0.044	-52.7
2016	0.001	0.001	24.3	0.084	0.040	-52.7
2017	0.001	0.001	24.3	0.084	0.040	-52.7
2018	0.001	0.001	24.3	0.084	0.040	-52.7

3B4gi Manure management - Laying hens

Table 8.63 The differences in laying hens manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.011	0.015	35.6	0.643	0.344	-46.4
1991	0.009	0.012	35.6	0.517	0.277	-46.4
1992	0.009	0.012	35.6	0.525	0.281	-46.4
1993	0.006	0.008	35.6	0.349	0.187	-46.4
1994	0.004	0.006	35.6	0.264	0.141	-46.4
1995	0.004	0.005	35.6	0.239	0.128	-46.4
1996	0.004	0.006	35.6	0.244	0.131	-46.4
1997	0.004	0.005	35.6	0.208	0.111	-46.4
1998	0.004	0.005	35.6	0.226	0.121	-46.4
1999	0.004	0.005	35.6	0.229	0.123	-46.4
2000	0.004	0.005	35.6	0.209	0.112	-46.4
2001	0.005	0.007	35.6	0.288	0.154	-46.4
2002	0.004	0.006	35.6	0.241	0.129	-46.4
2003	0.004	0.005	35.6	0.233	0.125	-46.4
2004	0.004	0.006	35.6	0.243	0.130	-46.4
2005	0.004	0.005	35.6	0.210	0.112	-46.4
2006	0.003	0.004	35.6	0.184	0.099	-46.4
2007	0.003	0.004	35.6	0.186	0.100	-46.4
2008	0.003	0.004	35.6	0.159	0.085	-46.4
2009	0.003	0.004	35.6	0.186	0.100	-46.4
2010	0.003	0.004	35.6	0.167	0.090	-46.4
2011	0.003	0.004	35.6	0.164	0.088	-46.4
2012	0.003	0.005	35.6	0.200	0.107	-46.4
2013	0.003	0.004	35.6	0.171	0.091	-46.4
2014	0.004	0.005	35.6	0.217	0.117	-46.4
2015	0.004	0.005	35.6	0.238	0.128	-46.4
2016	0.004	0.005	35.6	0.210	0.113	-46.4
2017	0.004	0.005	35.6	0.237	0.127	-46.4
2018	0.003	0.004	35.6	0.176	0.094	-46.4

3B4gii Manure management – Broilers

Table 8.64 The differences in broilers manure management NO_x and NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.006	0.007	9.7	0.240	0.267	11.1
1991	0.005	0.006	9.7	0.204	0.226	11.1
1992	0.003	0.003	9.7	0.126	0.140	11.1
1993	0.003	0.003	9.7	0.119	0.132	11.1
1994	0.003	0.003	9.7	0.111	0.124	11.1
1995	0.003	0.003	9.7	0.106	0.118	11.1
1996	0.002	0.002	9.7	0.065	0.072	11.1
1997	0.002	0.002	9.7	0.064	0.071	11.1
1998	0.002	0.003	9.7	0.096	0.107	11.1
1999	0.002	0.002	9.7	0.079	0.088	11.1
2000	0.002	0.002	9.7	0.076	0.084	11.1
2001	0.002	0.002	9.8	0.089	0.099	11.1
2002	0.003	0.003	9.7	0.114	0.126	11.1
2003	0.003	0.004	9.7	0.136	0.151	11.1
2004	0.004	0.004	9.7	0.141	0.156	11.1
2005	0.003	0.004	9.7	0.127	0.141	11.1
2006	0.003	0.003	9.7	0.121	0.134	11.1
2007	0.003	0.003	9.7	0.118	0.131	11.1
2008	0.003	0.004	9.7	0.127	0.141	11.1
2009	0.003	0.004	9.7	0.133	0.148	11.1
2010	0.004	0.004	9.7	0.149	0.166	11.1
2011	0.004	0.004	9.7	0.160	0.178	11.1
2012	0.004	0.004	9.7	0.156	0.173	11.1
2013	0.004	0.005	9.7	0.168	0.186	11.1
2014	0.004	0.005	9.7	0.172	0.191	11.1
2015	0.004	0.005	9.7	0.170	0.188	11.1
2016	0.004	0.005	9.7	0.175	0.195	11.1
2017	0.005	0.005	9.7	0.179	0.199	11.1
2018	0.005	0.005	9.7	0.176	0.199	13.0

3B4h Manure management - Other animals

Table 8.65 The differences in other manure management NO_x emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x		
	Old	Recalc.	Difference
1990	0.00007	0.00023	228.6
1991	0.00007	0.00023	228.6
1992	0.00006	0.00020	233.3
1993	0.00005	0.00017	240.0
1994	0.00004	0.00015	275.0
1995	0.00004	0.00013	225.0
1996	0.00002	0.00006	200.0
1997	0.00003	0.00009	200.0
1998	0.00003	0.00009	200.0
1999	0.00002	0.00007	250.0
2000	0.00002	0.00005	150.0
2001	0.00002	0.00006	200.0
2002	0.00002	0.00008	300.0
2003	0.00003	0.00010	233.3
2004	0.00003	0.00010	233.3
2005	0.00004	0.00013	225.0
2006	0.00003	0.00010	233.3
2007	0.00004	0.00012	200.0
2008	0.00003	0.00009	200.0
2009	0.00003	0.00010	233.3
2010	0.00003	0.00010	233.3
2011	0.00003	0.00011	266.7
2012	0.00003	0.00011	266.7
2013	0.00003	0.00010	233.3
2014	0.00003	0.00011	266.7
2015	0.00003	0.00012	300.0
2016	0.00002	0.00005	150.0
2017	0.00002	0.00005	150.0
2018	0.00001	0.00004	300.0

Table 8.66 The differences in other manure management NMVOC emissions (kt) for the year 2017 between 2020 and 2021 submissions (%)

Year	NMVOC		
	Old	Recalc.	Difference
2017	0.098	0.103	6.1

8.3.2. Agricultural Soils

3Da2a Animal manure applied to soils

NO_x and NH_3 emissions from animal manure applied to soils are recalculated due to the updated emission factors in EMEP/EEA Guidebook 2019.

Table 8.67 The differences in animal manure applied to soils emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	1.337	1.329	-0.6	8.897	7.637	-14.2
1991	1.237	1.228	-0.7	8.097	6.923	-14.5
1992	1.080	1.075	-0.5	7.124	6.090	-14.5
1993	0.869	0.862	-0.8	5.750	4.846	-15.7
1994	0.799	0.791	-1.0	5.256	4.404	-16.2
1995	0.729	0.721	-1.0	4.856	4.074	-16.1
1996	0.658	0.652	-0.9	4.429	3.713	-16.2
1997	0.653	0.646	-1.0	4.470	3.734	-16.5
1998	0.638	0.631	-1.1	4.410	3.672	-16.7
1999	0.587	0.580	-1.2	4.162	3.459	-16.9
2000	0.550	0.543	-1.2	3.838	3.187	-17.0
2001	0.605	0.597	-1.3	4.374	3.629	-17.0
2002	0.574	0.568	-1.1	4.163	3.469	-16.7
2003	0.577	0.569	-1.4	4.209	3.525	-16.3
2004	0.572	0.563	-1.5	4.246	3.575	-15.8
2005	0.567	0.557	-1.7	4.200	3.580	-14.8
2006	0.611	0.604	-1.3	4.013	3.450	-14.0
2007	0.616	0.608	-1.3	3.799	3.284	-13.6
2008	0.583	0.570	-2.1	3.513	3.054	-13.1
2009	0.588	0.575	-2.2	3.242	2.846	-12.2
2010	0.601	0.587	-2.3	3.026	2.683	-11.3
2011	0.599	0.584	-2.5	2.956	2.635	-10.9
2012	0.643	0.630	-1.9	2.940	2.639	-10.2
2013	0.626	0.609	-2.7	2.906	2.623	-9.7
2014	0.631	0.614	-2.7	2.780	2.531	-9.0
2015	0.591	0.574	-2.8	2.458	2.251	-8.4
2016	0.565	0.549	-2.8	2.501	2.191	-12.4
2017	0.575	0.559	-2.7	2.548	2.231	-12.5
2018	0.569	0.554	-2.7	2.468	2.212	-10.3

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3Da2c Other organic fertilisers applied to soils (including compost)

NO_x and NH_3 emissions for the whole time series were recalculated by using the amounts of dry weight compost instead of wet weight compost. Those amounts were obtained from the Estonian GHG inventory

Table 8.68 The differences in compost applied to soils category emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.005	0.002	-60.0	0.01	0.00	-60.0
1991	0.005	0.002	-60.0	0.01	0.00	-60.0
1992	0.005	0.002	-60.0	0.01	0.00	-60.0
1993	0.006	0.002	-60.0	0.01	0.00	-60.0
1994	0.006	0.002	-60.0	0.01	0.00	-60.0
1995	0.007	0.003	-60.0	0.01	0.01	-60.0
1996	0.004	0.002	-60.0	0.01	0.00	-60.0
1997	0.008	0.003	-60.0	0.02	0.01	-60.0
1998	0.001	0.001	-59.9	0.00	0.00	-60.0
1999	0.005	0.002	-60.0	0.01	0.00	-60.0
2000	0.014	0.006	-60.0	0.03	0.01	-60.0
2001	0.013	0.005	-60.0	0.03	0.01	-60.0
2002	0.012	0.005	-60.0	0.02	0.01	-60.0
2003	0.049	0.020	-60.0	0.10	0.04	-60.0
2004	0.048	0.019	-60.0	0.10	0.04	-60.0
2005	0.068	0.027	-60.0	0.14	0.05	-60.0
2006	0.071	0.028	-60.0	0.14	0.06	-60.0
2007	0.141	0.056	-60.0	0.28	0.11	-60.0
2008	0.131	0.052	-60.0	0.26	0.10	-60.0
2009	0.150	0.060	-60.0	0.30	0.12	-60.0
2010	0.143	0.057	-60.0	0.29	0.11	-60.0
2011	0.098	0.039	-60.0	0.20	0.08	-60.0
2012	0.109	0.043	-60.0	0.22	0.09	-60.0
2013	0.134	0.060	-55.2	0.27	0.12	-55.2
2014	0.094	0.053	-43.5	0.19	0.11	-43.5
2015	0.110	0.057	-48.5	0.22	0.11	-48.5
2016	0.149	0.077	-48.6	0.30	0.15	-48.6
2017	0.123	0.068	-44.9	0.25	0.14	-44.9
2018	0.158	0.072	-54.7	0.32	0.14	-54.7

3Da3 Urine and dung deposited by grazing animals

NH_3 from grazing have been recalculated for the years 1990-2018. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2019. NO_x emissions for the years 2018 were corrected due to the mistake done by the inventory expert

Table 8.69 The differences in grazing NH_3 emissions (kt) for the years 1990–2018 between 2020 and 2021 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	0.585	1.267	116.5
1991	0.553	1.205	117.8
1992	0.451	0.953	111.4
1993	0.364	0.697	91.6
1994	0.361	0.708	96.3
1995	0.304	0.581	91.6
1996	0.284	0.537	89.1
1997	0.275	0.516	87.5
1998	0.258	0.480	86.1
1999	0.233	0.439	88.4
2000	0.207	0.401	94.2
2001	0.226	0.439	94.1
2002	0.216	0.429	98.8
2003	0.219	0.437	99.8
2004	0.221	0.445	101.5
2005	0.214	0.441	105.7
2006	0.184	0.407	121.2
2007	0.151	0.372	146.8
2008	0.120	0.332	176.1
2009	0.092	0.292	217.8
2010	0.086	0.295	241.2
2011	0.092	0.304	229.6
2012	0.101	0.319	215.4
2013	0.114	0.340	198.6
2014	0.122	0.360	195.4
2015	0.123	0.364	195.2
2016	0.130	0.382	193.2
2017	0.131	0.375	186.0
2018	0.133	0.374	180.9

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Table 8.70 The differences in grazing NO_x emissions (kt) for the year 2018 between 2020 and 2021 submissions (%)

Year	NO_x		
	Old	Recalc.	Difference
2018	0.110	0.109	-1.3

3De Cultivated crops

NMVOC emissions for the years 2018 were corrected due to the correction of activity data from Statistics Estonia.

Table 8.71 The differences in cultivated crops $NMVOC_x$ emissions (kt) for the year 2018 between 2020 and 2021 submissions (%)

Year	NMVOC		
	Old	Recalc.	Difference
2018	0.184	0.199	-1.3

8.4. Waste Sector (NFR 5)

5B1 Solid waste disposal on land

In comparison to the previous submission, the emissions of NH_3 from NFR 5B1 were recalculated for the periods of 1996–1998 and 2004–2018. NH_3 recalculations were made due to the correction of activity data. The quantities of composted waste were specified. The quantities of composted waste were obtained from the Estonian GHG inventory (see Table 8.72).

Table 8.72 The differences of NH_3 emissions in NFR 5B1 for the years 1996-1998 and 2004-2018 between 2020 and 2021 submissions

Year	2020 kt	2021 kt	Difference %
1996	0.001	0.001	-0.1
1997	0.003	0.003	-0.1
1998	0.001	0.0005	-3.0
2004	0.018	0.016	-13.8
2005	0.025	0.022	-11.1
2006	0.028	0.023	-15.6
2007	0.045	0.046	3.6
2008	0.050	0.043	-13.5
2009	0.055	0.049	-11.2
2010	0.052	0.047	-10.4
2011	0.038	0.032	-15.1
2012	0.036	0.036	0.2
2013	0.043	0.049	14.1
2014	0.031	0.044	40.2
2015	0.039	0.046	19.8
2016	0.058	0.063	7.9
2017	0.059	0.056	-5.9
2018	0.041	0.059	44.6

5C1bi Industrial waste incineration

There are recalculations of pollutant emissions due to the corrections in point sources database, where emissions were allocated under a wrong SNAP code. In comparison to the previous submission, the emissions from light oil products, petrochemicals and liquefied gas terminal flare were reallocated from NFR 5C1bi to NFR 1B2c for the year of 2018 (see Table 8.73).

Table 8.73 The differences (%) of pollutant emissions for NFR 5C1bi for the year 2018 between 2020 and 2021 submissions

Substance	Unit	2020	2021	Difference %
NOx	kt	0.00856	0.00834	-2,6
NMVOC	kt	0.00088	0.00085	-4,2
SO_x	kt	0.07006	0.06995	-0,2
$PM_{2.5}$	kt	0.00014	0.00005	-63,8
PM_{10}	kt	0.00025	0.00009	-63,9
TSP	kt	0.00036	0.00013	-63,9
BC	kt	0.00001	0.00000	-64,0
CO	kt	0.00281	0.00258	-8,1
Pb	t	0.00079	0.00077	-2,9
Cr	t	0.00004	0.00003	-14,3
Cu	t	0.00015	0.00012	-17,2
Ni	t	0.00002	0.00002	-37,5

5C1bv Cremation

There are recalculations of pollutant emissions due to the corrections in statistical activity data. In 2020, the crematoriums in Estonia were contacted and asked to provide their 2018–2019 data on cremations. Based on the received data, recalculations of pollutant emissions were carried out for the year of 2018 (see Table 8.74).

Table 8.74 The differences (%) in the sector NFR 5C1bv emissions for 2018 between 2020 and 2021 submissions

Substance	Unit	2020	2021	Difference %
NO_x	kt	0.0067	0.0071	5.5
NMVOC	kt	0.0001	0.0001	4.7
SO_x	kt	0.0009	0.0010	5.4
$PM_{2.5}$	kt	0.0003	0.0003	5.3
PM_{10}	kt	0.0003	0.0003	5.3
TSP	kt	0.0003	0.0003	5.4
CO	kt	0.0011	0.0012	5.4
Pb	t	0.0002	0.0003	5.3
Cd	t	0.0000	0.0000	4.9
Hg	t	0.0121	0.0128	5.5
As	t	0.0001	0.0001	5.4
Cr	t	0.0001	0.0001	5.5
Cu	t	0.0001	0.0001	5.9
Ni	t	0.0001	0.0001	5.7
Se	t	0.0002	0.0002	5.6
Zn	t	0.0013	0.0014	5.5
PCDD/ PCDF	g I-TEQ	0.0002	0.0002	5.5
b(a)p	t	0.0000	0.0000	5.3
b(b)f	t	0.0000	0.0000	5.8
b(k)f	t	0.0000	0.0000	5.2
I(1,2,3-cd)p	t	0.0000	0.0000	5.6
HCB	kg	0.0012	0.0013	5.5
PCB	kg	0.0033	0.0035	5.5

5E Other waste

There are recalculations of pollutant emissions due to the corrections in statistical activity data. Adjusted data about fires for the year 2018 was obtained from the Estonian Rescue Board. Based on the received data, recalculations of pollutant emissions were carried out for the year of 2018 (see Table 8.75).

Table 8.75 The differences in the sector NFR 5E emissions for 2018 between 2020 and 2021 submissions

Substance	Unit	2020	2021	Difference %
$PM_{2.5}$	kt	0.0594	0.0614	3.4
PM_{10}	kt	0.0594	0.0614	3.4
TSP	kt	0.0594	0.0614	3.4
Pb	t	0.0002	0.0002	3.5
Cd	t	0.0003	0.0004	3.5
Hg	t	0.0003	0.0004	3.5
As	t	0.0005	0.0006	3.3
Cr	t	0.0005	0.0005	3.2
Cu	t	0.0012	0.0013	3.5
PCDD/ PCDF	g I-TEQ	0.6045	0.6254	3.4

Source: http://lofciam.pl

9. PROJECTIONS

9.1. Description of general methods, data sources and assumptions

Ministry of the Environment 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 MoE. With having a system in place for reporting GHG PaMs and projections, EERC is also is 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.

Estonia's emission projections described in this chapter and included in Annex IV have been calculated based on national strategy documents, legislation, and sector-specific studies (incl. economic and population forecasts). Where possible, long-term action plans of relevant companies have been taken into account in the projection compiling process.

9.2. Sectoral methods and projections

9.2.1. Energy

9.2.1.1. Electricity supply

The major national-level document aimed at the electricity sector is Estonia´s 2030 National Energy and Climate Plan (NECP 2030)[38]. The plan foresees a significant decrease in electricity production from oil shale and an increase in proportion of other sources of energy.

The plan emphasises that Estonia's electricity sector requires fundamental changes as the impact of electricity generation on the environment must be reduced. This process is also affected by the need to use the resources of oil shale in a more sustainable way. Therefore, the plan provides scenarios for the restructuring of electricity production in Estonia. The electricity generation from wind turbines (mainly wind farms) could be increased upto annual generation of ~2500 GWh, from biomass ~1200GWh and from solar parks ~415GWh.

According to the NECP 2030 new electricity production units have to be competitive in open electricity market without any subsidies. The support schemes for new production units are set in Electricity Market Act and are primarily aimed at renewable energy, combined heat and power (CHP) production and complying to the criteria of local production units.

[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] Ministry of Economic Affairs and Communications. Estonia´s national energy and climate plan 2030. [www] https://www.mkm.ee/et/eesmargid-tegevused/energeetika/eesti-riiklik-energia-ja-kliimakava-aastani-2030 (26.02.21)

The WEM measures that have an effect on air pollutant emissions in Electricity supply sector are the following:

1) Support for renewable and efficient CHP based electricity production – The support rates are presented inTable 4.1.
2) Investments for construction of wind parks – It is estimated that by 2030 the production of wind power should be approximately 2 500 GWh.
3) Increasing the share of solar energy in electricity generation – Investments for construction of solar parks.
4) Renewable energy support through underbidding auctions (technology neutral) – Increase energy production from renewable energy sources.
5) Introduction of renewable energy in maritime surveillance radar stations on small islands – Increase energy production from renewable energy sources.

The NIP measures that have a direct or indirect effect on AP emissions in Electricity supply sector, and might be added as an additional measure in the future, are the following:

1) The acquisition of air surveillance – To support the development of wind energy through the implementation of radars and other compensatory measures in order to promote the development of renewable energy in Estonia. Exempt onshore and wind farm areas from altitude and national defense restrictions that allow for the construction of wind farms.
2) Supporting the construction of electricity storage solutions - Increase energy production capacity from renewable energy sources.
3) Renewable energy support through underbidding auctions (technology specific) – Increase energy production from renewable energy sources.
4) Government actions to capture and store carbon or to promote its use – In 2019–2021, Tallinn University of Technology will carry out the project "Climate change mitigation through CCS and CCU technologies", the aim of which is to assess the suitability of different carbon capture technologies and develop scenarios for the implementation of these technologies in the Estonian oil shale industry.
5) Research and development program for the National Development Plan of the Energy Sector - Supporting the implementation of the energy economy development plan through research and development.

Table 9.1 Support for renewable and efficient CHP based electricity production

Level of subsidy	Conditions for receiving the subsidy
	Subsidies are paid for electricity that is produced:
0.0537 €/kWh	From renewable energy sources which do not exceed 100 MW
0.0537 €/kWh	From biomass in CHP mode. From 31.12.2010, 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 10MW

9.2.1.2. Heat supply

Heat supply, particularly district heating, is a sector with quite a large potential for increasing energy efficiency, which in turn will result in lower air pollutant emissions. The goals set in NECP 2030[38] are to use the full potential of CHP plants, promote the use of local fuels and to reduce the share of imported fuels in heat supply. It is expected, that the share of renewable energy in heat supply will be more than 60% and the share of imported fuels less than 30%.

Regarding biomass, a large amount of the primary energy arising from fuel wood (logs, chips, pellets and wood waste) is used in heat production. However, development is hindered by the large-scale exporting of biomass, due to which local energy producers in some cases do not have enough biomass resources. Exports result in elevated prices for some biomass products, especially wood pellets. The deployment of smaller-scale cogeneration CHP's as an element of decentralised energy production strategy would increase the security of energy supply in Estonia. A small heat load and the fact that new equipment producing only heat alone has already been installed in many areas with a favourable heat load can be indicated as hindrances to the development of combined heat and power production based on biomass.

As a rule, district heating is more environmentally benign as a heat supply option than local heating. Therefore, it is important that the District Heating Act[39] enables the zoning of district heating as an element of regional heat supply planning. The Act gives local governments the power to introduce the zoning of heat supply based on analyses, carried out for alternative heat supply options during the planning phase. The zoning of heat supply as an instrument of regulation of the energy sector gives municipalities the authority to avoid chaotic disconnection from district heating (DH) systems. The latter process had been taking place in some towns and cities for many years.

The main WEM measures that have an effect on air pollutant emissions in Heat supply sector are the following:

1) Development of the heat economy:

- Renovation of boilerhouses – This measure includes fuel switch from oil fuels to renewable and/or local energy sources like biomass, peat, etc.
- Renovation of heat networks – The aim of this measure is to reduce the losses in district heating networks.
- Transition of consumers to local and place heating – District heat networks that are operating inefficiently (the amount of MWh sold per meter of heat pipes is less than 1.2) will be restructured to local and place heating.

The main WAM measures that have an effect on air pollutant emissions in Heat supply sector are the following:

1) Additional development of the heat economy:

- Additional renovation of boilerhouses – This measure includes fuel switch from oil fuels to renewable and/or local energy sources like biomass, peat, etc.
- Additional renovation of heat networks – The aim of this measure is to reduce the losses in district heating networks.
- Additional transition of consumers to local and place heating – District heat networks that are operating inefficiently (the amount of MWh sold per meter of heat pipes is less than 1.2) will be restructured to local and place heating.

The additional savings in the WAM scenario are related to additional investments in the measures and therefore are projected to have greater effect on air pollutant emissions.

[39] Riigi Teataja. District heating act. [www] https://www.riigiteataja.ee/en/eli/520062017016/consolide (26.02.21)

9.2.1.3. Energy consumption – Manufacturing industries and construction

The Second National Energy Efficiency Action Plan of Estonia[40] (NEEAP2) declares that increasing the energy efficiency in Manufacturing industries is in Estonia mainly ensured by increasing environmental awareness and measures that are related to the wider energy policy, such as the opening up of the electricity market, the renewable energy charge, fuel and electricity excise duties and reduced differences in excise duty rates. For example, in the beginning of 2017 Ministry of Environment opened a measure for increasing industrial resource efficiency, of which the main objectives are gaining energy savings in small and medium sized companies. The actions supported are raising awareness, educating experts, conducting audits and making investments. Investment support is provided to five most important sectors: mining, food processing, wood, pulp, paper and non-metallic minerals industries. In 2017, a study is planned to be conducted to open investment to other sectors of manufacturing industries. According to the Energy Sector Organization Act[41], large companies are mandated to have regular energy audits.

9.2.1.4. Energy consumption – Other sectors (Commercial/institutional and residential sectors)

Measures taken into account in the Residential and Commercial/Institutional sector are mainly related to energy conservation through reconstruction of buildings. In Other sectors, the main measures having an effect on air pollutant emissions, that are already in place, include in the WEM scenario:

1) **Reconstruction of public and commercial buildings** – reconstruction of 20% of the existing buildings to energy efficiency class C by the year 2030.
2) **Reconstruction of private houses and apartment buildings** – reconstruction of 40% of existing private houses to energy efficiency class C or D and 50% of existing apartment buildings to energy efficiency class C by the year 2030.
3) **Street lighting reconstruction programme investments** – The aim of the programme is to increase the efficiency of the use of electricity in street lighting.
4) **Reconstruction of schools and kindergardens** – reconstruction of 40% of the existing schools and kindergardens by the year 2030.

A few additional measures are still under discussion or waiting additional funds and henceforth are reported as WAM. These measures include

1) **Additional reconstruction of public and commercial buildings** – reconstruction of additional existing buildings to energy efficiency class C by the year 2030.
2) **Additional reconstruction of private houses and apartment buildings** – According to the assumptions, an additional 10% of private houses and apartment buildings will be renovated by 2030.

The NIP measures that have a direct or indirect effect on air pollutant emissions in Energy consumption are the following:

1) **Implementation of the minimum requirements for nearly zero energy buildings** - The requirements will be implemented as required by the Energy Efficiency Directive and in the Government regulation "Minimum energy efficiency requirements".

[40] Ministry of Economic Affairs and Communications. The Second National Energy Efficiency Action Plan of Estonia. [www] https://www.buildup.eu/sites/default/files/content/EE%20-%20Energy%20Efficiency%20Action%20Plan%20EN.pdf (26.02.21)

[41] Riigi Teataja. Energy Sector Organization Act. [www] https://www.riigiteataja.ee/en/eli/ee/502092016001/consolide/current (26.02.21)

2) **Investments into energy saving of greenhouses and vegetable warehouses and dissemination of renewable energy** - The aim of the measure is to increase the share of renewable energy and energy savings in the horticultural sector through the introduction of modern technology.

The additional savings in the WAM scenario are related to additional investments in the measures and therefore are projected to have greater effect on air pollutant emissions.

9.2.1.5. Methodology

The scenarios projecting air pollutant emissions in the Energy sector are mostly based on the NECP 2030[38] scenarios, for which numerous studies from the *Estonian Energy Development Plan until 2030 (EEDP 2030+)*[42] were taken. In addition, some of the scenarios were updated by the input fron the Ministry of Economic Affairs and Communication, the Ministry of Environment and from the meeting points of the Government´s nvironment and Climate Commission.

The Balmorel[43] model was used for the electricity generation projections in the electricity generation sector. It is a model for analysing the electricity and combined heat and power sectors in an international perspective while minimising the total costs of the system. The Balmorel model combines the approach of bottom-up modelling in a classic technical modelling tradition with top-down economic analysis, projections and forecasts. The main assumption for the projection was that step-by-step, the use of oil shale shall decrease for the production of electricity and increase for the production of shale oil. The retort gas that occurs as a side product during the production of shale oil is used for electricity production. The projected future usage of fuel based on the model was applied while using the emission calculations of the EMEP/EEA 2019 Guidelines[44].

The projections for heat generation in the public heat and electricity generation sector are based primarily on the reconstruction rate of the NECP 2030[38] scenarios. The projections in the heat production are based on the studies done in the process of compiling EEDP 2030+[42]. The scenarios developed in the EEDP 2030+ were used in combination with the methodology of the EMEP/EEA 2019 Guidelines[44].

The projections of the AP emissions of shale oil production in the Manufacturing of solid fuels and other energy industries were calculated based on input from the industry. The amounts of oil shale used and the rate of construction of new shale oil production plants were used for the air pollutant projections.

The air pollutant projections in the Manufacturing industries and construction sector and in Other sectors are also based on historical trends, the future growth of Estonia´s GDP and the scenarios created in NECP 2030. The emissions are calculated based on the methodology of the EMEP/EEA 2019 Guidelines.

[42] Ministry of Economic Affairs and Communications. Estonian Energy Development Plan until 2030. [www] https://www.mkm.ee/sites/default/files/enmak_2030_koos_elamumajanduse_lisaga.pdf (26.02.21)

[43] Balmorel model. [www] http://www.balmorel.com/ (26.02.21)

[44] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (26.02.21)

9.2.1.6. AP emissions projections

The Energy sector 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; Transport; Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms sub-sectors) and Fugitive emissions from natural gas distribution.

The Energy sector's projected emissions in the WEM scenario are presented in Figure 9.1. In the WEM scenario, the NO_x emissions are projected to decrease by 46.9%, SO_2 by 50.8%, NMVOC by 24.4%, $PM_{2.5}$ by 25.8% and NH_3 by 50.5% from 2019 to 2050.

The main electricity producer in Estonia is Enefit Energiatootmine AS incl. the Eesti Power Plant and the Balti Power Plant. Both of these plants mainly use oil shale for electricity production. Due to the phasing out of oil shale pulverized combustion in these plants, the building of a more effective Auvere oil shale combustion plant, and the use of new shale oil production plants (fluidized bed combustion), air pollutant emissions are projected to decrease in the Energy industries sector.

Air pollutant emissions in the Manufacturing and construction sector (divided into iron and steel; non-ferrous metals; chemicals; pulp, paper and print; food processing, beverages and tobacco; non-metallic minerals; and other industries) are projected to increase. In this sector, only one scenario (WEM=WAM) is projected, as there are no additional planned policies or measures.

The emissions from the Transport sector are projected to decrease, mainly due to the uptake of alternative fuel vehicles (biomethane and electricity).

The emissions in Other sectors (Commercial/institutional, Residential and Agriculture/Forestry/Fishing/Fish farms) are expected to decrease.

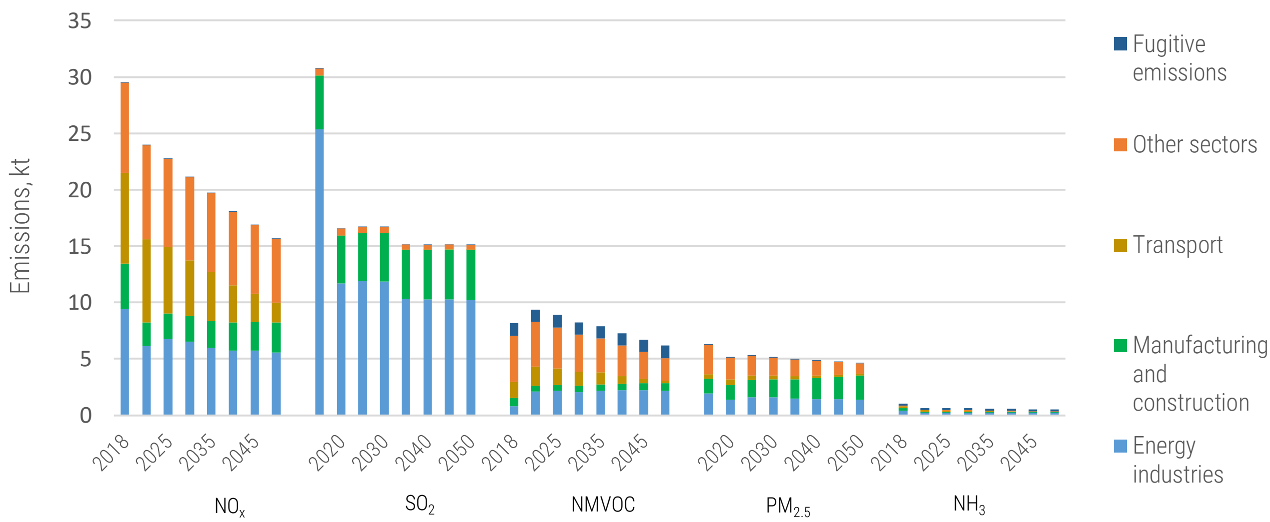

Figure 9.1 The amount of landfilled solid waste in the period of 1990-2019 (kt)

Total projected WEM scenario air pollutant emissions from Energy sector, kt

The projected emissions of the Energy sector in the WAM scenario are presented in Figure 9.2. In the WAM scenario, the NO_x emissions are projected to decrease by 50.6%, SO_2 by 51.7%, NMVOC by 27.0%, $PM_{2.5}$ by 28.2% and NH_3 by 50.7% from 2019 to 2050.

The increased reduction of air pollutant emissions in the WAM scenario results from higher energy efficiency requirements for buildings (entails additional funding for renovation purposes) and district heating networks, which help to decrease energy consumption for heat production. Decreased air pollutant emissions also result from an increased amount of energy unions that help to produce energy more efficiently for certain locations or interest groups.

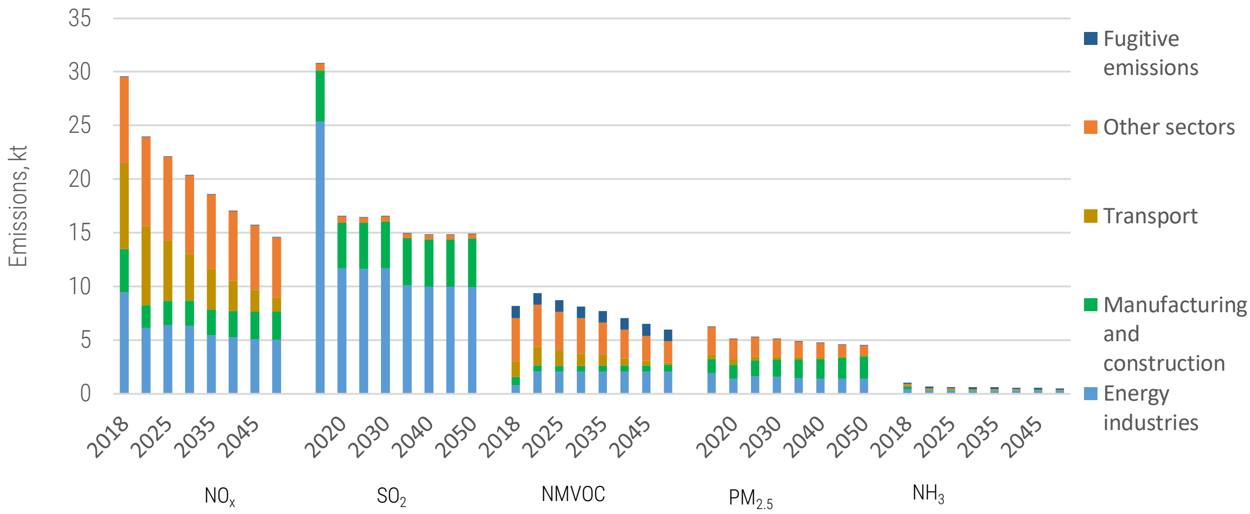

Figure 9.2 Total projected WAM scenario air pollutant emissions from Energy sector, kt

9.2.2. Transport

9.2.2.1. Methodology

The Estonian Parliament approved the Transport Development Plan 2014–2020[45] in February 2014. The development plan sets forth the following relating to climate policy:

- Decreasing the use of vehicles in towns by improving the conditions for walking, cycling and using public transport and use smart solutions to offer various new services, particularly short-term bicycle and car rent.
- Increasing the number of departures and speed of connection for train traffic for trains to become the most favoured means of transport that connects Tallinn and other towns; improving the train connection with Latvia (on Tartu–Riga line, Rail Baltic) and Russia (the trip to St Petersburg should be shorter than 5 hours).
- Increasing the share of more economic vehicles that run on renewable energy so that biomethane or compressed gas generated from domestic bio mass and waste would become the main alternative type of fuel in Estonia.

Reducing air pollutant emissions in the Transport sector is one of the key questions for Estonia in meeting the NEC targets in the future as the energy consumption has been growing in the same trend as the gross domestic product (GDP). The main goals for the measures implemented or planned in the Transport sector are directed at increasing the efficiency of vehicles and reducing

[45] Ministry of Economic Affairs and Communications. Transport development plan 2014-2020. [www] https://www.mkm.ee/sites/default/files/transpordi_arengukava.pdf (26.02.21)

the demand in domestic transport.

In the transport sector, the main WEM measures having an effect on air pollutant emissions, that are already in place, include:

1) Increasing the share of biofuels in transport sector – The main target of this measure is to achieve the 10% share of biofuels in transport sector by 2030.

2) Increasing of fuel economy in transport – Includes developing support system for energy efficient cars and also support the use of hybrid buses, hybrid trolleys, electrical buses etc.

3) Promotion of economical driving – This measure includes promoting the eco-driving.

4) Spatial and land-use measures for urban transport energy savings to increase and improve the efficiency of the transport system:

   a. Improvement of the traffic system - This measure includes updating the parking policies in cities, planning the land use to reduce the use of private cars, restructuring the streets in cities, etc.

   b. Reduction of forced movements with personal vehicles in transport - This measure includes developing telecommunication and also developing short-term rental cars systems.

   c. Development of the of convenient and modern public transport, development of ticket systems and new services – Includes improving the availability of public transport, developing ticket systems and new services.

5) Road usage fees for heavy duty vehicles – This measure includes a system of road usage fees for heavy duty vehicles. The system is based on time.

6) Electric car purchase support – Support for the purchase of electric cars is targeted at companies and individuals with high transport needs.

7) Promotion of clean and energy efficient road transport vehicles in public procurement – The government must implement the system provided in the Clean Vehicles Directive within 24 months, i.e. from August 2021.

8) Developing the railroad infrastructure (includes the building of Rail Baltic) – This measure includes building Rail Baltic, additional stops and raisin speed limits.

Following measures are still in discussion and henceforth are reported as planned in the WAM scenario:

1) Additional promoting economical driving – This measure includes additional implementation of the measure "Promotion of economical driving", which means a public campaign to raise awareness.

2) Additional spatial and land-use measures for urban transport energy savings to increase and improve the efficiency of the transport system - To ensure safety in cities, the construction of main networks of bicycle paths that serve the main connections within Tallinn between the city center and districts, as well as sustainable mobility in other major cities.

3) Road usage fees for heavy duty vehicles – The system is based on mileage.

4) Heavy duty tyres and aerodynamics - The measure introduces better rolling resistance tyres and improves the aerodynamics of vehicles. The training materials for truck drivers will be complemented to highlight the importance of checking tyres and tyre pressures.

5) Ferry traffic electrification - Includes the eletrification of the ferry traffic between the continent and the islands.

The NIP measures that have a direct effect on air pollutant emissions in the Transport, and might be added as an additional measure in the future, are the following:

1) Pilot project for hydrogen - A project covering the entire hydrogen use chain, i.e. from

production, transport, storage to consumption in public transport (eg by hydrogen bus).

2) **Passenger car registration and annual tax** - Passenger car registration and annual tax based on location, environmental aspects, etc.

3) **Developing and implementing a congestion charge system in cities** – The main target is to reduce traffic in the center of the cities.

The projections in the Transport sector are based on the information from the ITF report "*The Future of Passenger Mobility and Goods*"[46], Ministry of Economic Affairs and Communication, the Ministry of Environment and from the meeting points of the Government´s Environment and Climate Commission. As well as emission factor data from EMEP/EEA 2019[44] Guidelines along with country-specific emission factors were used to estimate air pollutant emissions.

The projections for the scenarios are also in line with Regulation (EC) No 443/2009 of the European Parliament and of the Council of 2021[47]. By year, the average emissions target for a new passenger car is 95 gCO_2/km and 147 gCO_2/km for light duty vehicles.

9.2.2.2. AP emissions projections

The main share of air pollutant emissions in the Transport sector originate from road transport.

The Transport sector's projected emissions in the WEM scenario are presented in Figure 9.3. In the WEM scenario, the NO_x emissions are projected to decrease by 77.8%, NMVOC by 84.7%, $PM_{2.5}$ by 50.6%, NH_3 by 95.4% and SO_2 by 2.4% from 2019 to 2050.

[46] International Transport Forum. The Future of Passenger Mobility and Goods Transport in Estonia. [www] https://www.itf-oecd.org/future-passenger-mobility-and-goods-transport-estonia (26.02.21)

[47] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011. [www] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32019R0631 (26.02.21)

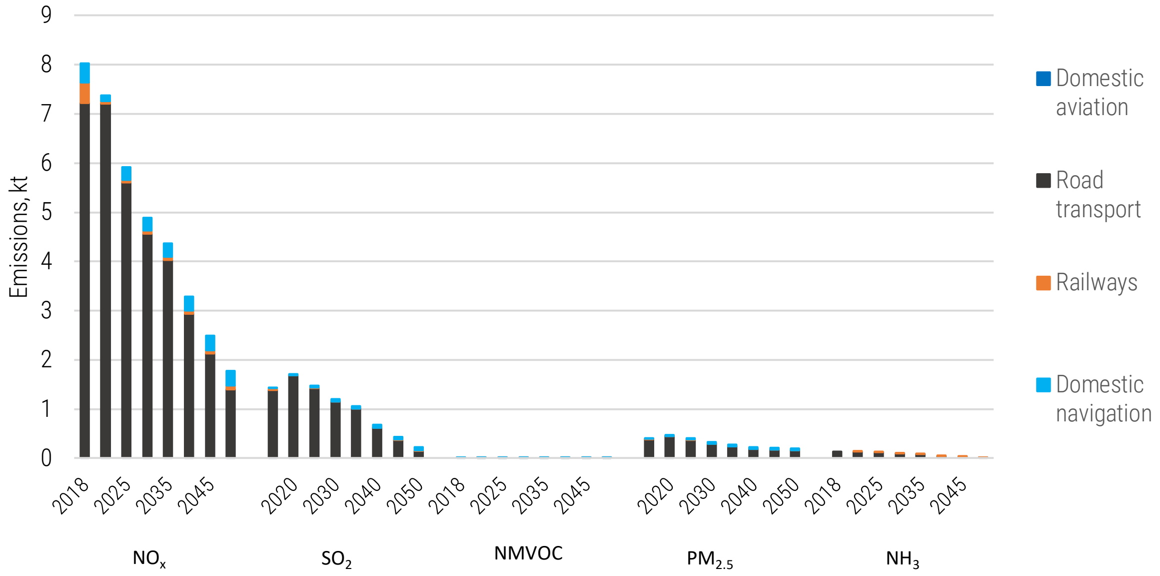

Figure 9.3 Total projected WEM scenario air pollutant emissions from Transport sector, kt

The emissions in the Transport sector in the WAM scenario are expected to decrease even more in 2050 compared to 2018. Domestic aviation and the Railways emissions are expected to stay approximately at the same level (as in the WEM scenario) during the period of 2018–2050. Domestic navigation and Road transportation emissions are projected to decrease compared to the base year. The largest emission reductions occur in Road transportation sector.

The Transport sector's projected emissions in the WAM scenario are presented in Figure 9.4. In the WAM scenario, the NO_x emissions are projected to decrease by 84.1%, NMVOC by 88.1%, $PM_{2.5}$ by 79.4%, NH_3 by 96.8% and SO_2 by 58.6% from 2019 to 2050.

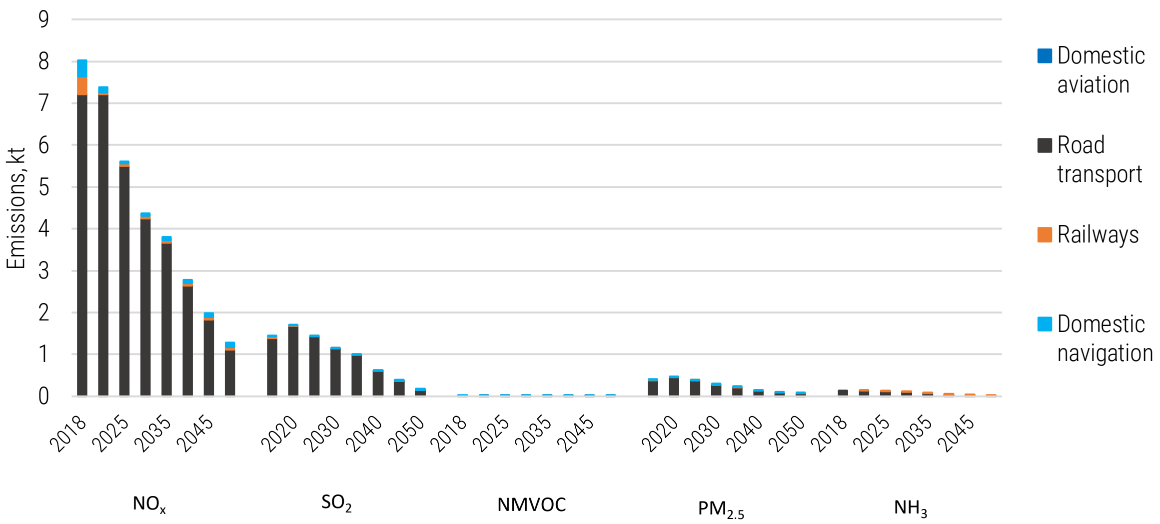

Figure 9.4 Total projected WAM scenario air pollutant emissions from Transport sector, kt

9.2.3. Industrial processes

9.2.3.1. Methodology

The following emission sources are reflected in the Industrial processes sector:

- 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 2018 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 2018, the Industrial processes sector (without Solvent use) constituted 0.2% of NO_x emissions, 4.3 % of $PM_{2.5}$ emissions, 3.8 % of NMVOC emissions, and 0.9% of NH_3 emissions in Estonia. The proportion of sulphur dioxide is marginal.

The air pollutant emissions' projections in the Industrial processes sector are based on historical emission trends, coupled with projections of Estonia´s GDP[48] and population[49]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2019 Guidelines[50]. 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[51] (IEA), which sets requirements for large combustion plants, waste incineration plants and co-incineration plants, titanium dioxide plants and organic solvent plants. The requirements of the IEA include emission limit values, monitoring and emission reduction measures through the implementation of best available Technologies (BATs), which will move towards an environmental impact and lower emissions in the industrial process.

Given that the industrial processes sector is governed by the IEA, and according to current reference documents for BATs (BREFs) all production plants have to comply with BATs as they operate, no new policy guidelines for achieving the atmospheric pollutant targets and leading to significant changes in production demand or concerning the BATs are expected to be adopted in the industrial processes sector. Therefore there is only WEM scenario for emissions from industrial processes sector (WEM=WAM).

[48] Long-term GDP projection of the Ministry of Finance of Estonia [www] https://www.rahandusministeerium.ee/et/riigieelarve-ja-majandus/majandusprognoosid (26.02.21)

[49] Statistics Estonia, RV086: Population Projection Until 2080 by Sex and Age (based on the population figure as at 1 January 2019) [www] https://andmed.stat.ee/et/stat/rahvastik__rahvastikunaitajad-ja-koosseis__rahvaarv-ja-rahvastiku-koosseis/RV086 (26.02.21)

[50] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (26.02.21)

[51] *Riigi Teataja*, Industrial Emissions Act (RT I, 16.05.2013, 1) [www] https://www.riigiteataja.ee/en/eli/508122020005/consolide (26.02.21)

9.2.3.2. AP emissions projections

Emissions in the years 2018–2050 according to WEM scenario are depicted in the Figure 9.5.

SO_2 emissions are marginal as the majority of these emissions come from burning fuels. SO_2 emissions in a magnitude 0.0001 kt yearly come from each of the following subsectors: Pulp and paper industry (2.H.1), Quarrying and mining of minerals other than coal (2.A.5.a), Other metal production (2.C.7.c) and Other production, consumption, storage, transportation or handling of bulk products (2.L) in 2018–2050.

NO_x emissions are at a low level until 2024 when ammonia industry plans to restore its production. Then these emissions are projected to more than double and stay at this level until 2050.

Approximately half 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 Iron and steel production (2.C.1), 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 55% until 2050.

NMVOC emissions arise largely from Food and Beverages industry. Production of foodstuffs is in correlation with GDP growth and the emissions are projected to rise *ca* 22% until 2050.

NH_3 emissions arise from Other metal production (2.C.7.c) and also from Ammonia production. In 2024 when the ammonia industry restarts production the emissions could be doubling. The forecast for 2050 is *ca* 4% lower than as in 2025 whereby the ammonia industry plans to decrease emissions, and emissions from Other metal production are projected to rise in correlation with GDP growth

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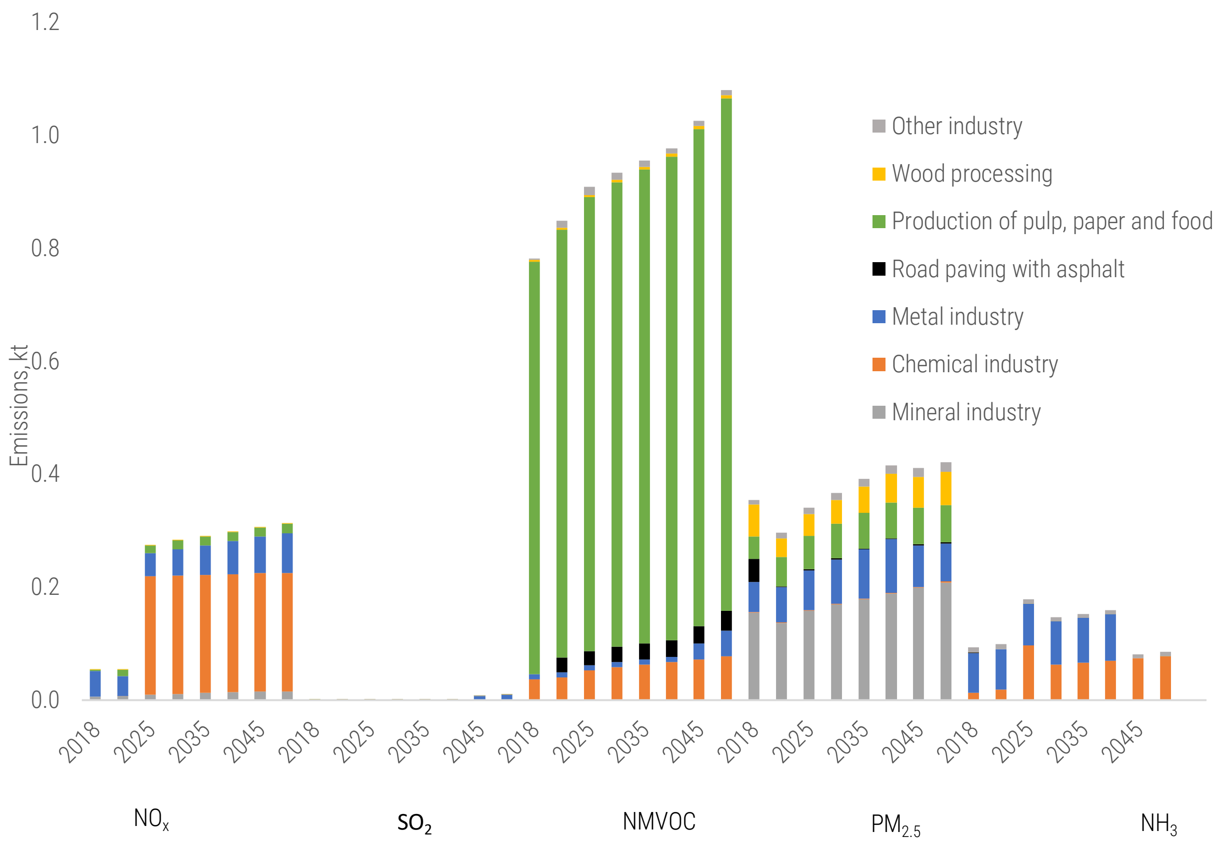

Figure 9.5 NO_x, SO_2, NMVOC, $PM_{2.5}$ nd NH_3 emissions from Industrial processes (including road paving with asphalt) in 2018–2050, kt

9.2.4. Solvents

9.2.4.1. Methodology

The emissions reported in the sector of Solvents include in particular those of NMVOC, which accounted for nearly 36.6% of national emissions in 2018, as well as, to a limited extent, the emissions of $PM_{2.5}$ (1.1% of national emissions), NO_x, SO_2 and NH_3 and originating from the following activities:

- use of solvents in households;
- use of paints;
- surface cleaning;
- dry cleaning;
- production and processing of chemical products;
- printing;
- other use of solvents;
- use of other products.

Emissions of pollutants from diffuse sources are calculated on the basis of the raw data of Statistics Estonia and Eurostat, historical emission trends, coupled with projections of Estonia´s GDP[52] and population[53]. The projections are calculated by category, based on the methodology and emission factors of the EMEP/EEA 2019 Guidelines[54].

Ca 80% 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)[55] and Directive 2004/42/CE[56] on paints on limitation of VOCs in paints. Concerning Domestic solvent use (2.D.3.a) following regulations have an effect on reduction of NMVOCs in products: Regulation (EC) No 648/2004[57] on detergents (requirements on biodegradability, and ingredient lists), Regulation (EC) No 1223/2009[58] on cosmetic products (requirement of safety assessment and bans of certain hazardous components) and Regulation (EU) No 528/2012[59] concerning the making available on the market and use of biocidal products (imposing bans of certain hazardous components).

The paints directive has set limits until the year 2010 and other beforementioned regulations do not impose further restrictions. In the future decreases of emission factors may demand further legislative measures. The European

[52] Long-term GDP projection of the Ministry of Finance of Estonia [www] https://www.rahandusministeerium.ee/et/riigieelarve-ja-majandus/majandusprognoosid (26.02.21)

[53] Statistics Estonia, RV086: Population Projection Until 2080 by Sex and Age (based on the population figure as at 1 January 2019) [www] https://andmed.stat.ee/et/stat/rahvastik__rahvastikunaitajad-ja-koosseis__rahvaarv-ja-rahvastiku-koosseis/RV086 (26.02.21)

[54] EMEP/EEA air pollutant emission inventory guidebook 2019. [www] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 (26.02.21)

[55] 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)

[56] Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0042 (26.02.21)

[57] 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 (26.02.21)

[58] Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products [www] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32009R1223 (26.02.21)

[59] Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0528

Commission published a chemicals strategy for sustainability on 14 October 2020[60]. 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 scenario for emissions from Solvents sector (WEM=WAM).

9.2.4.2. AP emissions projections

Emissions in the years 2018–2050 according WEM scenario are depicted in the Figure 9.6.

NMVOC emissions from Solvent and other product use are projected to decrease until 2030 and stay at the same level after that. This decrease is obtained because emission factors are projected to decrease until 2050. The consumption of many solvent containing products on the other hand is growing as GDP is growing. In 2030, 2040 and 2050 the NMVOC emissions are projected to be 10.0% smaller than in 2018.In Degreasing (2.D.3.e) and Printing (2.D.3.h) subcategories emissions are only slightly rising until 2030 because the effect of Industrial Emissions Directive Directive 2010/75/EU[61] is curbing emission factors. After 2030 the emissions are projected to stay the same

In the subcategory Other solvent use (2.D.3.i) most of the NMVOCs come from Application of glues and adhesives (SNAP 060405). This field of use is affected both from population as well from GDP growth. As population is declining but GDP growing, the emissions from this subcategory grow only a little until 2030. After 2030 the emissions are projected to stay the same. Industrial Emissions Directive Directive 2010/75/EU is curbing the emission factors.

NMVOC emissions from Dry cleaning are decreasing twofold until 2050 because of downward trend since 2005.

Another activity with small NMVOC emissions in comparison to other activities is Other Product use 2.G (mainly use of tobacco and fireworks). These emissions do not correlate with GDP growth very well so they are projected to stay pretty much at the 2018 year´s level.

Concerning to other air pollutants their only noteworthy source is subcategory Other Product use 2.G (mainly use of tobacco and fireworks). The emissions of these pollutants probably stay at the same level because GDP growth does not seem to have a large effect on them.

[60] 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 (26.02.21)

[61] 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 (26.02.21)

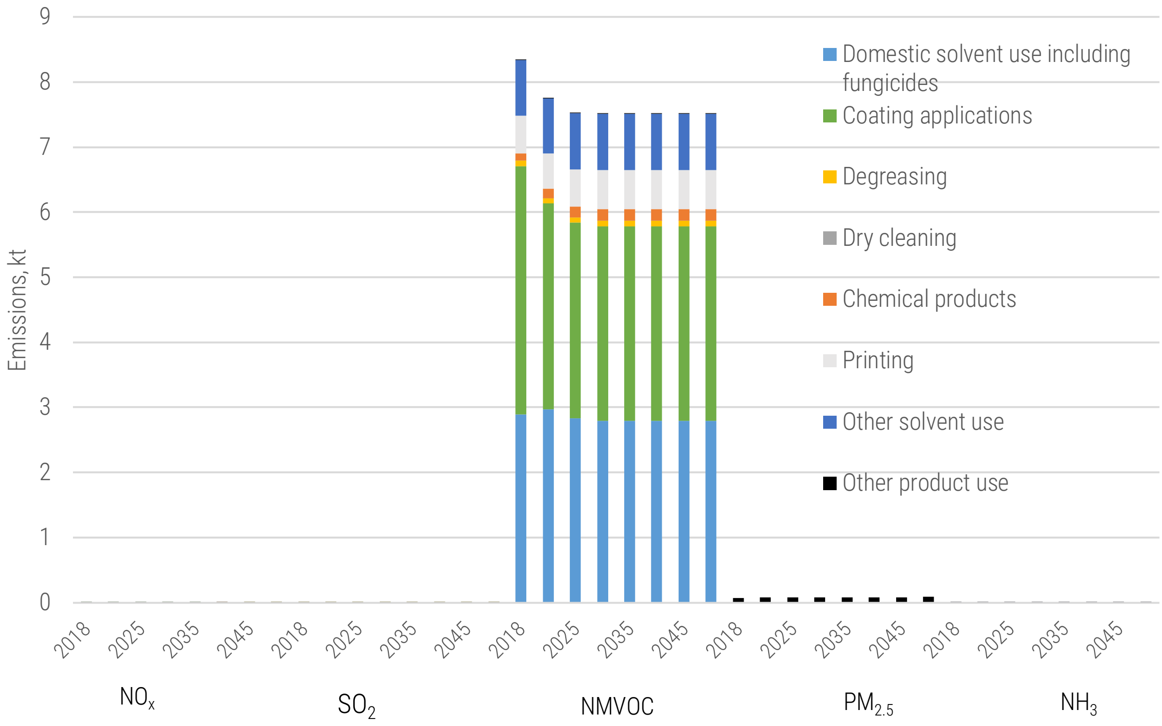

Figure 9.6 Projected AP emissions from Solvent and other product use (excluding road paving with asphalt) in 2018–2050, kt

9.2.5. Agriculture

9.2.5.1. Methodology

The development of the agriculture sector and the implementation of various targeted measures is mostly governed by the Estonian rural development plan 2014–2020 (ERDP)[62], the agriculture and fisheries development plan until 2030 (AFDP)[63], which is being prepared, climate change adaption development plan until 2030[64] and the general principles of climate policy until 2050 (GPCP 2050)[65]. The measures of ERDP are extended until the year 2022 due to the time-consuming process of developing post-2020 Common Agricultural Policy (CAP).

One of the ERDP priority area has been reducing GHG and ammonia emissions from the agricultural sector. Its objectives include promoting the use of biomass, producing renewable energy, investing in livestock buildings (incl. manure storage) and increasing the technological capacity of agricultural enterprises.

Emissions from Agriculture sector are projected with WEM and WAM scenarios. The existing measures that have the same impact on WEM and WAM scenarios as their impact can not be assessed are the following.

62 Estonian Rural Development Plan 2014–2020. [www] https://www.agri.ee/et/eesmargid-tegevused/eesti-maaelu-arengukava-mak-2014-2020 (26.02.21).
63 Agriculture and Fisheries Development Plan until 2030. [www] https://www.agri.ee/et/pollumajanduse-ja-kalanduse-valdkonna-arengukava-aastani-2030 (26.02.21).
64 Climate Change Adaption Development Plan until 2030 [www] https://www.envir.ee/sites/default/files/national_adaptation_strategy.pdf (26.02.21).
65 General Principles of Climate Policy until 2050 [www] https://www.envir.ee/en/news-goals-activities/climate/general-principles-climate-policy (26.02.21).

- Payment for agricultural practices beneficial for the climate and the environment (Regulation (EU) No 1307/2013; Commission Delegated Regulation (EU) No 639/2014)[66];
- Agri-environment-climate measures (including seven sub-measures); the measure consists of the following sub-measures: Support for environmentally friendly management, Regional water protection support, Regional soil protection support, Support for environment-friendly horticulture, Support for growing local plant varieties, Support for keeping animals of endangered breeds, Support for maintaining semi-natural habitats (ERDP[62], extended);
- Knowledge transfer and awareness (ERDP[62], extended);
- Advisory services, farm management and farm relief services (ERDP[62], extended);
- Investments into improved performance of agricultural holdings (ERDP[62], extended);
- Investments into diversification of non-agricultural economic activity in rural regions (ERDP[62], extended);
- Organic production (ERDP[62], extended);
- Natura 2000 support for agricultural land (ERDP[62], extended);
- Animal welfare support (ERDP[62], extended);
- Securing protection of habitats (Estonian Nature Conservation Development Plan until 2020[67], extended).

The planned measures which future impact can not be assessed are the following.

- Studies and pilot projects (Government Environment and Climate Commission);
- Audits in large agricultural holdings (Analysis of possibilities raising Estonia´s climate ambition[68], Government Environment and Climate Commission);
- Support for site-specific fertilization equipment (Analysis of possibilities raising Estonia´s climate ambition[68], Government Environment and Climate Commission);
- Producing bioenergy and increasing its share in the agriculture (Analysis of possibilities raising Estonia´s climate ambition[68], Government Environment and Climate Commission);
- Neutralization of acid soils (Analysis of possibilities raising Estonia´s climate ambition[68], Government Environment and Climate Commission).

The planned measure which impact has been accounted in WAM scenario calculations is the following.

- Improvement of manure management. Firstly, according to WAM scenario, the use of low-emission manure storage technologies (storage of liquid manure in tented roof or concrete roof storage facilities as well as in closed steel or plastic tanks) will increase by 2030 compared to today. The second component that influences WAM scenario emission calculations compared to WEM scenario is projected increased use of low-emission manure spreading technologies (e.g. injection of liquid manure) (Analysis of possibilities raising Estonia´s climate ambition[68], Government Environment and Climate Commission).

The third component – an assumption that has been projected into future and used in WAM calculations differently from WEM calculations is limiting of ammonia emissions from the use of mineral fertilisers by enhancing the share of rapid introduction of the fertilisers into the soil. This

[66] Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009; Commission Delegated Regulation (EU) No 639/2014 of 11 March 2014 supplementing Regulation (EU) No 1307/2013 of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and amending Annex X to that Regulation. [www] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R1307; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014R0639 (26.02.21).

[67] Estonian Nature Conservation Development Plan until 2020. [www] https://www.envir.ee/sites/default/files/lak_lop_0.pdf (26.02.21).

[68] SEI Tallinn. Analysis of possibilities raising Estonia´s climate ambition. [www] https://www.sei.org/wp-content/uploads/2019/10/kliimaambitsiooni-anal%C3%BC%C3%BCs.pdf (26.02.21).

may be related to the measure Support for site-specific fertilization equipment.

The Tier 1 and Tier 2 methods of the EMEP/EEA Guidebook 2019[69] have been used in the projections concerning atmospheric pollutants. Tier 3 method is used for calculating NH3 emissions from cattle and swine manure management, manure applied to soils and for finding emissions from urine and dung deposited by grazing animals by dairy- and non-dairy cattle and swine categories. These calculations show in WAM scenario the impact of the measure Improvement of manure management. In agricultutral soils category the NH3 emissions from the application of synthetic N-fertilizers are also calculated with Tier 3 method as it uses in WAM scenario calculations the assumption of enhancing the share of rapid introduction of the fertilisers into the soil. The calculations are based on the 2020 and 2021 inventories of atmospheric pollutants.

The projected numbers of animals have been mostly received from the expert judgements of the officials of the Ministry of Rural Affairs. Also, projected amounts of mineral fertilizers used have been received from the Ministry of Rural Affairs. The use of synthetic fertilizers in Estonia is projected to increase until 2025 compared to 2018 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 population of fur animals is expected to stay at the last three years average level. The number of pigs is anticipated to rise distinctly at nearly the antecedent level of the outbreak of African swine fever of 2014 by 2035 and will remain at the same level by 2050. The number of poultry production is expected to stay near today´s level. Average milk yield per cow should increase until 2025 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.

9.2.5.2. AP emissions projections

AP projections were made using both, WEM (Figure 9.7) and WAM (Figure 9.8) scenarios. The difference in the results of the two scenarios was due to the projected changes in the shares of covers of the manure stores, in manure and synthetic N-fertilizers applying methods. Thus, NH_3 emissions from Manure management and Agricultural soils were reduced in WAM scenario compared to WEM scenario. According to the WEM scenario NH_3 emissions in Agriculture sector are projected to increase 14%, i.e. from 9.23 kt to 10.49 kt between 2018 and 2050. In Manure management sub-sector an increase of NH_3 emissions will be from 4.79 kt in 2018 to 5.57 kt by 2050 (16%) and from Agricultural soils from 4.44 kt in 2018 to 4.92 kt (11%) by 2050. According to the WAM scenario NH_3 emissions are projected to decrease 24%, i.e. from 9.23 kt to 9.07 kt between 2018 and 2050. In Manure management sub-sector an increase of NH_3 emissions will be from 4.79 kt in 2018 to 4.91 kt by 2050 (3%) and from Agricultural soils decrease from 4.44 kt in 2018 to 4.16 kt (6%) by 2050. $PM_{2.5}$ emissions are projected to increase from 0.11 kt in 2018 to 0.12 kt by 2050 (8%) in Agriculture sector according to WAM and WEM scenarios. NMVOC emissions are projected to increase from 4.91 kt in 2018 to 4.97 kt by 2050 (1%) in Agriculture sector according to WAM and WEM scenarios. Projections of emissions from the Agriculture sector include NO_x emissions only from the Manure management category, as the reporting of NO_x emissions' projections from from activities falling under the 2014 Nomenclature for

[69] 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).

Reporting (NFR) as provided by the LRTAP Convention categories 3B (Manure management) and 3D (Agricultural soils) are not accounted for the purpose of NEC compliance[70]. NO_x emissions are projected to increase from 0.03 kt to 0.04 kt (23%) between 2018 and 2050 in Manure management sub-sector according to WAM and WEM scenarios.

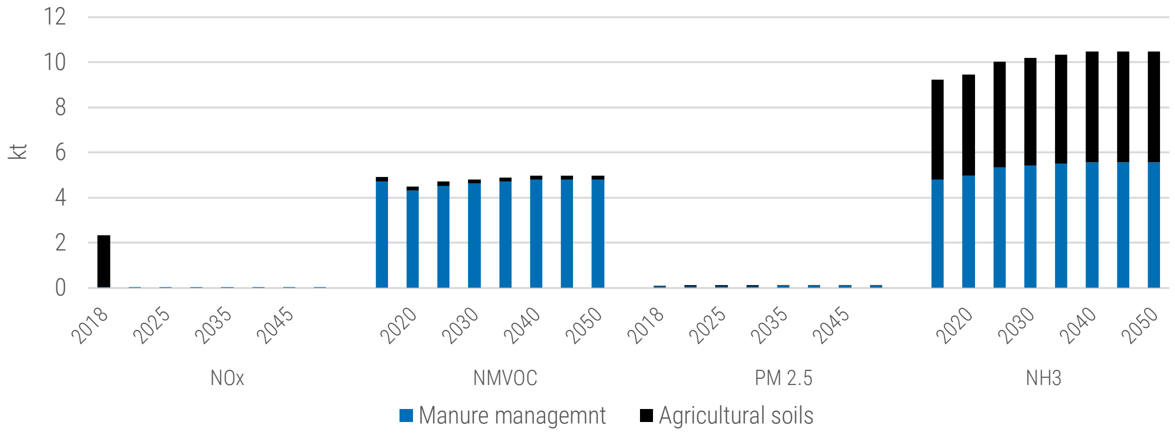

Figure 9.7 AP emissions from Agriculture sector according to WEM scenario (without NO_x emissions' projections from Agricultural soils), kt

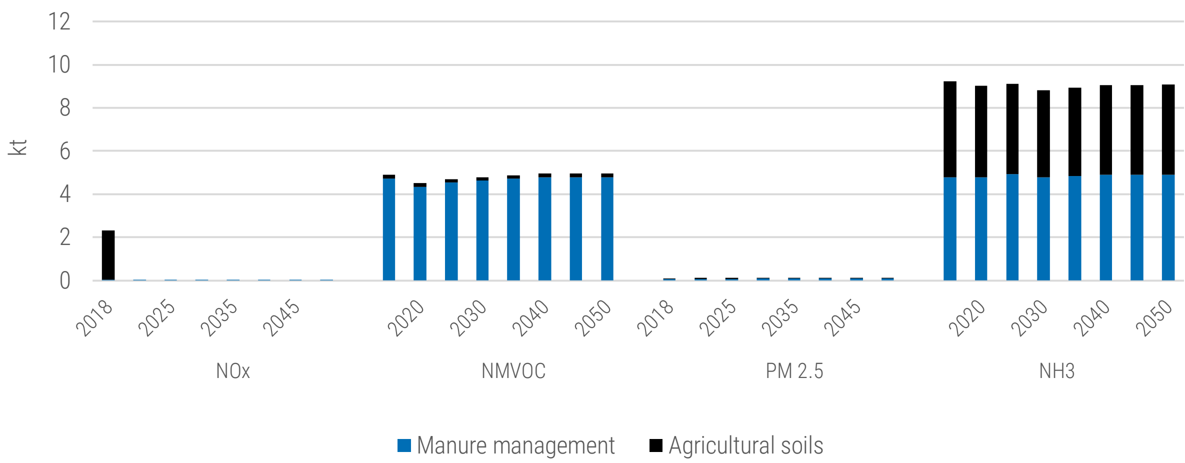

Figure 9.8 AP emissions from Agriculture sector according to WAM scenario (without NO_x emissions' projections from Agricultural soils), kt

[70] 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)

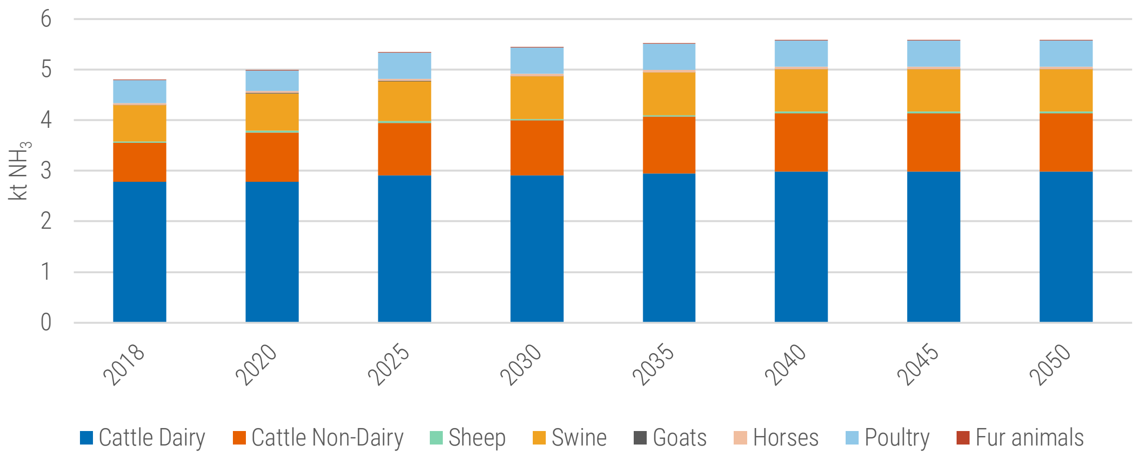

Figure 9.9 NH_3 emissions from Manure management subcategories according to WEM scenario, kt

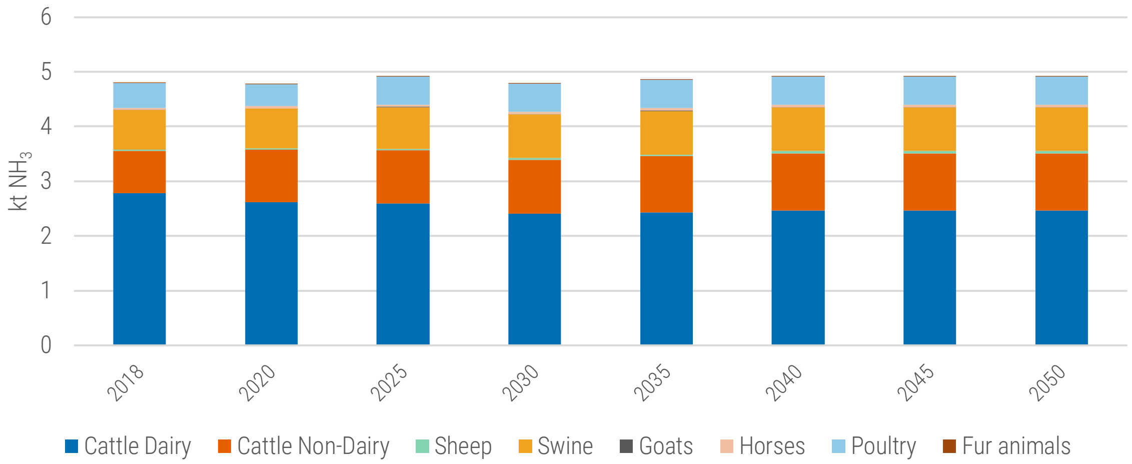

Figure 9.10 NH_3 emissions from Manure management subcategories according to WAM scenario, kt

9.2.6. Waste

9.2.6.1. Methodology

General waste related requirements and rules are stipulated under *Waste Act* (RT I, 10.12.2020, 7)[71] according to which all landfills had to meet the EU established requirements by 16 July 2009 and had to be conditioned in accordance with the requirements no later than 31 December 2015. *Waste Act* includes measures covering prohibition concerning percentage of biodegradable waste deposited and increasing reusing and recycling of waste materials.

Establishment of waste management rules incl. adoption and updating the waste management plan is stipulated under the *Local Government Organization Act* (RT I, 10.07.2020, 97) and is the responsibility of the local government. Most of local government waste management plans also

[71]Waste Act (RT I, 10.12.2020, 7) [www] https://www.riigiteataja.ee/en/eli/521122020002/consolide (26.02.21)

stipulate prohibition of open burning of municipal solid waste (MSW).

The *National Environmental Strategy until 2030*[72] includes a policy of reducing landfilling waste by 2030 (by 30%) and the hazard of waste is reduced significantly. Reaching the target is supported by measures that are included in the *Estonian Waste Management Plan 2014–2020 (NWMP)*[73].

Air pollutant emissions in Waste sector are mostly based on the *NWMP*. Estonia is currently in the process of updating its *NWMP*, therefore the *NWMP 2014-2020* is valid until a new Waste Management Plan is adopted. *The NWMP* comprises following measures that contribute to emission reduction:

- Limiting the percentage of biodegradable waste going to landfill and increasing the reuse and recycling of waste materials – Focus of the measure is to increasing the volume of recyclable municipal waste, including reducing the share of biodegradable waste, and developing a nationwide waste collection network with a more efficient reporting information system.
- Promoting the prevention and reduction of waste generated, including reducing the hazard of waste – 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.
- Reducing environmental risks arising from waste, improvement of monitoring and supervision – 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.

Since there are no additional measures intended in Waste sector then the WAM scenario emissions are equal to the WEM scenario.

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 NWMP measures and activity data growth in line with the appropriate basic indicators e.g. population and GDP.

[72] National Environmental Strategy until 2030 [www] https://www.envir.ee/sites/default/files/elfinder/article_files/ks_loplil_riigikokku_pdf.pdf (26.02.21)
[73] Estonian Waste Management Plan 2014–2020 (NWMP) [www] https://www.envir.ee/sites/default/files/riigi_jaatmekava_2014-2020.pdf (26.02.21)

9.2.6.2. AP emissions projections

Waste sector is not Estonia´s major source of emissions and WEM scenario emissions equal to WAM scenari emissions (Figure 9.11).

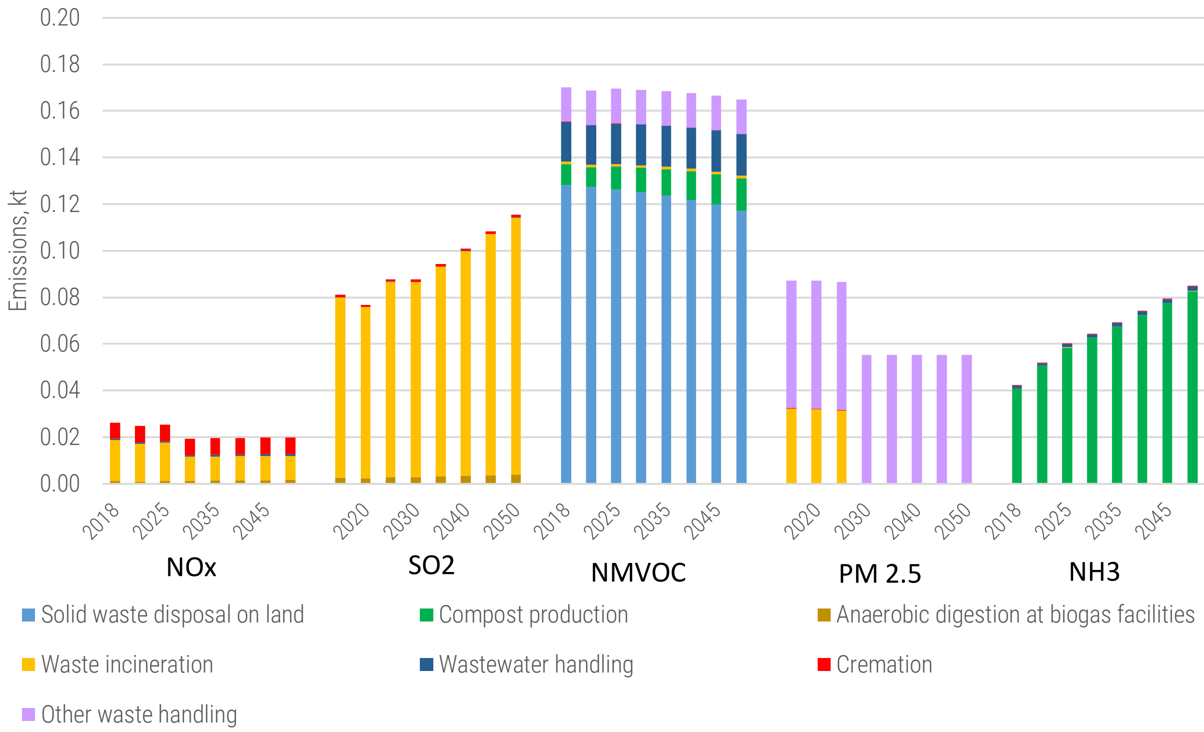

Figure 9.11 WEM = WAM emission projections in Waste sector, kt

NO_x emission projections is driven by industrial waste incineration category which is connected with GDP rise. Emission decrease in 2030 is connected with the assumptions that no open burning of MSW will take place after 2030.

SO_2 emission projections is driven by industrial waste incineration subcategory which is connected with GDP rise.

NMVOC emission projections are driven by solid waste disposal and domestic wastewater handling categories. Solid waste disposal emissions are in decreasing trend thanks to the implemented waste reduction measures.Projections in wastewater, compost and other waste handling categories are relatively stable.

$PM_{2.5}$ emission projections are driven by other waste handling and open burning of waste categories. Open burning of waste emissions are in decreasing trend thanks to the implemented waste reduction measures. Open burning of waste will stop after 2030. Other waste handling is projected to remain at the same level.

NH_3 emission projections is driven by compost category wihich is in increasing trend due to the increase of composting biodegradable waste.

9.3. Total projected AP emissions

Estonia's total projected AP emissions in the WEM and WAM scenario (excluding voluntary projections of NO_x emissions in the Agriculture sector) are presented in Figure 9.1 The overall main driver for decreasing AP projections is Energy industries subsector, due to the phasing out of oil shale pulverized combustion and using more renewable energy (wind and sun) by electricity producers. For NH_3, the main driver is Agriculture sector and increasing number on livestock (additional clarification are provided under each sectoral subchapters),

- NO_x – in 2018–2050, emissions are projected to decrease by 50% in WEM scenario and 53% in WAM scenario. This estimate takes into account emissions from Agriculture sector in 2018, but in projections does not account voluntary reporting of NO_x emissions from Agriculture sector.
- NMVOC – in 2018–2050, emissions are projected to decrease by 11% in WEM scenario and 12% in WAM scenario. This estimate takes into account NMVOC emissions form Agriculture sector both in 2018 and in projections.
- SO_2 – in 2018–2050, emissions are projected to decrease by 51% in WEM scenario and 51% in WAM scenario.
- NH_3 – in 2018–2050, emissions are projected to increase by 8% in WEM scenario and decrease by 6% in WAM scenario.
- $PM_{2.5}$ – in 2018–2050, emissions are projected to decrease by 22% in WEM scenario and 24% in WAM scenario.

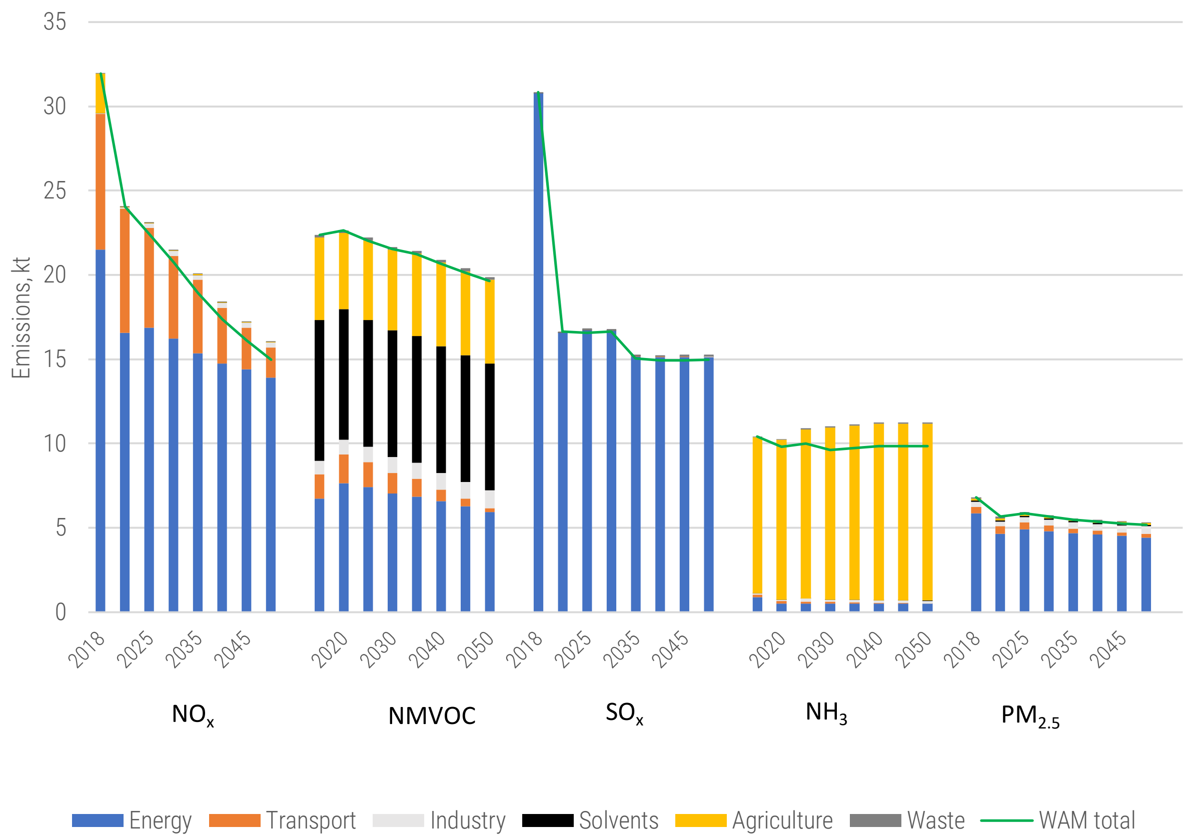

Figure 9.12 Sectoral WEM and total WAM scenario air pollutant emissions (excluding NO_x emissions projections from Agriculture sector) 2018–2050, kt

9.4. Explanations of circumstances justifying emissions that are temporarily higher than the ceilings established for it for one or more pollutants (after 2010)

The NEC Directive[74], which is part of the European Clean Air Policy Package, provides for the commitments of all Member States to reduce atmospheric pollutant emissions by 2020 and 2030 compared to 2005 (Figure 9.2).

Estonia's total projected NEC compliant AP emissions (i.e excluding NO_x and NMVOC emissions from Agriculture sector) and % change compared to 2005 according to projections in the WEM scenario are presented in Figure 9.2, in the WAM scenario in Figure 9.3, and projections in the WEM and WAM scenario compared to NEC Directive commitments in Figure 9.13.

Table 9.2. Commitments to reduce emissions of certain atmospheric pollutants established by the NEC Directive for Estonia and % change compared to 2005 according to projections WAM scenario

Pollutant	Reduction target 2020	% change in 2020	Reduction target 2030	% change in 2030
NO_x	-18%	-41%	-30%	-47%
NMVOC	-10%	-35%	-28%	-39%
SO_2	-32%	-78%	-68%	-78%
NH_3	-1%	+2%	-1%	+9%
$PM_{2.5}$	-15%	-56%	-41%	-56%

Table 9.3 Commitments to reduce emissions of certain atmospheric pollutants established by the NEC Directive for Estonia and % change compared to 2005 according to projections WEM scenario

Pollutant	Reduction target 2020	% change in 2020	Reduction target 2030	% change in 2030
NO_x	-18%	-41%	-30%	-49%
NMVOC	-10%	-35%	-28%	-40%
SO_2	-32%	-78%	-68%	-78%
NH_3	-1%	-3%	-1%	-5%
$PM_{2.5}$	-15%	-56%	-41%	-56%

According to current projections, in WEM scenario, only NH_3 reduction commitment will not be complied. According to projections (compared to base year 2005), the 2020 and 2030 target is exceeded by 2% and 9% respectively. The reason for exceeding NH_3 emissions is connected with the increasing number of livestock. In addition, milk production of dairy cattle and the use of mineral fertilizers are projected to increase compared to 2005.

Implementing Agriculture ´Improvement of manure management´ measure in WAM scenario enables to reduce projected NH_3 emissions by 3% in 2020 and 5% in 2030, compared to 2005. Further reseach would improve the underlying (activity) data and the ability to assess the impact of the implemented measures, increasing the precision of projections throughout the time series. Currently, several studies are ongoing to obtain better country-specific information, e.g. a study about feeding strategies of cattle and swine subcategories to obtain time series of feed digestibility coefficients and emission measurements made from different types of manure storages with different covers in summer and winter seasons.

[74] 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)

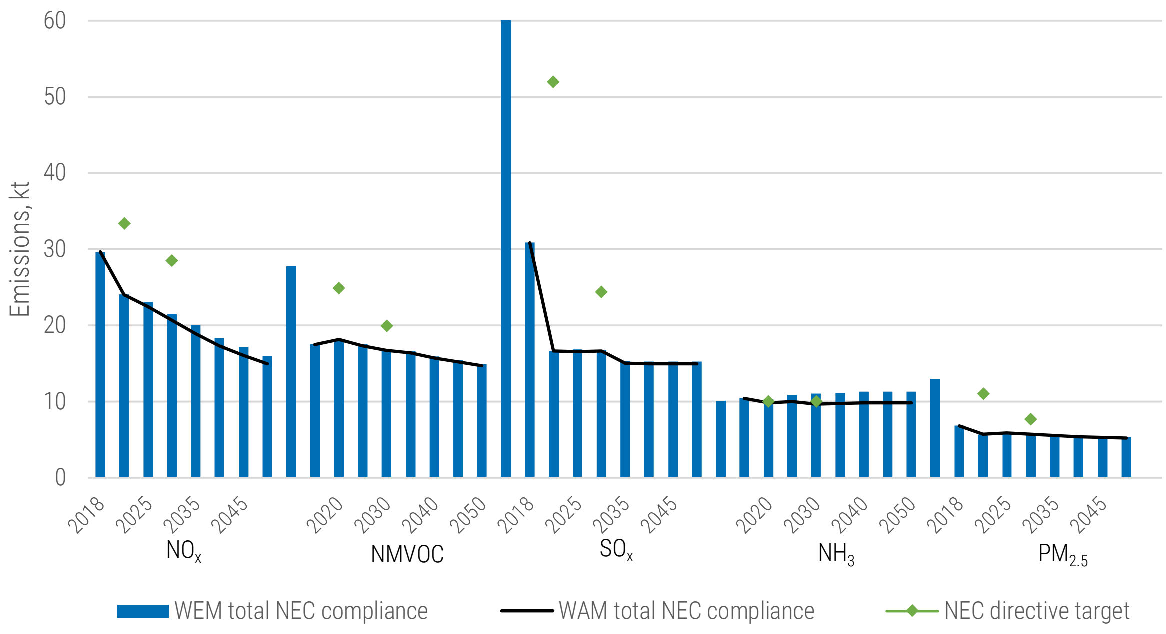

Figure 9.13 Total projected WEM and WAM scenario NEC compliant air pollutant emissions (i.e. excluding NO_x and NMVOC emissions form Agriculture sector) in 2018–2050 and NEC Directive reduction targets in 2020 and 2030, kt

Source: HDQ Cover Backgrounds. Kimiko Reece

10.REPORTING OF GRIDDED EMISSIONS AND LPS

10.1. Overview of the Gridded Emissions

10.1.1. Description of Gridded Emissions

The updated GRID emissions for 2019 for each GNFR (aggregated sectors) were submitted on 3 May 2021. Emissions data are disaggregated to the extended EMEP grid with a with the resolution of 0.1° x 0.1° long-lat. The previous gridded emissions reported in 2017 followed the old EMEP grid resolution of 50 km × 50 km.

Table 10.1 lists the aggregated sectors used for reporting emissions data and pollutants on grid, based on the Estonian air pollutants emission inventory.

Table 10.1 Activities and emissions reported for GRID data

GNFR	Emissions reported
A_PublicPower	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
B_Industry	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
C_OtherStationaryComb	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
D_Fugitive	NOx, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb
E_Solvents	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb, Cd, Hg, PCDD/F, PAHs
F_RoadTransport	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
G_Shipping	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, PCB
H_Aviation	NO_x, NMVOC, SO_x, PM_{10}, $PM_{2.5}$, BC, TSP, CO
I_Offroad	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5,}$ BC, TSP,, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
J_Waste	NO_x, NMVOC, SO_x, NH_3, PM_{10}, $PM_{2.5}$, BC, TSP, CO, Pb, Cd, Hg, PCDD/F, PAHs, HCB, PCB
K_AgriLivestock	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5,}$ TSP
L_AgriOther	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5,}$ TSP
M_Other	NO

10.1.2. Methodological Issues

The disaggregation of emissions is similar to Estonia's emissions inventory structure where data pertaining to the point sources and diffuse sources.

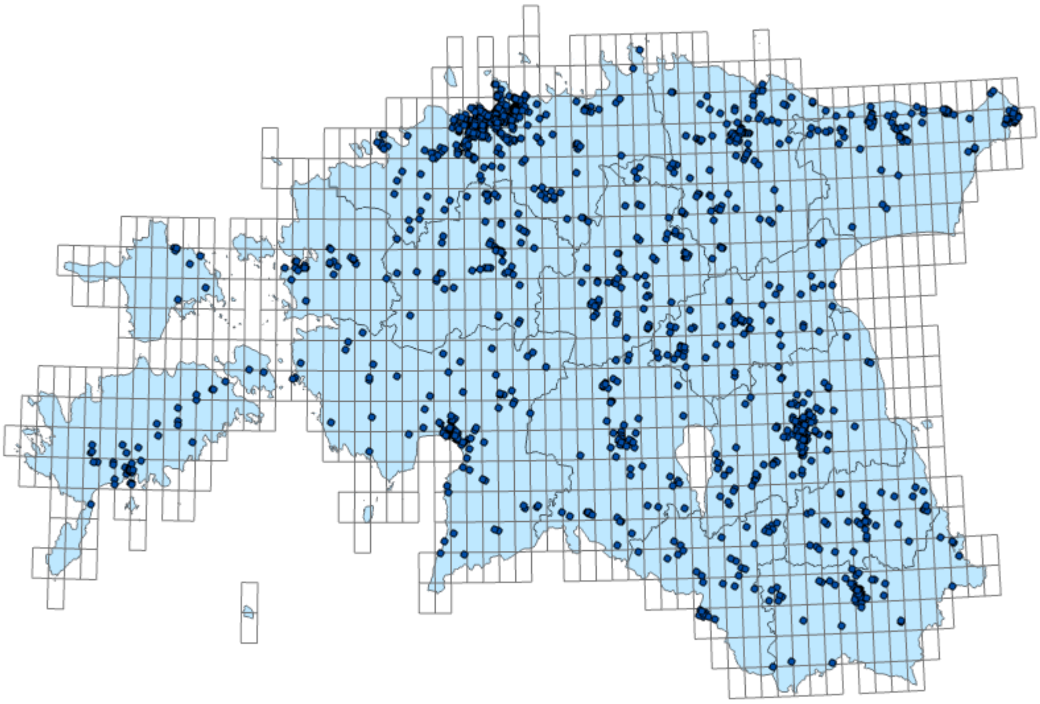

Figure 10.1 Point Sources distribution used for gridded emissions in 2019

The NFR-toolbox in the ArcGIS program where used to distribute spatially national emission on the grid in 0.1 x 0.1 degrees. LPS data for 1990, 1995, 2000, 2005, 2010, 2015 and 2019 and point sources data for 2019 were allocated directly to the grid by using their X and Y coordinates. The diffuse data were distributed by using different statistical and geographical data (e.g. road map, map on distribution of population etc.) from different institutions (Table 10.2).

Table 10.2 Distribution of Point and Diffuse Sources by aggregated sectors

NFR	Description	
A_PublicPower	Point and diffuse sources	Distributions of point sources data; production data, enterprises location and capital data from business register; distribution of population; fuel consumptions etc.
B_Industry	Point and diffuse sources	Distributions of point sources data; buildings locations and type data from buildings registry; distribution of population; fuel consumptions, production data, enterprises location and capital data from business register etc.
C_OtherStationaryComb	Point and diffuse sources	Distributions of point sources data; buildings locations and type data from buildings registry; distribution of population; fuel consumptions etc.
D_Fugitive	Point and diffuse sources	Distributions of point sources data; petrol and natural gas distribution etc.
E_Solvents	Point and diffuse sources	Population density; distributions of point sources data; production data, enterprises location and capital data from business register etc.
F_RoadTransport	Diffuse sources	Road map with the traffic density of different types of road transport etc.
G_Shipping	Diffuse sources	Ais data
H_Aviation	Emissions by Airports	Emissions by Airports

NFR	Description	
I_Offroad	Diffuse sources	Number of vehicles by county; the length of the railway; agricultural parcels locations etc.
J_Waste	Point and diffuse sources	Distributions of point sources data; number of fires by locations, amounts of landfilled waste by landfill etc.
K_AgriLivestock	Diffuse sources	Farms and parcels location data from agricultural support and agricultural Parcels register; livestock data etc.
L_AgriOther	Diffuse sources	Farms and parcels location data from Agricultural Support and Agricultural Parcels register etc.

10.1.3. Planned Improvements

For the 2022 submission, Estonia is planning to report disaggregated air pollutant emissions on the new EMEP grid with the resolution of 0.1° x 0.1° long-lat from previous years where it is possible. Also Estonia is planning to obtain different additional data that is needed for the distribution of historical national emissions.

10.2. Overview of the Large Point Sources (LPS)

10.2.1. Description of LPS emissions

The emissions data from the Large Point Sources are presented for the years 1990, 1995, 2000, 2005, 2010, 2015 and 2019 by GNFR (aggregated sectors) codes in NFR 2014-1 format and submitted into EIONET's Central Data Repository on 27 April 2021.

Data for 1990-2000 contain emissions of all facilities that exceed the threshold values in accordance with the requirements of the Guidelines for Reporting Emissions based on thresholds specified in annex II to the E-PRTR Regulation.

For identification of LPS for the period from 2005 to 2019, the principle of E-PRTR activities and pollutant emission thresholds in accordance with the requirements of annex I and II of the E-PRTR Regulation has originally been used. This was the main reason in the difference of the facilities number and emissions between the 2017 and 2021 reports. The reasons for the data difference and recalculations are given in chapter 10.2.2.

All E-PRTR facilities are required to submit annual reports on ambient air pollution. The reports contain information on the parameters of each sources of pollution, on the amount of emissions by source and by the facility as a whole. It also provides data on combustion plants with an indication of the capacities, the amount of fuel used, electricity and heat production; data about solvent used, liquid fuel distribution, livestock and other data.

The more detail description of data collection system from facilities is presented in the Chapter 1.3 "The process of Inventory Preparation" of the Estonian Informative Inventory Report 1990-2019.

Table 10.3 present the number of LPS in 2019 by GNFR sectors and reported pollutants. Each LPS emission has been aggregated by GNFR sectors and stack height classes. In case, if the total emission of the facility exceeded the applicable threshold value and the facility has different activities or stack height classes, then the data is submitted on each activity or stack class separately, regardless of a threshold.

Figure 10.2 and Table 10.4 shows the number of LPS for the period 1990-2019.

Table 10.3 Activities and pollutants Under LPS in 2019

GNFR	Emissions reported	Number of LPS facilities	Height class
A_PublicPower	NO_x, SO_x, NMVOC, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, PCDD/F, PCB	10	1,2,3,4,5
B_Industry	NO_x, SO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, CO, PCDD/F	8	1,2,3,4
C_OtherStationaryComb	SO_x	1	1
D_Fugitive	NO_x, SO_x, NMVOC, NH_3, PM_{10}, CO	4	1,2
K_AgriLivestock	NH_3	26	1
L_AgriOther	NH_3	7	1
J_Waste	NH_3, PCDD/F	2	1

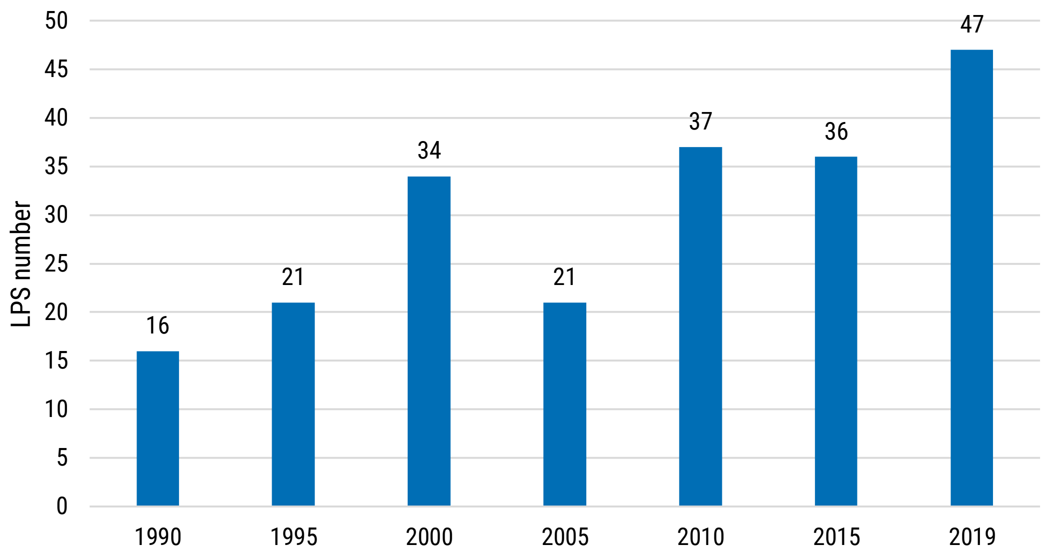

Figure 10.2 The number of large point sources in the period of 1990-2019

Table 10.4 The number of LPSs by GNFR sectors in the period of 1990-2019

GNFR	1990	1995	2000	2005	2010	2015	2019
A_PublicPower	6	7	9	7	7	9	10
B_Industry	10	11	19	9	6	8	8
C_OtherStationaryComb			2				1
D_Fugitive		1	4	3	5	3	4
E_Solvents		2	2	2			
K_AgriLivestock				1	17	17	26
L_AgriOther					9	15	7
J_Waste			1	1	1	1	2

During the period of 1990–2019, the number of LPS facilities had increased from 16 to 47 (Figure 10.2). The main reason is that since 2007, agricultural facilities that have an integrated emission permit or have exceeded the national ammonia emission threshold are required to report emissions. For example, in 2019, out of 47 facilities, 26 are agricultural (Table 10.4). That also explains the growth of ammonia emissions from the LPSs (Table 10.5).

As can be seen on the Figure 10.3, the share of only four pollutants from LPS exceeds 50% of the total emission: SO_2 – 71.5%, Pb – 84%, Cd – 58%, Hg – 78% (main contributors are oil shale power plants). The main sources of particulates, NO_x and PCB emissions also oil shale PP. The share of other substances from LPS is not so significant.

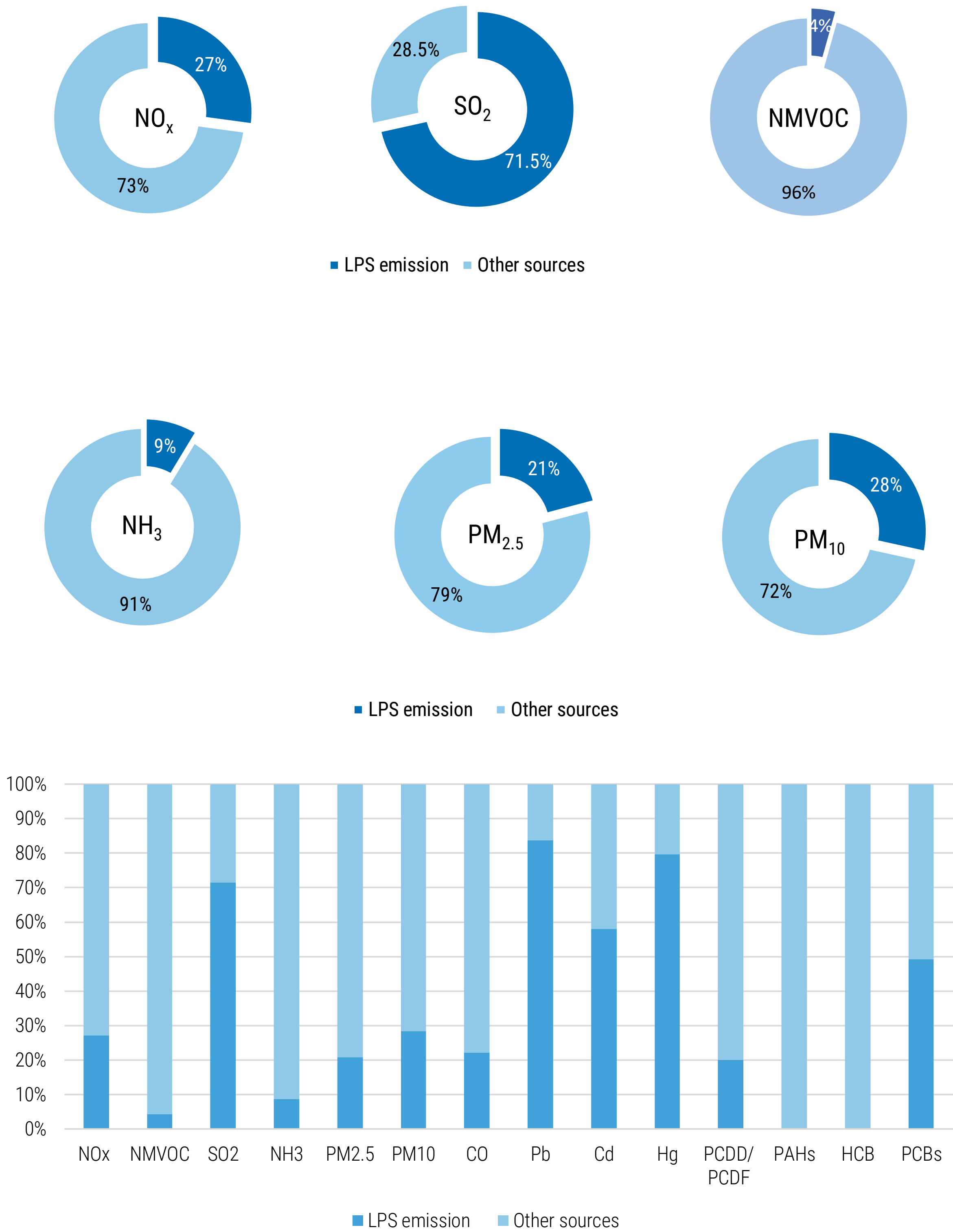

Figure 10.3 The contribution of LPS emissions in 2019 total emission

Figures 10.4-5 and Tables 10.6-7 illustrate the contribution of LPS emissions inside A_PublicPower and B_IndustrialCombustion sectors and into total emissions. For other sectors the LPS contribution in total emissions is not so significant.

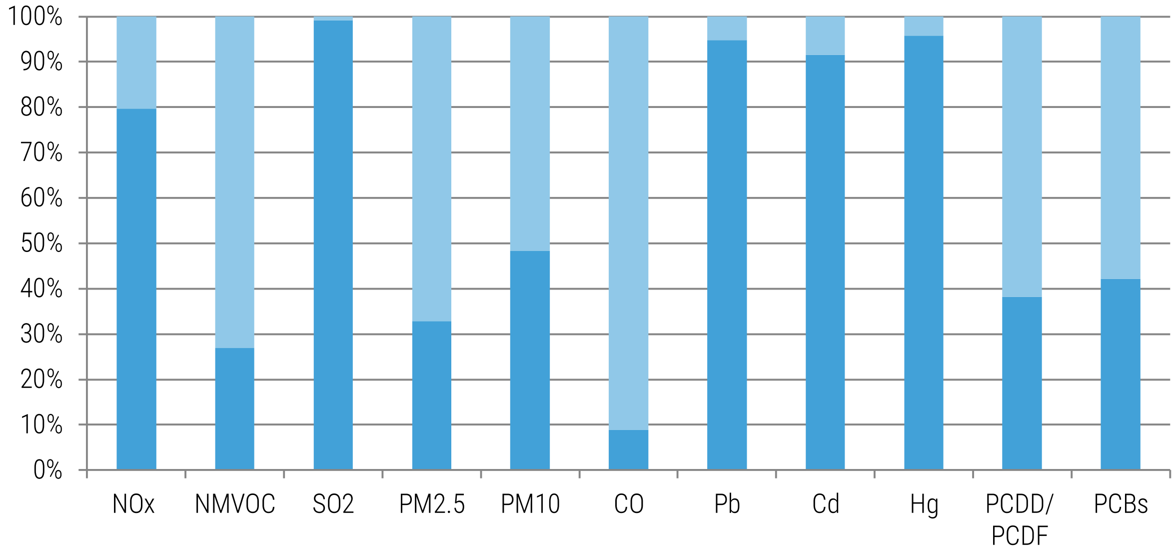

Figure 10.4 The contribution of LPS emissions in 2019 into A_PublicPower sector

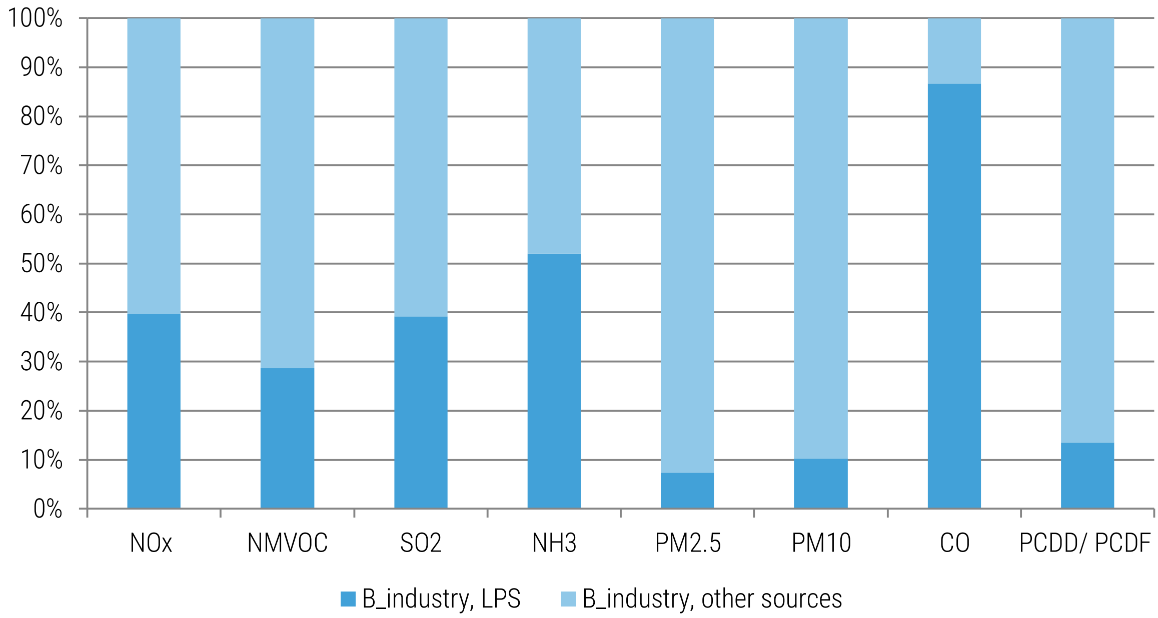

Figure 10.5 The contribution of LPS emissions in 2019 into B_IndustrialCombustion sector

It should be noted that during the period 1990-2019, the main large point sources, such as oil shale power plants, shale oil, cement, pulp and paper production factories, continued their operations. Emissions of all substances (excepted NH_3, CO and PCDD) are significantly dropped (Table 10.5, Figures 10.6-8), mainly due to the reduction in energy production and also introduction of new technologies at oil shale power plants and a renovation of clearing installations in cement production. The detailed description can be found in the Pollutants Emission Trends and Energy Sector Chapters of IIR.

Emission of carbon monoxide has increased about 3 times since 1990 mainly due to the increase in shale oil production plants. The increase in ammonia emissions is due to the addition of agricultural enterprises to the list of LPS since 2010. An increase in the share of biomass burned has led to an increase in dioxin emissions.

Table 10.5 Pollutant emissions from LPSs in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
	kt							t			g I-Teq	kg
1990	19.000	14.412	202.713	0.529	NR	NR	10.151	120.877	4.194	1.054	0.716	0.930
1995	11.348	4.794	94.52	0.099	NR	NR	10.705	56.034	1.817	0.547	0.251	0.486
2000	12.510	4.046	87.447	0.092	5.229	19.704	9.668	28.436	0.482	0.457	0.000	0.431
2005	11.073	1.128	61.886	0.240	2.391	6.42	12.874	29.770	0.484	0.484	0.122	0.472
2010	14.138	0.450	71.800	0.560	5.178	11.365	20.878	35.508	0.592	0.592	0.542	0.594
2015	8.324	0.965	25.792	0.896	1.996	4.122	28.637	25.690	0.478	0.478	0.952	0.317
2019	5.468	0.814	14.116	1.016	0.503	1.110	37.300	6.500	0.201	0.199	1.069	0.142
Trend 1990-2019, %	-71.2	-94.3	-93.0	92.0	-90.4	-94.4	267.5	-94.6	-95.2	-81.1	49.3	-84.7

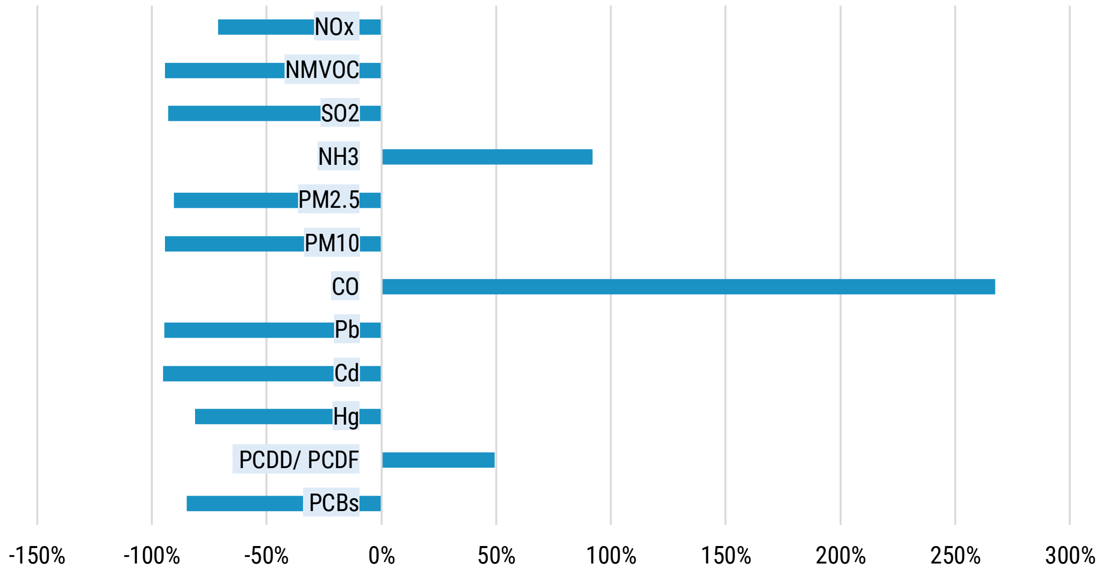

Figure 10.6 Change in pollutants emissions from LPS in the period 1990-2019

Table 10.6 LPS emissions from GNFR A_PublicPower in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
	kt							t			g I-Teq	kg
1990	17.542	NA	187.265	NA	NR	NR	1.211	59.135	0.985	0.985	0.153	0.930
1995	10.606	0.111	83.233	NA	NR	NR	1.039	31.042	0.517	0.517	NA	0.486
2000	10.438	NA	76.136	NA	3.968	16.992	NA	27.953	0.457	0.457	NA	0.431
2005	10.232	NA	59.088	NA	1.838	5.505	NA	29.770	0.484	0.484	NA	0.472
2010	13.238	NA	72.011	NA	5.127	11.353	NA	35.958	0.592	0.592	0.221	0.594
2015	7.795	0.103	24.395	NA	1.844	3.961	NA	25.690	0.478	0.478	0.229	0.317
2019	4.598	0.119	11.152	NA	0.379	0.780	0.558	6.500	0.201	0.199	0.484	0.142
Total 2019 A_PublicPower sector emission	5.767	0.441	11.249	0.218	1.153	1.614	6.354	6.855	0.220	0.208	1.264	0.337
Share in 2019 total A_PublicPower sector emission, %	79.7	26.9	99.1	0.0	32.8	48.3	8.8	94.8	91.6	95.7	38.3	42.2
Total 2019 emission	25.164	22.694	18.884	10.594	5.880	9.237	130.800	11.374	0.552	0.327	4.584	0.438
Share in total 2019 emission, %	18.3	0.5	59.1	0.0	6.4	8.4	0.4	57.1	36.5	60.8	10.5	32.5
Trend 1990-2019, %	-73.8		-94.0		-90.5	-95.4	-53.9	-89.0	-79.6	-79.8	215.3	-84.7

Table 10.7 LPS emissions from GNFR B_Industry in the period 1990-2019

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	CO	Pb	Cd	Hg	PCDD/ PCDF	PCBs
	kt							t			g I-Teq	kg
1990	1.458	14.412	15.448	0.529	NR	NR	8.940	61.742	3.209	0.069	0.563	NA
1995	0.742	3.851	11.287	0.099	NR	NR	9.666	24.992	1.3	0.030	0.251	NA
2000	1.962	0.680	10.531	0.092	1.261	2.712	9.668	0.483	0.025	NA	NA	NA
2005	0.841	0.235	2.798	0.172	0.553	0.915	12.874	NA	NA	NA	NA	NA
2010	1.080	0.000	1.610	0.052	0.402	0.767	20.878	NA	NA	NA	NA	NA
2015	0.529	0.741	1.397	0.264	0.152	0.160	28.625	NA	NA	NA	NA	NA
2019	0.869	0.596	2.714	0.304	0.124	0.326	36.737	NA	NA	NA	0.140	NA
Total 2019 B_Industry sector emission	2.189	2.085	6.914	0.584	1.683	3.188	42.374	0.686	0.019	0.017	1.033	0.061
Share in 2019 total B_Industry sector emission, %	39.7	28.6	39.3	52.0	7.4	10.2	86.7	0.0	0.0	0.0	13.5	0.0
Total 2019 emission	25.164	22.694	18.884	10.594	5.880	9.237	130.800	11.374	0.552	0.327	4.584	0.438
Share in total 2019 emission, %	3.5	2.6	14.4	2.9	2.1	3.5	28.1	0.0	0.0	0.0	3.1	0.0
Trend 1990-2019, %	-40.4	-95.9	-82.4	-42.6	-90.2	-88.0	310.9	-100.0	-100.0	-100.0	-75.1	

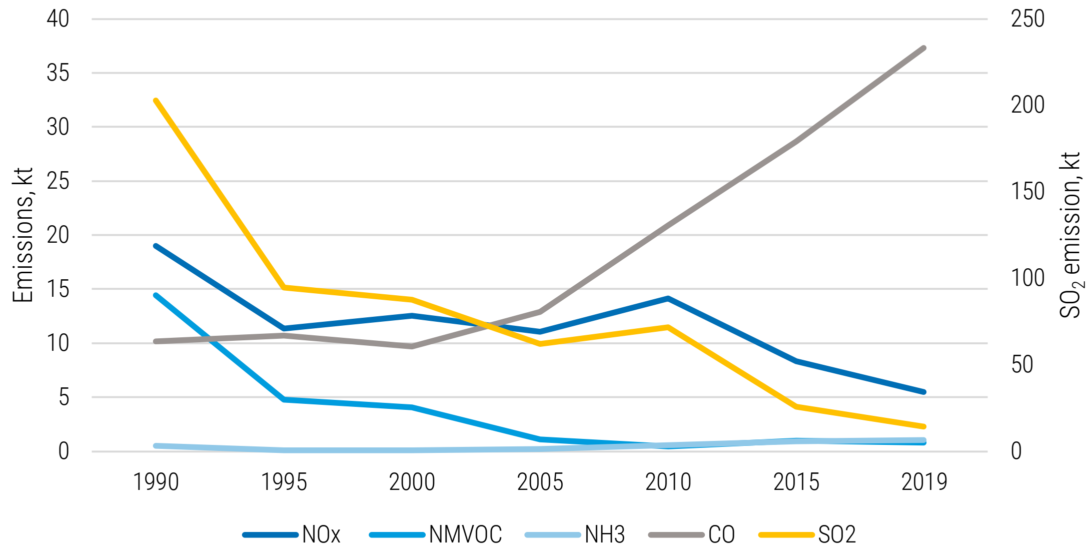

Figure 10.7 Main pollutant emissions from LPS in the period of 1990-2019

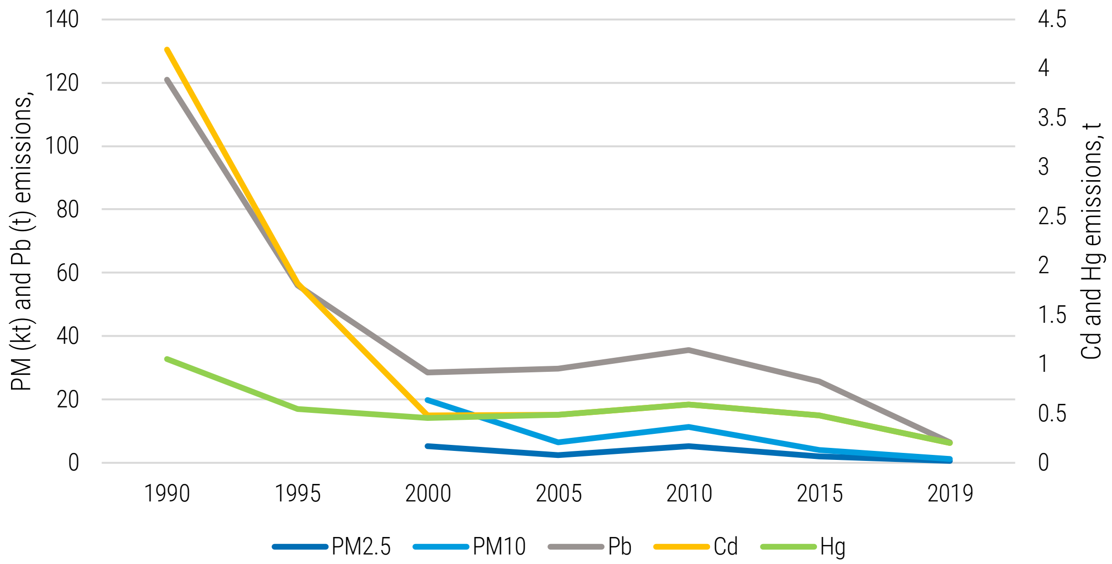

Figure 10.8 Pollutant emissions from LPS in the period of 1990-2019

10.2.2. Methodological Issues

The methods for emissions estimation are indicated in the relevant parts of the IIR, as well as in the E-PRTR reports. To estimate emissions, enterprises use various methods in accordance with the requirements of the pollution permits - measurement data, combined calculation methods, national methodologies. The operator can also calculate emissions through the use of other available methods, though this should be approved by the Environmental Board (regulated by the Atmospheric Air Protection Act). The operator shall indicate the method of emission calculation.

Emissions reported in the tables of Annex_VI for each facility are based on facility data, excluding POPs from fuel combustion, which have been recalculated in this year submission (Chapter

8.1.1). The emission factors used for calculations are given in the table 3.15 Chapter 3.2.2.2 (chapter 6.5.2 – for the industrial and clinical waste incineration). Only dioxin emissions from cement production facility present by operator on the base of measurement. Also, some operators provide data only on TSP and in this case the emissions of fine particles are calculated by the experts of the inventory team.

10.2.3. Recalculations

As already noted in part 10.2.1, the number of facilities and emissions for the period from 1990 to 2000 is identical in both, 2017 and 2021 submissions.

In comparison with the previous submission for the period from 2005 to 2019, the principle of E-PRTR activities and pollutant emission thresholds in accordance with the requirements of annex I and II of the E-PRTR Regulation has originally been used. This was the main reason in the difference of the facilities number and emissions between the 2017 and 2021 reports (Figure 10.9).

The second reason for the inconsistency of the 2015 data is the recalculation of NO_x, SO_2 and fine particulates emissions for 3 oil shale power plants and one municipal waste incineration plant, which used the validated average measurements values to calculate emissions. A detailed description is given in Chapter 8.1.1. of "Estonia IIR 2019". However, despite a 20% increase in SO_2 emissions from oil shale stations, emissions decreased by about 14%, which was the result of the exclusion from the lists of two combustion plants burning shale gas, the capacity of which is less than 50 MWth, but the total SO_2 emission is more than 8 thousand tons.

The differences in the large point sources emissions data between the 2017 and 2021 submissions are presented in Tables 10.8-10.10. The largest impact on the change in ammonia emissions had the exclusion from the list of LPS non-Annex 1 agriculture facilities (cattle farms).

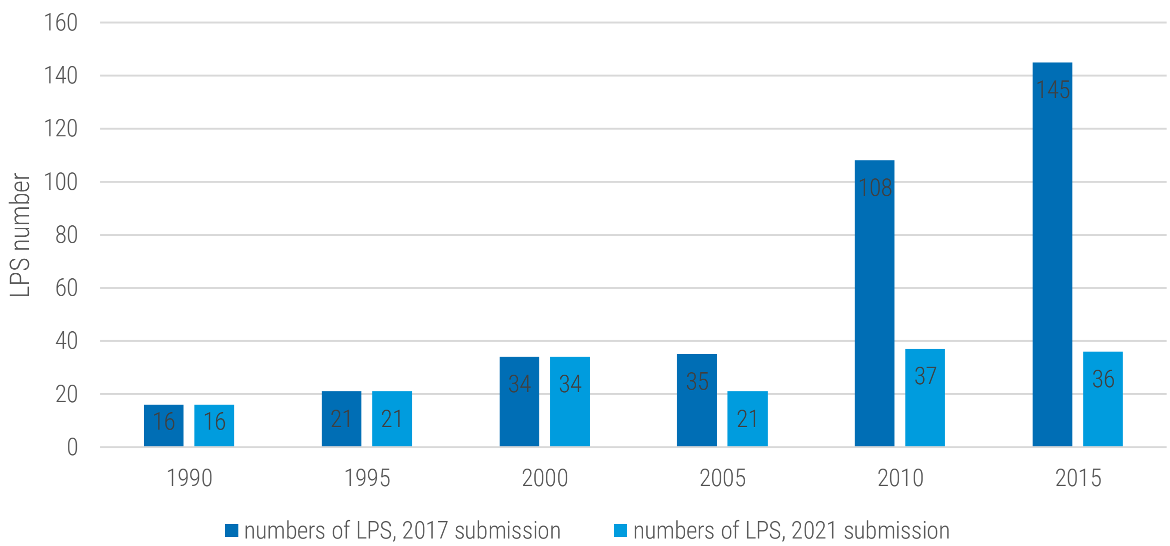

Figure 10.9 The differents in number of LPS in 2017 and 2021 submission

In comparison with the 2017 submission, also POPs emissions from the combustion activities have been recalculated (Chapter 8.1.1 2021 IIR)

Table 10.8 The differences in the LPS main pollutants emissions (kt) for 1990-2015 between 2017 and 2021 submissions

Year	NO_x			NMVOC			SO_x			NH_3			CO		
	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%
1990	19.000	19.000	0.0	14.412	14.412	0.0	202.713	202.713	0.0	0.529	0.529	0.0	10.570	10.570	0.0
1995	11.348	11.348	0.0	4.794	4.794	0.0	94.520	94.520	0.0	0.099	0.099	0.0	10.705	10.705	0.0
2000	12.510	12.510	0.0	4.046	4.046	0.0	87.447	87.447	0.0	0.092	0.092	0.0	9.668	9.668	0.0
2005	11.222	11.073	-1.3	4.763	1.128	-76.3	71.242	61.886	-13.1	0.316	0.240	-24.1	13.611	12.874	-5.4
2010	14.318	14.318	0.0	1.176	0.450	-61.7	80.578	73.622	-8.6	2.279	0.560	-75.4	20.878	20.878	0.0
2015	6.974	8.377	20.1	1.835	0.965	-47.4	29.937	25.792	-13.8	3.742	0.896	-76.1	28.637	28.637	0.0

Table 10.9 The differences in the LPS particulates (kt) and heavy metals (t) emissions for 1990-2015 between 2017 and 2021 submissions

Year	$PM_{2.5}$			PM_{10}			Pb			Cd			Hg		
	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%	2017	2021	%
1990	NR	NR		NR	NR		120.977	120.977	0.0	4.194	4.194	0.0	1.054	1.054	0.0
1995	NR	NR		NR	NR		56.162	56.162	0.0	1.817	1.817	0.0	0.547	0.547	0.0
2000	5.229	5.229	0.0	19.704	19.704	0.0	28.436	28.436	0.0	0.482	0.482	0.0	0.457	0.457	0.0
2005	2.861	2.391	-16.4	7.247	6.420	-11.4	30.043	29.770	-0.9	0.484	0.484	0.0	0.484	0.484	0.0
2010	5.960	5.530	-7.2	12.687	12.120	-4.5	35.977	35.977	0.0	0.592	0.592	0.0	0.593	0.592	-0.2
2015	1.392	1.996	43.4	2.881	4.122	43.1	25.690	25.690	0.0	0.478	0.478	0.0	0.478	0.478	0.0

Table 10.10 The differences in the LPS POPs emissions for 1990-2015 between 2017 and 2021 submissions

Year	PCDD/ PCDF, g I-Teq			HCB, kg			PCB, kg		
	2017	2021	%	2017	2021	%	2017	2021	%
1990	NE	0.716	100.0	NE	NA		NE	0.930	100.0
1995	NE	0.251	100.0	NE	NA		NE	0.486	100.0
2000	NE	NA		NE	NA		NE	0.431	100.0
2005	NE	0.122	100.0	NE	NA		NE	0.472	100.0
2010	0.017	0.542	3,156.4	NE	NA		NE	0.594	100.0
2015	0.424	0.952	124.7	0.012	0.000	-100.0	NE	0.317	100.0

10.2.4. Planned Improvements

Estonia plans to recalculate dioxin emissions from industrial and clinical waste incineration in the next LPS report.

ANNEX I – Inclusion/Exclusion of the Condensable Component from PM_{10} and $PM_{2.5}$ Emission Factors

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A1a	Public electricity and heat production		X	National emission factors of TSP for the calculation of emissions from boilers were adopted by a Regulation of the Minister of the Environment: https://www.riigiteataja.ee/aktilisa/1291/1201/6006/KKM_m59_Lisa3.pdf# In the text of the regulation there is no reference what include emissions, but within the discussion with the company which was carrying out measurements it became clear that particles excluded condensable component. Some facilities calculate emissions from boilers or other combustion activities using their own specific EF (base on the measurements or combine methods). It is not known if the condensable part is included or not. In the next reporting year, Estonia will organize a survey among operators to determine which methodology is used particulates emissions calculation.
1A1c	Manufacture of solid fuels and other energy industries		X	See comment for NFR 1A1a
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel		X	See comment for NFR 1A1a
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals		X	See comment for NFR 1A1a
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals		X	See comment for NFR 1A1a
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print		X	See comment for NFR 1A1a
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco		X	See comment for NFR 1A1a
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals		X	See comment for NFR 1A1a
1A2gvii	Mobile Combustion in manufacturing industries and construction: (specified in the IIR)	X		EMEP/EEA Guidebook 2019: PM factors represent total PM emissions (filterable and condensable fractions)
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (specified in the IIR)		X	See comment for NFR 1A1a
1A3ai(i)	International aviation LTO (civil)	–	–	EMEP/EEA Guidebook 2019
1A3aii(i)	Domestic aviation LTO (civil)	–	–	EMEP/EEA Guidebook 2019
1A3bi	Road transport: Passenger cars	X		EMEP/EEA Guidebook 2019: Road transport PM mass emission factors in this chapter are considered to include both filterable and condensable material
1A3bii	Road transport: Light duty vehicles	X		EMEP/EEA Guidebook 2019: Road transport PM mass emission factors in this chapter are considered to include both filterable and condensable material
1A3biii	Road transport: Heavy duty vehicles and buses	X		EMEP/EEA Guidebook 2019: Road transport PM mass emission factors in this chapter are considered to include both filterable and condensable material
1A3biv	Road transport: Mopeds & motorcycles	X		EMEP/EEA Guidebook 2019: Road transport PM mass emission factors in this chapter are considered to include both filterable and condensable material
1A3bvi	Road transport: Automobile tyre and brake wear	–	–	EMEP/EEA Guidebook 2019
1A3bvii	Road transport: Automobile road abrasion	–	–	EMEP/EEA Guidebook 2019
1A3c	Railways	–	–	EMEP/EEA Guidebook 2019

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A3dii	National navigation (shipping)	–	–	EMEP/EEA Guidebook 2019
1A4ai	Commercial/institutional: Stationary			See comment for NFR 1A1a
1A4aii	Commercial/institutional: Mobile	X		EMEP/EEA Guidebook 2019: PM factors represent total PM emissions (filterable and condensable fractions)
1A4bi	Residential: Stationary		X	EMEP/EEA Guidebook 2019 for the solid, liquid and gaseous fuels. Emissions from wood burning are calculated using national factors derived from measurements: https://www.envir.ee/sites/default/files/clrtap_pos_protokolli_nouete_taitmine.pdf In the text there is no reference what include emissions, but within the discussion with the company which was carrying out measurements it became clear that particles excluded condensable component.
1A4bii	Residential: Household and gardening (mobile)	X		EMEP/EEA Guidebook 2019: PM factors represent total PM emissions (filterable and condensable fractions)
1A4ci	Agriculture/Forestry/Fishing: Stationary			See comment for NFR 1A1a
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	X		EMEP/EEA Guidebook 2019: PM factors represent total PM emissions (filterable and condensable fractions)
1A4ciii	Agriculture/Forestry/Fishing: National fishing	–	–	EMEP/EEA Guidebook 2019
1B1b	Fugitive emission from solid fuels: Solid fuel transformation			Facility specific EF. It is not known if the condensable part is included or not.
1B1c	Other fugitive emissions from solid fuels			Facility specific EF. It is not known if the condensable part is included or not.
1B2aiv	Fugitive emissions oil: Refining / storage			Facility specific EF. It is not known if the condensable part is included or not.
1B2c	Venting and flaring (oil, gas, combined oil and gas)			Facility specific EF. It is not known if the condensable part is included or not.
2A1	Cement production			Facility specific EF. It is not known if the condensable part is included or not.
2A2	Lime production			Facility specific EF. It is not known if the condensable part is included or not.
2A5a	Quarrying and mining of minerals other than coal			Facility specific EF. It is not known if the condensable part is included or not.
2A5b	Construction and demolition			EMEP/EEA Guidebook 2019
2A6	Other mineral products (specified in the IIR)			Facility specific EF. It is not known if the condensable part is included or not.
2B10a	Chemical industry: Other (specified in the IIR)			Facility specific EF. It is not known if the condensable part is included or not.
2B10b	Storage, handling and transport of chemical products (specified in the IIR)			Facility specific EF. It is not known if the condensable part is included or not.
2C1	Iron and steel production			Facility specific EF. It is not known if the condensable part is included or not.
2C3	Aluminium production			Facility specific EF. It is not known if the condensable part is included or not.
2C5	Lead production			Facility specific EF. It is not known if the condensable part is included or not.
2C6	Zinc production			Facility specific EF. It is not known if the condensable part is included or not.
2C7a	Copper production			Facility specific EF. It is not known if the condensable part is included or not.
2C7c	Other metal production (specified in the IIR)			Facility specific EF. It is not known if the condensable part is included or not.
2D3b	Road paving with asphalt	–	–	EMEP/EEA Guidebook 2019
2D3d	Coating applications	–	–	Facility specific EF. It is not known if the condensable part is included or not.
2D3e	Degreasing	–	–	Facility specific EF. It is not known if the condensable part is included or not.
2D3g	Chemical products	–	–	Facility specific EF. It is not known if the condensable part is included or not.
2D3h	Printing	–	–	Facility specific EF. It is not known if the condensable part is included or not.
2D3i	Other solvent use (specified in the IIR)	–	–	Facility specific EF. It is not known if the condensable part is included or not.
2G	Other product use (specified in the IIR)	–	–	EMEP/EEA Guidebook 2019
2H1	Pulp and paper industry			Facility specific EF. It is not known if the condensable part is included or not.

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
2H2	Food and beverages industry			Facility specific EF. It is not known if the condensable part is included or not.
2I	Wood processing			Facility specific EF. It is not known if the condensable part is included or not.
2L	Other production, consumption, storage, transportation or handling of bulk products (specified in the IIR)			Facility specific EF. It is not known if the condensable part is included or not.
3B1a	Manure management - Dairy cattle			EMEP/EEA Guidebook 2016
3B1b	Manure management - Non-dairy cattle			EMEP/EEA Guidebook 2016
3B2	Manure management – Sheep			EMEP/EEA Guidebook 2016
3B3	Manure management – Swine			EMEP/EEA Guidebook 2016
3B4d	Manure management - Goats			EMEP/EEA Guidebook 2016
3B4e	Manure management - Horses			EMEP/EEA Guidebook 2016
3B4gi	Manure management - Laying hens			EMEP/EEA Guidebook 2016
3B4gii	Manure management - Broilers			EMEP/EEA Guidebook 2016
3B4giv	Manure management - Other poultry			EMEP/EEA Guidebook 2016
3B4h	Manure management - Other animals (specified in the IIR)			EMEP/EEA Guidebook 2016
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products			EMEP/EEA Guidebook 2019
5A	Biological treatment of waste - Solid waste disposal on land	–	–	The combination of facility specific and the EMEP/EEA Guidebook 2016 EFs. It is not known if the condensable part is included or not.
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	–	–	Facility specific EF. It is not known if the condensable part is included or not.
5C1bi	Industrial waste incineration	–	–	Facility specific EF. It is not known if the condensable part is included or not.
5C1bv	Cremation	–	–	EMEP/EEA Guidebook 2019
5C2	Open burning of waste	–	–	EMEP/EEA Guidebook 2019
5E	Other waste (please specify in IIR)	–	–	EMEP/EEA Guidebook 2019
6A	Other (included in national total for entire territory) (specified in the IIR)			

ANNEX II – Recommendations from the NECD Review, Considering Revised Estimates (RE), Technical Corrections (TC) and their Status of Implementation in Estonia

Recommendations from the NECD Review 2019 for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$ that have not been implemented in the inventory submission 2020

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-1A2gvii-2020-0001	Yes	1A2gvii Mobile Combustion in Manufacturing Industries and Construction, NO_X, NMVOC, $PM_{2.5}$, 2005-2018	N/A	RE	Yes

Recommendation

For categories within the non-road mobile machinery sector: 1A2gvii Mobile combustion in manufacturing industries and construction (NO_X, 2015-2018), 1A4bii Household and gardening mobile combustion (NMVOC, 2010 and 2018) and 1A4cii Off-road vehicles and other machinery from agriculture/forestry/fishing (NO_X, 2005, 2010, 2015-2018; $PM_{2.5}$, 2018) the TERT noted that a Tier 1 method is used for key categories. In response to a question raised during the review, Estonia agrees that the use of the Tier 1 method is not the best practice. Estonia provided revised estimates for years 2005, 2010, 2015-18 based on a Tier 2 method and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Estonia.

The TERT recommends that Estonia include the revised estimate in its 2021 NFR and IIR submission.

Improvement made	IIR Chapter, page
Recalculations have been carried out for the industrial machinery (NFR 1A2gvii), commercial machinery (NFR 1A4aii), household and gardening machinery (NFR 1A4bii) and agricultural machinery (NFR 1A4cii) sector for the period 1990-2018. Recalculations entail using Tier 2 methodology and corresponding emission factors for main pollutants and particulate matter.	Chapter 3.3.6, Chapter 8.1.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-1A3c-2020-0001	Yes	1A3c Railways, NO_X, 2005, 2010	N/A	UPTC	Yes

Recommendation

The TERT notes with reference to the IIR page 118, category 1A3c Railways, NO_X, years 2005 and 2010 that a Tier 1 method is used for a key category. The TERT notes that using a Tier 1 method is not best practice, and could result in an over- or under-estimate of emissions. This over- or under-estimate may have an impact on total emissions that is above the threshold of significance. Estonia has not provided a revised estimate which has been accepted by the TERT. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 2 method, and therefore the issue will be flagged as Potential Technical Correction, and will be assessed as a high priority item in future reviews.

The TERT recommends that Estonia should calculate NO_X emissions from 1A3c using a Tier 2 or Tier 3 method for inclusion in next years' inventory submission.

Improvement made	IIR Chapter, page
There are improvements planned for this sector: more detailed emission calculations for the railway transport sector which are based on Tier 2 method. Recalculations will be carried out this year and will be reported in the 2022 submission.	

<table>
<tr><th>Review year of initial recommendation (number of years it has been recommended)</th><th>Observation</th><th>Key Category</th><th>NFR, Pollutant(s), Year(s)</th><th>RE, TC, or UPTC in 2019</th><th>RE, TC, or UPTC in 2020</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2019 (2)</td><td>EE-3Da1-2019-0002</td><td>Yes</td><td>3Da1 Inorganic N-Fertilizers, NH_3, 2012-2016</td><td>UPTC</td><td>UPTC</td><td>Yes</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
The TERT notes with reference to 3Da1 Inorganic N-fertilizers (includes also urea application) and NH_3 for years 2005, 2010, 2015- 2018 that Estonia only differentiates urea and other fertilizers, therefore a complete Tier 2 method is not used for a key category. The TERT notes that using a Tier 1 method is not best practice, and could result in an over- or under-estimate of emissions. This over- or under-estimate may have an impact on total emissions that is above the threshold of significance. Estonia has not provided a revised estimate which has been accepted by the TERT. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 2 method, and therefore the issue will be flagged as Potential Technical Correction, and will be assessed as a high priority item in future reviews. Estonia indicated that the results of the project to improve Estonian Air Emissions Inventory and the Estonian GHG Inventory will be included in the inventory for the 2022 submission.
The TERT recommends that Estonia calculate NH_3 emissions from 3Da1 Inorganic N-fertilizers (includes also urea application) using a complete Tier 2 (or if possible a Tier 3) method for inclusion in next years' inventory submission.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">After consulting various authorities including Statistics Estonia, the Agricultural Board, and the Environmental Research Centre, the main result was 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. The project is planned to take place in the years 2020–2023. The results of the project to improve Estonian Air Emissions Inventory and the Estonian GHG Inventory will be included in the inventory for the 2022 submission.</td><td colspan="3"></td></tr>
</table>

<table>
<tr><th>Review year of initial recommendation (number of years it has been recommended)</th><th>Observation</th><th>Key Category</th><th>NFR, Pollutant(s), Year(s)</th><th>RE, TC, or UPTC in 2019</th><th>RE, TC, or UPTC in 2020</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2020 (1)</td><td>EE-1A2gvii-2020-0002</td><td>No</td><td>1A2gvii Mobile Combustion in Manufacturing Industries and Construction, SO_2, 2018</td><td>N/A</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Recommendation
For 1A2gvii Mobile Combustion in Manufacturing Industries and Construction, SO_2, year 2018 the TERT noted that there are >95% reduction in SO_2 emissions between 2017 and 2018. In response to a question raised during the review Estonia clarified that there is a mistake made in reporting to the NFR table and provided the corrected value. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that the correct SO_2 emissions be reported for year 2018 in the 2021 submission.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">Correction has been made in the NFR table.</td><td colspan="3">NFR table</td></tr>
</table>

<table>
<tr><th>Review year of initial recommendation (number of years it has been recommended)</th><th>Observation</th><th>Key Category</th><th>NFR, Pollutant(s), Year(s)</th><th>RE, TC, or UPTC in 2019</th><th>RE, TC, or UPTC in 2020</th><th>Tier 1 used for Key Category</th></tr>
</table>

2019 (2)	EE-2B10a-2019-0002	No	2B10a Chemical Industry: Other, SO_2, 2017	No	No	No

Assessment of the implementation of the initial recommendation
For 2B10a Chemical industry: Other (please specify in the IIR) for SO_2 for 2017 and 2018 the TERT noted that Estonia changed the notation key from 'NA' to 'NE' for the 2020 submission whilst emission estimates were provided for 2009-2016 (and for other years in the time series), and that there are plans to investigate the facility data and, if possible, calculate emissions in the 2021 submission. This was raised during the 2019 NECD review. The 2020 review noted that the IIR (p. 265) states that the issue has been included in the list of improvements and that the recommendation will be addressed in the 2021 submission.
The TERT reiterates the recommendation that Estonia includes the SO_2 emissions of this category for 2017, 2018 and 2019 in its 2021 submission.

Improvement made	IIR Chapter, page
SO2 emissions for 2001 and 2003–2004 are reallocated under NFR 1A2gviii, because it is related to the fuel combustion process. Between 2009 and 2017, there were emissions from only one explosives manufacturing facility. Since 2017, the company has slightly changed its technology, carried out measures to reduce emissions, and the Department of the Environment allowed not to submit reports due to really insignificant emissions (Emission SO2 in 2016 was only 4.5 kg). We believe that such a small emission will not affect the emissions of the state as a whole.	Chapter 8.2.1, Table 8.39

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-3B4d-2019-0001	No	3B4d Manure Management - Goats, $PM_{2.5}$, 2000-2017	No	No	No

Assessment of the implementation of the initial recommendation
This was raised during the 2019 NECD review. The TERT noted that the issue is below the threshold of significance for a technical correction. The 2020 review noted that the IIR states that the issue has been included in the list of improvements and that the recommendation will be addressed in the 2021 submission.
The TERT reiterates the recommendation that Estonia revise the estimates based on the housing period of the animals, for all animal categories.

Improvement made	IIR Chapter, page
An explanation has been added in agriculture chapter.	Chapter 5.2.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-3De-2020-0001	No	3De Cultivated Crops, NMVOC, 2005, 2010, 2015, 2016, 2017, 2018	N/A	No	No

Recommendation

For 3De Cultivated crops, NMVOC and years 2005, 2010, 2015-2018 the TERT noted that default Tier 2 EF used are not correct. IIR 2020 indicates in table 5.22 the following emission factors: wheat - 0.110, rye - 0.050, rape - 0.130, grass - 0.100 kg crop/ha. The values are taken from last column in table 3.4 of EMEP/EEA 2016, however these EFs already consider the crops distribution and are used for calculating Tier 1 EF. Tier 2 EF are those presented in column "NMVOC, kg ha−1a−1 of table 3.4".

The TERT recommends that Estonia correct the EF used in 2021 submission.

Improvement made	IIR Chapter, page
The reference used was incorrect and has been updated.	Chapter 5.3.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2017 (4)	EE-5B2-2017-0001	No	5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities, NH_3, 2005, 2010, 2015	No	No	No

Assessment of the implementation of the initial recommendation

For 5B2 Anaerobic digestion at biogas facilities and NH_3, NO_X, CO, NMVOC and SO_2 the TERT noted that there is a lack of transparency regarding the reporting of emissions from incinerating biogas. The TERT notes that the NFR 5B2 according to the EMEP/EEA Guidebook is used for the pre-storage of feedstock, leakage, separation of digestate and post storage of digestate. The TERT notes that combustion emission related to energy recovery need to be reported in 1A1 and that other combustion emissions need to be reported under their subsequent combustion NFR as for instance 1A5a Other, Stationary (Including Military). This does not relate to an under-estimate of emissions above the threshold of significance. This was raised during the 2017 NECD review. In response to a question raised during the review, Estonia explained that these emissions relate to flaring of biogas.

The TERT recommends that Estonia reports the emissions coming from flaring of biogas from anaerobic digestion at biogas facilities under the correct NFR and to include the emissions from pre- and post-storage, leakage and separation feedstock and digestate under 5B2 in the next submission.

Improvement made	IIR Chapter, page
Unfortunately, it was not possible to update data for this NFR source code in this (2021) submission due the change of waste expert. The analysis is still ongoing. We have started to collect more data about biogas production facilities. Work with the GHG inventory team is planned. This year, plans are in place to analyse activity data and the NH3 emission calculation methodology and to make necessary updates and recalculations for the 2022 submission.	

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-5C1bi-2020-0001	No	5C1bi Industrial Waste Incineration, SO_2, 2017, 2018	N/A	No	No

Recommendation For 5C1bi Industrial waste incineration the TERT noted that there is a lack of transparency regarding the large time series variability between the years 2017 and 2018. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Estonia explained that they currently have no concrete explanation and that this issue needs further investigation and that it seems that some emission's activity might still be wrongly classified. Correction and explanation for that will be included in the IIR for the 2021 submission. **The TERT recommends that Estonia corrects any wrongly classified activity data and explains the remaining fluctuations in the next IIR submission.**	
Improvement made	IIR Chapter, page
Emissions from industrial 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. Further analysis of the annual reports of the facilities for 2017 and 2018 showed that the difference in SO_2 emissions between 2017 and 2018 is due to the data provided by the company. According to the 2017 annual reports, there were no emissions from one point source which belongs under the NFR 5C1b1.	

Table 6 All recommendations, revised estimates, technical corrections and unquantified potential technical corrections including those additionally made during the NECD Review 2020 and those not implemented from previous reviews, for heavy metals and POPs

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	EE-1A1a-2018-0002	Yes	1A1a Public Electricity and Heat Production, PAHs, PCBs, HCB, PCDD/F, 1990-2016	No	RE	Yes

Assessment of the implementation of the initial recommendation

For category 1A1a Public electricity and heat production and pollutants PAH, PCB, HCB and PCDD/F for years 1990-2018 that a Tier 1 method is used for a key category. This was raised during the 2018 and 2019 NECD review. In response to a question raised during the review, Estonia provided revised estimates for years 1990, 2005, 2016, 2017 and 2018 (and also for NFR 1A1c Manufacture of solid fuels and other energy industries, 1A2gviii Stationary combustion in manufacturing industries and construction: Other , 1A4ai Commercial/industrial stationary combustion and 1A4ci Agriculture/forestry/fishing stationary combustion) and stated that the revised estimate will be included for the full time series in the next submission. The TERT agreed with the revised estimate provided by Estonia.

The TERT recommends that Estonia includes the revised estimate in its 2021 NFR and IIR submission.

Improvement made	IIR Chapter, page
The 2021 submission includes recalculated POPs emissions using Tier 2 methodology for the entire period from 1990 to 2018 for sectors 1A1a, 1A1c, 1A2gviii, 1A4ai and 1A4ci. It should be noted that there may be slight differences from the calculations carried out in the framework of the 2020 review, due to the correction of some activities data and in the formulas.	Chapter 3.2.2.2, Chapter 8.1.1

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-3Df-2019-0001	No	3Df Use of Pesticides, HCB, 1990, 2005, 2016, 2017	No	UPTC	No

Assessment of the implementation of the initial recommendation

The TERT notes with reference to 3Df Use of pesticides and HCB in 1990, 2005, 2016-2018 that these are reported as 'NO', that could result in an under-estimate of emissions. This under-estimate may have an impact on total emissions that is above the threshold of significance. Estonia has not provided a revised estimate which has been accepted by the TERT. Estonia indicated that the list of active substances will be reviewed after updating an Estonian National Implementation Plan Under the Stockholm Convention, that should be completed by the end of 2020 and that according to the current knowledge, these emissions are not relevant. It is currently not possible for the TERT to provide a numerical emission estimate based on a Tier 1, and therefore the issue will be flagged as Potential Technical Correction, and will be assessed as a high priority item in future reviews.

The TERT recommends that Estonia calculate HCB emissions from 3Df Use of pesticides using a Tier 1 method for inclusion in next years' inventory submission.

Improvement made	IIR Chapter, page
For the categories Use of pesticides (3Df) notation key 'NO' was replaced with 'NE' . Due to the lack of activity data for the years 1990-2011, it is not possible to estimate HCB emissions from 3Df category. Additional analyse to find alternative source of activity data is ongoing. It is planned to make additional calculations for the 2022 submission, if it is possible	Chapter 5.3.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-1A1a-2019-0001	Yes	1A1a Public Electricity and Heat Production, BaP, PAHs, Pb, 2016, 2017	No	No	No

Assessment of the implementation of the initial recommendation

For category NFR 1A1a Public Electricity and Heat Production and pollutants Pb, BaP, PAH in years 2016 and 2017 the TERT noted that ratios to particulate matter were outside the range of other countries. This was raised during the 2019 NECD review. The TERT noted that the issue is related to a non-mandatory category and/or year. The 2020 review noted that the IIR (page 279) states that the issue could not be addressed for the 2020 submission, but analysis has begun and it is planned to apply recalculations for the 2021 submission.

The TERT reiterates the recommendation to correct estimates for heavy metals and POPs in the 2021 submission.

Improvement made	IIR Chapter, page
As noted in the response to this question in the 2019 review, at the moment, there is no possibility to compare the Pb and PAHs ratio compared to PM10 with other countries, since we do not have relevant information. We agree that for sector 1A1a there is a discrepancy between PM10 and Pb emissions IEF ratio. The share of oil shale power plants in the PM10 and Pb emissions in NFR 1A1a in 2017 is 68% and 98%, respectively; so in this case, it is enough to analyse the situation in shale power plants. The discrepancy is due to the fact that particle emissions are calculated on the basis of measurements (continuous monitoring of the TSP and then determining PM10 and PM2.5 by percentage). Heavy metals are calculated based on the old methodology, which does not take into account the combustion and abatement technologies. During the period from 2000 to 2017, new combustion and abatement technologies were introduced at oil shale power plants, some old boilers were closed, the efficiency of particulates cleaning equipment increased, which undoubtedly affected the reduction of emissions and changes in the IEF of substances. In this case we acknowledge that stability of the IEF of heavy metals is incorrect and emissions are overestimated. The decrease in particulates emission and IEF was mainly due to the modernisation of electric precipitators at oil shale power plants. Since 2019, shale power plants have been using a new methodology for calculating heavy metals, but in order to compare the data, it is necessary to analyse and recalculate the data for the entire period. This work is planned to be carried out in 2021–2022. The POPs emission were recalculated for the period 1990–2018	

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2017 (4)	EE-1A1c-2017-0002	Yes	1A1c Manufacture of Solid Fuels and Other Energy Industries, PCDD/F, PAHs, 2005-2015	No	No	No

Assessment of the implementation of the initial recommendation

For category 1A1c Manufacture of solid fuels and other energy industries the TERT noted Estonia has moved activity data from 1A1c Manufacture of Solid Fuels and Other Energy Industries in all years except 1990-1993. This was raised during the 2017, 2018 and 2019 NECD reviews. In response to a question raised during the review Estonia clarified emissions are allocated to 1A1a Public Electricity and Heat Production and 1A1c and provided an activity estimate for 1A1c for years 1990-1992. The notation key 'NA' is used for PCDD/F and PAH emissions in 1990-1992 where estimates are provided for other pollutants and emissions in later years are provided. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that PCDD/F and PAH emission estimates are included in the 2021 submission for 1990-1992 to improve completeness and accuracy of inventory.

Improvement made	IIR Chapter, page
Activity data were additionally provided for the years 1990-1992. Emissions of POPs for NFR 1A1c were additionally estimated for 1990-1992	Chapter 8.1.1, Tables 8.2-8.3

<table>
<tr><td colspan="7"></td></tr>
<tr><td>Review year of initial recommendation (number of years it has been recommended)</td><td>Observation</td><td>Key Category</td><td>NFR, Pollutant(s), Year(s)</td><td>RE, TC, or UPTC in 2019</td><td>RE, TC, or UPTC in 2020</td><td>Tier 1 used for Key Category</td></tr>
<tr><td>2019 (2)</td><td>EE-1A2a-2019-0001</td><td>No</td><td>1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel, Cd, Hg, 2016</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
For NFR 1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel and pollutants Hg and Pb for 2016/2917 in the 2019 submission, the TERT noted that notation keys were used for heavy metals where a Tier 1 method was available. This was raised during the 2019 NECD review. The TERT notes that the issue related to a non-mandatory year. The TERT notes that the 2020 IIR (page 279) states that the issue has been included in the list of improvements and that the recommendation will be addressed in the 2021 submission.
The TERT reiterates the recommendation that heavy metal emissions are reviewed and, where appropriate, corrected for the 2021 submission.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">An error was made when compiling the report for 2016. In this reporting year, the data on Hg and Cd emissions for 2016 were corrected</td><td colspan="3">Chapter 8.1.1, Table 8.4</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Review year of initial recommendation (number of years it has been recommended)</td><td>Observation</td><td>Key Category</td><td>NFR, Pollutant(s), Year(s)</td><td>RE, TC, or UPTC in 2019</td><td>RE, TC, or UPTC in 2020</td><td>Tier 1 used for Key Category</td></tr>
<tr><td>2019 (2)</td><td>EE-1A2c-2019-0001</td><td>No</td><td>1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals, Cd, 2016-2017</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
For NFR 1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals and pollutant Cd that the notation key 'NA' is used whilst a Tier 1 method is available in the 2016 EMEP/EEA Guidebook and that there may be an under-estimate of emissions. This was raised during the 2019 NECD review. In response to a question raised during the review Estonia indicated that it plans to address this issue in the 2021 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that Estonia calculate the emissions and include the estimates and transparent methodology in the 2021 submission.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">Emissions of Cd and Hg for NFR 1A2c were additionally estimated for 2012 and 2014–2018</td><td colspan="3">Chapter 8.1.1, Table 8.6</td></tr>
<tr><td colspan="7"></td></tr>
</table>

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-1A2c-2019-0002	No	1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals, Cd, Hg, 2012, 2014, 2015	No	No	No

Assessment of the implementation of the initial recommendation

The TERT notes that the notation key 'NA' (not applicable) was used for categories 1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel for the years and pollutants: Cd and Hg (2010, 2016); 1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals for the years and pollutants: Cd and Hg (2010-12, 2015-2017); and 1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals for the years and pollutants: Cd and Hg (2012, 2014-2017) whilst emission estimates are expected. The TERT notes that the issue is below the threshold of significance for a technical correction. The TERT notes that the 2020 IIR (page 281) states that it is planned to analyse the industrial combustion sector and the recommendation will be addressed in the 2021 submission.

The TERT reiterates the recommendation that heavy metal emissions are reviewed and, where appropriate, estimates and methodologies are provided for the 2021 submission.

Improvement made	IIR Chapter, page
Emissions of Cd and Hg for NFR 1A2a were additionally estimated for 2010 and 2016; Emissions of Cd, Hg, Cr, Ni and Zn for NFR 1A2b for the periods 2010–2012 and 2015–2018.	Chapter 8.1.1, Table 8.6

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	EE-1A2f-2018-0001	No	1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals, Hg, 1990-2016	No	No	No

Assessment of the implementation of the initial recommendation

For NFR 1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals and pollutant Hg in 2004 and 2005 the TERT noted that emissions were not reported. This was raised during the 2018 and 2019 NECD review. In response to a question raised during the review Estonia provided a revised estimate of emissions for 2004 and 2005 based on interpolation from other years and plans to investigate if other data may be available. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia reviews the estimates and any available emission data and documents how the data gaps are addressed in the 2021 submission and IIR.

Improvement made	IIR Chapter, page
Emissions of Hg for NFR 1A2f were additionally estimated for 2004 and 2005.	Chapter 8.1.1, Table 8.7

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-1A3b-2020-0001	No	1A3b Road Transport, Cd, 2018	N/A	No	No

Recommendation
For categories 1A3bi-iv, Cd, 2018 the TERT noted that Cd emissions have reduced by 99% between 2017 and 2018. In response to a question raised during the review Estonia clarified that heavy metals emissions from lubricant consumption were omitted and provided the correct emissions data for the year 2018. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that the correct heavy metal emissions (covering both exhaust emissions and emissions from lubricant consumption) to be reported for year 2018 in the 2021 submission.

Improvement made	IIR Chapter, page
A correction has been made in reporting heavy metal emissions. Concerning lubricant consumption in 4-stroke engines, all heavy metals emissions are reported in 2G (Other product use) in accordance with EMEP/EEA Guidebook 2019.	Chapter 3.3.3, Chapter 8.1.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2020 (1)	EE-1A3bvi-2020-0001	No	1A3bvi Road Transport: Automobile Tyre and Brake Wear, BaP, PAHs, 1990-2018	N/A	No	No

Recommendation
For 1A3bvi Road Transport: Automobile Tyre and Brake Wear, BaP and PAHs (Benzo(b)fluoranthene and Benzo(k)fluoranthene) for all years the TERT noted that emissions are not currently estimated. In response to a question raised during the review Estonia stated that they will address the issue in the 2021 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that Bap and PAHs emissions from 1A3bvi to be reported in the 2021 submission.

Improvement made	IIR Chapter, page
The emissions of PAHs were calculated for the period 1990-2019 and reported in the 2021 submission	Chapter 3.3.3, Chapter 8.1.2

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	EE-2C1-2018-0005	No	2C1 Iron and Steel Production, Cd, PCDD/F, 1990, 2005, 2016	No	No	No

Assessment of the implementation of the initial recommendation

For 2C1 Iron and steel production for Cd and PCDD/F emissions for the entire time series the TERT noted that there may be an under-estimate of emissions. Estonia reported 'NA' in its NFR tables, while a Tier 1 method and EF, a Tier 2 method and EF for several technologies/processes in the 2016 EMEP/EEA Guidebook exist. This was raised during the 2018 and 2019 NECD review (EE-2C1-2018-0005). The TERT notes that Estonia states in its 2020 IIR (p. 273) that due to a lack of AD, it is not possible to estimate Cd and PCDD/F emissions from 2C1, and that Estonia is trying to develop a method to calculate emissions where operators do not provide emissions data and would be grateful if the TERT can help to provide recommendations on how to go about this.

Despite the TERT not having an overview of Estonia's actions so far, the TERT recommends Estonia to make an overview of the sector with the most important companies/activities and try to contact sector organizations or the main companies in order to find out why no activity data can be provided. The TERT recommends Estonia to report on the outcome of these actions in its 2021 inventory.

Improvement made	IIR Chapter, page
Emissions of Cd for NFR 2C1 additionally estimated for 2000-2018	Chapter 8.2.1, Table 8.42

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	EE-2C1-2018-0006	No	2C1 Iron and Steel Production, Hg, HCB, PCBs, 1990, 2005, 2016	No	No	No

Assessment of the implementation of the initial recommendation

For 2C1 Iron and steel production for Hg, HCB and PCB emissions for the entire time series the TERT noted that there may be an under-estimate of emissions. Estonia reported 'NA' in its NFR tables, while there exists a Tier 1 method and EF and a Tier 2 method and EF for several technologies/processes in the 2016 EMEP/EEA Guidebook. This was raised during the 2018 and 2019 NECD review (EE-2C1-0006). The TERT notes that Estonia states in its 2020 IIR (p. 274) that due to a lack of AD, it is not possible to estimate Hg, HCB and PCBs emissions from 2C1, and that Estonia is also trying to develop a method to calculate emissions where operators do not provide emissions data and would be grateful if the TERT can help to provide recommendations on how to go about this.

Despite not having an overview of Estonia's actions so far, the TERT recommends Estonia to make an overview of the sector with the most important companies/activities and try to contact a sector organization or the main companies in order to find out why no activity data can be provided. The TERT recommends Estonia to report on the outcome of these actions in its 2021 inventory.

Improvement made	IIR Chapter, page

<table>
<tr><td>Review year of initial recommendation (number of years it has been recommended)</td><td>Observation</td><td>Key Category</td><td>NFR, Pollutant(s), Year(s)</td><td>RE, TC, or UPTC in 2019</td><td>RE, TC, or UPTC in 2020</td><td>Tier 1 used for Key Category</td></tr>
<tr><td>2018 (3)</td><td>EE-2C3-2018-0001</td><td>No</td><td>2C3 Aluminium Production, PCDD/F, HCB, 1990, 2005, 2016</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
For PCDD/F and HCB for 2C3 Aluminium production, for the entire time series, the TERT noted that there may be an under-estimate of emissions. Estonia reported 'NA' (Not Applicable) in its NFR tables although there is a Tier 1 method and EF in the 2016 EMEP/EEA Guidebook. This was raised in the 2018 review (EE-2C3-2018-0001) and Estonia commented that the under-estimate would be addressed no later than the 2020 submission. The 2020 TERT notes that Estonia states in its 2020 IIR (p. 275) that it was not possible to estimate PCDD/F and HCB emissions from 2C3 due to a lack of AD, however, it is planned to make additional calculations for the 2021 submission if possible.
The TERT recommends Estonia to make an overview of the sector with the most important companies/activities and try to contact a sector organization or the main companies in order to find out why no activity data can be provided.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">PCDD/F and HCB emissions for 2C3 additionally estimated for 2007 - 2018</td><td colspan="3">Chapter 8.2.1, Table 8.45 – 8.47</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Review year of initial recommendation (number of years it has been recommended)</td><td>Observation</td><td>Key Category</td><td>NFR, Pollutant(s), Year(s)</td><td>RE, TC, or UPTC in 2019</td><td>RE, TC, or UPTC in 2020</td><td>Tier 1 used for Key Category</td></tr>
<tr><td>2018 (3)</td><td>EE-2C5-2018-0001</td><td>No</td><td>2C5 Lead Production, PCBs, 1990, 2005, 2016</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
For 2C5 Lead production for PCB emissions for the entire time series the TERT noted that there may be an under-estimate of emissions. Estonia reported 'NA' (Not Applicable) in its NFR tables although there is a Tier 1 method and EF in the 2016 EMEP/EEA Guidebook. This was raised in the 2018 review (EE-2C5-2018-0001) and Estonia commented that they will address the issue no later than the 2020 submission. The TERT notes that Estonia states in its 2020 IIR (p. 276) that it was not possible to estimate PCB emissions from 2C5 due to a lack of AD. However, it is planned to make additional calculations for the 2021 submission if possible.
Despite the TERT not having an overview of Estonia's actions so far, the TERT recommends Estonia to make an overview of the sector with the most important companies/activities and try to contact a sector organization or the main companies in order to find out why no activity data can be provided. The TERT recommends Estonia to report on the outcome of these actions in its 2021 inventory.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">PCDD/F and PCB emissions for 2C5 additionally estimated for the 2000 – 2018</td><td colspan="3">Chapter 8.2.1, Table 8.48 – 8.49</td></tr>
<tr><td colspan="7"></td></tr>
</table>

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-2C7a-2019-0002	No	2C7a Copper Production, Cd, Hg, 1990-2018	No	No	No

Assessment of the implementation of the initial recommendation

For 2C7a Copper production and 2C7c Other metal production for Cd and Hg emissions the TERT noted that there is a lack of transparency regarding the allocation of emissions. 2018 emissions are reported only in 2C7c (other than Hg) and not in 2C7a but for earlier years emissions are still reported in 2C7a. This does not relate to an over- or under-estimate of emissions. This was raised during the 2019 NECD review. In response to a question raised during the review, Estonia explained that for NFR 2020 reporting and early years only particulate emissions in the 2C7a sector are included and heavy metals are included in other metal industry sectors while particulate emissions from mechanical treatment of copper pipes are still included in sector 2C7a. Estonia also stated that in next year's submission, the data will be reallocated to NFR code 2C7c.

The TERT recommends that Estonia does so and reports clearly on the changes in its IIR.

Improvement made	IIR Chapter, page
Particulates emissions from mechanical treatment of copper pipes were mistakenly reallocated from the 2C7a sector to NFR 2C1. In the next reporting year, emissions will be accounted under 2C7c	Chapter 8.2.1, Tables 8.41, 8.43

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2018 (3)	EE-2C7a-2018-0001	No	2C7a Copper Production, Cd, Pb, 1990, 2005, 2016	No	No	No

Assessment of the implementation of the initial recommendation

For 2C7a Copper production and 2C7c Other metal production for Cd and Pb emissions the TERT noted that there is a lack of transparency regarding the allocation of emissions: for 2018 emissions of Pb are reported in 2C7c and not in 2C7a, but no emissions of Cd are included. However emissions are reported in 2C7a for earlier years. This does not relate to an over- or under-estimate of emissions. This was raised during the 2018 and 2019 NECD review. In response to a question raised during the review, Estonia explained that for NFR report 2020 and early years only particulate emissions in the 2C7a sector are included and heavy metals are included in other metal industry sectors while particulate emissions from mechanical treatment of copper pipes are still included in sector 2C7a. Estonia also stated that in next year's submission, the data will be reallocated to NFR code 2C7c.

The TERT recommends that Estonia does so and reports clearly on the changes in its IIR.

Improvement made	IIR Chapter, page
Particulates emissions from mechanical treatment of copper pipes were reallocated from the 2C7a sector to NFR 2C7c	Chapter 8.2.1, Tables 8.41, 8.43

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-3F-2019-0001	No	3F Field Burning of Agricultural Residues, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, BaP, PAHs, HCB, Cd, Hg, Pb, PCDD/F, 1990, 2005, 2010, 2015, 2016, 2017	No	No	No

Assessment of the implementation of the initial recommendation

For 3F Field burning of agricultural residues and years 1990, 2005, 2010, 2015-2018 the TERT noted that Estonia is using the notation key 'NO'. This issue was raised during 2019 NECD review. The TERT noted that the issue is likely below the threshold of significance for a technical correction. The 2020 review noted that the IIR states that the issue has been included in the list of improvements and that the recommendation will be addressed in the 2021 submission. The IIR 2020 indicates that possible historical data is being analysed and results of the analysis will be incorporated in the submission 2021.

The TERT reiterates the recommendation that Estonia review the emission estimates for category 3F for all pollutants in light of the analysis of historical data, and include further justification for its reporting in 2021 submission.

Improvement made	IIR Chapter, page
The analyse it is still ongoing. By an Estonian legislative the burning of crop waste is not prohibited since 2004 and according to the knowledge of experts from Estonian Ministry of Rural Affairs widespread practice of burning agricultural waste has taken place during the previous period or it has been marginal.	Chapter 5.4

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC, or UPTC in 2019	RE, TC, or UPTC in 2020	Tier 1 used for Key Category
2019 (2)	EE-5C-2019-0001	Yes	5C1bi Industrial Waste Incineration, PCDD/F, 1990-2018	No	No	Yes

Assessment of the implementation of the initial recommendation

For 5C Waste Incineration and PCDD/F and years 1990-2018 the TERT noted that in the IIR it is stated that in addition to the facility data, the PCDD/F-emissions from both Industrial and Clinical incineration are calculated and that the emission factors for this come from the UNEP Standardized Toolkit and that this is a 'Tier 1-like' methodology used for a Key Category. The TERT notes furthermore, that Estonia would re-allocated the emissions from Industrial and Clinical waste incineration as the facilities use an energy recovery system. The TERT notes that the calculation of PCDD/F-emissions is not changed and no reallocation has taken place for incinerators with energy recovery. This does not relate to an over- or under-estimate of emissions. This was raised during the 2019 NECD review. In response to a question raised during the review, Estonia explained that the planned improvements unfortunately couldn't be realized as planned for the 2020 submission and that this was unintentionally not explained in the IIR.

The TERT reiterates the recommendation from the 2019 review that Estonia develops a country specific EF times series based on facility measurements when available (recent years) and on the basis of information on the implementation of abatement technologies for earlier years and that Estonia re-allocates the emissions of incineration plants with energy recovery to the energy sector.

Improvement made	IIR Chapter, page
Unfortunately, it was not possible to update data for this NFR source code in this (2021) submission due the change of waste expert. The analysis is still ongoing. Plans are in place t make necessary updates and recalculations for the 2022 submission.	

<table>
<tr><th>Review year of initial recommendation (number of years it has been recommended)</th><th>Observation</th><th>Key Category</th><th>NFR, Pollutant(s), Year(s)</th><th>RE, TC, or UPTC in 2019</th><th>RE, TC, or UPTC in 2020</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2018 (3)</td><td>EE-5C1biv-2018-0001</td><td>Yes</td><td>5C1biv Sewage Sludge Incineration, PCDD/F, HCB, 1990, 2005, 2016</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td colspan="7">Assessment of the implementation of the initial recommendation
For 5C1biv Sewage Sludge Incineration and PCDD/F and HCB for years 1990-2018 the TERT noted that there is a lack of transparency (and completeness) regarding the implementation of the improvement for reporting the emissions from this source and instead the notation key 'NA' is reported. The TERT noted that the issue is below the threshold of significance for a technical correction. This was raised during the 2018 NECD review. In response to a question raised during the review, Estonia explained that due to the workload the improvement could not be implemented in the 2020 submission, but that the planning now is to report the emissions from this source in the 2021 submission. The TERT reiterates the recommendation from the 2018 review that Estonia implements this improvement in their next submission.</td></tr>
<tr><td colspan="4">Improvement made</td><td colspan="3">IIR Chapter, page</td></tr>
<tr><td colspan="4">Unfortunately, it was not possible to update data for this NFR source code in this (2021) submission due the change of waste expert. The analysis is still ongoing. Plans are in place t make necessary updates and recalculations for the 2022 submission.</td><td colspan="3"></td></tr>
<tr><td colspan="7"></td></tr>
</table>

Table 8: All recommendations, revised estimates and unquantified potential technical corrections made during the NECD Review 2020 for LPS data

Review year of initial recommendation (number of years it has been recommended)	Observation	GNFR sector, Pollutant(s), Year(s)	RE or UPTC in 2020
2020 (1)	EE-LPS-GEN-2020-0001	General, PCBs, 2015	No
Recommendation For the LPS reporting, the TERT noted that emissions of several pollutants were not reported, including PCBs. In response to a question raised during the review Estonia explained that they will analyse the PCB emissions for 2015 and, if necessary, the data will be correct it in the 2021 submission. **The TERT recommends that Estonia clarifies whether any LPS emit PCBs above the threshold and report any emissions above the reporting threshold in the next submission.**			
Improvement made			IIR Chapter, page
Will be answered in May.			

Table 10: All recommendations and unquantified potential technical corrections made during the NECD Review 2020 for gridded data

Review year of initial recommendation (number of years it has been recommended)	Observation	GNFR sector, Pollutant(s), Year(s)	UPTC in 2020
2020 (1)	EE-GRID-GEN-2020-0001	General, 2015	No
Recommendation For Gridded emissions and the 2015 emissions inventory the TERT noted that there is a lack of transparency regarding Longitude and Latitude used to indicate the centre of the 0.1° x 0.1° grid cell as submitted on the 28 February 2020. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Estonia explained that due the technical reasons gridded emissions were reported at 50 x 50 square kilometres (km²). **The TERT recommends that Estonia makes improvements to the gridding methods for the 2021 submission and report emissions at 0.1° x 0.1° in accordance with the requirements outlined in Annex II of the reporting guidelines.**			
Improvement made			IIR Chapter, page
Will be answered in May.			
Review year of initial recommendation (number of years it has been recommended)	Observation	GNFR sector, Pollutant(s), Year(s)	UPTC in 2020
2020 (1)	EE-GRID-F-2020-0001	F Road Transport, NO_X, NMVOC, 2015	No
Recommendation For Gridded emissions and the 2015 emissions inventory the TERT noted that there is a lack of transparency regarding gridded emissions F_RoadTransport sector. This does not relate to an over- or under-estimate of emissions but does relate to an inaccurate representation of the distribution of emissions. In response to a question raised during the review, Estonia explained that some methods used in the gridding of emissions were inappropriate as the old GNFR sector codes were used instead. **The TERT recommends that Estonia makes improvements to the gridding methods for the 2021 submission with distributions that reflect activities in all relevant GNFR sector for all pollutants in accordance with the requirements outlined in the EMEP/EEA Guidebook.**			
Improvement made			IIR Chapter, page
Will be answered in May.			

Review year of initial recommendation (number of years it has been recommended)	Observation	GNFR sector, Pollutant(s), Year(s)	UPTC in 2020
2020 (1)	EE-GRID-F-2020-0002	F Road Transport, SO_2, NH_3, $PM_{2.5}$, PM_{10}, CO, Cd, Pb, PCDD/F, PAHs, HCB, PCBs, 2015	No

Recommendation
For Gridded emissions and the 2015 emissions inventory the TERT noted that there is a lack of transparency regarding gridded emissions F_RoadTransport sector. This does not relate to an over- or under-estimate of emissions but does relate to an inaccurate representation of the distribution of emissions. In response to a question raised during the review, Estonia explained that some methods used in the gridding of emissions were inappropriate as the old GNFR sector codes were used instead.
The TERT recommends that Estonia makes improvements to the gridding methods for the 2021 submission with distributions that reflect activities in all relevant GNFR sector for all pollutants in accordance with the requirements outlined in the EMEP/EEA Guidebook.

Improvement made	IIR Chapter, page
Will be answered in May.	

Review year of initial recommendation (number of years it has been recommended)	Observation	GNFR sector, Pollutant(s), Year(s)	UPTC in 2020
2020 (1)	EE-GRID-I-2020-0001	I Offroad, Hg, 2015	No

Recommendation
For Gridded emissions and the 2015 emissions inventory the TERT noted that there is a lack of transparency regarding gridded emissions I_Offroad sector. This does not relate to an over- or under-estimate of emissions but does relate to an inaccurate representation of the distribution of emissions. In response to a question raised during the review, Estonia explained that some methods used in the gridding of emissions were inappropriate.
The TERT recommends that Estonia makes improvements to the gridding methods for the 2021 submission with distributions that reflect activities in all relevant GNFR sector for all pollutants in accordance with the requirements outlined in the EMEP/EEA Guidebook.

Improvement made	IIR Chapter, page
Will be answered in May.	

ANNEX III – The Results of the Uncertainty Calculations by Air Pollutants and NFR Codes

NFR sector	NFR name	Pollutant	1990 emissions kt	2019 emissions kt	Activity data uncertainty %	Emission factor uncertainty %	Combined uncertainty %	Contribution to Variance by Category in Year 2019	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor uncertainty %	Uncertainty in trend in national emissions introduced by activity data uncertainty %	Uncertainty in trend in national emissions introduced into the trend in total national emissions %
1A1a	Public electricity and heat production	NO_x	25.6900	5.7669	2%	20%	20.10%	0.002122	-2.87%	7.20%	-0.57%	0.20%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	NO_x	0.0000	0.3759	2%	20%	20.10%	0.000009	0.47%	0.47%	0.09%	0.01%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NO_x	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	NO_x	5.3622	0.4457	2%	50%	50.04%	0.000079	-1.55%	0.56%	-0.77%	0.02%	0.01%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NO_x	5.6000	1.7464	2%	20%	20.10%	0.000195	-0.02%	2.18%	0.00%	0.06%	0.00%
1A3ai(i)	International aviation LTO (civil)	NO_x	0.0507	0.0836	2%	30%	30.07%	0.000001	0.08%	0.10%	0.025%	0.003%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	NO_x	0.0016	0.0019	2%	30%	30.07%	0.000000	0.002%	0.00%	0.001%	0.000%	0.00%
1A3bi	Road transport: Passenger cars	NO_x	12.9947	3.0236	2%	20%	20.10%	0.000583	-1.32%	3.78%	-0.265%	0.107%	0.00%
1A3bii	Road transport: Light duty vehicles	NO_x	1.5736	1.1501	2%	20%	20.10%	0.000084	0.82%	1.44%	0.164%	0.041%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	NO_x	10.4232	2.6298	2%	20%	20.10%	0.000441	-0.81%	3.28%	-0.161%	0.093%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	NO_x	0.1174	0.0117	2%	20%	20.10%	0.000000	-0.03%	0.01%	-0.006%	0.000%	0.00%

NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
1A3c	Railways	NO_x	2.4310	0.5717	2%	100%	100.02%	0.000516	-0.24%	0.71%	-0.240%	0.020%	0.00%
1A3dii	National navigation (shipping)	NO_x	0.5495	0.4184	2%	100%	100.02%	0.000277	0.31%	0.52%	0.307%	0.015%	0.00%
1A4ai	Commercial/institutional: Stationary	NO_x	0.3000	0.3029	2%	50%	50.04%	0.000036	0.26%	0.38%	0.130%	0.011%	0.00%
1A4aii	Commercial/institutional: Mobile	NO_x	0.3980	0.2665	2%	50%	50.04%	0.000028	0.18%	0.33%	0.088%	0.009%	0.00%
1A4bi	Residential: Stationary, liquid fuels	NO_x	0.2278	0.0241	3%	50%	50.09%	0.000000	-0.06%	0.03%	-0.030%	0.001%	0.00%
1A4bi	Residential: Stationary, solid fuels	NO_x	0.6649	0.0067	2%	50%	50.04%	0.000000	-0.25%	0.01%	-0.126%	0.000%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	NO_x	0.1331	0.1351	2%	50%	50.04%	0.000007	0.12%	0.17%	0.058%	0.005%	0.00%
1A4bi	Residential: Stationary, biomass	NO_x	3.2871	4.3189	5%	50%	50.25%	0.007438	4.10%	5.39%	2.051%	0.381%	0.04%
1A4bi	Residential: Stationary, waste	NO_x	0.0722	0.0914	50%	50%	70.71%	0.000007	0.09%	0.11%	0.043%	0.081%	0.00%
1A4bii	Residential: Household and gardening (mobile)	NO_x	0.0048	0.0374	2%	50%	50.04%	0.000001	0.04%	0.05%	0.022%	0.001%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	NO_x	0.3300	0.1695	2%	50%	50.04%	0.000011	0.08%	0.21%	0.041%	0.006%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NO_x	4.0071	0.9885	2%	50%	50.04%	0.000386	-0.34%	1.23%	-0.169%	0.035%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NO_x	0.8571	0.0520	2%	100%	100.02%	0.000004	-0.27%	0.06%	-0.272%	0.002%	0.00%
1B1c	Other fugitive emissions from solid fuels	NO_x	0.0000	0.0203	2%	50%	50.04%	0.000000	0.03%	0.03%	0.013%	0.001%	0.00%
1B2aiv	Fugitive emissions oil: Refining and storage	NO_x	0.0000	0.0015	2%	50%	50.04%	0.000000	0.00%	0.00%	0.001%	0.000%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NO_x	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2A5a	Quarrying and mining of minerals other than coal	NO_x	0.0000	0.0057	2%	50%	50.04%	0.000000	0.01%	0.01%	0.004%	0.000%	0.00%
2A6	Other mineral products	NO_x	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2B1	Ammonia production	NO_x	0.1900	0.0000	2%	50%	50.04%	0.000000	-0.07%	0.00%	-0.037%	0.000%	0.00%
2B10a	Chemical industry: Other	NO_x	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2C1	Iron and steel production	NO_x	0.0000	0.0593	2%	50%	50.04%	0.000001	0.07%	0.07%	0.037%	0.002%	0.00%
2C7c	Other metal production	NO_x	0.0000	0.0003	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2D3d	Coating applications	NO_x	0.0000	0.0000	5%	50%	50.25%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2G	Other product use	NO_x	0.0075	0.0028	5%	50%	50.25%	0.000000	0.001%	0.00%	0.000%	0.000%	0.00%
2H1	Pulp and paper industry	NO_x	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
2H2	Food and beverages industry	NO_x	0.0000	0.0017	2%	50%	50.04%	0.000000	0.00%	0.00%	0.001%	0.000%	0.00%
2I	Wood processing	NO_x	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.000%	0.000%	0.00%
3B1a	Manure management - Dairy cattle	NO_x	0.0679	0.0066	2%	100%	100.02%	0.000000	-0.018%	0.01%	-0.018%	0.000%	0.00%
3B1b	Manure management - Non-dairy cattle	NO_x	0.0418	0.0124	2%	100%	100.02%	0.000000	-0.001%	0.02%	-0.001%	0.000%	0.00%
3B2	Manure management - Sheep	NO_x	0.0019	0.0009	2%	100%	100.02%	0.000000	0.000%	0.00%	0.000%	0.000%	0.00%

NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
3B3	Manure management - Swine	NO_x	0.0054	0.0010	2%	100%	100.02%	0.000000	-0.001%	0.00%	-0.001%	0.000%	0.00%
3B4d	Manure management - Goats	NO_x	0.0000	0.0001	2%	100%	100.02%	0.000000	0.000%	0.00%	0.000%	0.000%	0.00%
3B4e	Manure management - Horses	NO_x	0.0022	0.0014	2%	100%	100.02%	0.000000	0.001%	0.00%	0.001%	0.000%	0.00%
3B4gi	Manure management - Laying hens	NO_x	0.0147	0.0037	2%	100%	100.02%	0.000000	-0.001%	0.00%	-0.001%	0.000%	0.00%
3B4gii	Manure management - Broilers	NO_x	0.0067	0.0050	2%	100%	100.02%	0.000000	0.004%	0.01%	0.004%	0.000%	0.00%
3B4giv	Manure management - Other poultry	NO_x	0.0036	0.0013	2%	100%	100.02%	0.000000	0.000%	0.00%	0.000%	0.000%	0.00%
3B4h	Manure management - Other animals	NO_x	0.0002	0.0000	2%	100%	100.02%	0.000000	0.000%	0.00%	0.000%	0.000%	0.00%
3Da1	Inorganic N-fertilizers (includes also urea application)	NO_x	2.8680	1.6575	2%	100%	100.02%	0.004340	0.944%	2.07%	0.944%	0.059%	0.01%
3Da2a	Animal manure applied to soils	NO_x	1.3289	0.5601	2%	100%	100.02%	0.000496	0.178%	0.70%	0.178%	0.020%	0.00%
3Da2b	Sewage sludge applied to soils	NO_x	0.0031	0.0027	2%	100%	100.02%	0.000000	0.002%	0.00%	0.002%	0.000%	0.00%
3Da2c	Other organic fertilisers applied to soils (including compost)	NO_x	0.0020	0.0652	2%	100%	100.02%	0.000007	0.081%	0.08%	0.081%	0.002%	0.00%
3Da3	Urine and dung deposited by grazing animals	NO_x	0.4260	0.1097	2%	100%	100.02%	0.000019	-0.030%	0.14%	-0.030%	0.004%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NO_x	0.0000	0.0011	2%	100%	100.02%	0.000000	0.001%	0.00%	0.001%	0.000%	0.00%
5C1bi	Industrial waste incineration	NO_x	0.0000	0.0113	2%	100%	100.02%	0.000000	0.014%	0.01%	0.014%	0.000%	0.00%
5C1bv	Cremation	NO_x	0.0000	0.0071	2%	100%	100.02%	0.000000	0.009%	0.01%	0.009%	0.000%	0.00%
5C2	Open burning of waste	NO_x	0.0138	0.0063	10%	100%	100.50%	0.000000	0.00%	0.01%	0.002%	0.001%	0.00%
5D2	Industrial wastewater handling	NO_x	0.0000	0.0006	2%	100%	100.02%	0.000000	0.00%	0.00%	0.001%	0.000%	0.00%
TOTAL			80.0596	25.1643				0.017089					0.0007
					% uncertainty in total inventory			13.07%		Trend uncertainty:			2.59%

NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
	A	B	C	D	E	F	G	H	I	J	K	L	M
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	NMVOC	0.9000	0.4415	2%	50%	50.04%	0.000095	0.20%	0.66%	0.10%	0.02%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	NMVOC	0.8627	0.4813	2%	50%	50.04%	0.000113	0.28%	0.72%	0.14%	0.02%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NMVOC	IE	IE	2%	50%	50.04%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	NMVOC	1.3087	0.0715	2%	50%	50.04%	0.000002	-0.56%	0.11%	-0.28%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NMVOC	0.6200	0.7484	2%	50%	50.04%	0.000272	0.81%	1.12%	0.40%	0.03%	0.00%
1A3ai(i)	International aviation LTO (civil)	NMVOC	0.0096	0.0124	2%	30%	30.07%	0.000000	0.014%	0.019%	0.004%	0.001%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	NMVOC	0.0025	0.0028	2%	30%	30.07%	0.000000	0.003%	0.004%	0.001%	0.000%	0.00%
1A3bi	Road transport: Passenger cars	NMVOC	10.3324	0.8935	2%	20%	20.10%	0.000063	-3.945%	1.343%	-0.789%	0.038%	0.01%
1A3bii	Road transport: Light duty vehicles	NMVOC	0.7875	0.0606	2%	20%	20.10%	0.000000	-0.312%	0.091%	-0.062%	0.003%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	NMVOC	2.4899	0.0803	2%	20%	20.10%	0.000001	-1.155%	0.121%	-0.231%	0.003%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	NMVOC	0.4671	0.0510	2%	20%	20.10%	0.000000	-0.163%	0.077%	-0.033%	0.002%	0.00%
1A3bv	Road transport: Gasoline evaporation	NMVOC	3.4187	0.2691	2%	20%	20.10%	0.000006	-1.347%	0.404%	-0.269%	0.011%	0.00%
1A3c	Railways	NMVOC	0.2245	0.0507	2%	100%	100.02%	0.000005	-0.039%	0.076%	-0.039%	0.002%	0.00%
1A3dii	National navigation (shipping)	NMVOC	0.0196	0.0149	2%	100%	100.02%	0.000000	0.012%	0.022%	0.012%	0.001%	0.00%
1A4ai	Commercial/institutional: Stationary	NMVOC	0.0600	0.0654	2%	50%	50.04%	0.000002	0.068%	0.098%	0.034%	0.003%	0.00%
1A4aii	Commercial/institutional: Mobile	NMVOC	0.6026	0.0472	2%	50%	50.04%	0.000001	-0.238%	0.071%	-0.119%	0.002%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, liquid fuels	NMVOC	0.0029	0.0006	3%	50%	50.09%	0.000000	-0.001%	0.001%	0.000%	0.000%	0.00%
1A4bi	Residential: Stationary, solid fuels	NMVOC	3.3400	0.0171	2%	50%	50.04%	0.000000	-1.685%	0.026%	-0.842%	0.001%	0.01%
1A4bi	Residential: Stationary, gaseous fuels	NMVOC	0.0047	0.0047	2%	50%	50.04%	0.000000	0.005%	0.007%	0.002%	0.000%	0.00%
1A4bi	Residential: Stationary, biomass	NMVOC	2.3885	2.9714	5%	50%	50.25%	0.004329	3.240%	4.465%	1.620%	0.316%	0.03%
1A4bi	Residential: Stationary, waste	NMVOC	0.0612	0.0775	50%	50%	70.71%	0.000006	0.085%	0.117%	0.043%	0.082%	0.00%
1A4bii	Residential: Household and gardening (mobile)	NMVOC	0.1198	0.2703	2%	50%	50.04%	0.000036	0.345%	0.406%	0.172%	0.011%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	NMVOC	0.0400	0.0184	2%	50%	50.04%	0.000000	0.007%	0.028%	0.004%	0.001%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NMVOC	1.3801	0.0914	2%	50%	50.04%	0.000004	-0.570%	0.137%	-0.285%	0.004%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NMVOC	0.1639	0.0019	2%	100%	100.02%	0.000000	-0.081%	0.003%	-0.081%	0.000%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	NMVOC	0.0000	0.1350	2%	50%	50.04%	0.000009	0.203%	0.203%	0.101%	0.006%	0.00%
1B2av	Distribution of oil products	NMVOC	2.3780	0.7131	2%	50%	50.04%	0.000247	-0.147%	1.072%	-0.073%	0.030%	0.00%
1B2b	Fugitive emissions from natural gas	NMVOC	0.0960	0.0129	2%	50%	50.04%	0.000000	-0.030%	0.019%	-0.015%	0.001%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NMVOC	0.0000	0.0000	2%	50%	50.04%	0.000000	0.000%	0.000%	0.000%	0.000%	0.00%
2B1	Ammonia production	NMVOC	0.0052	0.0000	2%	50%	50.04%	0.000000	-0.003%	0.000%	-0.001%	0.000%	0.00%
2B10a	Chemical industry: Other	NMVOC	13.3000	0.0281	2%	50%	50.04%	0.000000	-6.758%	0.042%	-3.379%	0.001%	0.11%
2B10b	Storage, handling and transport of chemical products	NMVOC	0.0000	0.0059	2%	50%	50.04%	0.000000	0.009%	0.009%	0.004%	0.000%	0.00%
2C1	Iron and steel production	NMVOC	0.0000	0.0132	2%	50%	50.04%	0.000000	0.020%	0.020%	0.010%	0.001%	0.00%
2C3	Aluminium production	NMVOC	0.0000	0.0022	2%	50%	50.04%	0.000000	0.003%	0.003%	0.002%	0.000%	0.00%
2C7c	Other metal production	NMVOC	0.0000	0.0014	2%	50%	50.04%	0.000000	0.002%	0.002%	0.001%	0.000%	0.00%
2D3a	Domestic solvent use including fungicides	NMVOC	4.0679	3.1087	2%	50%	50.04%	0.004698	2.585%	4.671%	1.293%	0.132%	0.02%
2D3b	Road paving with asphalt	NMVOC	0.0270	0.0260	2%	100%	100.02%	0.000001	0.025%	0.039%	0.025%	0.001%	0.00%
2D3d	Coating applications	NMVOC	2.2421	4.5466	2%	50%	50.04%	0.010050	5.681%	6.831%	2.840%	0.193%	0.08%
2D3e	Degreasing	NMVOC	0.1795	0.0678	10%	30%	31.62%	0.000001	0.010%	0.102%	0.003%	0.014%	0.00%
2D3f	Dry cleaning	NMVOC	0.0146	0.0062	10%	50%	50.99%	0.000000	0.002%	0.009%	0.001%	0.001%	0.00%
2D3g	Chemical products	NMVOC	0.4959	0.1111	2%	20%	20.10%	0.000001	-0.087%	0.167%	-0.017%	0.005%	0.00%
2D3h	Printing	NMVOC	0.0798	0.5281	2%	100%	100.02%	0.000542	0.753%	0.793%	0.753%	0.022%	0.01%
2D3i	Other solvent use	NMVOC	1.2644	1.0397	5%	50%	50.25%	0.000530	0.914%	1.562%	0.457%	0.110%	0.00%
2G	Other product use	NMVOC	0.0531	0.0509	5%	50%	50.25%	0.000001	0.049%	0.077%	0.025%	0.005%	0.00%
2H1	Pulp and paper industry	NMVOC	0.2200	0.0357	2%	50%	50.04%	0.000001	-0.059%	0.054%	-0.030%	0.002%	0.00%
2H2	Food and beverages industry	NMVOC	1.7884	0.7247	2%	50%	50.04%	0.000255	0.173%	1.089%	0.086%	0.031%	0.00%
2I	Wood processing	NMVOC	0.0000	0.0184	2%	50%	50.04%	0.000000	0.028%	0.028%	0.014%	0.001%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	NMVOC	0.0000	0.0000	2%	50%	50.04%	0.000000	0.000%	0.000%	0.000%	0.000%	0.00%
3B1a	Manure management - Dairy cattle	NMVOC	3.1439	2.1850	2%	100%	100.02%	0.009273	1.671%	3.283%	1.671%	0.093%	0.03%
3B1b	Manure management - Non-dairy cattle	NMVOC	4.2472	1.5044	2%	100%	100.02%	0.004396	0.084%	2.260%	0.084%	0.064%	0.00%
3B2	Manure management - Sheep	NMVOC	0.0442	0.0198	2%	100%	100.02%	0.000001	0.007%	0.030%	0.007%	0.001%	0.00%
3B3	Manure management - Swine	NMVOC	0.8506	0.1928	2%	100%	100.02%	0.000072	-0.146%	0.290%	-0.146%	0.008%	0.00%
3B4d	Manure management - Goats	NMVOC	0.0013	0.0029	2%	100%	100.02%	0.000000	0.004%	0.004%	0.004%	0.000%	0.00%
3B4e	Manure management - Horses	NMVOC	0.0669	0.0444	2%	100%	100.02%	0.000004	0.032%	0.067%	0.032%	0.002%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B4gi	Manure management - Laying hens	NMVOC	0.3670	0.0929	2%	100%	100.02%	0.000017	-0.048%	0.140%	-0.048%	0.004%	0.00%
3B4gii	Manure management - Broilers	NMVOC	0.2108	0.1570	2%	100%	100.02%	0.000048	0.128%	0.236%	0.128%	0.007%	0.00%
3B4giv	Manure management - Other poultry	NMVOC	0.6159	0.2240	2%	100%	100.02%	0.000097	0.021%	0.337%	0.021%	0.010%	0.00%
3B4h	Manure management - Other animals	NMVOC	0.4480	0.0075	2%	100%	100.02%	0.000000	-0.218%	0.011%	-0.218%	0.000%	0.00%
3De	Cultivated crops	NMVOC	0.6055	0.1740	2%	100%	100.02%	0.000059	-0.049%	0.261%	-0.049%	0.007%	0.00%
5A	Biological treatment of waste - Solid waste disposal on land	NMVOC	0.1347	0.1281	2%	100%	100.02%	0.000032	0.123%	0.192%	0.123%	0.005%	0.00%
5B1	Biological treatment of waste - Composting	NMVOC	0.0000	0.0090	2%	100%	100.02%	0.000000	0.014%	0.014%	0.014%	0.000%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NMVOC	0.0000	0.0000	2%	100%	100.02%	0.000000	0.000%	0.000%	0.000%	0.000%	0.00%
5C1bi	Industrial waste incineration	NMVOC	0.0000	0.0011	2%	100%	100.02%	0.000000	0.002%	0.002%	0.002%	0.000%	0.00%
5C1bv	Cremation	NMVOC	0.0000	0.0001	2%	100%	100.02%	0.000000	0.000%	0.000%	0.000%	0.000%	0.00%
5C2	Open burning of waste	NMVOC	0.0002	0.0001	10%	100%	100.50%	0.000000	0.00003%	0.000%	0.000%	0.000%	0.00%
5D1	Domestic wastewater handling	NMVOC	0.0000	0.0160	2%	100%	100.02%	0.000000	0.02401%	0.024%	0.024%	0.001%	0.00%
5D2	Industrial wastewater handling	NMVOC	0.0000	0.0010	2%	100%	100.02%	0.000000	0.00148%	0.001%	0.001%	0.000%	0.00%
5E	Other waste	NMVOC	0.0000	0.0147	2%	100%	100.02%	0.000000	0.02213%	0.022%	0.022%	0.001%	0.00%
TOTAL			66.5546	22.6944				0.035272					0.0030
					% uncertainty in total inventory			18.78%		Trend uncertainty:			5.44%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	SO_x (SO_2)	220.4000	11.2488	2%	10%	10.20%	0.003690	-1.41%	4.09%	-0.14%	0.12%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	SO_x (SO_2)	0.4800	2.3964	2%	10%	10.20%	0.000167	0.86%	0.87%	0.09%	0.02%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	SO_x (SO_2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	SO_x (SO_2)	38.5100	4.5177	2%	10%	10.20%	0.000595	0.68%	1.64%	0.07%	0.05%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	SO_x (SO_2)	1.6320	0.0007	2%	50%	50.04%	0.000000	-0.04%	0.00%	-0.02%	0.00%	0.00%
1A3ai(i)	International aviation LTO (civil)	SO_x (SO_2)	0.0053	0.0079	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	SO_x (SO_2)	0.0003	0.0003	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	SO_x (SO_2)	0.9010	0.0051	2%	20%	20.10%	0.000000	-0.02%	0.00%	0.00%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	SO_x (SO_2)	0.3209	0.0010	2%	20%	20.10%	0.000000	-0.01%	0.00%	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	SO_x (SO_2)	1.9671	0.0016	2%	20%	20.10%	0.000000	-0.05%	0.00%	-0.01%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	SO_x (SO_2)	0.0235	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3c	Railways	SO_x (SO_2)	0.5671	0.0002	2%	50%	50.04%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
1A3dii	National navigation (shipping)	SO_x (SO_2)	0.0700	0.0107	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	SO_x (SO_2)	1.3000	0.0584	2%	20%	20.10%	0.000000	-0.01%	0.02%	0.00%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	SO_x (SO_2)	0.1240	0.0002	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	SO_x (SO_2)	0.3055	0.0118	3%	20%	20.22%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, solid fuels	SO_x (SO_2)	4.9835	0.0306	2%	20%	20.10%	0.000000	-0.11%	0.01%	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	SO_x (SO_2)	0.0007	0.0007	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	SO_x (SO_2)	0.0740	0.1910	5%	20%	20.62%	0.000004	0.07%	0.07%	0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, waste	SO_x (SO_2)	0.0063	0.0080	50%	50%	70.71%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bii	Residential: Household and gardening (mobile)	SO_x (SO_2)	0.0022	0.0001	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	SO_x (SO_2)	1.7800	0.2816	2%	20%	20.10%	0.000009	0.06%	0.10%	0.01%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	SO_x (SO_2)	1.1682	0.0014	2%	50%	50.04%	0.000000	-0.03%	0.00%	-0.01%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	SO_x (SO_2)	0.1098	0.0013	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	SO_x (SO_2)	0.0000	0.0236	2%	20%	20.10%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	SO_x (SO_2)	0.0000	0.0018	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	SO_x (SO_2)	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	SO_x (SO_2)	0.0000	0.0002	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	SO_x (SO_2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	SO_x (SO_2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	SO_x (SO_2)	0.0000	0.0015	5%	50%	50.25%	0.000000	0.0005%	0.00%	0.00%	0.00%	0.00%
2H2	Food and beverages industry	SO_x (SO_2)	0.0000	0.0000	2%	50%	50.04%	0.000000	0.0000%	0.00%	0.00%	0.00%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	SO_x (SO_2)	0.0000	0.0025	2%	50%	50.04%	0.000000	0.0009%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	SO_x (SO_2)	0.0000	0.0715	2%	50%	50.04%	0.000004	0.0260%	0.03%	0.01%	0.00%	0.00%
5C1bv	Cremation	SO_x (SO_2)	0.0000	0.0010	2%	50%	50.04%	0.000000	0.0004%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	SO_x (SO_2)	0.0130	0.0059	10%	50%	50.99%	0.000000	0.002%	0.00%	0.00%	0.00%	0.00%
5D2	Industrial wastewater handling	SO_x (SO_2)	0.0000	0.0001	2%	50%	50.04%	0.000000	0.000%	0.00%	0.00%	0.00%	0.00%
TOTAL			274.7444	18.8838				0.004471					0.000005
					% uncertainty in total inventory			6.69%		Trend uncertainty:			0.22%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	NH_3	0.0806	0.2179	2%	50%	50.04%	0.000106	0.83%	1.01%	0.41%	0.03%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	NH_3	0.0000	0.2371	2%	50%	50.04%	0.000125	1.10%	1.10%	0.55%	0.03%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	NH_3	0.0012	0.0003	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NH3	0.0095	0.2576	2%	50%	50.04%	0.000148	1.17%	1.19%	0.59%	0.03%	0.00%
1A3bi	Road transport: Passenger cars	NH_3	0.0107	0.1226	2%	20%	20.10%	0.000005	0.54%	0.57%	0.11%	0.02%	0.00%
1A3bii	Road transport: Light duty vehicles	NH_3	0.0010	0.0058	2%	20%	20.10%	0.000000	0.02%	0.03%	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	NH_3	0.0039	0.0126	2%	20%	20.10%	0.000000	0.05%	0.06%	0.01%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	NH_3	0.0006	0.0001	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3c	Railways	NH_3	0.0003	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	NH_3	0.0144	0.0352	2%	50%	50.04%	0.000003	0.13%	0.16%	0.07%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	NH_3	0.0001	0.0002	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	NH_3	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	NH_3	0.0020	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	NH_3	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	NH_3	0.0216	0.0434	5%	100%	100.12%	0.000017	0.15%	0.20%	0.15%	0.01%	0.00%
1A4bi	Residential: Stationary, waste	NH_3	0.0010	0.0012	50%	100%	111.80%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A4bii	Residential: Household and gardening (mobile)	NH3	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	NH3	0.0073	0.0104	2%	50%	50.04%	0.000000	0.03%	0.05%	0.02%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NH_3	0.0009	0.0006	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	NH_3	0.0000	0.0968	2%	50%	50.04%	0.000021	0.45%	0.45%	0.22%	0.01%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	NH_3	0.0000	0.0004	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2B1	Ammonia production	NH3	0.0218	0.0000	2%	20%	20.10%	0.000000	-0.05%	0.00%	-0.01%	0.00%	0.00%
2B10a	Chemical industry: Other	NH_3	0.3482	0.0000	2%	20%	20.10%	0.000000	-0.79%	0.00%	-0.16%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	NH_3	0.0000	0.0171	2%	20%	20.10%	0.000000	0.08%	0.08%	0.02%	0.00%	0.00%
2C1	Iron and steel production	NH_3	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
2C7c	Other metal production	NH_3	0.1600	0.0667	2%	200%	200.01%	0.000158	-0.06%	0.31%	-0.11%	0.01%	0.00%
2D3g	Chemical products	NH_3	0.0000	0.0018	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
2D3i	Other solvent use	NH_3	0.0000	0.0000	5%	100%	100.12%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	NH_3	0.0173	0.0061	5%	50%	50.25%	0.000000	-0.01%	0.03%	-0.01%	0.00%	0.00%
2H2	Food and beverages industry	NH_3	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	NH_3	0.1370	0.0050	2%	200%	200.01%	0.000001	-0.29%	0.02%	-0.58%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	NH_3	2.8285	2.8077	2%	100%	100.02%	0.070269	6.57%	13.02%	6.57%	0.37%	0.43%
3B1b	Manure management - Non-dairy cattle	NH_3	1.5657	0.7742	2%	100%	100.02%	0.005343	0.02%	3.59%	0.02%	0.10%	0.00%
3B2	Manure management - Sheep	NH_3	0.0634	0.0283	2%	100%	100.02%	0.000007	-0.01%	0.13%	-0.01%	0.00%	0.00%
3B3	Manure management - Swine	NH_3	2.5329	0.7447	2%	100%	100.02%	0.004943	-2.32%	3.45%	-2.32%	0.10%	0.05%
3B4d	Manure management - Goats	NH_3	0.0008	0.0019	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
3B4e	Manure management - Horses	NH_3	0.0602	0.0399	2%	100%	100.02%	0.000014	0.05%	0.19%	0.05%	0.01%	0.00%
3B4gi	Manure management - Laying hens	NH_3	0.3444	0.0871	2%	100%	100.02%	0.000068	-0.38%	0.40%	-0.38%	0.01%	0.00%
3B4gii	Manure management - Broilers	NH_3	0.2670	0.1988	2%	100%	100.02%	0.000352	0.31%	0.92%	0.31%	0.03%	0.00%
3B4giv	Manure management - Other poultry	NH_3	0.4878	0.1774	2%	100%	100.02%	0.000281	-0.29%	0.82%	-0.29%	0.02%	0.00%
3B4h	Manure management - Other animals	NH_3	0.0046	0.0001	2%	100%	100.02%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
3Da1	Inorganic N-fertilizers (includes also urea application)	NH_3	3.6421	1.8133	2%	100%	100.02%	0.029311	0.11%	8.41%	0.11%	0.24%	0.00%
3Da2a	Animal manure applied to soils	NH_3	7.6374	2.2117	2%	100%	100.02%	0.043604	-7.12%	10.26%	-7.12%	0.29%	0.51%
3Da2b	Sewage sludge applied to soils	NH_3	0.0107	0.0090	2%	100%	100.02%	0.000001	0.02%	0.04%	0.02%	0.00%	0.00%
3Da2c	Other organic fertilisers applied to soils (including compost)	NH_3	0.0040	0.1304	2%	100%	100.02%	0.000152	0.60%	0.60%	0.60%	0.02%	0.00%
3Da3	Urine and dung deposited by grazing animals	NH_3	1.2673	0.3750	2%	100%	100.02%	0.001254	-1.15%	1.74%	-1.15%	0.05%	0.01%
5A	Biological treatment of waste - Solid waste disposal on land	NH_3	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5B1	Biological treatment of waste - Composting	NH_3	0.0016	0.0535	2%	50%	50.04%	0.000006	0.24%	0.25%	0.12%	0.01%	0.00%
5C1bi	Industrial waste incineration	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5D1	Domestic wastewater handling	NH_3	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5D2	Other wastewater handling	NH_3	0.0000	0.0012	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
TOTAL			21.5579	10.5938				0.156189					0.0103
					% uncertainty in total inventory			39.52%		Trend uncertainty:			10.14%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	2000 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	$PM_{2.5}$	7.3066	1.1528	2%	20%	20.10%	0.001553	-10.61%	7.49%	-2.12%	0.21%	0.05%
1A1c	Manufacture of solid fuels and other energy industries	$PM_{2.5}$	0.3600	0.1763	2%	20%	20.10%	0.000036	0.25%	1.15%	0.05%	0.03%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	$PM_{2.5}$	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	$PM_{2.5}$	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	$PM_{2.5}$	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	$PM_{2.5}$	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	$PM_{2.5}$	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	$PM_{2.5}$	0.5946	0.0564	2%	20%	20.10%	0.000004	-1.11%	0.37%	-0.22%	0.01%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	$PM_{2.5}$	0.0514	0.0209	2%	50%	50.04%	0.000003	0.01%	0.14%	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	$PM_{2.5}$	1.0676	1.2027	2%	20%	20.10%	0.001690	5.16%	7.82%	1.03%	0.22%	0.01%
1A3ai(i)	International aviation LTO (civil)	$PM_{2.5}$	0.0003	0.0005	2%	30%	30.07%	0.000000	0.002%	0.0030%	0.0007%	0.0001%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	$PM_{2.5}$	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	$PM_{2.5}$	0.1105	0.1349	2%	20%	20.10%	0.000021	0.60%	0.88%	0.12%	0.02%	0.00%
1A3bii	Road transport: Light duty vehicles	$PM_{2.5}$	0.2041	0.0362	2%	20%	20.10%	0.000002	-0.27%	0.24%	-0.05%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	$PM_{2.5}$	0.2952	0.0430	2%	20%	20.10%	0.000002	-0.45%	0.28%	-0.09%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	$PM_{2.5}$	0.0003	0.0008	2%	20%	20.10%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	$PM_{2.5}$	0.0622	0.1091	2%	20%	20.10%	0.000014	0.55%	0.71%	0.11%	0.02%	0.00%
1A3bvii	Road transport: Automobile road abrasion	$PM_{2.5}$	0.0368	0.0562	2%	20%	20.10%	0.000004	0.27%	0.37%	0.05%	0.01%	0.00%
1A3c	Railways	$PM_{2.5}$	0.0596	0.0149	2%	100%	100.02%	0.000006	-0.05%	0.10%	-0.05%	0.00%	0.00%
1A3dii	National navigation (shipping)	$PM_{2.5}$	0.0098	0.0075	2%	100%	100.02%	0.000002	0.02%	0.05%	0.02%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4ai	Commercial/institutional: Stationary	$PM_{2.5}$	0.3302	0.0923	2%	20%	20.10%	0.000010	-0.22%	0.60%	-0.04%	0.02%	0.00%
1A4aii	Commercial/institutional: Mobile	$PM_{2.5}$	0.0209	0.0135	2%	50%	50.04%	0.000001	0.04%	0.09%	0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	$PM_{2.5}$	0.0015	0.0008	3%	20%	20.22%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	$PM_{2.5}$	0.3991	0.0128	2%	20%	20.10%	0.000000	-0.91%	0.08%	-0.18%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	$PM_{2.5}$	0.0031	0.0042	2%	20%	20.10%	0.000000	0.02%	0.03%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	$PM_{2.5}$	2.9495	1.6779	5%	20%	20.62%	0.003461	3.57%	10.91%	0.71%	0.77%	0.01%
1A4bi	Residential: Stationary, waste	$PM_{2.5}$	0.4833	0.4103	50%	50%	70.71%	0.002435	1.47%	2.67%	0.73%	1.89%	0.04%
1A4bii	Residential: Household and gardening (mobile)	$PM_{2.5}$	0.0105	0.0102	2%	50%	50.04%	0.000001	0.04%	0.07%	0.02%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	$PM_{2.5}$	0.1501	0.0822	2%	20%	20.10%	0.000008	0.16%	0.53%	0.03%	0.02%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	$PM_{2.5}$	0.0715	0.0359	2%	50%	50.04%	0.000009	0.06%	0.23%	0.03%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	$PM_{2.5}$	0.0030	0.0009	2%	100%	100.02%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	$PM_{2.5}$	0.0100	0.0033	2%	100%	100.02%	0.000000	0.00%	0.02%	0.00%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	$PM_{2.5}$	0.0000	0.0064	2%	100%	100.02%	0.000001	0.04%	0.04%	0.04%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	$PM_{2.5}$	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A1	Cement production	$PM_{2.5}$	0.0075	0.0186	2%	50%	50.04%	0.000002	0.10%	0.12%	0.05%	0.00%	0.00%
2A2	Lime production	$PM_{2.5}$	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A3	Glass production	$PM_{2.5}$	0.0000	0.0014	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	$PM_{2.5}$	0.0000	0.0092	2%	100%	100.02%	0.000002	0.06%	0.06%	0.06%	0.00%	0.00%
2A5b	Construction and demolition	$PM_{2.5}$	0.0496	0.1025	5%	100%	100.12%	0.000305	0.54%	0.67%	0.54%	0.05%	0.00%
2A6	Other mineral products	$PM_{2.5}$	0.0710	0.0000	2%	50%	50.04%	0.000000	-0.18%	0.00%	-0.09%	0.00%	0.00%
2B10a	Chemical industry: Other	$PM_{2.5}$	0.0892	0.0008	2%	50%	50.04%	0.000000	-0.22%	0.01%	-0.11%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	$PM_{2.5}$	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	$PM_{2.5}$	0.0186	0.0209	2%	50%	50.04%	0.000003	0.09%	0.14%	0.04%	0.00%	0.00%
2C3	Aluminium production	$PM_{2.5}$	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	$PM_{2.5}$	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C6	Zinc production	$PM_{2.5}$	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C7c	Other metal production	$PM_{2.5}$	0.0002	0.0007	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	$PM_{2.5}$	0.0007	0.0016	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
2G	Other product use	$PM_{2.5}$	0.0561	0.0692	5%	50%	50.25%	0.000035	0.31%	0.45%	0.16%	0.03%	0.00%
2H1	Pulp and paper industry	$PM_{2.5}$	0.0840	0.0237	2%	50%	50.04%	0.000004	-0.05%	0.15%	-0.03%	0.00%	0.00%
2H2	Food and beverages industry	$PM_{2.5}$	0.0011	0.0066	2%	100%	100.02%	0.000001	0.04%	0.04%	0.04%	0.00%	0.00%
2I	Wood processing	$PM_{2.5}$	0.0000	0.0533	2%	100%	100.02%	0.000082	0.35%	0.35%	0.35%	0.01%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	$PM_{2.5}$	0.0000	0.0079	2%	100%	100.02%	0.000002	0.05%	0.05%	0.05%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	$PM_{2.5}$	0.0537	0.0349	2%	100%	100.02%	0.000035	0.09%	0.23%	0.09%	0.01%	0.00%
3B1b	Manure management - Non-dairy cattle	$PM_{2.5}$	0.0170	0.0248	2%	100%	100.02%	0.000018	0.12%	0.16%	0.12%	0.00%	0.00%
3B2	Manure management - Sheep	$PM_{2.5}$	0.0007	0.0014	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
3B3	Manure management - Swine	$PM_{2.5}$	0.0016	0.0015	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B4d	Manure management - Goats	$PM_{2.5}$	0.0001	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	$PM_{2.5}$	0.0006	0.0008	2%	100%	100.02%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	$PM_{2.5}$	0.0022	0.0017	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
3B4gii	Manure management - Broilers	$PM_{2.5}$	0.0012	0.0029	2%	100%	100.02%	0.000000	0.02%	0.02%	0.02%	0.00%	0.00%
3B4giv	Manure management - Other poultry	$PM_{2.5}$	0.0063	0.0092	2%	100%	100.02%	0.000002	0.04%	0.06%	0.04%	0.00%	0.00%
3B4h	Manure management - Other animals	$PM_{2.5}$	0.0002	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	$PM_{2.5}$	0.0272	0.0353	2%	100%	100.02%	0.000036	0.16%	0.23%	0.16%	0.01%	0.00%
5A	Biological treatment of waste - Solid waste disposal on land	$PM_{2.5}$	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	$PM_{2.5}$	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	$PM_{2.5}$	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	$PM_{2.5}$	0.1050	0.0321	10%	100%	100.50%	0.000030	-0.05%	0.21%	-0.05%	0.03%	0.00%
5E	Other waste	$PM_{2.5}$	0.1995	0.0548	2%	100%	100.02%	0.000087	-0.14%	0.36%	-0.14%	0.01%	0.00%
TOTAL			15.3851	5.8795				0.009911					0.0012
					% uncertainty in total inventory			9.96%		Trend uncertainty:			3.40%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	2000 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PM_{10}	20.5766	1.6137	2%	20%	20.10%	0.001233	-13.30%	5.02%	-2.66%	0.14%	0.07%
1A1c	Manufacture of solid fuels and other energy industries	PM_{10}	0.8200	0.3752	2%	20%	20.10%	0.000067	0.43%	1.17%	0.09%	0.03%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	PM_{10}	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	PM_{10}	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	PM_{10}	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	PM_{10}	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	PM_{10}	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	PM_{10}	1.4013	0.0677	2%	20%	20.10%	0.000002	-1.04%	0.21%	-0.21%	0.01%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	PM_{10}	0.0514	0.0209	2%	50%	50.04%	0.000001	0.02%	0.07%	0.01%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PM_{10}	1.2779	1.2927	2%	20%	20.10%	0.000791	2.88%	4.02%	0.58%	0.11%	0.00%
1A3ai(i)	International aviation LTO (civil)	PM_{10}	0.0003	0.0005	2%	30%	30.07%	0.000000	0.001%	0.0015%	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	PM_{10}	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	PM_{10}	0.1105	0.1349	2%	20%	20.10%	0.000009	0.32%	0.42%	0.06%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	PM_{10}	0.2041	0.0362	2%	20%	20.10%	0.000001	-0.07%	0.11%	-0.01%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PM_{10}	0.2952	0.0430	2%	20%	20.10%	0.000001	-0.13%	0.13%	-0.03%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PM_{10}	0.0003	0.0008	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	PM_{10}	0.1169	0.2025	2%	20%	20.10%	0.000019	0.53%	0.63%	0.11%	0.02%	0.00%
1A3bvii	Road transport: Automobile road abrasion	PM_{10}	0.0682	0.1041	2%	20%	20.10%	0.000005	0.26%	0.32%	0.05%	0.01%	0.00%
1A3c	Railways	PM_{10}	0.0626	0.0157	2%	100%	100.02%	0.000003	-0.01%	0.05%	-0.01%	0.00%	0.00%
1A3dii	National navigation (shipping)	PM_{10}	0.0105	0.0080	2%	100%	100.02%	0.000001	0.02%	0.02%	0.02%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4ai	Commercial/institutional: Stationary	PM_{10}	0.4502	0.1162	2%	20%	20.10%	0.000006	-0.04%	0.36%	-0.01%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	PM_{10}	0.0209	0.0135	2%	50%	50.04%	0.000001	0.02%	0.04%	0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	PM_{10}	0.0015	0.0008	3%	20%	20.22%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	PM_{10}	0.4099	0.0136	2%	20%	20.10%	0.000000	-0.32%	0.04%	-0.06%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	PM_{10}	0.0031	0.0042	2%	20%	20.10%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	PM_{10}	3.0557	1.7374	5%	20%	20.62%	0.001503	2.67%	5.41%	0.53%	0.38%	0.00%
1A4bi	Residential: Stationary, waste	PM_{10}	0.5088	0.4319	50%	50%	70.71%	0.001093	0.89%	1.34%	0.44%	0.95%	0.01%
1A4bii	Residential: Household and gardening (mobile)	PM_{10}	0.0105	0.0102	2%	50%	50.04%	0.000000	0.02%	0.03%	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PM_{10}	0.1601	0.0998	2%	20%	20.10%	0.000005	0.17%	0.31%	0.03%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	PM_{10}	0.0715	0.0359	2%	50%	50.04%	0.000004	0.05%	0.11%	0.02%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PM_{10}	0.0032	0.0010	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	PM_{10}	0.0500	0.0325	2%	100%	100.02%	0.000012	0.06%	0.10%	0.06%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	PM_{10}	0.0000	0.0125	2%	100%	100.02%	0.000002	0.04%	0.04%	0.04%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	PM_{10}	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A1	Cement production	PM_{10}	0.0135	0.0333	2%	50%	50.04%	0.000003	0.09%	0.10%	0.05%	0.00%	0.00%
2A2	Lime production	PM_{10}	0.0000	0.0005	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A3	Glass production	PM_{10}	0.0000	0.0016	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	PM_{10}	0.0000	0.0884	2%	100%	100.02%	0.000092	0.28%	0.28%	0.28%	0.01%	0.00%
2A5b	Construction and demolition	PM_{10}	0.4956	1.0251	5%	100%	100.12%	0.012346	2.75%	3.19%	2.75%	0.23%	0.08%
2A6	Other mineral products	PM_{10}	0.2129	0.0001	2%	100%	100.02%	0.000000	-0.19%	0.00%	-0.19%	0.00%	0.00%
2B10a	Chemical industry: Other	PM_{10}	0.1626	0.0025	2%	50%	50.04%	0.000000	-0.14%	0.01%	-0.07%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	PM_{10}	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	PM_{10}	0.0239	0.0269	2%	50%	50.04%	0.000002	0.06%	0.08%	0.03%	0.00%	0.00%
2C3	Aluminium production	PM_{10}	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	PM_{10}	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C6	Zinc production	PM_{10}	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C7c	Other metal production	PM_{10}	0.0002	0.0009	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	PM_{10}	0.0133	0.0325	2%	100%	100.02%	0.000012	0.09%	0.10%	0.09%	0.00%	0.00%
2D3d	Coating applications	PM_{10}	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	PM_{10}	0.0595	0.0928	5%	50%	50.25%	0.000025	0.24%	0.29%	0.12%	0.02%	0.00%
2H1	Pulp and paper industry	PM_{10}	0.1120	0.0317	2%	50%	50.04%	0.000003	0.00%	0.10%	0.00%	0.00%	0.00%
2H2	Food and beverages industry	PM_{10}	0.0033	0.0198	2%	100%	100.02%	0.000005	0.06%	0.06%	0.06%	0.00%	0.00%
2I	Wood processing	PM_{10}	0.0000	0.1587	2%	100%	100.02%	0.000295	0.49%	0.49%	0.49%	0.01%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	PM_{10}	0.0000	0.0306	2%	100%	100.02%	0.000011	0.10%	0.10%	0.10%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	PM_{10}	0.0825	0.0536	2%	100%	100.02%	0.000034	0.09%	0.17%	0.09%	0.00%	0.00%
3B1b	Manure management - Non-dairy cattle	PM_{10}	0.0262	0.0378	2%	100%	100.02%	0.000017	0.09%	0.12%	0.09%	0.00%	0.00%
3B2	Manure management - Sheep	PM_{10}	0.0020	0.0043	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B3	Manure management - Swine	PM_{10}	0.0359	0.0327	2%	100%	100.02%	0.000013	0.07%	0.10%	0.07%	0.00%	0.00%
3B4d	Manure management - Goats	PM_{10}	0.0002	0.0003	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	PM_{10}	0.0009	0.0013	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	PM_{10}	0.0289	0.0225	2%	100%	100.02%	0.000006	0.04%	0.07%	0.04%	0.00%	0.00%
3B4gii	Manure management - Broilers	PM_{10}	0.0123	0.0291	2%	100%	100.02%	0.000010	0.08%	0.09%	0.08%	0.00%	0.00%
3B4giv	Manure management - Other poultry	PM_{10}	0.0439	0.0641	2%	100%	100.02%	0.000048	0.16%	0.20%	0.16%	0.01%	0.00%
3B4h	Manure management - Other animals	PM_{10}	0.0004	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	PM_{10}	0.7060	0.9171	2%	100%	100.02%	0.009860	2.22%	2.85%	2.22%	0.08%	0.05%
5A	Biological treatment of waste - Solid waste disposal on land	PM_{10}	0.0001	0.0004	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	PM_{10}	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	PM_{10}	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	PM_{10}	0.1563	0.0478	10%	100%	100.50%	0.000027	0.01%	0.15%	0.01%	0.02%	0.00%
5E	Other waste	PM_{10}	0.1995	0.0548	2%	100%	100.02%	0.000035	-0.01%	0.17%	-0.01%	0.00%	0.00%
TOTAL			32.1335	9.2374				0.027604					0.0022
					% uncertainty in total inventory			16.61%		Trend uncertainty:			4.70%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	TSP	172.7961	2.0413	2%	20%	20.10%	0.000867	-2.31%	0.73%	-0.46%	0.02%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	TSP	0.4900	0.4365	2%	20%	20.10%	0.000040	0.15%	0.07%	0.03%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	TSP	0.7427	0.0209	2%	50%	50.04%	0.000001	-0.01%	0.01%	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	TSP	89.7911	1.5004	2%	20%	20.10%	0.000468	-1.05%	0.53%	-0.21%	0.02%	0.00%
1A3ai(i)	International aviation LTO (civil)	TSP	0.0004	0.0005	2%	30%	30.07%	0.000000	0.000%	0.0002%	0.0000%	0.0000%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	TSP	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	TSP	0.1306	0.1349	2%	20%	20.10%	0.000004	0.05%	0.05%	0.01%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	TSP	0.1413	0.0362	2%	20%	20.10%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	TSP	0.2724	0.0430	2%	20%	20.10%	0.000000	0.01%	0.02%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	TSP	0.0063	0.0008	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	TSP	0.2346	0.2677	2%	20%	20.10%	0.000015	0.09%	0.10%	0.02%	0.00%	0.00%
1A3bvii	Road transport: Automobile road abrasion	TSP	0.2156	0.2083	2%	20%	20.10%	0.000009	0.07%	0.07%	0.01%	0.00%	0.00%
1A3c	Railways	TSP	0.0847	0.0166	2%	100%	100.02%	0.000001	0.00%	0.01%	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	TSP	0.0105	0.0080	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4ai	Commercial/institutional: Stationary	TSP	0.6502	0.1785	2%	20%	20.10%	0.000007	0.05%	0.06%	0.01%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	TSP	0.0645	0.0135	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	TSP	0.0061	0.0008	3%	20%	20.22%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	TSP	2.5825	0.0147	2%	20%	20.10%	0.000000	-0.04%	0.01%	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	TSP	0.0041	0.0042	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	TSP	1.4523	1.8832	5%	20%	20.62%	0.000776	0.64%	0.67%	0.13%	0.05%	0.00%
1A4bi	Residential: Stationary, waste	TSP	0.3752	0.4751	50%	50%	70.71%	0.000581	0.16%	0.17%	0.08%	0.12%	0.00%
1A4bii	Residential: Household and gardening (mobile)	TSP	0.0023	0.0102	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	TSP	0.7400	0.1361	2%	20%	20.10%	0.000004	0.04%	0.05%	0.01%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	TSP	0.5349	0.0359	2%	50%	50.04%	0.000002	0.00%	0.01%	0.00%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	TSP	0.0232	0.0010	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	TSP	0.0000	0.0663	2%	100%	100.02%	0.000023	0.02%	0.02%	0.02%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	TSP	0.0000	0.0239	2%	100%	100.02%	0.000003	0.01%	0.01%	0.01%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	TSP	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A1	Cement production	TSP	0.0000	0.0382	2%	50%	50.04%	0.000002	0.01%	0.01%	0.01%	0.00%	0.00%
2A2	Lime production	TSP	0.0000	0.0013	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A3	Glass production	TSP	0.0000	0.0018	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	TSP	0.0000	0.1917	2%	100%	100.02%	0.000189	0.07%	0.07%	0.07%	0.00%	0.00%
2A5b	Construction and demolition	TSP	4.9751	3.3881	5%	100%	100.12%	0.059254	1.12%	1.21%	1.12%	0.09%	0.01%
2A6	Other mineral products	TSP	0.0000	0.0004	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2B10a	Chemical industry: Other	TSP	0.9400	0.0075	2%	50%	50.04%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	TSP	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	TSP	0.0000	0.0460	2%	50%	50.04%	0.000003	0.02%	0.02%	0.01%	0.00%	0.00%
2C3	Aluminium production	TSP	0.0000	0.0002	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	TSP	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C6	Zinc production	TSP	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C7c	Other metal production	TSP	0.0000	0.0015	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	TSP	0.2567	0.2441	2%	100%	100.02%	0.000307	0.08%	0.09%	0.08%	0.00%	0.00%
2D3d	Coating applications	TSP	0.0000	0.0014	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3e	Degreasing	TSP	0.0000	0.0000	10%	100%	100.50%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3g	Chemical products	TSP	0.0000	0.0023	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3h	Printing	TSP	0.0000	0.0011	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3i	Other solvent use	TSP	0.0000	0.0025	5%	100%	100.12%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	TSP	0.1352	0.0976	5%	50%	50.25%	0.000012	0.03%	0.03%	0.02%	0.00%	0.00%
2H1	Pulp and paper industry	TSP	0.0000	0.0396	2%	50%	50.04%	0.000002	0.01%	0.01%	0.01%	0.00%	0.00%
2H2	Food and beverages industry	TSP	0.0000	0.0600	2%	100%	100.02%	0.000019	0.02%	0.02%	0.02%	0.00%	0.00%
2I	Wood processing	TSP	0.0000	0.4841	2%	100%	100.02%	0.001207	0.17%	0.17%	0.17%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
2L	Other production, consumption, storage, transportation or handling of bulk products	TSP	0.0000	0.0717	2%	100%	100.02%	0.000026	0.03%	0.03%	0.03%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	TSP	0.3874	0.1173	2%	100%	100.02%	0.000071	0.03%	0.04%	0.03%	0.00%	0.00%
3B1b	Manure management - Non-dairy cattle	TSP	0.2185	0.0820	2%	100%	100.02%	0.000035	0.03%	0.03%	0.03%	0.00%	0.00%
3B2	Manure management - Sheep	TSP	0.0222	0.0099	2%	100%	100.02%	0.000001	0.00%	0.00%	0.00%	0.00%	0.00%
3B3	Manure management - Swine	TSP	0.6647	0.2170	2%	100%	100.02%	0.000242	0.07%	0.08%	0.07%	0.00%	0.00%
3B4d	Manure management - Goats	TSP	0.0003	0.0007	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	TSP	0.0041	0.0027	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	TSP	0.4226	0.1069	2%	100%	100.02%	0.000059	0.03%	0.04%	0.03%	0.00%	0.00%
3B4gii	Manure management - Broilers	TSP	0.0781	0.0581	2%	100%	100.02%	0.000017	0.02%	0.02%	0.02%	0.00%	0.00%
3B4giv	Manure management - Other poultry	TSP	0.1763	0.0641	2%	100%	100.02%	0.000021	0.02%	0.02%	0.02%	0.00%	0.00%
3B4h	Manure management - Other animals	TSP	0.0042	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	1.2313	0.9171	2%	100%	100.02%	0.004332	0.30%	0.33%	0.30%	0.01%	0.00%
5A	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	0.0004	0.0012	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	TSP	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	TSP	0.0000	0.0003	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	TSP	0.1399	0.0638	10%	100%	100.50%	0.000021	0.02%	0.02%	0.02%	0.00%	0.00%
5E	Other waste	TSP	0.0000	0.0548	2%	100%	100.02%	0.000015	0.02%	0.02%	0.02%	0.00%	0.00%
TOTAL			281.0084	13.9360				0.068637					0.0002
					% uncertainty in total inventory			26.20%		Trend uncertainty:			1.30%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	CO	11.5300	6.3542	2%	20%	20.10%	0.000095	0.17%	2.50%	0.03%	0.07%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	CO	6.4900	35.1758	2%	20%	20.10%	0.002922	12.52%	13.83%	2.50%	0.39%	0.06%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	CO	8.1236	1.8381	2%	50%	50.04%	0.000049	-0.92%	0.72%	-0.46%	0.02%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	CO	6.1800	6.5692	2%	20%	20.10%	0.000102	1.33%	2.58%	0.27%	0.07%	0.00%
1A3ai(i)	International aviation LTO (civil)	CO	0.0907	0.1550	2%	30%	30.07%	0.000000	0.04%	0.06%	0.01%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	CO	0.0296	0.0379	2%	30%	30.07%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	CO	100.9658	9.0513	2%	20%	20.10%	0.000193	-16.80%	3.56%	-3.36%	0.10%	0.11%
1A3bii	Road transport: Light duty vehicles	CO	8.9297	0.5716	2%	20%	20.10%	0.000001	-1.58%	0.22%	-0.32%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	CO	4.0990	0.6850	2%	20%	20.10%	0.000001	-0.56%	0.27%	-0.11%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	CO	6.4053	0.4293	2%	20%	20.10%	0.000000	-1.13%	0.17%	-0.23%	0.00%	0.00%
1A3c	Railways	CO	0.6030	0.1167	2%	100%	100.02%	0.000001	-0.08%	0.05%	-0.08%	0.00%	0.00%
1A3dii	National navigation (shipping)	CO	0.0518	0.0394	2%	100%	100.02%	0.000000	0.01%	0.02%	0.01%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	CO	0.7000	0.6893	2%	20%	20.10%	0.000001	0.13%	0.27%	0.03%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	CO	1.6288	0.2849	2%	50%	50.04%	0.000001	-0.22%	0.11%	-0.11%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	CO	0.0458	0.0094	3%	20%	20.22%	0.000000	-0.01%	0.00%	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, solid fuels	CO	32.9358	0.1679	2%	20%	20.10%	0.000000	-6.59%	0.07%	-1.32%	0.00%	0.02%
1A4bi	Residential: Stationary, gaseous fuels	CO	0.0671	0.0681	2%	20%	20.10%	0.000000	0.01%	0.03%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	CO	40.7414	62.6270	5%	20%	20.62%	0.009743	16.36%	24.63%	3.27%	1.74%	0.14%
1A4bi	Residential: Stationary, waste	CO	0.8982	1.1374	50%	20%	53.85%	0.000022	0.27%	0.45%	0.05%	0.32%	0.00%
1A4bii	Residential: Household and gardening (mobile)	CO	0.6463	3.1385	2%	50%	50.04%	0.000144	1.10%	1.23%	0.55%	0.03%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	CO	0.5100	0.2513	2%	20%	20.10%	0.000000	0.00%	0.10%	0.00%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	CO	21.5372	0.5390	2%	50%	50.04%	0.000004	-4.14%	0.21%	-2.07%	0.01%	0.04%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	CO	0.5025	0.0049	2%	100%	100.02%	0.000000	-0.10%	0.00%	-0.10%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	CO	0.0000	0.1297	2%	100%	100.02%	0.000001	0.05%	0.05%	0.05%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	CO	0.0000	0.0045	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	CO	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	CO	0.0000	0.0083	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2A6	Other mineral products (please specify in the IIR)	CO	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2B10a	Chemical industry: Other	CO	0.3400	0.5880	2%	50%	50.04%	0.000005	0.16%	0.23%	0.08%	0.01%	0.00%
2C1	Iron and steel production	CO	0.0000	0.0171	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
2C7c	Other metal production	CO	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3d	Coating applications	CO	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3g	Chemical products	CO	0.0000	0.0032	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	CO	0.2295	0.0847	5%	50%	50.25%	0.000000	-0.01%	0.03%	-0.01%	0.00%	0.00%
2H1	Pulp and paper industry	CO	0.0000	0.0017	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2H2	Food and beverages industry	CO	0.0000	0.0129	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
2I	Wood processing	CO	0.0000	0.0013	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	CO	0.0000	0.0005	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	CO	0.0000	0.0034	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	CO	0.0000	0.0012	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	CO	0.0054	0.0024	10%	50%	50.99%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			254.2865	130.8003				0.013287					0.0038
					% uncertainty in total inventory			11.53%		Trend uncertainty:			6.20%

NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
	A	B	C	D	E	F	G	H	I	J	K	L	M
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	Pb	63.1201	6.8552	2%	150%	150.01%	0.817436	1.63%	3.30%	2.45%	0.09%	0.06%
1A1c	Manufacture of solid fuels and other energy industries	Pb	0.0220	0.0101	2%	150%	150.01%	0.000002	0.00%	0.00%	0.01%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	Pb	0.9000	0.0101	2%	50%	50.04%	0.000000	-0.02%	0.00%	-0.01%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Pb	62.4600	0.6685	2%	100%	100.02%	0.003456	-1.32%	0.32%	-1.32%	0.01%	0.02%
1A3bi	Road transport: Passenger cars	Pb	49.3898	0.0005	2%	20%	20.10%	0.000000	-1.30%	0.00%	-0.26%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	Pb	4.4056	0.0001	2%	20%	20.10%	0.000000	-0.12%	0.00%	-0.02%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Pb	17.4247	0.0001	2%	20%	20.10%	0.000000	-0.46%	0.00%	-0.09%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Pb	1.7604	0.0000	2%	20%	20.10%	0.000000	-0.05%	0.00%	-0.01%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Pb	0.2599	0.2724	2%	30%	30.07%	0.000052	0.12%	0.13%	0.04%	0.00%	0.00%
1A3c	Railways	Pb	0.0159	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	Pb	0.0009	0.0007	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Pb	0.1400	0.0291	2%	100%	100.02%	0.000007	0.01%	0.01%	0.01%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	Pb	0.3000	0.0010	2%	50%	50.04%	0.000000	-0.01%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Pb	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, solid fuels	Pb	0.8259	0.0061	2%	100%	100.02%	0.000000	-0.02%	0.00%	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Pb	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	Pb	0.1375	0.4277	5%	100%	100.12%	0.001418	0.20%	0.21%	0.20%	0.01%	0.00%
1A4bi	Residential: Stationary, waste	Pb	1.7428	2.2476	50%	100%	111.80%	0.048809	1.04%	1.08%	1.04%	0.77%	0.02%
1A4bii	Residential: Household and gardening (mobile)	Pb	0.1260	0.0210	2%	50%	50.04%	0.000001	0.01%	0.01%	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	Pb	0.1800	0.0688	2%	100%	100.02%	0.000037	0.03%	0.03%	0.03%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Pb	3.4896	0.0001	2%	50%	50.04%	0.000000	-0.09%	0.00%	-0.05%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Pb	0.0014	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Pb	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	Pb	0.0000	0.0002	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	Pb	0.0000	0.0066	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C7c	Other metal production	Pb	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2D3e	Degreasing	Pb	0.0000	0.0000	10%	50%	50.99%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	Pb	0.0020	0.3850	5%	50%	50.25%	0.000289	0.19%	0.19%	0.09%	0.01%	0.00%
5C1bi	Industrial waste incineration	Pb	0.0000	0.0000	5%	50%	50.25%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	Pb	0.0000	0.0003	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	Pb	0.7949	0.3627	10%	100%	100.50%	0.001027	0.15%	0.17%	0.15%	0.02%	0.00%
5E	Other waste	Pb	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			207.4995	11.3742				0.872533					0.0010
					% uncertainty in total inventory			93.41%		Trend uncertainty:			3.09%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	Cd	1.1300	0.2199	2%	150%	150.01%	0.357579	1.82%	4.81%	2.73%	0.14%	0.07%
1A1c	Manufacture of solid fuels and other energy industries	Cd	0.0010	0.0004	2%	150%	150.01%	0.000001	0.01%	0.01%	0.01%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	Cd	0.0017	0.0004	2%	50%	50.04%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Cd	3.2300	0.0152	2%	100%	100.02%	0.000757	-8.15%	0.33%	-8.15%	0.01%	0.66%
1A3bi	Road transport: Passenger cars	Cd	0.0001	0.0001	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	Cd	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Cd	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Cd	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Cd	0.0012	0.0013	2%	30%	30.07%	0.000000	0.02%	0.03%	0.01%	0.00%	0.00%
1A3c	Railways	Cd	0.0007	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	Cd	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Cd	0.0000	0.0009	2%	100%	100.02%	0.000003	0.02%	0.02%	0.02%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	Cd	0.0001	0.0002	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Cd	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	Cd	0.0085	0.0001	2%	100%	100.02%	0.000000	-0.02%	0.00%	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Cd	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	Cd	0.0662	0.2059	5%	100%	100.12%	0.139781	4.33%	4.51%	4.33%	0.32%	0.19%
1A4bi	Residential: Stationary, waste	Cd	0.0570	0.0735	50%	100%	111.80%	0.022186	1.46%	1.61%	1.46%	1.14%	0.03%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bii	Residential: Household and gardening (mobile)	Cd	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	Cd	0.0100	0.0007	2%	100%	100.02%	0.000002	-0.01%	0.02%	-0.01%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Cd	0.0014	0.0007	2%	50%	50.04%	0.000000	0.01%	0.02%	0.01%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Cd	0.0001	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Cd	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	Cd	0.0000	0.0030	2%	50%	50.04%	0.000007	0.07%	0.07%	0.03%	0.00%	0.00%
2G	Other product use	Cd	0.0324	0.0169	5%	50%	50.25%	0.000236	0.28%	0.37%	0.14%	0.03%	0.00%
5C1bv	Cremation	Cd	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	Cd	0.0260	0.0119	10%	100%	100.50%	0.000467	0.19%	0.26%	0.19%	0.04%	0.00%
5E	Other waste	Cd	0.0000	0.0003	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
TOTAL			4.5664	0.5515				0.521020					0.0096
				% uncertainty in total inventory			72.18%			Trend uncertainty:			9.81%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	Hg	1.0136	0.2077	2%	150%	150.01%	0.906771	-5.28%	17.07%	-7.92%	0.48%	0.63%
1A1c	Manufacture of solid fuels and other energy industries	Hg	0.0010	0.0015	2%	150%	150.01%	0.000045	0.10%	0.12%	0.15%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Hg	0.0802	0.0151	2%	100%	100.02%	0.002136	-0.53%	1.24%	-0.53%	0.04%	0.00%
1A3bi	Road transport: Passenger cars	Hg	0.0030	0.0033	2%	20%	20.10%	0.000004	0.21%	0.27%	0.04%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	Hg	0.0004	0.0005	2%	20%	20.10%	0.000000	0.03%	0.04%	0.01%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Hg	0.0019	0.0008	2%	20%	20.10%	0.000000	0.02%	0.06%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Hg	0.0001	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Hg	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3c	Railways	Hg	0.0009	0.0000	2%	50%	50.04%	0.000000	-0.02%	0.00%	-0.01%	0.00%	0.00%
1A3dii	National navigation (shipping)	Hg	0.0002	0.0002	2%	50%	50.04%	0.000000	0.01%	0.01%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Hg	0.0000	0.0008	2%	100%	100.02%	0.000006	0.06%	0.06%	0.06%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Hg	0.0004	0.0000	3%	100%	100.04%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	Hg	0.0301	0.0003	2%	100%	100.02%	0.000001	-0.64%	0.02%	-0.64%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Hg	0.0002	0.0002	2%	100%	100.02%	0.000001	0.01%	0.02%	0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	Hg	0.0029	0.0089	5%	100%	100.12%	0.000737	0.67%	0.73%	0.67%	0.05%	0.00%
1A4bi	Residential: Stationary, waste	Hg	0.0469	0.0605	50%	100%	111.80%	0.042742	3.93%	4.97%	3.93%	3.52%	0.28%
1A4ci	Agriculture/Forestry/Fishing: Stationary	Hg	0.0000	0.0002	2%	100%	100.02%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Hg	0.0003	0.0000	2%	50%	50.04%	0.000000	-0.01%	0.00%	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Hg	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	Hg	0.0135	0.0044	5%	50%	50.25%	0.000046	0.06%	0.36%	0.03%	0.03%	0.00%
5C1bv	Cremation	Hg	0.0000	0.0128	2%	50%	50.04%	0.000381	1.05%	1.05%	0.52%	0.03%	0.00%
5C2	Open burning of waste	Hg	0.0214	0.0098	10%	100%	100.50%	0.000899	0.33%	0.80%	0.33%	0.11%	0.00%
5E	Other waste	Hg	0.0000	0.0003	2%	100%	100.02%	0.000001	0.03%	0.03%	0.03%	0.00%	0.00%
TOTAL			1.2171	0.3272				0.953768					0.0092
					% uncertainty in total inventory			97.66%			Trend uncertainty:		9.61%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			g I-TEQ	g I-TEQ	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PCDD/F	1.5260	1.2641	2%	200%	200.01%	0.304193	5.62%	12.77%	11.24%	0.36%	1.27%
1A1c	Manufacture of solid fuels and other energy industries	PCDD/F	0.0524	0.0088	2%	200%	200.01%	0.000015	-0.16%	0.09%	-0.31%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PCDD/F	1.7729	0.9946	2%	200%	200.01%	0.188335	1.75%	10.05%	3.50%	0.28%	0.12%
1A3bi	Road transport: Passenger cars	PCDD/F	0.1621	0.2032	2%	250%	250.01%	0.012287	1.29%	2.05%	3.24%	0.06%	0.10%
1A3bii	Road transport: Light duty vehicles	PCDD/F	0.0120	0.0322	2%	250%	250.01%	0.000309	0.27%	0.33%	0.67%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PCDD/F	0.0994	0.0289	2%	250%	250.01%	0.000248	-0.17%	0.29%	-0.43%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PCDD/F	0.0100	0.0011	2%	250%	250.01%	0.000000	-0.04%	0.01%	-0.09%	0.00%	0.00%
1A3c	Railways	PCDD/F	0.0242	0.0000	2%	250%	250.01%	0.000000	-0.11%	0.00%	-0.28%	0.00%	0.00%
1A3dii	National navigation (shipping)	PCDD/F	0.0009	0.0007	2%	250%	250.01%	0.000000	0.00%	0.01%	0.01%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PCDD/F	0.0647	0.1066	2%	200%	200.01%	0.002163	0.77%	1.08%	1.55%	0.03%	0.02%
1A4bi	Residential: Stationary, liquid fuels	PCDD/F	0.0059	0.0006	3%	250%	250.02%	0.000000	-0.02%	0.01%	-0.05%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	PCDD/F	4.6243	0.0280	2%	250%	250.01%	0.000232	-21.26%	0.28%	-53.14%	0.01%	28.24%
1A4bi	Residential: Stationary, gaseous fuels	PCDD/F	0.0036	0.0036	2%	250%	250.01%	0.000004	0.02%	0.04%	0.05%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	PCDD/F	0.6402	0.6830	5%	100%	100.12%	0.022254	3.90%	6.90%	3.90%	0.49%	0.15%
1A4bi	Residential: Stationary, waste	PCDD/F	0.0177	0.0224	50%	100%	111.80%	0.000030	0.14%	0.23%	0.14%	0.16%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCDD/F	0.0505	0.0208	2%	200%	200.01%	0.000082	-0.03%	0.21%	-0.05%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCDD/F	0.0014	0.0001	2%	250%	250.01%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
2C3	Aluminium production	PCDD/F	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2Cf	Lead production	PCDD/F	0.0000	0.0268	2%	100%	100.02%	0.000034	0.27%	0.27%	0.27%	0.01%	0.00%
2C6	Zinc production	PCDD/F	0.0000	0.0033	2%	100%	100.02%	0.000001	0.03%	0.03%	0.03%	0.00%	0.00%
2G	Other product use	PCDD/F	0.0004	0.0001	5%	250%	250.05%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	PCDD/F	0.0534	0.3418	2%	250%	250.01%	0.034742	3.20%	3.45%	8.01%	0.10%	0.64%
5C1biii	Clinical waste incineration	PCDD/F	0.4700	0.1146	2%	250%	300.00%	0.005623	-1.04%	1.16%	-2.60%	0.03%	0.07%
5C1bv	Cremation	PCDD/F	0.0000	0.0002	2%	250%	300.00%	0.000000	0.00%	0.00%	0.01%	0.00%	0.00%
5C2	Open burning of waste	PCDD/F	0.3057	0.1395	10%	250%	250.20%	0.005796	-0.02%	1.41%	-0.05%	0.20%	0.00%
5E	Other waste	PCDD/F	0.0000	0.5590	2%	250%	250.01%	0.092964	5.65%	5.65%	14.12%	0.16%	1.99%
TOTAL			9.8975	4.5840				0.669313					0.3263
					% uncertainty in total inventory			81.81%		Trend uncertainty:			57.12%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(a)p	0.3955	0.0789	2%	200%	200.01%	0.030717	-2.22%	3.03%	-4.44%	0.09%	0.20%
1A1c	Manufacture of solid fuels and other energy industrie	B(a)p	0.0060	0.0001	2%	200%	200.01%	0.000000	-0.08%	0.00%	-0.15%	0.00%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(a)p	0.0051	0.0011	2%	200%	200.01%	0.000006	-0.02%	0.04%	-0.05%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(a)p	0.1207	0.0870	2%	200%	200.01%	0.037367	1.74%	3.34%	3.47%	0.09%	0.12%
1A3bi	Road transport: Passenger cars	B(a)p	0.0032	0.0085	2%	200%	200.01%	0.000359	0.28%	0.33%	0.57%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	B(a)p	0.0007	0.0021	2%	200%	200.01%	0.000022	0.07%	0.08%	0.14%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(a)p	0.0014	0.0007	2%	200%	200.01%	0.000002	0.01%	0.03%	0.02%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(a)p	0.0002	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi		B(a)p	0.0006	0.0007	2%	200%	200.01%	0.000002	0.02%	0.03%	0.04%	0.00%	0.00%
1A3c	Railways	B(a)p	0.0068	0.0003	2%	200%	200.01%	0.000001	-0.08%	0.01%	-0.16%	0.00%	0.00%
1A3dii		B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(a)p	0.0125	0.0126	2%	200%	200.01%	0.000783	0.32%	0.48%	0.64%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	B(a)p	0.0004	0.0007	2%	200%	200.01%	0.000002	0.02%	0.03%	0.04%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	B(a)p	0.0002	0.0000	3%	200%	200.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(a)p	1.3193	0.0092	2%	200%	200.01%	0.000415	-17.09%	0.35%	-34.17%	0.01%	11.68%
1A4bi	Residential: Stationary, gaseous fuels	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(a)p	0.7071	0.6844	5%	100%	100.12%	0.579832	16.86%	26.29%	16.86%	1.86%	2.88%
1A4bi	Residential: Stationary, waste	B(a)p	0.0034	0.0042	50%	100%	111.80%	0.000028	0.12%	0.16%	0.12%	0.12%	0.00%
1A4bii	Residential: Household and gardening (mobile)	B(a)p	0.0000	0.0002	2%	200%	200.01%	0.000000	0.01%	0.01%	0.02%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(a)p	0.0150	0.0069	2%	200%	200.01%	0.000233	0.06%	0.26%	0.13%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(a)p	0.0043	0.0022	2%	200%	200.01%	0.000023	0.03%	0.08%	0.05%	0.00%	0.00%
1A4ciii		B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	B(a)p	0.0005	0.0002	5%	200%	200.06%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
5C1bv	Cremation	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(a)p	0.0000	0.0000	10%	200%	200.25%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			**2.6029**	**0.9000**				**0.649792**					**0.1488**
					% uncertainty in total inventory			**80.61%**		**Trend uncertainty:**			**38.57%**

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(b)f	0.4913	0.1014	2%	200%	200.01%	0.051562	-1.12%	3.17%	-2.24%	0.09%	0.05%
1A1c	Manufacture of solid fuels and other energy industrie	B(b)f	0.0079	0.0002	2%	200%	200.01%	0.000000	-0.06%	0.00%	-0.13%	0.00%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(b)f	0.0083	0.0018	2%	200%	200.01%	0.000017	-0.02%	0.06%	-0.03%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(b)f	0.1629	0.1388	2%	200%	200.01%	0.096631	2.92%	4.34%	5.83%	0.12%	0.34%
1A3bi	Road transport: Passenger cars	B(b)f	0.0054	0.0097	2%	200%	200.01%	0.000470	0.26%	0.30%	0.51%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	B(b)f	0.0009	0.0024	2%	200%	200.01%	0.000028	0.07%	0.07%	0.13%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(b)f	0.0086	0.0043	2%	200%	200.01%	0.000092	0.06%	0.13%	0.12%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(b)f	0.0003	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3c	Railways	B(b)f	0.0093	0.0005	2%	200%	200.01%	0.000001	-0.06%	0.02%	-0.13%	0.00%	0.00%
1A3dii	National navigation (shipping)	B(b)f	0.0001	0.0001	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(b)f	0.0171	0.0191	2%	200%	200.01%	0.001835	0.45%	0.60%	0.90%	0.02%	0.01%
1A4aii	Commercial/institutional: Mobile	B(b)f	0.0007	0.0011	2%	200%	200.01%	0.000006	0.03%	0.03%	0.06%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	B(b)f	0.0001	0.0000	3%	200%	200.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(b)f	1.8489	0.0110	2%	200%	200.01%	0.000612	-15.71%	0.35%	-31.43%	0.01%	9.88%
1A4bi	Residential: Stationary, gaseous fuels	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(b)f	0.6067	0.5858	5%	100%	100.12%	0.431661	13.00%	18.32%	13.00%	1.30%	1.71%
1A4bi	Residential: Stationary, waste	B(b)f	0.0034	0.0043	50%	100%	111.80%	0.000029	0.10%	0.13%	0.10%	0.10%	0.00%
1A4bii	Residential: Household and gardening (mobile)	B(b)f	0.0000	0.0002	2%	200%	200.01%	0.000000	0.01%	0.01%	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(b)f	0.0183	0.0084	2%	200%	200.01%	0.000351	0.10%	0.26%	0.20%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(b)f	0.0065	0.0036	2%	200%	200.01%	0.000066	0.06%	0.11%	0.11%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	B(b)f	0.0001	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	B(b)f	0.0002	0.0001	5%	200%	200.06%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(b)f	0.0000	0.0000	10%	200%	200.25%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			3.1970	0.8928				0.583362					0.1199
					% uncertainty in total inventory			76.38%		Trend uncertainty:			34.62%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(k)f	0.2504	0.0344	2%	200%	200.01%	0.014316	-3.28%	2.10%	-6.56%	0.06%	0.43%
1A1c	Manufacture of solid fuels and other energy industries	B(k)f	0.0042	0.0001	2%	200%	200.01%	0.000000	-0.08%	0.01%	-0.17%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(k)f	0.0628	0.0436	2%	200%	200.01%	0.023002	1.32%	2.67%	2.63%	0.08%	0.07%
1A3bi	Road transport: Passenger cars	B(k)f	0.0022	0.0074	2%	200%	200.01%	0.000656	0.40%	0.45%	0.81%	0.01%	0.01%
1A3bii	Road transport: Light duty vehicles	B(k)f	0.0006	0.0018	2%	200%	200.01%	0.000041	0.10%	0.11%	0.20%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(k)f	0.0096	0.0048	2%	200%	200.01%	0.000278	0.09%	0.29%	0.17%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(k)f	0.0001	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	B(k)f	0.0001	0.0001	2%	200%	200.01%	0.000000	0.00%	0.00%	0.01%	0.00%	0.00%
1A3c	Railways	B(k)f	0.0044	0.0004	2%	200%	200.01%	0.000002	-0.07%	0.02%	-0.14%	0.00%	0.00%
1A3dii	National navigation (shipping)	B(k)f	0.0001	0.0001	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(k)f	0.0077	0.0065	2%	200%	200.01%	0.000516	0.23%	0.40%	0.47%	0.01%	0.00%
1A4bi	Residential: Stationary, liquid fuels	B(k)f	0.0002	0.0000	3%	200%	200.02%	0.000000	0.00%	0.00%	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(k)f	0.7982	0.0053	2%	200%	200.01%	0.000338	-16.77%	0.32%	-33.55%	0.01%	11.26%
1A4bi	Residential: Stationary, gaseous fuels	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(k)f	0.4820	0.4640	5%	100%	100.12%	0.652249	17.96%	28.38%	17.96%	2.01%	3.26%
1A4bi	Residential: Stationary, waste	B(k)f	0.0015	0.0019	50%	100%	111.80%	0.000013	0.08%	0.11%	0.08%	0.08%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(k)f	0.0106	0.0048	2%	200%	200.01%	0.000284	0.07%	0.30%	0.13%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	B(k)f	0.0001	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	B(k)f	0.0002	0.0001	5%	200%	200.06%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(k)f	0.0000	0.0000	10%	200%	200.25%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			1.6348	0.5752				0.691695					0.1503
					% uncertainty in total inventory			83.17%		Trend uncertainty:			38.77%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			t	t	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	I(1.2.3-cd)p	0.1639	0.0267	2%	200%	200.01%	0.003992	-3.26%	1.58%	-6.51%	0.04%	0.42%
1A1c	Manufacture of solid fuels and other energy industries	I(1.2.3-cd)p	0.0028	0.0001	2%	200%	200.01%	0.000000	-0.08%	0.00%	-0.16%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	I(1.2.3-cd)p	0.0594	0.0354	2%	200%	200.01%	0.006986	0.34%	2.09%	0.67%	0.06%	0.00%
1A3bi	Road transport: Passenger cars	I(1.2.3-cd)p	0.0060	0.0085	2%	200%	200.01%	0.000405	0.33%	0.50%	0.65%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	I(1.2.3-cd)p	0.0009	0.0020	2%	200%	200.01%	0.000022	0.09%	0.12%	0.18%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	I(1.2.3-cd)p	0.0022	0.0011	2%	200%	200.01%	0.000007	0.00%	0.07%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	I(1.2.3-cd)p	0.0003	0.0000	2%	200%	200.01%	0.000000	-0.01%	0.00%	-0.02%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	I(1.2.3-cd)p	0.0003	0.0003	2%	200%	200.01%	0.000000	0.01%	0.02%	0.02%	0.00%	0.00%
1A3c	Railways	I(1.2.3-cd)p	0.0026	0.0001	2%	200%	200.01%	0.000000	-0.07%	0.01%	-0.14%	0.00%	0.00%
1A3dii	National navigation (shipping)	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	I(1.2.3-cd)p	0.0054	0.0051	2%	200%	200.01%	0.000148	0.14%	0.30%	0.29%	0.01%	0.00%
1A4bi	Residential: Stationary, liquid fuels	I(1.2.3-cd)p	0.0004	0.0000	3%	200%	200.02%	0.000000	-0.01%	0.00%	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	I(1.2.3-cd)p	0.6540	0.0044	2%	200%	200.01%	0.000106	-18.97%	0.26%	-37.94%	0.01%	14.40%
1A4bi	Residential: Stationary, gaseous fuels	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	I(1.2.3-cd)p	0.7872	0.7575	5%	100%	100.12%	0.803430	21.40%	44.74%	21.40%	3.16%	4.68%
1A4bi	Residential: Stationary, waste	I(1.2.3-cd)p	0.0018	0.0023	50%	100%	111.80%	0.000009	0.08%	0.14%	0.08%	0.10%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	I(1.2.3-cd)p	0.0059	0.0026	2%	200%	200.01%	0.000039	-0.02%	0.16%	-0.04%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2G	Other product use	I(1.2.3-cd)p	0.0002	0.0001	5%	200%	200.06%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL			**1.6933**	**0.8462**				**0.815143**					**0.1951**
					% uncertainty in total inventory			**90.29%**		**Trend uncertainty:**			**44.17%**

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions kg	2019 emissions kg	Activity data uncertainty %	Emission factor uncertainty %	Combined uncertainty %	Contribution to Variance by Category in Year 2019	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor uncertainty %	Uncertainty in trend in national emissions introduced by activity data uncertainty %	Uncertainty in trend in national emissions introduced into the trend in total national emissions %
1A1a	Public electricity and heat production	HCB	0.1331	0.1281	2%	250%	250.01%	0.863792	-21.22%	50.80%	-53.04%	1.44%	28.16%
1A1c	Manufacture of solid fuels and other energy industries	HCB	0.0003	0.0000	2%	250%	250.01%	0.000000	-0.16%	0.00%	-0.39%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	HCB	0.0070	0.0446	2%	250%	250.01%	0.104513	13.85%	17.67%	34.63%	0.50%	11.99%
1A3bi	Road transport: Passenger cars	HCB	0.0002	0.0002	2%	250%	250.01%	0.000002	-0.01%	0.08%	-0.02%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	0.01%	0.01%	0.02%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	-0.01%	0.00%	-0.01%	0.00%	0.00%
1A3c	Railways	HCB	0.0001	0.0000	2%	100%	100.02%	0.000000	-0.04%	0.00%	-0.04%	0.00%	0.00%
1A3dii	National navigation (shipping)	HCB	0.0006	0.0004	2%	100%	100.02%	0.000002	-0.13%	0.17%	-0.13%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	HCB	0.0020	0.0048	2%	100%	100.02%	0.000192	0.82%	1.90%	0.82%	0.05%	0.01%
1A4bi	Residential: Stationary, solid fuels	HCB	0.0042	0.0000	2%	250%	250.01%	0.000000	-2.24%	0.01%	-5.61%	0.00%	0.31%
1A4bi	Residential: Stationary, biomass	HCB	0.0760	0.1414	5%	100%	100.12%	0.168767	14.86%	56.06%	14.86%	3.96%	2.37%
1A4bi	Residential: Stationary, waste	HCB	0.0115	0.0146	50%	100%	111.80%	0.002252	-0.46%	5.80%	-0.46%	4.10%	0.17%
1A4ci	Agriculture/Forestry/Fishing: Stationary	HCB	0.0011	0.0006	2%	100%	100.02%	0.000003	-0.35%	0.25%	-0.35%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	HCB	0.0009	0.0001	2%	100%	100.02%	0.000000	-0.45%	0.02%	-0.45%	0.00%	0.00%
2C3	Aluminium production	HCB	0.0000	0.0015	2%	100%	100.02%	0.000019	0.59%	0.59%	0.59%	0.02%	0.00%
5C1bv	Cremation	HCB	0.0000	0.0013	2%	100%	100.02%	0.000014	0.51%	0.51%	0.51%	0.01%	0.00%
5C2	Open burning of waste	HCB	0.0153	0.0070	10%	250%	250.20%	0.002564	-5.51%	2.77%	-13.78%	0.39%	1.90%
TOTAL			**0.2522**	**0.3446**				**1.142120**					**0.44921**
					% uncertainty in total inventory			**106.87%**		**Trend uncertainty:**			**67.02%**

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2019 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2019	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kg	kg	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PCB	1.7120	0.3373	2%	200%	200.01%	2.373218	3.42%	9.90%	6.85%	0.28%	0.47%
1A1c	Manufacture of solid fuels and other energy industries	PCB	0.0787	0.0000	2%	200%	200.01%	0.000000	-0.30%	0.00%	-0.59%	0.00%	0.00%
1A2gvi ii	Stationary combustion in manufacturing industries and construction: Other	PCB	0.3726	0.0606	2%	200%	200.01%	0.076561	0.37%	1.78%	0.74%	0.05%	0.01%
1A3bi	Road transport: Passenger cars	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
1A3c	Railways	PCB	0.0202	0.0000	2%	100%	100.02%	0.000000	-0.08%	0.00%	-0.08%	0.00%	0.00%
1A3dii	National navigation (shipping)	PCB	0.0003	0.0002	2%	100%	100.02%	0.000000	0.00%	0.01%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PCB	0.0111	0.0068	2%	200%	200.01%	0.000956	0.16%	0.20%	0.31%	0.01%	0.00%
1A4bi	Residential: Stationary, solid fuels	PCB	1.1416	0.0085	2%	150%	150.01%	0.000844	-4.05%	0.25%	-6.07%	0.01%	0.37%
1A4bi	Residential: Stationary, biomass	PCB	0.0003	0.0004	5%	150%	150.08%	0.000002	0.01%	0.01%	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCB	0.0284	0.0021	2%	150%	150.01%	0.000053	-0.04%	0.06%	-0.07%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCB	0.0004	0.0000	2%	150%	150.01%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	PCB	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
2C6	Zinc production	PCB	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00%	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	PCB	0.0000	0.0035	2%	150%	150.01%	0.000145	0.10%	0.10%	0.15%	0.00%	0.00%
5C2	Open burning of waste	PCB	0.0405	0.0185	10%	150%	150.33%	0.004026	0.39%	0.54%	0.58%	0.08%	0.00%
TOTAL			**3.4061**	**0.4379**				**2.455805**					**0.00852**
					% uncertainty in total inventory			156.71%		Trend uncertainty:			9.23%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	2000 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PM10	20.5766	2.9928	2%	20%	20.10%	0.002849	-0.13128	9.33%	-2.63%	0.26%	0.07%
1A1c	Manufacture of solid fuels and other energy industries	PM10	0.8200	0.2258	2%	20%	20.10%	0.000016	-0.00194	0.70%	-0.04%	0.02%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	PM10	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	PM10	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	PM10	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	PM10	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	PM10	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	PM10	1.4013	0.0511	2%	20%	20.10%	0.000001	-0.01375	0.16%	-0.28%	0.00%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	PM10	0.0317	0.1168	2%	50%	50.04%	0.000027	0.00330	0.36%	0.16%	0.01%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PM10	1.2779	1.3655	2%	30%	30.07%	0.001327	0.02856	4.26%	0.86%	0.12%	0.01%
1A3ai(i)	International aviation LTO (civil)	PM10	0.0003	0.0005	2%	30%	30.07%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	PM10	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	PM10	0.1105	0.1387	2%	20%	20.10%	0.000006	0.00312	0.43%	0.06%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	PM10	0.2041	0.0329	2%	20%	20.10%	0.000000	-0.00121	0.10%	-0.02%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PM10	0.2952	0.0479	2%	20%	20.10%	0.000001	-0.00174	0.15%	-0.03%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PM10	0.0003	0.0010	2%	20%	20.10%	0.000000	0.00003	0.00%	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	PM10	0.1167	0.1975	2%	20%	20.10%	0.000012	0.00488	0.62%	0.10%	0.02%	0.00%
1A3bvii	Road transport: Automobile road abrasion	PM10	0.0681	0.1022	2%	20%	20.10%	0.000003	0.00244	0.32%	0.05%	0.01%	0.00%
1A3c	Railways	PM10	0.0626	0.0115	2%	20%	20.10%	0.000000	-0.00033	0.04%	-0.01%	0.00%	0.00%
1A3dii	National navigation (shipping)	PM10	0.0105	0.0075	2%	20%	20.10%	0.000000	0.00012	0.02%	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PM10	0.4502	0.1508	2%	20%	20.10%	0.000007	-0.00023	0.47%	0.00%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	PM10	0.0136	0.0290	2%	50%	50.04%	0.000002	0.00075	0.09%	0.04%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, liquid fuels	PM10	0.0014	0.0006	3%	20%	20.22%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	PM10	0.4023	0.0148	2%	20%	20.10%	0.000000	-0.00395	0.05%	-0.08%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	PM10	0.0031	0.0039	2%	20%	20.10%	0.000000	0.00009	0.01%	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	PM10	3.0557	1.8786	5%	20%	20.62%	0.001181	0.02507	5.86%	0.50%	0.41%	0.00%
1A4bi	Residential: Stationary, waste	PM10	0.5088	0.4303	50%	50%	70.71%	0.000729	0.00784	1.34%	0.39%	0.95%	0.01%
1A4bii	Residential: Household and gardening (mobile)	PM10	0.0092	0.0106	2%	50%	50.04%	0.000000	0.00023	0.03%	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PM10	0.1601	0.0943	2%	20%	20.10%	0.000003	0.00118	0.29%	0.02%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	PM10	0.0461	0.1260	2%	50%	50.04%	0.000031	0.00342	0.39%	0.17%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PM10	0.0032	0.0009	2%	50%	50.04%	0.000000	-0.00001	0.00%	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	PM10	0.0500	0.0543	2%	100%	100.02%	0.000023	0.00115	0.17%	0.11%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	PM10	0.0000	0.0128	2%	100%	100.02%	0.000001	0.00040	0.04%	0.04%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	PM10	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2A1	Cement production	PM10	0.0135	0.0083	2%	100%	100.02%	0.000001	0.00011	0.03%	0.01%	0.00%	0.00%
2A2	Lime production	PM10	0.0000	0.0008	2%	100%	100.02%	0.000000	0.00003	0.00%	0.00%	0.00%	0.00%
2A3	Glass production	PM10	0.0000	0.0005									
2A5a	Quarrying and mining of minerals other than coal	PM10	0.0000	0.0577	2%	100%	100.02%	0.000026	0.00180	0.18%	0.18%	0.01%	0.00%
2A5b	Construction and demolition	PM10	0.4956	1.3982	5%	100%	100.12%	0.015431	0.03816	4.36%	3.82%	0.31%	0.15%
2A6	Other mineral products	PM10	0.2129	0.0117	2%	100%	100.02%	0.000001	-0.00197	0.04%	-0.20%	0.00%	0.00%
2B10a	Chemical industry: Other	PM10	0.1626	0.0021	2%	20%	20.10%	0.000000	-0.00172	0.01%	-0.03%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	PM10	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2C1	Iron and steel production	PM10	0.0239	0.0347	2%	20%	20.10%	0.000000	0.00082	0.11%	0.02%	0.00%	0.00%
2C3	Aluminium production	PM10	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2C5	Lead production	PM10	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2C6	Zinc production	PM10	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2C7a	Copper production	PM10	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2C7c	Other metal production	PM10	0.0002	0.0011	2%	20%	20.10%	0.000000	0.00003	0.00%	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	PM10	0.0133	0.0316	2%	100%	100.02%	0.000008	0.00084	0.10%	0.08%	0.00%	0.00%
2D3d	Coating applications	PM10	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2D3i	Other solvent use	PM10	0.0000	0.0001	5%	50%	50.25%	0.000000	0.00000	0.00%	0.00%	0.00%	0.00%
2G	Other product use	PM10	0.0595	0.0973	5%	50%	50.25%	0.000019	0.00238	0.30%	0.12%	0.02%	0.00%
2H1	Pulp and paper industry	PM10	0.1120	0.0465	2%	100%	100.02%	0.000017	0.00022	0.14%	0.02%	0.00%	0.00%
2H2	Food and beverages industry	PM10	0.0033	0.0158	2%	100%	100.02%	0.000002	0.00046	0.05%	0.05%	0.00%	0.00%
2I	Wood processing	PM10	0.0000	0.1691	2%	100%	100.02%	0.000225	0.00527	0.53%	0.53%	0.01%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	PM10	0.0000	0.0273	2%	100%	100.02%	0.000006	0.00085	0.09%	0.09%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	PM10	0.0825	0.0537	2%	100%	100.02%	0.000023	0.00077	0.17%	0.08%	0.00%	0.00%
3B1b	Manure management - Non-dairy cattle	PM10	0.0262	0.0373	2%	100%	100.02%	0.000011	0.00087	0.12%	0.09%	0.00%	0.00%
3B2	Manure management - Sheep	PM10	0.0020	0.0044	2%	100%	100.02%	0.000000	0.00011	0.01%	0.01%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B3	Manure management - Swine	PM10	0.0359	0.0320	2%	100%	100.02%	0.000008	0.00060	0.10%	0.06%	0.00%	0.00%
3B4d	Manure management - Goats	PM10	0.0002	0.0003	2%	100%	100.02%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	PM10	0.0009	0.0013	2%	100%	100.02%	0.000000	0.00003	0.00%	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	PM10	0.0289	0.0243	2%	100%	100.02%	0.000005	0.00044	0.08%	0.04%	0.00%	0.00%
3B4gii	Manure management - Broilers	PM10	0.0123	0.0290	2%	100%	100.02%	0.000007	0.00077	0.09%	0.08%	0.00%	0.00%
3B4giv	Manure management - Other poultry	PM10	0.0439	0.0573	2%	100%	100.02%	0.000026	0.00131	0.18%	0.13%	0.01%	0.00%
3B4h	Manure management - Other animals	PM10	0.0004	0.0003	2%	100%	100.02%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	PM10	0.7060	0.9202	2%	100%	100.02%	0.006671	0.02095	2.87%	2.10%	0.08%	0.04%
5A	Biological treatment of waste - Solid waste disposal on land	PM10	0.0001	0.0004	2%	100%	100.02%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	PM10	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
5C1bv	Cremation	PM10	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00001	0.00%	0.00%	0.00%	0.00%
5C2	Open burning of waste	PM10	0.1563	0.0472	10%	100%	100.50%	0.000018	-0.00024	0.15%	-0.02%	0.02%	0.00%
5E	Other waste	PM10	0.1995	0.0594	2%	100%	100.02%	0.000028	-0.00033	0.19%	-0.03%	0.01%	0.00%
TOTAL			32.0718	11.2695				0.028753					0.00288
					% uncertainty in total inventory			16.96%			Trend uncertainty:		5.37%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	TSP	172.7961	3.4102	2%	20%	20.10%	0.001640	-0.02518	0.01222	-0.50%	0.03%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	TSP	0.4900	0.2886	2%	20%	20.10%	0.000012	0.00093	0.00072	0.02%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	TSP	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	TSP	0.3418	0.1168	2%	50%	50.04%	0.000012	0.00034	0.00042	0.02%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	TSP	89.7911	1.6224	2%	20%	20.10%	0.000371	-0.01366	0.00581	-0.27%	0.02%	0.00%
1A3ai(i)	International aviation LTO (civil)	TSP	0.0004	0.0005	2%	30%	30.07%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	TSP	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	TSP	0.1306	0.1387	2%	20%	20.10%	0.000003	0.00047	0.00050	0.01%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	TSP	0.1413	0.0329	2%	20%	20.10%	0.000000	0.00009	0.00012	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	TSP	0.2724	0.0479	2%	20%	20.10%	0.000000	0.00011	0.00017	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	TSP	0.0063	0.0010	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	TSP	0.2345	0.2612	2%	20%	20.10%	0.000010	0.00088	0.00094	0.02%	0.00%	0.00%
1A3bvii	Road transport: Automobile road abrasion	TSP	0.2156	0.2044	2%	20%	20.10%	0.000006	0.00069	0.00073	0.01%	0.00%	0.00%
1A3c	Railways	TSP	0.0847	0.0122	2%	20%	20.10%	0.000000	0.00003	0.00004	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	TSP	0.0105	0.0075	2%	20%	20.10%	0.000000	0.00002	0.00003	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	TSP	0.6502	0.2389	2%	20%	20.10%	0.000008	0.00071	0.00086	0.01%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	TSP	0.0328	0.0290	2%	50%	50.04%	0.000001	0.00010	0.00010	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, liquid fuels	TSP	0.0061	0.0006	3%	20%	20.22%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	TSP	1.3580	0.0160	2%	20%	20.10%	0.000000	-0.00024	0.00006	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	TSP	0.0037	0.0039	2%	20%	20.10%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	TSP	1.5239	2.0362	5%	20%	20.62%	0.000615	0.00696	0.00730	0.14%	0.05%	0.00%
1A4bi	Residential: Stationary, waste	TSP	0.3752	0.4734	50%	50%	70.71%	0.000391	0.00161	0.00170	0.08%	0.12%	0.00%
1A4bii	Residential: Household and gardening (mobile)	TSP	0.0018	0.0106	2%	50%	50.04%	0.000000	0.00004	0.00004	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	TSP	0.7400	0.1247	2%	20%	20.10%	0.000002	0.00029	0.00045	0.01%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	TSP	0.2182	0.1260	2%	50%	50.04%	0.000014	0.00040	0.00045	0.02%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	TSP	0.0232	0.0009	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	TSP	0.0000	0.1109	2%	100%	100.02%	0.000043	0.00040	0.00040	0.04%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	TSP	0.0000	0.0268	2%	100%	100.02%	0.000003	0.00010	0.00010	0.01%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	TSP	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A1	Cement production	TSP	0.0000	0.0103	2%	100%	100.02%	0.000000	0.00004	0.00004	0.00%	0.00%	0.00%
2A2	Lime production	TSP	0.0000	0.0021	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2A3	Glass production	TSP	0.0000	0.0006									
2A5a	Quarrying and mining of minerals other than coal	TSP	0.0000	0.1192	2%	100%	100.02%	0.000050	0.00043	0.00043	0.04%	0.00%	0.00%
2A5b	Construction and demolition	TSP	4.9751	4.6188	5%	100%	100.12%	0.074639	0.01547	0.01655	1.55%	0.12%	0.02%
2A6	Other mineral products	TSP	0.0000	0.0320	2%	100%	100.02%	0.000004	0.00011	0.00011	0.01%	0.00%	0.00%
2B10a	Chemical industry: Other	TSP	0.9400	0.0063	2%	20%	20.10%	0.000000	-0.00018	0.00002	0.00%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	TSP	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C1	Iron and steel production	TSP	0.0000	0.0578	2%	20%	20.10%	0.000000	0.00021	0.00021	0.00%	0.00%	0.00%
2C3	Aluminium production	TSP	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C5	Lead production	TSP	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C6	Zinc production	TSP	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7a	Copper production	TSP	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7c	Other metal production	TSP	0.0000	0.0018	2%	20%	20.10%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	TSP	0.2567	0.2368	2%	100%	100.02%	0.000196	0.00079	0.00085	0.08%	0.00%	0.00%
2D3d	Coating applications	TSP	0.0000	0.0009	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3e	Degreasing	TSP	0.0000	0.0000	10%	100%	100.50%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3g	Chemical products	TSP	0.0000	0.0029	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2D3h	Printing	TSP	0.0000	0.0012	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3i	Other solvent use	TSP	0.0000	0.0094	5%	100%	100.12%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
2G	Other product use	TSP	0.1127	0.1025	5%	50%	50.25%	0.000009	0.00034	0.00037	0.02%	0.00%	0.00%
2H1	Pulp and paper industry	TSP	0.0000	0.0581	2%	100%	100.02%	0.000012	0.00021	0.00021	0.02%	0.00%	0.00%
2H2	Food and beverages industry	TSP	0.0000	0.0465	2%	100%	100.02%	0.000008	0.00017	0.00017	0.02%	0.00%	0.00%
2I	Wood processing	TSP	0.0000	0.5157	2%	100%	100.02%	0.000928	0.00185	0.00185	0.18%	0.01%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	TSP	0.0000	0.0609	2%	100%	100.02%	0.000013	0.00022	0.00022	0.02%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B1a	Manure management - Dairy cattle	TSP	0.3874	0.1176	2%	100%	100.02%	0.000048	0.00034	0.00042	0.03%	0.00%	0.00%
3B1b	Manure management - Non-dairy cattle	TSP	0.2185	0.0807	2%	100%	100.02%	0.000023	0.00024	0.00029	0.02%	0.00%	0.00%
3B2	Manure management - Sheep	TSP	0.0222	0.0102	2%	100%	100.02%	0.000000	0.00003	0.00004	0.00%	0.00%	0.00%
3B3	Manure management - Swine	TSP	0.6647	0.2126	2%	100%	100.02%	0.000158	0.00062	0.00076	0.06%	0.00%	0.00%
3B4d	Manure management - Goats	TSP	0.0003	0.0007	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	TSP	0.0041	0.0027	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	TSP	0.4226	0.1156	2%	100%	100.02%	0.000047	0.00032	0.00041	0.03%	0.00%	0.00%
3B4gii	Manure management - Broilers	TSP	0.0781	0.0581	2%	100%	100.02%	0.000012	0.00019	0.00021	0.02%	0.00%	0.00%
3B4giv	Manure management - Other poultry	TSP	0.1763	0.0573	2%	100%	100.02%	0.000011	0.00017	0.00021	0.02%	0.00%	0.00%
3B4h	Manure management - Other animals	TSP	0.0042	0.0008	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	1.2313	0.9202	2%	100%	100.02%	0.002957	0.00303	0.00330	0.30%	0.01%	0.00%
5A	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	0.0004	0.0011	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5B2	Biological treatment of waste - Solid waste disposal on land	TSP	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	TSP	0.0000	0.0004	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bv	Cremation	TSP	0.0000	0.0003	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	TSP	0.1399	0.0630	10%	100%	100.50%	0.000014	0.00020	0.00023	0.02%	0.00%	0.00%
5E	Other waste	TSP	0.0000	0.0594	2%	100%	100.02%	0.000012	0.00021	0.00021	0.02%	0.00%	0.00%
TOTAL			279.0825	16.9274				0.082270					0.0003
					% uncertainty in total inventory			28.68%			Trend uncertainty:		1.71%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	CO	11.5300	6.0994	2%	20%	20.10%	0.000089	-0.00100	0.02582	-0.02%	0.07%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	CO	6.4900	32.2964	2%	20%	20.10%	0.002501	0.12158	0.13671	2.43%	0.39%	0.06%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	CO	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	CO	6.3676	0.5982	2%	50%	50.04%	0.000005	-0.01227	0.00253	-0.61%	0.01%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	CO	6.1800	6.9118	2%	20%	20.10%	0.000115	0.01488	0.02926	0.30%	0.08%	0.00%
1A3ai(i)	International aviation LTO (civil)	CO	0.0907	0.1590	2%	30%	30.07%	0.000000	0.00046	0.00067	0.01%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	CO	0.0296	0.0356	2%	30%	30.07%	0.000000	0.00008	0.00015	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	CO	100.9529	8.9481	2%	20%	20.10%	0.000192	-0.19608	0.03788	-3.92%	0.11%	0.15%
1A3bii	Road transport: Light duty vehicles	CO	8.9247	0.6224	2%	20%	20.10%	0.000001	-0.01812	0.00263	-0.36%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	CO	4.0975	0.7686	2%	20%	20.10%	0.000001	-0.00628	0.00325	-0.13%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	CO	6.4015	0.5504	2%	20%	20.10%	0.000001	-0.01255	0.00233	-0.25%	0.01%	0.00%
1A3c	Railways	CO	0.6030	0.0856	2%	100%	100.02%	0.000000	-0.00104	0.00036	-0.10%	0.00%	0.00%
1A3dii	National navigation (shipping)	CO	0.0518	0.0370	2%	100%	100.02%	0.000000	0.00004	0.00016	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	CO	0.7000	0.6501	2%	20%	20.10%	0.000001	0.00112	0.00275	0.02%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	CO	1.3709	0.2868	2%	50%	50.04%	0.000001	-0.00197	0.00121	-0.10%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	CO	0.0457	0.0082	3%	20%	20.22%	0.000000	-0.00007	0.00003	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	CO	17.3189	0.1837	2%	20%	20.10%	0.000000	-0.03947	0.00078	-0.79%	0.00%	0.01%
1A4bi	Residential: Stationary, gaseous fuels	CO	0.0596	0.0634	2%	20%	20.10%	0.000000	0.00013	0.00027	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, biomass	CO	42.7493	65.8558	5%	20%	20.62%	0.010940	0.17901	0.27876	3.58%	1.97%	0.17%
1A4bi	Residential: Stationary, waste	CO	0.8982	1.1331	50%	20%	53.85%	0.000022	0.00271	0.00480	0.05%	0.34%	0.00%
1A4bii	Residential: Household and gardening (mobile)	CO	0.5848	2.6594	2%	50%	50.04%	0.000105	0.00990	0.01126	0.49%	0.03%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	CO	0.5100	0.2229	2%	20%	20.10%	0.000000	-0.00024	0.00094	0.00%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	CO	19.2083	0.7934	2%	50%	50.04%	0.000009	-0.04128	0.00336	-2.06%	0.01%	0.04%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	CO	0.5025	0.0046	2%	50%	50.04%	0.000000	-0.00115	0.00002	-0.06%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	CO	0.0000	0.1654	2%	100%	100.02%	0.000002	0.00070	0.00070	0.07%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	CO	0.0000	0.0059	2%	100%	100.02%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	CO	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	CO	0.0000	0.0059	2%	100%	100.02%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
2A6	Other mineral products (please specify in the IIR)	CO	0.0000	0.0013	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2B10a	Chemical industry: Other	CO	0.3400	0.5141	2%	50%	50.04%	0.000004	0.00139	0.00218	0.07%	0.01%	0.00%
2C1	Iron and steel production	CO	0.0000	0.0147	2%	50%	50.04%	0.000000	0.00006	0.00006	0.00%	0.00%	0.00%
2C7c	Other metal production	CO	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3g	Chemical products	CO	0.0000	0.0021	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2G	Other product use	CO	0.2295	0.0950	5%	50%	50.25%	0.000000	-0.00013	0.00040	-0.01%	0.00%	0.00%
2H1	Pulp and paper industry	CO	0.0000	0.0045	2%	50%	50.04%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
2H2	Food and beverages industry	CO	0.0000	0.0122	2%	50%	50.04%	0.000000	0.00005	0.00005	0.00%	0.00%	0.00%
2I	Wood processing	CO	0.0000	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	CO	0.0000	0.0007	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	CO	0.0000	0.0028	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
5C1bv	Cremation	CO	0.0000	0.0011	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	CO	0.0054	0.0024	10%	50%	50.99%	0.000000	0.00000	0.00001	0.00%	0.00%	0.00%
TOTAL			**236.2423**	**129.8023**				**0.013990**					**0.0044**
					% uncertainty in total inventory			**11.83%**			**Trend uncertainty:**		**6.64%**

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	Pb	63.1201	28.6850	2%	200%	200.01%	2.985016	0.08936	0.13850	17.87%	0.39%	3.20%
1A1c	Manufacture of solid fuels and other energy industries	Pb	0.0220	0.0034	2%	200%	200.01%	0.000000	0.00000	0.00002	0.00%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Pb	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	Pb	0.9000	0.0000	2%	50%	50.04%	0.000000	-0.00070	0.00000	-0.03%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Pb	62.4600	0.6509	2%	100%	100.02%	0.000384	-0.04507	0.00314	-4.51%	0.01%	0.20%
1A3bi	Road transport: Passenger cars	Pb	49.4037	0.0005	2%	20%	20.10%	0.000000	-0.03815	0.00000	-0.76%	0.00%	0.01%
1A3bii	Road transport: Light duty vehicles	Pb	4.4030	0.0001	2%	20%	20.10%	0.000000	-0.00341	0.00000	-0.07%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Pb	17.4144	0.0001	2%	20%	20.10%	0.000000	-0.01347	0.00000	-0.27%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Pb	1.7594	0.0000	2%	20%	20.10%	0.000000	-0.00136	0.00000	-0.03%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Pb	0.2598	0.2653	2%	30%	30.07%	0.000006	0.00108	0.00128	0.03%	0.00%	0.00%
1A3c	Railways	Pb	0.0159	0.0000	2%	50%	50.04%	0.000000	-0.00001	0.00000	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	Pb	0.0009	0.0007	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Pb	0.1400	0.0674	2%	100%	100.02%	0.000004	0.00022	0.00033	0.02%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	Pb	0.3000	0.0012	2%	50%	50.04%	0.000000	-0.00023	0.00001	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Pb	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	Pb	0.4343	0.0066	2%	100%	100.02%	0.000000	-0.00030	0.00003	-0.03%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Pb	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, biomass	Pb	0.1443	0.4413	5%	100%	100.12%	0.000177	0.00202	0.00213	0.20%	0.02%	0.00%
1A4bi	Residential: Stationary, waste	Pb	1.7428	2.2393	50%	50%	70.71%	0.002274	0.00946	0.01081	0.47%	0.76%	0.01%
1A4bii	Residential: Household and gardening (mobile)	Pb	0.1260	0.0191	2%	50%	50.04%	0.000000	-0.00001	0.00009	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	Pb	0.1800	0.0454	2%	100%	100.02%	0.000002	0.00008	0.00022	0.01%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Pb	3.4896	0.0002	2%	50%	50.04%	0.000000	-0.00270	0.00000	-0.13%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Pb	0.0014	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Pb	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C1	Iron and steel production	Pb	0.0000	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C5	Lead production	Pb	0.0000	0.0084	2%	50%	50.04%	0.000000	0.00004	0.00004	0.00%	0.00%	0.00%
2C7c	Other metal production	Pb	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3e	Degreasing	Pb	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	Pb	0.0020	0.4128	5%	50%	50.25%	0.000039	0.00199	0.00199	0.10%	0.01%	0.00%
5C1bi	Industrial waste incineration	Pb	0.0000	0.0008	5%	50%	50.25%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bv	Cremation	Pb	0.0000	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	Pb	0.7949	0.3580	10%	100%	100.50%	0.000117	0.00111	0.00173	0.11%	0.02%	0.00%
5E	Other waste	Pb	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
TOTAL			207.1144	33.2073				2.988019					0.0341
					% uncertainty in total inventory			172.86%			Trend uncertainty:		18.48%

NFR sector	A NFR name	B Pollutant	C 1990 emissions kt	D 2018 emissions kt	E Activity data uncertainty %	F Emission factor uncertainty %	G Combined uncertainty %	H Contribution to Variance by Category in Year 2018	I Type A sensitivity %	J Type B sensitivity %	K Uncertainty in trend in national emissions introduced by emission factor uncertainty %	L Uncertainty in trend in national emissions introduced by activity data uncertainty %	M Uncertainty in trend in national emissions introduced into the trend in total national emissions %
1A1a	Public electricity and heat production	Cd	1.1300	0.4842	2%	200%	200.01%	1.420116	0.06186	0.10616	12.37%	0.30%	1.53%
1A1c	Manufacture of solid fuels and other energy industries	Cd	0.0010	0.0001	2%	200%	200.01%	0.000000	-0.00002	0.00002	0.00%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Cd	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	Cd	0.0017	0.0006	2%	50%	50.04%	0.000000	0.00006	0.00012	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Cd	3.2300	0.0146	2%	100%	100.02%	0.000321	-0.12212	0.00319	-12.21%	0.01%	1.49%
1A3bi	Road transport: Passenger cars	Cd	0.0038	0.0001	2%	20%	20.10%	0.000000	-0.00013	0.00001	0.00%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	Cd	0.0005	0.0000	2%	20%	20.10%	0.000000	-0.00002	0.00000	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Cd	0.0012	0.0000	2%	20%	20.10%	0.000000	-0.00004	0.00000	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Cd	0.0001	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Cd	0.0012	0.0012	2%	30%	30.07%	0.000000	0.00023	0.00027	0.01%	0.00%	0.00%
1A3c	Railways	Cd	0.0007	0.0001	2%	50%	50.04%	0.000000	-0.00001	0.00002	0.00%	0.00%	0.00%
1A3dii	National navigation (shipping)	Cd	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Cd	0.0000	0.0027	2%	100%	100.02%	0.000011	0.00058	0.00058	0.06%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	Cd	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00002	0.00003	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Cd	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	Cd	0.0045	0.0001	2%	100%	100.02%	0.000000	-0.00016	0.00002	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Cd	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	Cd	0.0695	0.2125	5%	100%	100.12%	0.068541	0.04387	0.04659	4.39%	0.33%	0.19%
1A4bi	Residential: Stationary, waste	Cd	0.0570	0.0732	50%	50%	70.71%	0.004057	0.01382	0.01605	0.69%	1.13%	0.02%
1A4bii	Residential: Household and gardening (mobile)	Cd	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4ci	Agriculture/Forestry/Fishing: Stationary	Cd	0.0100	0.0007	2%	100%	100.02%	0.000001	-0.00023	0.00016	-0.02%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Cd	0.0014	0.0007	2%	50%	50.04%	0.000000	0.00009	0.00014	0.00%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Cd	0.0001	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Cd	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	Cd	0.0225	0.0097	5%	50%	50.25%	0.000036	0.00125	0.00213	0.06%	0.02%	0.00%
5C1bv	Cremation	Cd	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
5C2	Open burning of waste	Cd	0.0260	0.0117	10%	100%	100.50%	0.000209	0.00155	0.00257	0.16%	0.04%	0.00%
5E	Other waste	Cd	0.0000	0.0003	2%	100%	100.02%	0.000000	0.00008	0.00008	0.01%	0.00%	0.00%
TOTAL			4.5611	0.8127			1.493293						0.03234623
				% uncertainty in total inventory			122.20%			Trend uncertainty:			17.99%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	Hg	1.0136	0.4816	2%	200%	200.01%	2.581412	-0.02023	0.40107	-4.05%	1.13%	0.18%
1A1c	Manufacture of solid fuels and other energy industries	Hg	0.0010	0.0000	2%	200%	200.01%	0.000000	-0.00038	0.00004	-0.08%	0.00%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Hg	IE	IE	2%	100%	100.02%	IE	IE	IE	IE	IE	IE
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Hg	0.0802	0.0151	2%	100%	100.02%	0.000631	-0.02081	0.01254	-2.08%	0.04%	0.04%
1A3bi	Road transport: Passenger cars	Hg	0.0030	0.0035	2%	20%	20.10%	0.000001	0.00163	0.00287	0.03%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	Hg	0.0004	0.0005	2%	20%	20.10%	0.000000	0.00027	0.00043	0.01%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	Hg	0.0019	0.0009	2%	20%	20.10%	0.000000	-0.00004	0.00076	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	Hg	0.0001	0.0000	2%	20%	20.10%	0.000000	-0.00002	0.00002	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	Hg	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3c	Railways	Hg	0.0009	0.0000	2%	50%	50.04%	0.000000	-0.00039	0.00000	-0.02%	0.00%	0.00%
1A3dii	National navigation (shipping)	Hg	0.0002	0.0002	2%	50%	50.04%	0.000000	0.00004	0.00012	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	Hg	0.0000	0.0010	2%	100%	100.02%	0.000003	0.00082	0.00083	0.08%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	Hg	0.0004	0.0000	3%	100%	100.04%	0.000000	-0.00014	0.00002	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	Hg	0.0158	0.0003	2%	100%	100.02%	0.000000	-0.00635	0.00022	-0.63%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	Hg	0.0002	0.0002	2%	100%	100.02%	0.000000	0.00010	0.00019	0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	Hg	0.0030	0.0092	5%	100%	100.12%	0.000234	0.00638	0.00762	0.64%	0.05%	0.00%
1A4bi	Residential: Stationary, waste	Hg	0.0469	0.0603									
1A4ci	Agriculture/Forestry/Fishing: Stationary	Hg	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00015	0.00015	0.02%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Hg	0.0003	0.0000	2%	100%	100.02%	0.000000	-0.00012	0.00002	-0.01%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Hg	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	Hg	0.0112	0.0045	5%	50%	50.25%	0.000014	-0.00093	0.00375	-0.05%	0.03%	0.00%
5C1bv	Cremation	Hg	0.0000	0.0121	2%	50%	50.04%	0.000102	0.01008	0.01008	0.50%	0.03%	0.00%
5C2	Open burning of waste	Hg	0.0214	0.0096	10%	100%	100.50%	0.000261	-0.00087	0.00803	-0.09%	0.11%	0.00%
5E	Other waste	Hg	0.0000	0.0003	2%	100%	100.02%	0.000000	0.00029	0.00029	0.03%	0.00%	0.00%
TOTAL			1.2007	0.5995				2.582659					0.0023
					% uncertainty in total inventory			160.71%			Trend uncertainty:		4.81%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PCDD/F	2.3300	0.8964	2%	250%	250.01%	0.361482	-0.02118	0.11033	-5.29%	0.31%	0.28%
1A1c	Manufacture of solid fuels and other energy industries	PCDD/F	0.0000	0.0159	2%	250%	250.01%	0.000114	0.00196	0.00196	0.49%	0.01%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PCDD/F	1.4400	0.4913	2%	250%	250.01%	0.108578	-0.02081	0.06047	-5.20%	0.17%	0.27%
1A3bi	Road transport: Passenger cars	PCDD/F	0.1883	0.2056	2%	250%	250.01%	0.019023	0.01467	0.02531	3.67%	0.07%	0.13%
1A3bii	Road transport: Light duty vehicles	PCDD/F	0.0310	0.0300	2%	250%	250.01%	0.000406	0.00195	0.00370	0.49%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PCDD/F	0.0994	0.0310	2%	250%	250.01%	0.000433	-0.00179	0.00382	-0.45%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PCDD/F	0.0100	0.0017	2%	250%	250.01%	0.000001	-0.00036	0.00021	-0.09%	0.00%	0.00%
1A3c	Railways	PCDD/F	0.0242	0.0000	2%	250%	250.01%	0.000000	-0.00136	0.00000	-0.34%	0.00%	0.00%
1A3dii	National navigation (shipping)	PCDD/F	0.0009	0.0007	2%	250%	250.01%	0.000000	0.00003	0.00008	0.01%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PCDD/F	0.0200	0.0505	2%	250%	250.01%	0.001146	0.00508	0.00621	1.27%	0.02%	0.02%
1A4bi	Residential: Stationary, liquid fuels	PCDD/F	0.0059	0.0004	3%	250%	250.02%	0.000000	-0.00028	0.00005	-0.07%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	PCDD/F	2.4316	0.0304	2%	250%	250.01%	0.000416	-0.13317	0.00374	-33.29%	0.01%	11.08%
1A4bi	Residential: Stationary, gaseous fuels	PCDD/F	0.0032	0.0034	2%	250%	250.01%	0.000005	0.00024	0.00042	0.06%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	PCDD/F	0.6717	0.7321	5%	100%	100.12%	0.038676	0.05214	0.09011	5.21%	0.64%	0.28%
1A4bi	Residential: Stationary, waste	PCDD/F	0.0177	0.0224	50%	100%	111.80%	0.000045	0.00175	0.00275	0.18%	0.19%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCDD/F	0.0200	0.0068	2%	250%	250.01%	0.000021	-0.00029	0.00084	-0.07%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCDD/F	0.0014	0.0001	2%	250%	250.01%	0.000000	-0.00007	0.00001	-0.02%	0.00%	0.00%
2C6	Zinc production	PCDD/F	0.0000	0.0036	2%	20%	20.10%	0.000000	0.00045	0.00045	0.01%	0.00%	0.00%
2G	Other product use	PCDD/F	0.0004	0.0002	5%	250%	250.05%	0.000000	0.00000	0.00002	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	PCDD/F	0.0534	0.3483	2%	250%	250.01%	0.054575	0.03985	0.04287	9.96%	0.12%	0.99%
5C1biii	Clinical waste incineration	PCDD/F	0.4700	0.1143	2%	250%	300.00%	0.008456	-0.01247	0.01406	-3.12%	0.04%	0.10%
5C1bv	Cremation	PCDD/F	0.0000	0.0002	2%	250%	300.00%	0.000000	0.00003	0.00003	0.01%	0.00%	0.00%
5C2	Open burning of waste	PCDD/F	0.3057	0.1377	10%	250%	250.20%	0.008541	-0.00032	0.01695	-0.08%	0.24%	0.00%
5E	Other waste	PCDD/F	0.0000	0.6045	2%	250%	250.01%	0.164382	0.07440	0.07440	18.60%	0.21%	3.46%
TOTAL			8.1248	3.7275				0.766300					0.1662
					% uncertainty in total inventory			87.54%			Trend uncertainty:		40.77%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(a)p	0.6200	1.0229	2%	200%	200.01%	0.830342	0.18323	0.43193	36.65%	1.22%	13.44%
1A1c	Manufacture of solid fuels and other energy industries	B(a)p	0.0000	0.0031	2%	200%	200.01%	0.000007	0.00129	0.00129	0.26%	0.00%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(a)p	0.0051	0.0017	2%	200%	200.01%	0.000002	-0.00134	0.00070	-0.27%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(a)p	0.2262	0.3787	2%	200%	200.01%	0.113804	0.06929	0.15991	13.86%	0.45%	1.92%
1A3bi	Road transport: Passenger cars	B(a)p	0.0032	0.0084	2%	200%	200.01%	0.000056	0.00225	0.00354	0.45%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	B(a)p	0.0007	0.0020	2%	200%	200.01%	0.000003	0.00053	0.00083	0.11%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(a)p	0.0014	0.0007	2%	200%	200.01%	0.000000	-0.00026	0.00031	-0.05%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(a)p	0.0002	0.0000	2%	200%	200.01%	0.000000	-0.00005	0.00001	-0.01%	0.00%	0.00%
1A3c	Railways	B(a)p	0.0068	0.0002	2%	200%	200.01%	0.000000	-0.00262	0.00010	-0.52%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(a)p	0.0300	0.0626	2%	200%	200.01%	0.003110	0.01442	0.02644	2.88%	0.07%	0.08%
1A4aii	Commercial/institutional: Mobile	B(a)p	0.0004	0.0004	2%	200%	200.01%	0.000000	0.00000	0.00017	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	B(a)p	0.0002	0.0000	3%	200%	200.02%	0.000000	-0.00007	0.00000	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(a)p	0.6937	0.0099	2%	200%	200.01%	0.000078	-0.27274	0.00419	-54.55%	0.01%	29.75%
1A4bi	Residential: Stationary, gaseous fuels	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(a)p	0.7420	0.7384	5%	100%	100.12%	0.108429	0.01470	0.31180	1.47%	2.20%	0.07%
1A4bi	Residential: Stationary, waste	B(a)p	0.0034	0.0042	50%	100%	111.80%	0.000004	0.00044	0.00179	0.04%	0.13%	0.00%
1A4bii	Residential: Household and gardening (mobile)	B(a)p	0.0000	0.0002	2%	200%	200.01%	0.000000	0.00007	0.00008	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(a)p	0.0300	0.0096	2%	200%	200.01%	0.000073	-0.00795	0.00406	-1.59%	0.01%	0.03%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(a)p	0.0043	0.0020	2%	200%	200.01%	0.000003	-0.00088	0.00084	-0.18%	0.00%	0.00%
2G	Other product use	B(a)p	0.0005	0.0002	5%	200%	200.06%	0.000000	-0.00011	0.00008	-0.02%	0.00%	0.00%
5C1bv	Cremation	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(a)p	0.0000	0.0000	10%	200%	200.25%	0.000000	-0.00001	0.00001	0.00%	0.00%	0.00%
TOTAL			2.3681	2.2451				1.055913					0.4531
					% uncertainty in total inventory			102.76%			Trend uncertainty:		67.31%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(b)f	0.7400	1.3645	2%	200%	200.01%	1.069103	0.23726	0.49633	47.45%	1.40%	22.54%
1A1c	Manufacture of solid fuels and other energy industries	B(b)f	0.0000	0.0040	2%	200%	200.01%	0.000009	0.00147	0.00147	0.29%	0.00%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(b)f	0.0083	0.0028	2%	200%	200.01%	0.000004	-0.00190	0.00101	-0.38%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(b)f	0.2766	0.5040	2%	200%	200.01%	0.145856	0.08664	0.18333	17.33%	0.52%	3.01%
1A3bi	Road transport: Passenger cars	B(b)f	0.0054	0.0095	2%	200%	200.01%	0.000052	0.00158	0.00346	0.32%	0.01%	0.00%
1A3bii	Road transport: Light duty vehicles	B(b)f	0.0009	0.0022	2%	200%	200.01%	0.000003	0.00047	0.00080	0.09%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(b)f	0.0086	0.0044	2%	200%	200.01%	0.000011	-0.00139	0.00162	-0.28%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(b)f	0.0003	0.0000	2%	200%	200.01%	0.000000	-0.00009	0.00001	-0.02%	0.00%	0.00%
1A3c	Railways	B(b)f	0.0093	0.0004	2%	200%	200.01%	0.000000	-0.00311	0.00015	-0.62%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(b)f	0.0400	0.0826	2%	200%	200.01%	0.003920	0.01608	0.03005	3.22%	0.09%	0.10%
1A4aii	Commercial/institutional: Mobile	B(b)f	0.0007	0.0007	2%	200%	200.01%	0.000000	0.00001	0.00025	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	B(b)f	0.0001	0.0000	3%	200%	200.02%	0.000000	-0.00003	0.00000	-0.01%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(b)f	0.9722	0.0120	2%	200%	200.01%	0.000083	-0.33396	0.00437	-66.79%	0.01%	44.61%
1A4bi	Residential: Stationary, gaseous fuels	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(b)f	0.6366	0.6321	5%	100%	100.12%	0.057486	0.00757	0.22991	0.76%	1.63%	0.03%
1A4bi	Residential: Stationary, waste	B(b)f	0.0034	0.0043	50%	100%	111.80%	0.000003	0.00037	0.00156	0.04%	0.11%	0.00%
1A4bii	Residential: Household and gardening (mobile)	B(b)f	0.0000	0.0002	2%	200%	200.01%	0.000000	0.00007	0.00008	0.01%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(b)f	0.0400	0.0123	2%	200%	200.01%	0.000087	-0.00949	0.00448	-1.90%	0.01%	0.04%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(b)f	0.0065	0.0033	2%	200%	200.01%	0.000006	-0.00108	0.00120	-0.22%	0.00%	0.00%
2G	Other product use	B(b)f	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00004	0.00003	-0.01%	0.00%	0.00%
5C1bv	Cremation	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(b)f	0.0000	0.0000	10%	200%	200.25%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
TOTAL			2.7493	2.6395				1.276625					0.7033
					% uncertainty in total inventory			112.99%			Trend uncertainty:		83.86%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions kt	2018 emissions kt	Activity data uncertainty %	Emission factor uncertainty %	Combined uncertainty %	Contribution to Variance by Category in Year 2018	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor uncertainty %	Uncertainty in trend in national emissions introduced by activity data uncertainty %	Uncertainty in trend in national emissions introduced into the trend in total national emissions %
1A1a	Public electricity and heat production	B(k)f	0.3800	0.5195	2%	200%	200.01%	0.667943	0.13179	0.34412	26.36%	0.97%	6.96%
1A1c	Manufacture of solid fuels and other energy industries	B(k)f	0.0000	0.0016	2%	200%	200.01%	0.000007	0.00108	0.00108	0.22%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(k)f	0.1455	0.1905	2%	200%	200.01%	0.089825	0.04500	0.12620	9.00%	0.36%	0.81%
1A3bi	Road transport: Passenger cars	B(k)f	0.0022	0.0073	2%	200%	200.01%	0.000130	0.00357	0.00481	0.71%	0.01%	0.01%
1A3bii	Road transport: Light duty vehicles	B(k)f	0.0006	0.0017	2%	200%	200.01%	0.000007	0.00080	0.00114	0.16%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	B(k)f	0.0096	0.0050	2%	200%	200.01%	0.000061	-0.00207	0.00329	-0.41%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	B(k)f	0.0001	0.0000	2%	200%	200.01%	0.000000	-0.00004	0.00001	-0.01%	0.00%	0.00%
1A3c	Railways	B(k)f	0.0044	0.0003	2%	200%	200.01%	0.000000	-0.00227	0.00018	-0.45%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	B(k)f	0.0200	0.0315	2%	200%	200.01%	0.002460	0.00973	0.02088	1.95%	0.06%	0.04%
1A4bi	Residential: Stationary, liquid fuels	B(k)f	0.0002	0.0000	3%	200%	200.02%	0.000000	-0.00009	0.00000	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	B(k)f	0.4197	0.0057	2%	200%	200.01%	0.000082	-0.22969	0.00380	-45.94%	0.01%	21.10%
1A4bi	Residential: Stationary, gaseous fuels	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	B(k)f	0.5057	0.5007	5%	100%	100.12%	0.155452	0.04936	0.33163	4.94%	2.34%	0.30%
1A4bi	Residential: Stationary, waste	B(k)f	0.0015	0.0019	50%	100%	111.80%	0.000003	0.00041	0.00123	0.04%	0.09%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(k)f	0.0200	0.0056	2%	200%	200.01%	0.000079	-0.00742	0.00373	-1.48%	0.01%	0.02%
2G	Other product use	B(k)f	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00005	0.00005	-0.01%	0.00%	0.00%
5C1bv	Cremation	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	B(k)f	0.0000	0.0000	10%	200%	200.25%	0.000000	-0.00001	0.00001	0.00%	0.00%	0.00%
TOTAL			1.5097	1.2714				0.916048					0.2924
					% uncertainty in total inventory			95.71%			Trend uncertainty:		54.07%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	I(1.2.3-cd)p	0.2600	0.5100	2%	200%	200.01%	0.421243	0.15876	0.32538	31.75%	0.92%	10.09%
1A1c	Manufacture of solid fuels and other energy industries	I(1.2.3-cd)p	0.0000	0.0015	2%	200%	200.01%	0.000004	0.00095	0.00095	0.19%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	I(1.2.3-cd)p	0.0930	0.1888	2%	200%	200.01%	0.057728	0.06093	0.12045	12.19%	0.34%	1.49%
1A3bi	Road transport: Passenger cars	I(1.2.3-cd)p	0.0060	0.0083	2%	200%	200.01%	0.000112	0.00147	0.00531	0.29%	0.02%	0.00%
1A3bii	Road transport: Light duty vehicles	I(1.2.3-cd)p	0.0009	0.0018	2%	200%	200.01%	0.000005	0.00060	0.00117	0.12%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	I(1.2.3-cd)p	0.0022	0.0011	2%	200%	200.01%	0.000002	-0.00068	0.00073	-0.14%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	I(1.2.3-cd)p	0.0003	0.0000	2%	200%	200.01%	0.000000	-0.00019	0.00002	-0.04%	0.00%	0.00%
1A3c	Railways	I(1.2.3-cd)p	0.0026	0.0001	2%	200%	200.01%	0.000000	-0.00160	0.00004	-0.32%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	I(1.2.3-cd)p	0.0200	0.0309	2%	200%	200.01%	0.001546	0.00691	0.01971	1.38%	0.06%	0.02%
1A4bi	Residential: Stationary, liquid fuels	I(1.2.3-cd)p	0.0004	0.0000	3%	200%	200.02%	0.000000	-0.00023	0.00000	-0.05%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	I(1.2.3-cd)p	0.3439	0.0047	2%	200%	200.01%	0.000036	-0.21653	0.00301	-43.31%	0.01%	18.75%
1A4bi	Residential: Stationary, gaseous fuels	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	I(1.2.3-cd)p	0.8260	0.8175	5%	100%	100.12%	0.271248	-0.00687	0.52158	-0.69%	3.69%	0.14%
1A4bi	Residential: Stationary, waste	I(1.2.3-cd)p	0.0018	0.0023	50%	100%	111.80%	0.000003	0.00030	0.00146	0.03%	0.10%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	I(1.2.3-cd)p	0.0100	0.0045	2%	200%	200.01%	0.000032	-0.00354	0.00285	-0.71%	0.01%	0.01%
2G	Other product use	I(1.2.3-cd)p	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00007	0.00005	-0.01%	0.00%	0.00%
5C1bv	Cremation	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
TOTAL			1.5673	1.5715				0.751959					0.3050
					% uncertainty in total inventory			86.72%			Trend uncertainty:		55.22%

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	HCB	0.0200	0.1002	2%	250%	250.01%	0.622573	0.34514	0.50993	86.28%	1.44%	74.47%
1A1c	Manufacture of solid fuels and other energy industries	HCB	0.0000	0.0003	2%	250%	250.01%	0.000005	0.00146	0.00146	0.37%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	HCB	0.0636	0.0391	2%	250%	250.01%	0.094957	-0.32266	0.19915	-80.66%	0.56%	65.07%
1A3bi	Road transport: Passenger cars	HCB	0.0002	0.0002	2%	250%	250.01%	0.000003	-0.00030	0.00103	-0.07%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	0.00005	0.00015	0.01%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	-0.00002	0.00012	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	HCB	0.0000	0.0000	2%	250%	250.01%	0.000000	-0.00007	0.00001	-0.02%	0.00%	0.00%
1A3c	Railways	HCB	0.0001	0.0000	2%	100%	100.02%	0.000000	-0.00061	0.00000	-0.06%	0.00%	0.00%
1A3dii	National navigation (shipping)	HCB	0.0006	0.0004	2%	100%	100.02%	0.000002	-0.00257	0.00204	-0.26%	0.01%	0.00%
1A4ai	Commercial/institutional: Stationary	HCB	0.0025	0.0061	2%	100%	100.02%	0.000374	0.01076	0.03122	1.08%	0.09%	0.01%
1A4bi	Residential: Stationary, solid fuels	HCB	0.0022	0.0000	2%	250%	250.01%	0.000000	-0.01783	0.00017	-4.46%	0.00%	0.20%
1A4bi	Residential: Stationary, biomass	HCB	0.0797	0.1477	5%	100%	100.12%	0.216816	0.09567	0.75140	9.57%	5.31%	1.20%
1A4bi	Residential: Stationary, waste	HCB	0.0115	0.0146	50%	100%	111.80%	0.002633	-0.02080	0.07415	-2.08%	5.24%	0.32%
1A4ci	Agriculture/Forestry/Fishing: Stationary	HCB	0.0000	0.0007	2%	100%	100.02%	0.000004	0.00340	0.00340	0.34%	0.01%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	HCB	0.0009	0.0001	2%	100%	100.02%	0.000000	-0.00687	0.00025	-0.69%	0.00%	0.00%
5C1bv	Cremation	HCB	0.0000	0.0012	2%	100%	100.02%	0.000015	0.00620	0.00620	0.62%	0.02%	0.00%
5C2	Open burning of waste	HCB	0.0153	0.0069	10%	250%	250.20%	0.002943	-0.09058	0.03503	-22.64%	0.50%	5.13%
TOTAL			**0.1965**	**0.3175**				**0.940323**					**1.4641**
					% uncertainty in total inventory			**96.97%**			**Trend uncertainty:**		**121.00%**

	A	B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	1990 emissions	2018 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2018	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PCB	5.2437	3.5413	2%	150%	150.01%	1.084658	0.04127	0.42280	6.19%	1.20%	0.40%
1A1c	Manufacture of solid fuels and other energy industries	PCB	0.0000	0.0146	2%	150%	150.01%	0.000018	0.00174	0.00174	0.26%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PCB	2.0000	1.2395	2%	100%	100.02%	0.059075	0.00256	0.14799	0.26%	0.42%	0.00%
1A3bi	Road transport: Passenger cars	PCB	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PCB	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3c	Railways	PCB	0.0202	0.0000	2%	100%	100.02%	0.000000	-0.00147	0.00000	-0.15%	0.00%	0.00%
1A3dii	National navigation (shipping)	PCB	0.0003	0.0002	2%	100%	100.02%	0.000000	0.00000	0.00002	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PCB	0.2500	0.2039	2%	150%	150.01%	0.003598	0.00617	0.02435	0.93%	0.07%	0.01%
1A4bi	Residential: Stationary, solid fuels	PCB	0.6003	0.0092	2%	150%	150.01%	0.000007	-0.04252	0.00110	-6.38%	0.00%	0.41%
1A4bi	Residential: Stationary, biomass	PCB	0.0003	0.0004	5%	150%	150.08%	0.000000	0.00002	0.00005	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCB	0.2200	0.0701	2%	150%	150.01%	0.000425	-0.00763	0.00837	-1.14%	0.02%	0.01%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCB	0.0004	0.0000	2%	150%	150.01%	0.000000	-0.00003	0.00000	0.00%	0.00%	0.00%
2C6	Zinc production	PCB	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bv	Cremation	PCB	0.0000	0.0033	2%	150%	150.01%	0.000001	0.00040	0.00040	0.06%	0.00%	0.00%
5C2	Open burning of waste	PCB	0.0405	0.0182	10%	150%	150.33%	0.000029	-0.00077	0.00218	-0.12%	0.03%	0.00%
TOTAL			8.3758	5.1008				1.147811					0.00830
					% uncertainty in total inventory			107.14%			Trend uncertainty:		9.11%