Republic of Estonia
Environment Agency

Estonian Informative Inventory Report 1990-2018

Submitted under the Convention on Long-Range Transboundary Air Pollution

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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
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
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

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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 1990-2018 was submitted on 13th February 2020. 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 2017. The reasons for the recalculations are specified in the The status of recalculations in the 2020 submission Table 0.1.

Table 0.1 The status of recalculations in the 2020 submission

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1a	Public electricity and heat production	Correction of emissions data	All pollutants	2005
1A1c	Manufacture of solid fuels and other energy industries	Correction of emissions data	$PM_{2.5}$, PM_{10}	2015-2017
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Correction of emissions data	Pb	2017
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Correction of emissions data	TSP, $PM_{2.5}$, PM_{10}, BC	2004-2017
1A2giii	Stationary combustion in manufacturing industries and construction: Other	Correction of emissions data	NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, Pb, As, Cu, Se	2000-2009
			NO_x, CO	2000-2007, 2009
			BC, Cd, Hg	2005
			Cr, Zn	2003-2009
			PCCD, PAHs, HCB, PCB	2005
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	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
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	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
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	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
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	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
1A3bv	Road transport: Gasoline evaporation	Correction of activity data and emission factors	NMVOC	1990-2017
1A3bvi	Road transport: Automobile tyre and brake wear	Correction of activity data and emission factors	TSP, HMs	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
1A3bvii	Road transport: Automobile road abrasion	Correction of activity data and emission factors	TSP	1990-2017
			$PM_{2.5}$, PM_{10}, BC	2000-2017
1A3dii	National navigation (shipping)	Correction of emission factors	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO	1990-2017
1A4ai	Commercial/institutional: Stationary	Correction of emissions data	All pollutants	2005
1A4bi	Residential: Stationary	Correction of emission data	All pollutants	1990-2017
1A4cii	Agriculture/Forestry/Fishing: National fishing	Corrections of statistical data (fuel consumption)	All pollutants	1990-2002
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Corrections of statistical data (fuel consumption)	All pollutants	1990-2002
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	Emissions of NO_x, particulates and CO realocated to NFR 2C1 and	NO_x, particulates, CO	2017

NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
		emissions were replaced with the notation key NA		
1B2av	Distribution of oil products	Corrections of statistical data (gasoline consumption) from Statistics Estonia	NMVOC	2017
2A3	Glass production	Emissions of particulates reallocated from 1A2f	$PM_{2.5}$, PM_{10}, TSP, BC	2004-2017
2A5a	Quarrying and mining of minerals other than coal	Correction of emissions data	PM_{10}	2017
2C1	Iron and steel production	Correction of emissions data. Distribution of emissions between 2C categories	NO_x, CO	2000-2007; 2011-2015; 2017
			NMVOC	2000-2007; 2013-2015
			SO_x, NH_3	2000-2007; 2012-2017
			$PM_{2.5}$, PM_{10}, TSP, BC	2000-2017
			Pb, Cu	2000-2009; 2013-2015
			Cr, Ni	2000-2007; 2013-2015
			Zn	2000-2006
				2008-2017 - NA
2C3	Aluminium production	Correction of emissions data. Distribution of emissions between 2C categories	NMVOC	2007-2008; 2016
			$PM_{2.5}$, PM_{10}, BC	2007-2017
2C5	Lead production	Correction of emissions data. Distribution of emissions between 2C categories	SO_x, TSP, Pb	2000-2008
			$PM_{2.5}$, PM_{10}	2000-2017
2C6	Zinc production	Correction of emissions data. Distribution of emissions between 2C categories. Additionally calculated PCCD and PCB emissions	$PM_{2.5}$, PM_{10}, TSP	2002-2008
			Zn	2002-2017
			PCCD, PCB	2004-2017
2C7a	Copper production	Correction of emissions data on the base of Guidebook 2019 EF	$PM_{2.5}$, PM_{10}, TSP, BC	2009-2017
2C7c	Other metal production	Correction of emissions data. Distribution of emissions between 2C categories. Additionally calculated PCCD and PCB emissions	NO_x	2000-2007; 2009-2015
			NMVOC	2000-2007; 2010; 2013-2015
			SO_x	2000-2010; 2013
			NH_3	2000-2007; 2009-2010
			$PM_{2.5}$, PM_{10}, TSP, BC	2000-2017
			CO	2000-2007; 2009-2015
			Pb	2000-2005; 2007; 2010-2011; 2013-2015
			Cr	2000-2009
			Cu, Ni	2000-2007; 2010
			Zn	2000-2014; 2016-2017
2D3a	Domestic solvent use including fungicides	Tier 2 methodology was used for emission calculations	NMVOC	2004-2017
		As the EMEP/EEA Guidebook 2019 does not include any more Hg EF from the fluorescent tubes, the emissions were replaced with the notation key NA	Hg	1990-2017
2D3b	Road paving with asphalt	Correction of emissions factor	BC	1990-2017
2D3d	Coating application	Corrections of statistical activity data from Statistics Estonia	NMVOC	2017
		Corrected emissions data form the OSIS point sources database	Pb, Cu; Zn	2013-2015; 2009, 2012-2017
2D3h	Printing	Corrections of statistical activity data from Statistics Estonia	NMVOC	2017

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NFR19 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
2G	Other product use	Corrections of statistical activity data (use of fireworks) from Statistics Estonia	NO_x, SO_2, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn	2017
3B4d	Manure management - Goats	Corrected emission factor.	PM_{10}	2000-2017
3Da1	Inorganic N-fertilizers (includes also urea application)	Corrections of statistical activity data and renewed emission factor from GB2019	NH_3	1990-2017
3Da2b	Sewage sludge applied to soils	Renewed emission factor from GB2019	NH_3	1990-2017
3De	Cultivated crops	Tier 2 methodology was used for emission calculations	NMVOC	1990-2017
5A	Solid waste disposal on land	Tier 2 methodology was used for emission calculations	NMVOC	1990-2017
5B2	Biological treatment of waste – Anaerobic digestion at biogas facilities	Corrected emissions data form the OSIS point sources database	NH_3	2017
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, Cu	2017
		Corrected emissions data form the OSIS point sources database	SO_2, TSP, CO	2003
		Emission was relocated under NFR 1A2gviii	Pb	2006
		Emissions were relocated under NFR 1A2gviii	NMVOC, SO_2, Pb	2004-2005
5E	Other waste	Corrected emissions data from car fires and various types of house fires	$PM_{2.5}$, PM_{10}, TSP, Cd, Hg, As, Cr, Cu, PCDD/F	2016-2017
		Corrected emissions data from car fires and various types of house fires	Pb	2016

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

The differences in total emissions between the 2019 and 2020 submissions are presented in the Table 0.2.

Table 0.2 Difference between the 2019 and 2020 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As
1990	1.06	-1.73	0.00	3.14	NR	NR	-0.01	NR	-0.09	0.80	1.26	3.32	0.19
1991	1.14	-1.82	0.00	2.82	NR	NR	-0.01	NR	-0.08	0.98	1.45	4.09	0.24
1992	1.21	-2.65	0.00	3.23	NR	NR	-0.01	NR	-0.12	1.60	2.18	5.45	0.30
1993	1.26	-3.46	0.00	2.26	NR	NR	-0.01	NR	-0.09	2.08	3.06	7.37	0.41
1994	0.71	-2.39	0.00	2.08	NR	NR	-0.01	NR	-0.04	1.89	2.47	7.75	0.44
1995	0.64	-2.49	0.00	1.64	NR	NR	-0.01	NR	-0.03	2.77	3.57	8.73	0.49
1996	0.85	-2.49	0.00	1.61	NR	NR	-0.02	NR	-0.04	3.60	6.01	8.88	0.48
1997	0.77	-2.65	0.00	1.97	NR	NR	-0.02	NR	-0.04	5.12	5.91	8.93	0.49
1998	0.81	-2.25	0.00	2.40	NR	NR	-0.02	NR	-0.04	5.90	6.59	10.14	0.55
1999	0.65	-2.33	0.00	2.05	NR	NR	-0.02	NR	-0.03	6.23	7.05	10.70	0.59
2000	0.86	-1.78	-0.00	2.52	-0.12	-0.05	-0.02	-0.45	-0.04	7.17	10.91	11.19	0.63
2001	1.01	-2.06	0.01	1.88	-0.11	-0.04	-0.01	-0.45	-0.04	6.80	10.76	10.90	0.62
2002	1.43	-2.26	0.02	1.67	-0.24	-0.13	-0.08	-0.67	-0.08	6.62	9.97	10.28	0.59
2003	0.77	-2.80	0.00	2.19	-0.20	-0.11	-0.07	-0.51	-0.07	5.99	8.75	8.36	0.47
2004	0.73	-2.27	0.00	2.33	-0.17	-0.10	-0.06	-0.44	-0.06	5.90	8.98	8.67	0.46
2005	0.54	-1.64	0.05	1.75	-8.85	-5.88	-3.85	-10.13	-1.76	5.03	7.96	8.39	0.48
2006	1.10	-0.53	0.01	2.12	-0.29	-0.15	-0.07	-0.91	-0.10	6.65	9.45	8.88	0.52
2007	1.53	-0.61	0.01	2.24	-0.43	-0.23	-0.17	-1.17	-0.13	5.94	7.86	7.41	0.41
2008	1.95	-0.21	0.00	3.18	-0.54	-0.33	-0.22	-1.34	-0.16	6.25	8.71	8.57	0.48
2009	0.90	-0.40	0.00	2.62	-0.26	-0.15	-0.11	-0.65	-0.06	7.72	10.13	10.89	0.59
2010	0.77	-0.58	0.00	2.74	-0.18	-0.10	-0.08	-0.53	-0.06	5.55	7.86	7.66	0.40
2011	0.48	-0.07	0.00	2.13	0.19	0.11	0.10	0.39	-0.27	5.70	8.31	7.74	0.41

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As
2012	0.46	2.56	-0.05	1.22	0.49	0.33	0.25	0.78	-0.26	6.55	9.13	8.92	0.47
2013	0.50	2.17	-0.00	2.71	-0.12	-0.07	-0.05	-0.37	-0.03	5.78	7.58	7.60	0.41
2014	0.73	3.67	-0.01	1.58	-0.20	-0.12	-0.10	2.03	-0.09	6.24	8.12	7.67	0.45
2015	0.84	3.91	-0.03	1.40	-0.20	1.63	-0.11	2.06	-0.05	8.01	9.74	9.59	0.59
2016	0.73	4.05	-0.03	1.57	1.79	2.63	-0.10	3.79	-0.04	6.87	9.00	8.55	0.51
2017	0.86	5.13	-0.01	1.64	1.46	2.28	-0.19	4.24	-0.06	6.88	9.07	8.98	0.48

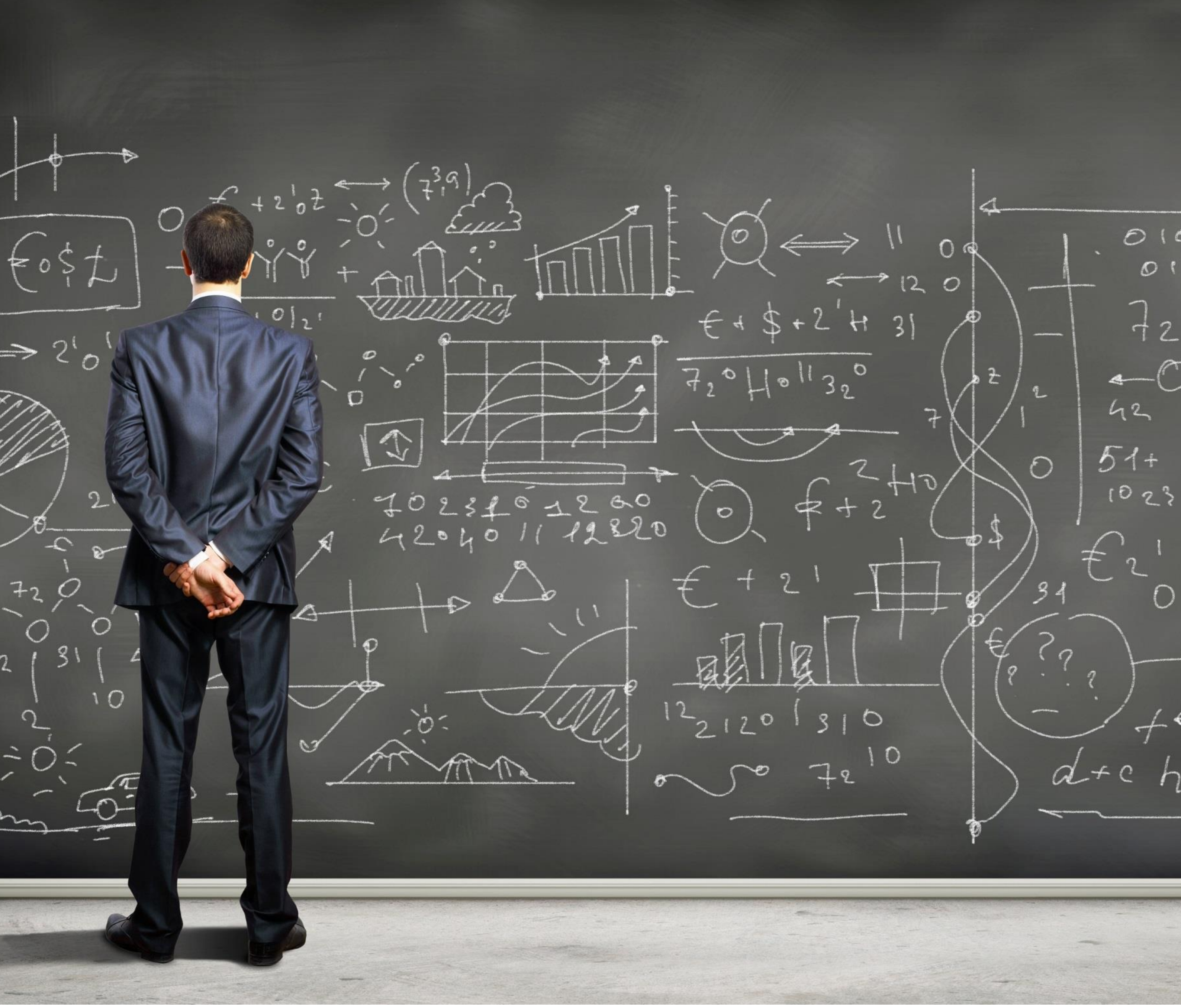
Table 0.2 continues

Year	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
1990	0.02	-0.08	0.04	4.69	0.02	0.04	-0.02	-0.03	0.00	0.00	-0.02	0.44	0.00
1991	0.02	-0.07	0.05	4.68	0.02	0.04	-0.02	-0.03	0.00	0.00	-0.02	0.45	0.00
1992	0.03	-0.07	0.06	6.49	0.02	0.03	-0.02	-0.04	0.00	0.00	-0.02	0.38	0.01
1993	0.04	-0.07	0.06	6.21	0.03	0.03	-0.03	-0.04			-0.02	0.39	0.01
1994	0.55	0.20	0.08	2.84	1.82	6.60	-0.01	-0.02	-0.00	-0.00	-0.01	0.13	0.00
1995	0.04	-0.05	0.05	1.81	0.03	0.02	-0.01	-0.01	0.00	0.00	0.00	0.07	0.00
1996	0.04	-0.01	0.05	1.70	0.03	0.01	-0.01	-0.02	0.00	0.00	-0.01	0.07	0.00
1997	0.04	-0.01	0.06	1.52	0.03	0.01	-0.01	-0.01	0.00	0.00	-0.01	0.06	0.00
1998	0.05	-0.01	0.07	1.78	0.04	0.01	-0.01	-0.02	0.00	0.00	-0.01	0.07	0.00
1999	0.05	0.02	0.06	0.81	0.04	0.01	-0.01	-0.01	-0.00	-0.00	-0.01	0.04	0.00
2000	0.15	0.34	0.29	1.25	0.05	0.01	-0.01	-0.02	0.00	0.00	-0.01	0.05	0.00
2001	0.05	0.22	0.16	2.30	0.04	0.02	-0.00	-0.01	0.01	0.02	0.00	0.11	0.00
2002	0.09	-0.14	0.05	2.69	0.04	0.01	-0.02	-0.03	-0.00	-0.00	-0.02	0.14	0.00
2003	0.78	0.09	0.64	0.11	0.04	0.00	-0.01	-0.02	-0.00	-0.00	-0.01	0.00	0.00
2004	1.72	0.29	0.86	0.11	0.08	0.48	-0.01	-0.02	-0.00	0.00	-0.01	0.00	0.00
2005	-0.41	-0.15	-0.57	0.27	-1.29	-0.71	-3.75	-4.58	-3.06	-2.39	-3.58	-3.07	-7.18
2006	0.07	-0.00	-0.01	0.10	0.03	0.65	-0.02	-0.03	0.00	0.00	-0.01	0.00	0.00
2007	0.05	0.04	0.04	0.13	0.02	0.38	-0.03	-0.04	0.00	0.00	-0.02	0.00	0.00
2008	0.04	0.19	0.04	0.00	0.05	0.53	-0.03	-0.05	-0.00	0.00	-0.02	0.00	0.00
2009	0.05	0.20	0.05	0.01	0.20	0.15	-0.01	-0.02	-0.00	0.00	-0.01	0.00	0.00
2010	0.04	0.03	0.04	0.01	0.06	0.50	-0.01	-0.02	-0.00	-0.00	-0.01	0.00	0.00
2011	0.04	0.03	0.04	0.01	0.09	0.70	-0.01	-0.01	-0.00	-0.00	-0.01	-0.10	0.00
2012	0.04	0.03	0.04	0.01	0.10	0.52	-0.00	-0.01	-0.00	-0.00	-0.01	-0.10	0.00
2013	0.97	0.31	0.11	0.01	0.21	0.08	-0.01	-0.01	0.00	0.00	-0.00	0.00	0.00
2014	0.10	0.36	0.10	-0.00	0.13	0.07	-0.01	-0.01	-0.00	-0.00	-0.01	0.00	0.00
2015	0.08	0.30	0.06	0.00	0.07	0.07	-0.01	-0.01	-0.00	-0.00	-0.01	0.00	0.00
2016	0.04	0.02	0.05	0.01	0.17	-1.80	-0.01	-0.01	-0.00	-0.00	-0.01	0.00	0.00
2017	0.04	-0.27	0.03	-0.02	0.06	0.14	-0.01	-0.01	0.00	-0.00	-0.01	0.02	0.00

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 POPs emissions from energy sector and waste incineration;
- 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 2018. 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 was established on June 1st 2013 when two environmental organisations were joined together after reorganisation. The new agency will consolidate the former Estonian Environment Information Centre and the Estonian Meteorological and Hydrological Institute into a single organisation. 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.

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

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

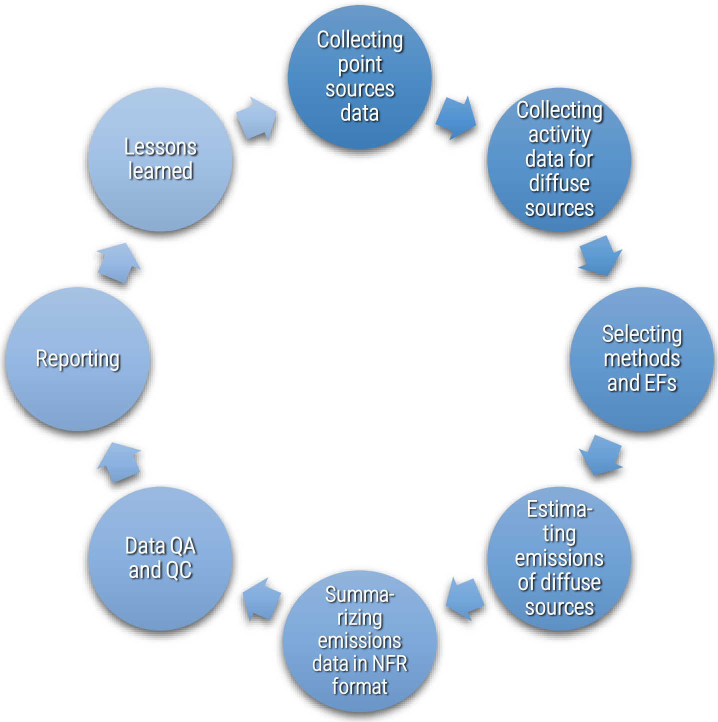

Figure 1.1 The main activities of inventory preparation

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 point sources information system contains data reported by the operators that have a pollution permit issued by the Estonian Environmental Board. 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 OSIS information system 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 into the OSIS information system, 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).

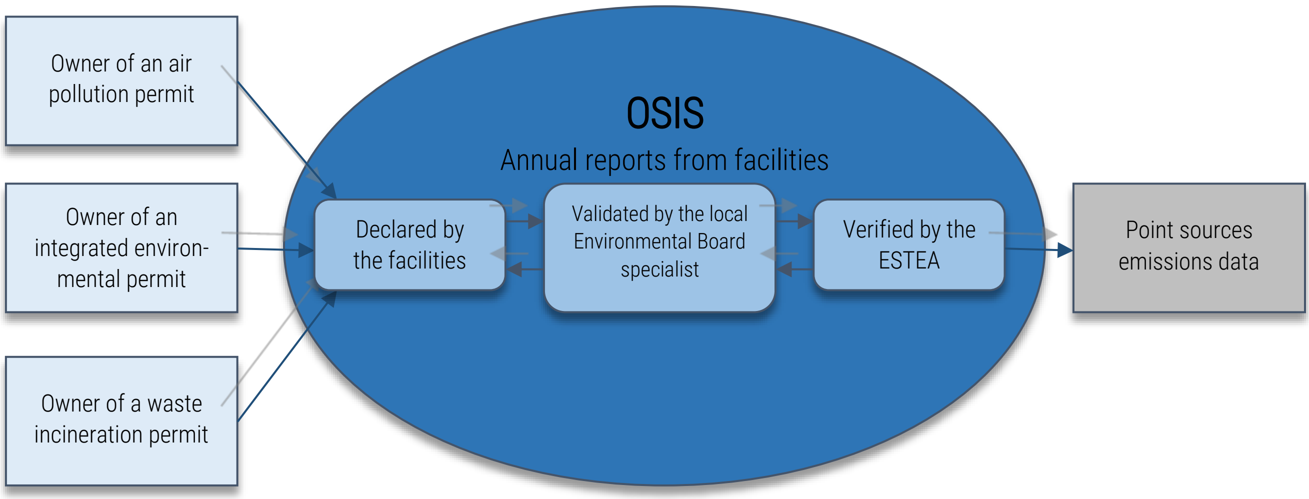

Figure 1.2 Validation of Estonian point sources data

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.

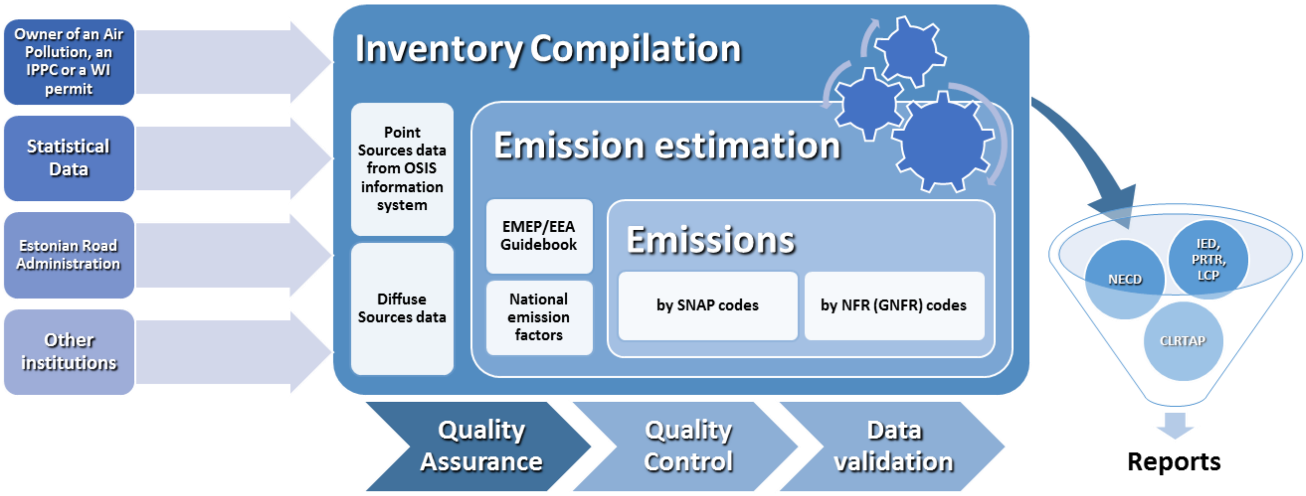

Figure 1.3 Air pollution inventory structure

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. 5.3.0) 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. According to the study, for certain emissions ("Key sources analysis and uncertainty assessment of sulphur dioxide, nitrogen oxides and ammonia emissions in Estonia" Elo Mandel, Tallinn 2009) in 2007 there were no significant differences between the results of the level and trend assessment of key sources analysis. So, for 2018, only the level assessment was chosen.

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) 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 (17.0%). 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 76.4% of SO_2 emissions in 2018. 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. The influence of energy sector (1Aa) is also significant for ammonia.

The construction and demolition sector (2A5b) 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 residential plants (1A4bi) is also significant for them.

According to level assessment, 51.8% 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										90.7
	(76.4%)	(14.3%)										
NO_x	1A1a	1A4bi	1A3bi	1A3biii	1A4cii	1A2gvii	3Da1	1A3bii				83.1
	(28.2%)	(15.0%)	(9.8%)	(8.9%)	(7.1%)	(5.6%)	(4.8%)	(3.7%)				
NH_3	3Da2a	3B1a	3Da1	3B1b	3B3	3Da2c						80.7
	(23.9%)	(22.3%)	(16.5%)	(8.5%)	(6.4%)	(3.1%)						
NMVOC	2D3d	1A4bi	2D3a	3B1a	3B1b	1B2av	1A3bi	2D3i	2H2	2D3h	1A4bii	80.8
	(17.0%)	(14.5%)	(12.9%)	(10.2%)	(6.6%)	(4.0%)	(4.0%)	(3.8%)	(3.2%)	(2.6%)	(2.1%)	
CO	1A4bi	1A1c	1A3bi									83.6
	(51.8%)	(24.9%)	(6.9%)									
TSP	2A5b	1A1a	1A4bi	1A2gviii	3Dc	2I	1A1c					81.1
	(27.3%)	(20.1%)	(14.9%)	(8.5%)	(5.4%)	(3.0%)	(1.7%)					
PM_{10}	1A1a	1A4bi	2A5b	1A2gviii	3Dc	1A1c						81.1
	(26.6%)	(20.7%)	(12.4%)	(11.3%)	(8.2%)	(2.0%)						
$PM_{2.5}$	1A4bi	1A1a	1A2gviii	2A5b	1A3bi	1A4cii						81.1
	(32.9%)	(26.8%)	(15.4%)	(2.1%)	(2.0%)	(1.9%)						
Pb	1A1a											86.4
	(86.4%)											
Hg	1A1a											80.3
	(80.3%)											
Cd	1A1a	1A4bi										94.7
	(59.6%)	(35.2%)										
DIOX	1A1a	1A4bi	5E	1A2gviii	5C1bi							83.9
	(24.0%)	(21.2%)	(16.2%)	(13.2%)	(9.3%)							
PAH	1A1a	1A4bi	1A2gviii									95.9
	(44.2%)	(35.4%)	(16.3%)									
HCB	1A4bi	1A1a										82.7
	(51.1%)	(31.6%)										

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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 2017-2019 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 2018.

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						

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

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 2018, the uncertainties for trends in 1990-2018, and the full uncertainty figures for 2018's national emissions.

Table 1.5 Uncertainty evaluation

Pollutant	Total emission, 1990	Total emission, 2018	Unit	Trend in 1990-2018, %	Uncertainty, %	Trend uncertainty 1990-2018, %
NO_x	79.875	32.138	kt	-59.76	12.96%	2.46%
NMVOC	63.737	22.385	kt	-64.88	18.57%	5.45%
SO_x	272.385	30.861	kt	-88.67	7.98%	0.27%
NH_3	22.187	10.311	kt	-53.53	38.51%	9.73%
$PM_{2.5}$	15.324	6.807	kt	-55.58	9.90%	3.27%
PM_{10}	32.072	11.270	kt	-64.86	16.96%	5.37%
TSP	279.083	16.927	kt	-93.93	28.68%	1.71%
CO	236.242	129.802	kt	-45.06	11.83%	6.64%
Pb	207.114	33.207	t	-83.97	172.86%	18.48%
Cd	4.561	0.813	t	-82.18	122.20%	17.99%
Hg	1.201	0.599	t	-50.07	160.71%	4.81%

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Pollutant	Total emission, 1990	Total emission, 2018	Unit	Trend in 1990-2018, %	Uncertainty, %	Trend uncertainty 1990-2018, %
PCDD/F	8.125	3.728	g I-TEQ	-54.12	87.54%	40.77%
B(a)p	2.368	2.245	t	-5.19	102.76%	67.31%
B(b)f	2.749	2.640	t	-3.99	112.99%	83.86%
B(k)f	1.510	1.271	t	-15.78	95.71%	54.07%
I(1,2,3-cd)p	1.567	1.572	t	0.27	86.72%	55.22%
HCB	0.197	0.318	kg	61.57	96.97%	121.00%
PCB	8.376	5.101	kg	-39.10	107.14%	9.11%

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	POPs	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

NFR19 code	Substance(s)	Reason for not estimated
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
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
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	1A2giii
1A2b	NH_3, all POPs	1A2giii
1A2c	NH_3, all POPs	1A2giii
1A2d	All POPs	1A2giii
1A2e	All POPs	1A2giii
1A2f	All POPs	1A2giii
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 (2013-2018)	1A1a
5D2	NMVOC (1994-2007)	5D1

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: 1990–2018;
- PM_{10}, $PM_{2.5}$ and BC: 2000–2018;
- All Heavy Metals: 1990–2018;
- POPs: 1990–2018.

Table 2.1 Main pollutant emissions in the period of 1990–2018 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	CO	$PM_{2.5}$	PM_{10}	BC	TSP
1990	79.875	63.737	272.385	22.187	236.242	NR	NR	NR	279.083
1991	73.736	60.841	250.091	20.076	228.783	NR	NR	NR	277.762
1992	48.219	41.151	190.990	17.627	134.814	NR	NR	NR	249.318
1993	42.265	32.854	155.218	12.843	128.291	NR	NR	NR	195.373
1994	47.304	35.689	150.042	11.988	162.523	NR	NR	NR	169.955
1995	48.261	39.932	115.730	10.948	212.158	NR	NR	NR	127.399
1996	52.390	40.872	124.702	9.742	244.813	NR	NR	NR	115.297
1997	51.645	42.404	115.930	9.924	247.855	NR	NR	NR	92.241
1998	49.087	39.127	104.295	10.054	218.735	NR	NR	NR	84.168
1999	44.330	36.150	97.779	9.299	202.987	NR	NR	NR	82.520
2000	45.272	36.475	97.109	8.983	198.538	15.324	32.072	3.436	70.137
2001	47.368	35.365	90.720	9.904	200.394	16.246	31.982	3.726	68.339
2002	48.177	34.699	87.050	9.392	189.856	16.619	28.040	3.910	48.455
2003	48.785	33.182	100.326	10.090	182.694	14.280	24.327	3.682	44.453
2004	45.793	33.575	88.185	10.374	173.718	15.419	24.881	3.807	43.116
2005	42.088	31.784	76.295	10.435	152.717	12.964	21.174	3.140	34.363
2006	40.999	30.607	69.916	10.362	141.534	9.765	16.311	2.520	27.225
2007	45.559	28.067	88.055	10.548	157.392	12.659	22.754	3.011	32.814
2008	42.454	26.383	69.495	10.888	156.319	11.868	18.970	3.070	28.374
2009	36.839	23.720	54.895	10.135	155.830	9.615	15.492	2.573	22.601
2010	43.193	23.206	83.293	10.199	156.671	13.904	23.369	3.191	30.151
2011	41.576	23.136	72.719	10.193	131.511	18.262	34.481	3.558	42.757
2012	38.552	23.524	42.901	10.321	141.615	8.731	14.162	2.229	20.849
2013	37.413	22.856	41.694	10.534	134.284	12.114	20.402	2.573	26.664
2014	36.998	22.901	46.832	10.514	128.762	8.898	15.374	2.085	22.026
2015	32.911	22.556	36.071	10.225	128.855	9.728	14.661	2.600	19.708
2016	32.605	22.387	34.937	10.118	140.029	7.909	12.233	2.246	17.051
2017	33.486	23.388	38.649	10.423	138.205	9.356	14.229	2.595	19.672
2018	32.138	22.385	30.861	10.311	129.802	6.807	11.270	1.972	16.927
Change 1990-2018, %	-59.8	-64.9	-88.7	-53.5	-45.1	-55.6	-64.9	-42.6	-93.9
Change 2005-2018, %	-23.6	-29.6	-59.6	-1.2	-15.0	-47.5	-46.8	-37.2	-50.7
Change 2017-2018, %	-4.0	-4.3	-20.2	-1.1	-6.1	-27.2	-20.8	-24.0	-14.0

2.1. Sulphur Dioxide

During the period of 1990–2018, the emissions of sulphur dioxide had decreased by about 89%, which was largely influenced by a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 231 PJ in 1990 to 167 PJ in 2018) (see Figure 2.1 and Table 2.1). 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.

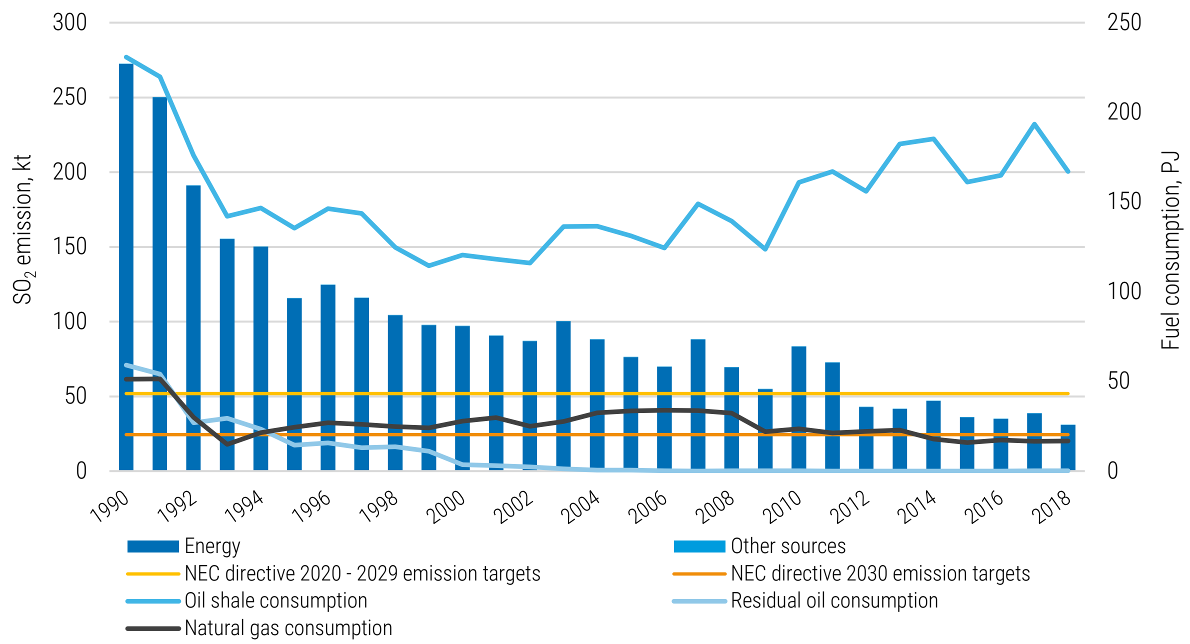

Figure 2.1 SO_2 emissions in the period of 1990–2018 and NEC directive 2016/2284 targets

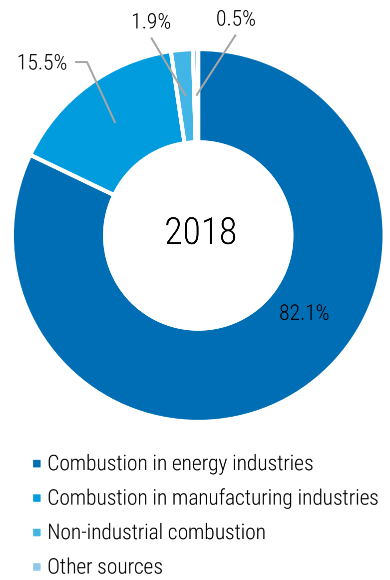

Figure 2.2 SO_2 emissions by sources of pollution in 2018

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 PPs on four energy production units of the Eesti Power Plant (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 2018, SO_2 emissions had decreased by about 20% when compared to 2017'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 15%) and a higher proportion of cleaner and more efficient units.

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The share of energy sector, including mobile sources, in total SO_2 emission is 99.8%; the combustion in energy industry (NFRs 1A1a-c) is responsible for about 82% of total emissions in 2018 (see Figure 2.2). The share of SO_2 emissions from the two large oil shale plants – Narva PP (Eesti and Balti PPs) – accounts for approximately 65.2% of total SO_2 emissions.

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 59.6% in 2018 compared to 2005.

2.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 59.8% compared to 1990 (see Figure 2.3 and Table 2.1). 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. The energy industry and road transport sector are the main sources of nitrogen oxide emissions – 28.2% and 22.4% respectively, the share of other mobile sources was 17.2% and non-industrial combustion – 16.2% in 2018 (see Figure 2.4).

In 2018, NO_x emissions decreased by 4.2% in comparison to 2017's figures. The primary reason for reducing emissions is a decrease in electricity production. 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. (*Eesti Energia*)

At the same period the NO_x emission from road transport decreased by 3.9%, 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).

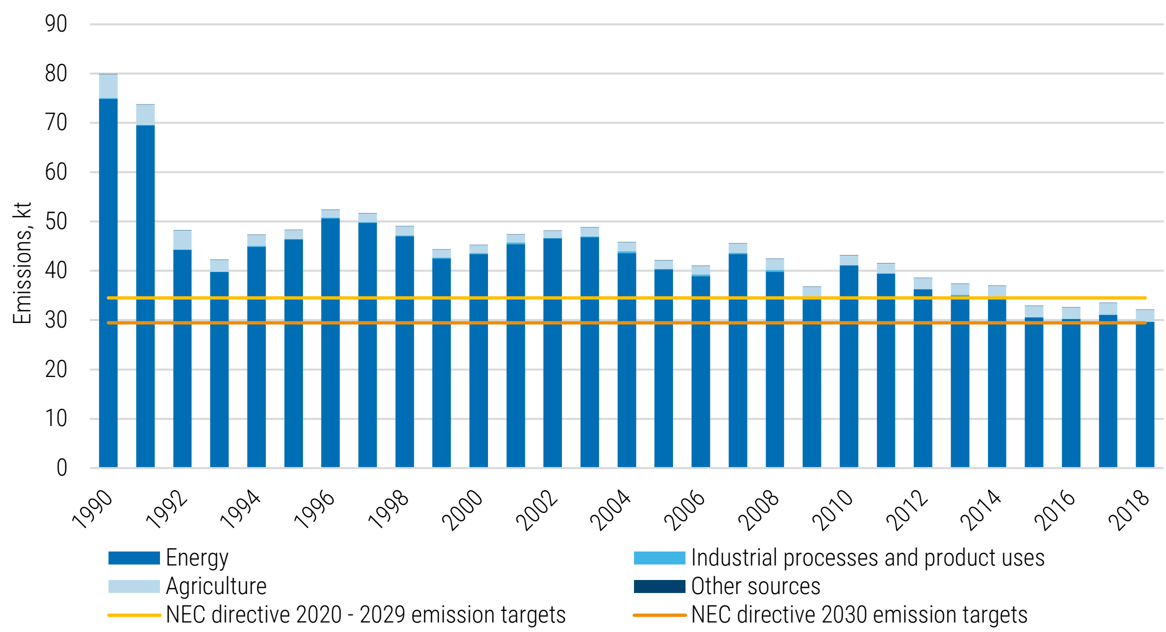

Figure 2.3 NO_x emissions in the period of 1990–2018 and NEC directive 2016/2284 targets

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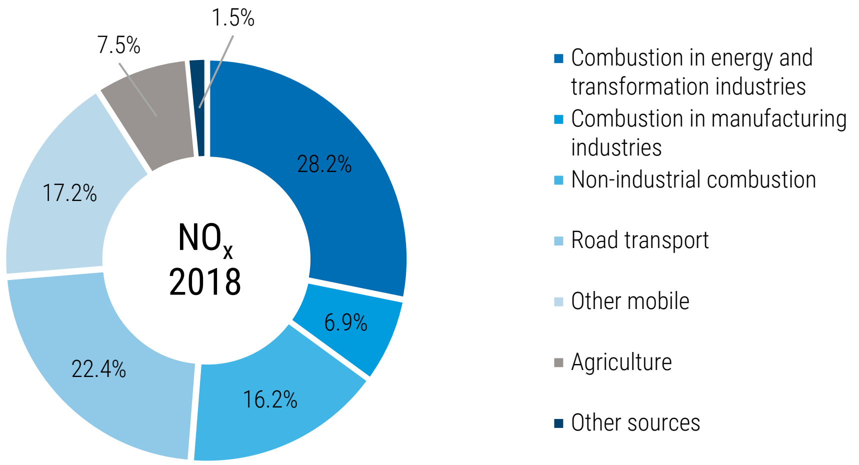

Figure 2.4 NO_x emissions by sources of pollution in 2018

Estonia fulfilled the requirements of the NEC directive 2016/2284 and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of nitrogen oxides emissions by 18% relative to 2005 baseline emissions by 2020, already in 2015. NO_x emissions decreased by 23.6% in 2018 compared to 2005.

2.3. Non-Methane Volatile Organic Compounds

Emissions of NMVOC in 2018 decreased by 4.3% compared to 2017 (see Figure 2.6). During this period, emissions decreased in all sectors except agriculture, mainly due to an increase in the number of non-dairy cattle and used amounts of inorganic N- fertilisers.

The decrease in gasoline consumption by other mobile sources in 2018 was the reason for the reduction in emissions (16.4%), as the NMVOC emission factor for gasoline is much higher than for diesel fuel.

During the same period NMVOC emissions from road transport decreased by 5.4%, 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).

The decrease in the amount of wood being burned resulted in a decrease in emissions from the manufacturing industries (involving combustion processes) and as well as in the non-industrial combustion sector.

It should be noted that an increase in the amount of wood burned in the energy sector has not led to an 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.

NMVOC emissions from the industry and product use sector remained almost at the level of the previous year.

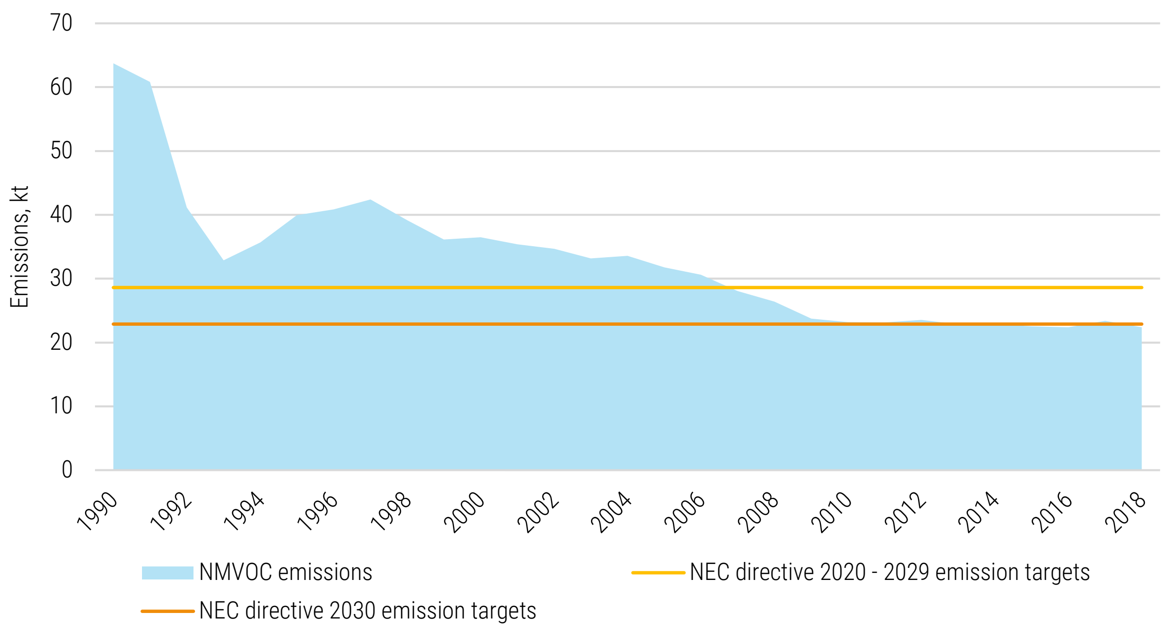

Figure 2.5 NMVOC emissions in the period of 1990–2018 and NEC directive 2016/2284 targets

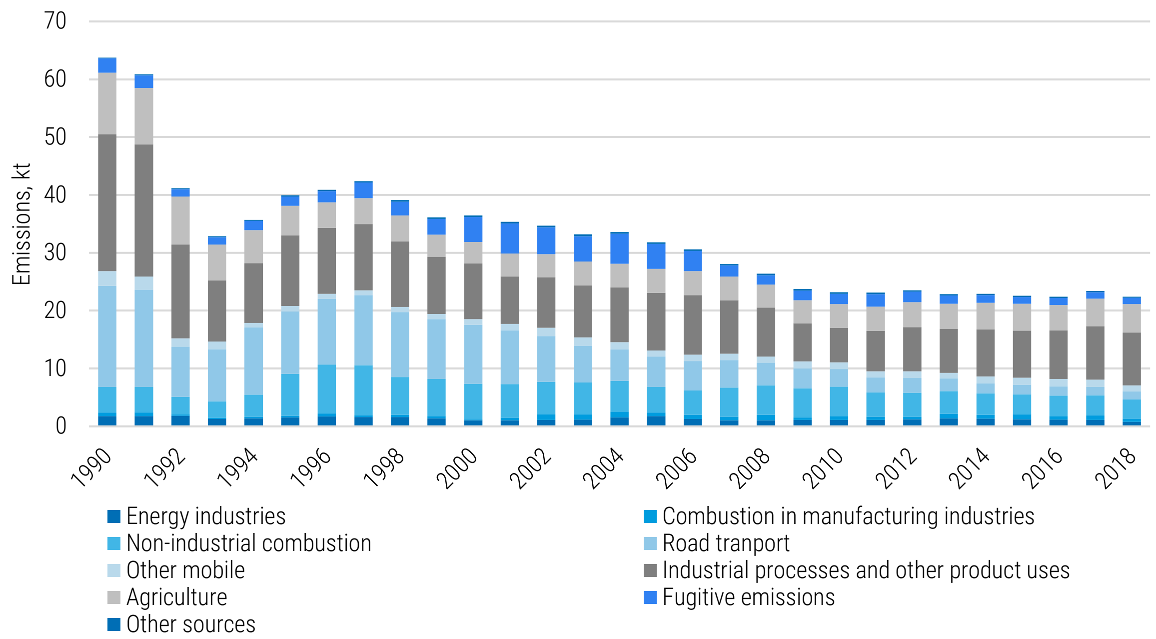

Figure 2.6 NMVOC emissions in the period of 1990–2018

The total emissions of non-methane volatile organic compounds decreased by 64.9% between 1990 and 2018 (see Table 2.1, Figure 2.5). In 1990, the main polluters of NMVOC were industrial processes and product uses (35.8%) and road transport (26.4%). In 2018, the dominant source was the same – industrial processes and product uses sector (39%), but share of non-industrial combustion has increased from 6.7% to 14% and share of road transport has decreased from 26.4% to 6% (see Figure 2.7).

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 1990–2018, 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).

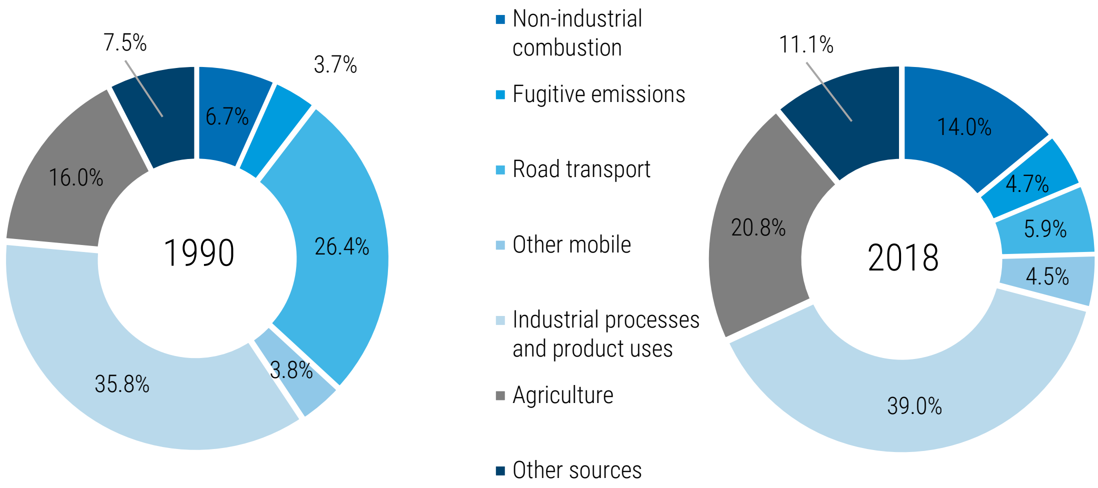

Figure 2.7 NMVOC emissions by sources of pollution in 1990 and 2018

2.4. Ammonia

Total NH_3 emissions decreased by 53.5% between the years 1990 to 2018 due to a reduction in the number of animals and the use of fertilisers (see Figure 2.8). Livestock manure management and use of mineral fertiliser are the main sources of pollution regarding ammonia (about 88.6% in 2018). The process of combustion in energy and transformation industries and combustion in manufacturing industries sectors is responsible for 4.1% and 2.2% of total emissions respectively. Fugitive emissions from solid fuels (oil shale open cast mining, mainly explosive works) account for approximately 1.5% of emissions, and road transport makes up 1.3%. All other sectors (non-industrial combustion, waste, and other mobiles) account for approximately 2.3% of total ammonia emissions (see Figure 2.9).

In 2018, NH_3 emissions decreased by about 1.1% when compared to 2017's figures, due mainly to an decrease in the number of poultry and wood and wood waste combustion in manufacturing industries.

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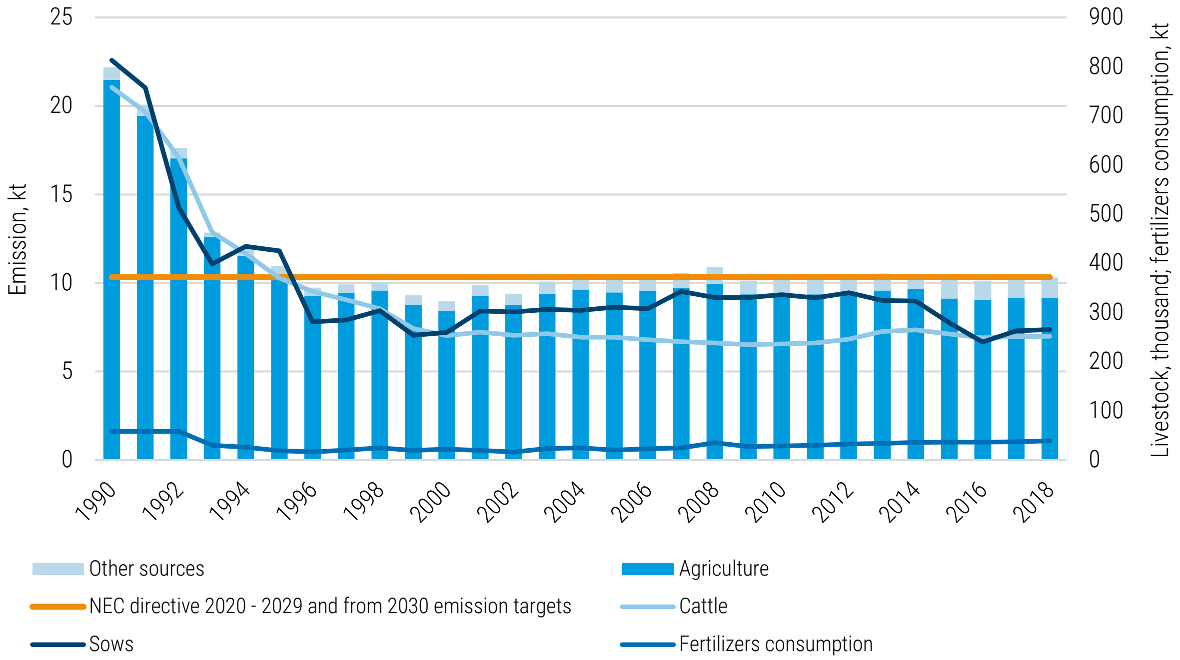

Figure 2.8 NH_3 emissions in the period of 1990–2018 and NEC directive 2016/2284 targets

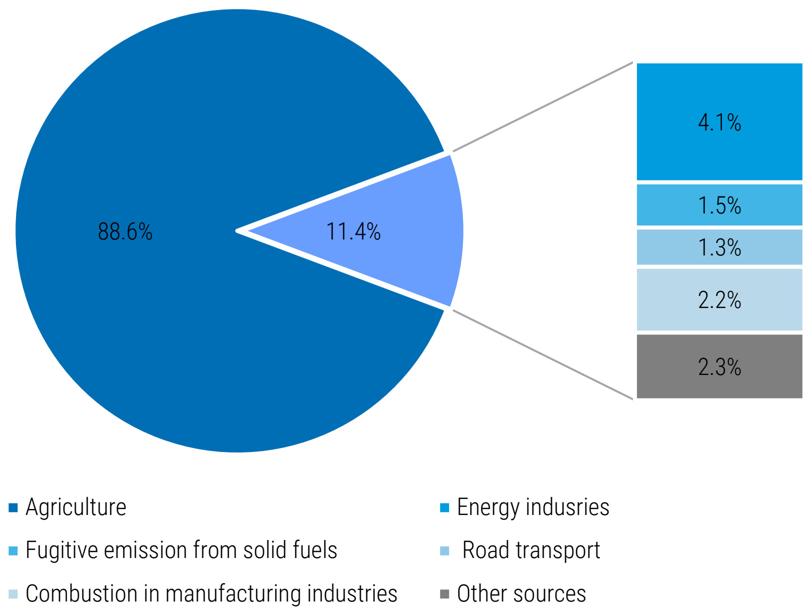

Figure 2.9 NH_3 emissions by sources of pollution in 2018

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 2018, ammonia emissions remained approximately at the 2005 level. Although in 2018, both the number of animals in total and their productivity was higher than in 2005, ammonia emissions have remained at the same level as in 2005 due to technological innovations in the agricultural sector as well as in environmental protection measures (e.g. duration and time of manure spreading).

2.5. Carbon Monoxide

In the period of 1990–2018, the emissions of carbon monoxide decreased by 45.1%. 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 Figure 2.10).

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 6.9% in the road transport sector in 2018 when compared to the previous year.

The decrease in gasoline consumption by industrial machinery in 2018 was the reason for the reduction in emissions from other mobile sources (46.7%), since the CO emission factor for gasoline is much higher than for diesel fuel.

In 1990, the main polluters of carbon monoxide were road transport (51%), while in 2018, the dominant source was non-industrial combustion (52.5%) (see Figure 2.11). 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 sector increased at the same period from 7.6% to 29.6%, mainly due to an increase in shale oil production in Enefit Energiatootmine AS (Eesti Energia Oil Industry plant).

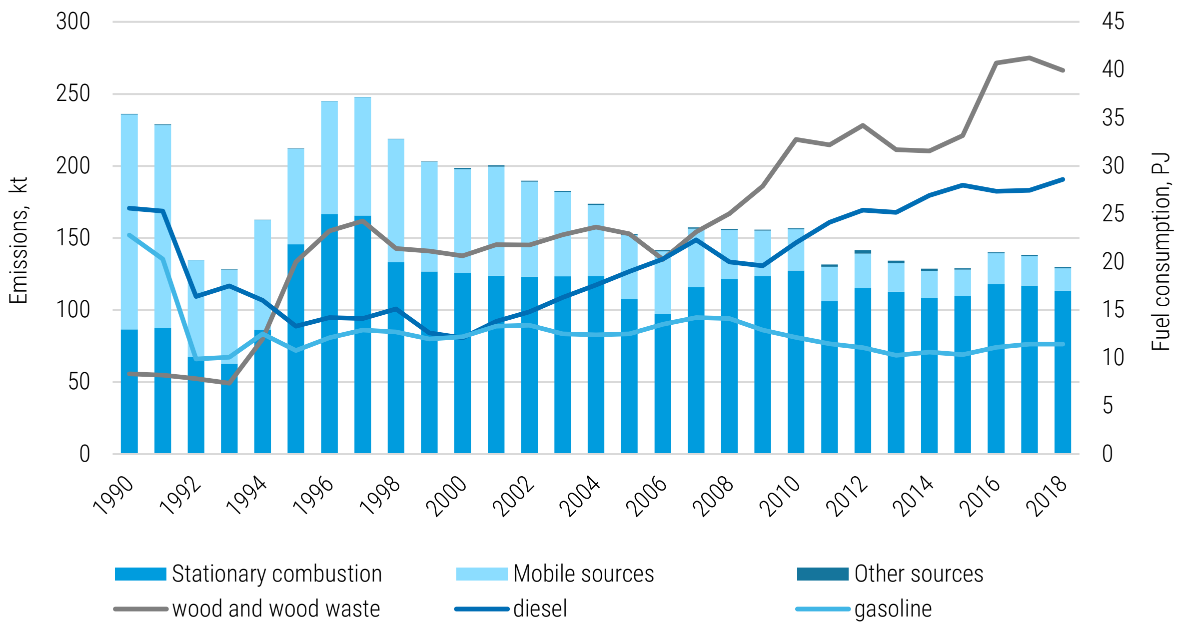

Figure 2.10 CO emissions in the period of 1990–2018

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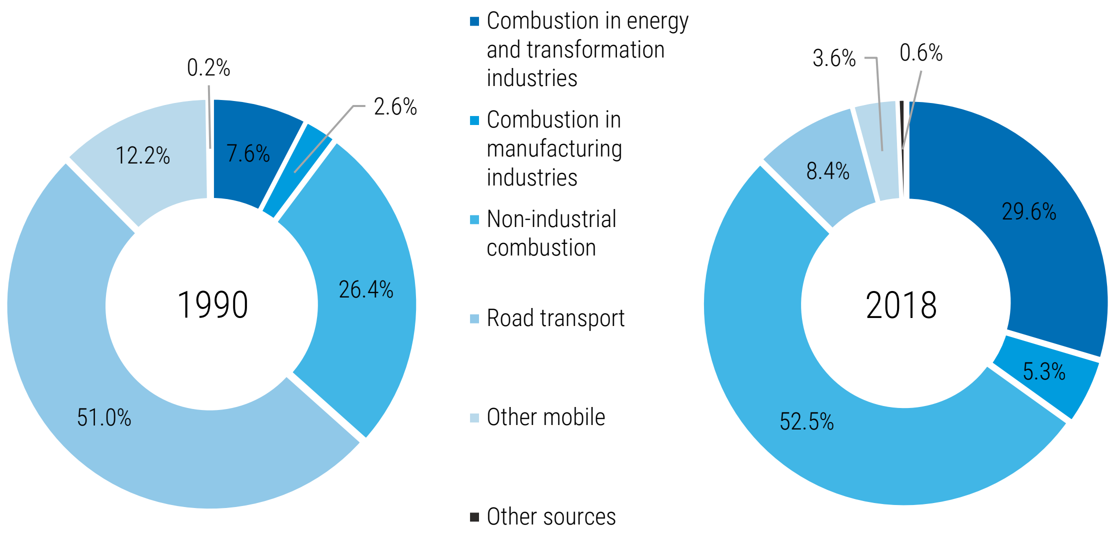

Figure 2.11 CO emissions by sources of pollution in 1990 and 2018

In 2018, carbon emissions decreased by 6.1% in comparison to 2017. 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 27% due to the increase of oil shale consumption on the two shale production facilities. At the same time, there has been a significant decrease in emissions in the industrial combustion sector (26.7%) as a result of a decrease in wood combustion. The reasons for the reduction of emissions in the transport sector are given above.

In 2018, the biggest polluters of CO were combustion in the non-industrial sector (about 52.5%, from which a large part is wood combustion in the domestic sector), combustion in the energy industry (29.6%, mainly from shale oil production industry) and road transport – 8.4% (see Figure 2.11).

2.6. Particulates

The main source of particulates in 2018 is the energy sector (including mobile sources), which accounts for 54.4% of the total. The emissions of TSP by sectors of pollution are shown in Figure 2.13.

In 1990–2018, TSP emissions dropped significantly – by 93.9% (see Figure 2.12 and Table 2.1). 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. 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 (Eesti Energia Narva Elektrijaamad AS) and it is a result of bad operation of electric precipitators on two power units of this power plant.

In 2018, particulate emissions decreased by 14% in comparison to 2017, due mainly to a decrease in the use of wood and wood waste in the industrial combustion sector and also due to a decrease in electricity production at oil shale power plants.

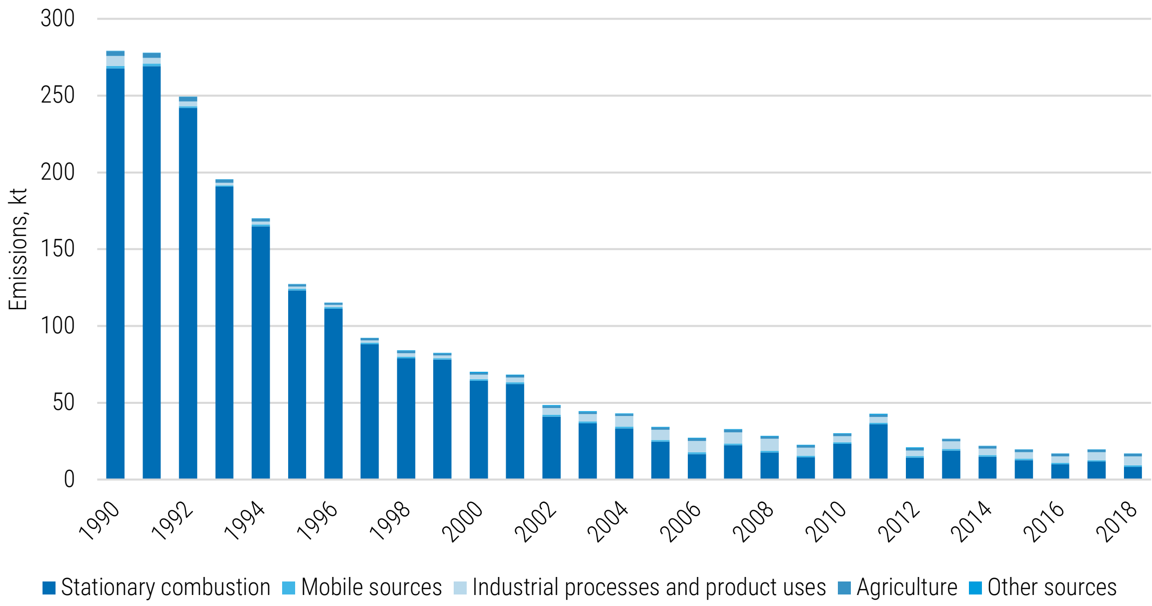

Figure 2.12 TSP emissions in the period of 1990–2018

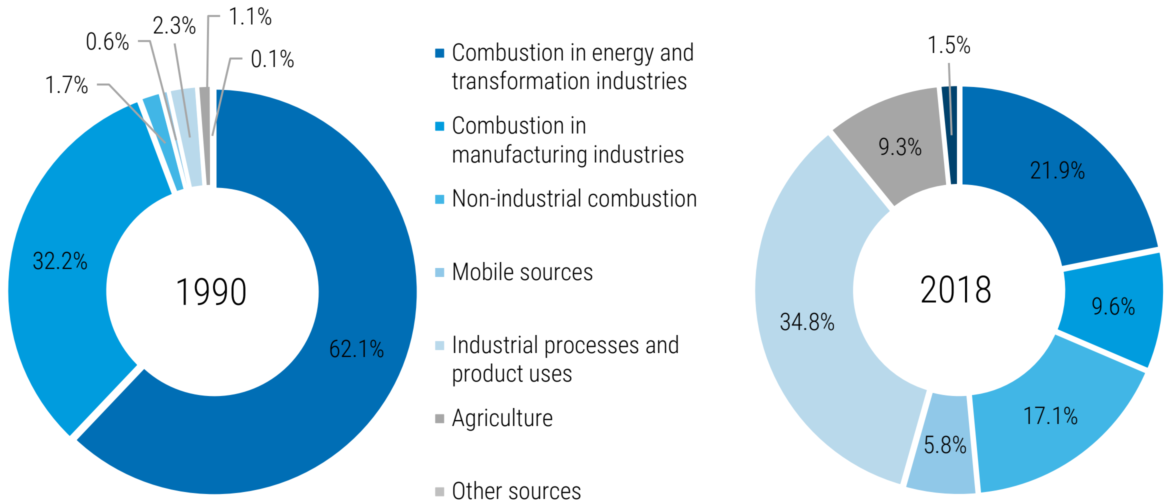

Figure 2.13 TSP emissions by sources of pollution in 1990 and 2018

In 1990, the main polluters of TSP were the energy industry (62.1%) and combustion in manufacturing industries (32.2%). In 2018, the share of combustion in energy industries dropped to 22% and dominant source was industrial processes and product uses (more precisely, construction and demolition) (34.8%). The share of energy and transformation sector has decreased by 40.1%, while the share of non-industrial combustion, agriculture, and mobile sources had increased by 15.4%, 8.2% and 5.2% respectively compared to 1990 (see Figure 2.13).

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.

The emissions of fine particulates PM_{10}, $PM_{2.5}$ and BC are shown in Figure 2.14.

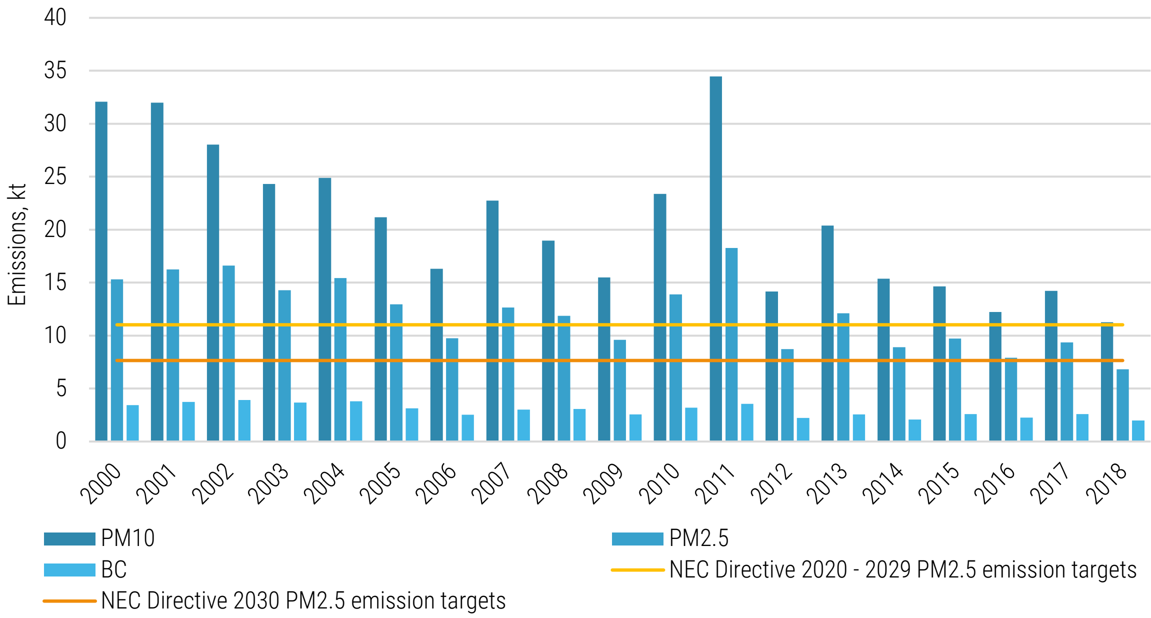

Figure 2.14 PM_{10}, $PM_{2.5}$ and BC emissions in the period of 2000–2018 and NEC Directive 2016/2284 $PM_{2.5}$ targets

Emission of black carbon for all activities was calculated in this submission for 2000–2018. In the process of making the calculations in 2018 year submission, the new EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019 methodology was applied.

In the period between 2000-2018, emissions of PM_{10}, $PM_{2.5}$, and BC increased by 64.9%, 55.6%, and 42.6% respectively, despite an increase in electricity production in the same period (by 45.2%). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants.

The reasons of increase in emissions in 2018 in comparison with 2017 same as well as for TSP.

The primary sources of fine particulates (PM_{10}) emission in 2018 were non-industrial combustion (36%, mainly wood combustion), combustion in energy and transformation industries (28%, mainly oil shale combustion) and combustion in manufacturing industries (17%) (see Figure 2.15). The distribution of $PM_{2.5}$ and BC emissions by sources of pollution is also visible in Figure 2.15 and Figure 2.16. It is interesting to note that if the share of non-industrial combustion (generally wood combustion in domestic sector) in TSP emissions makes up 17.1% of the total emissions, then share in emissions of BC is significantly higher and makes up 49%.

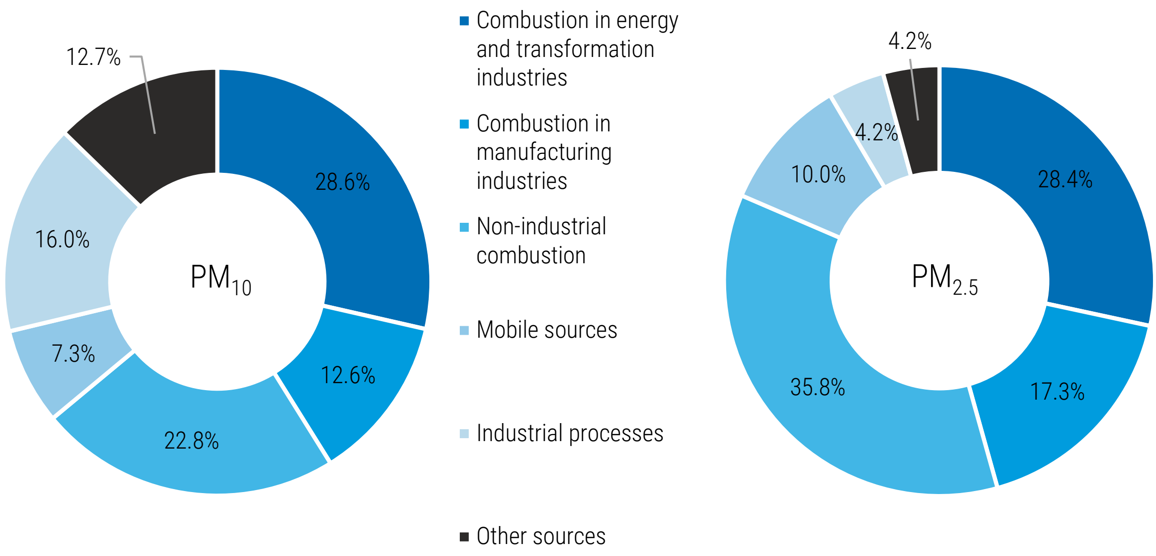

Figure 2.15 PM_{10} and $PM_{2.5}$ emissions by activities in 2018

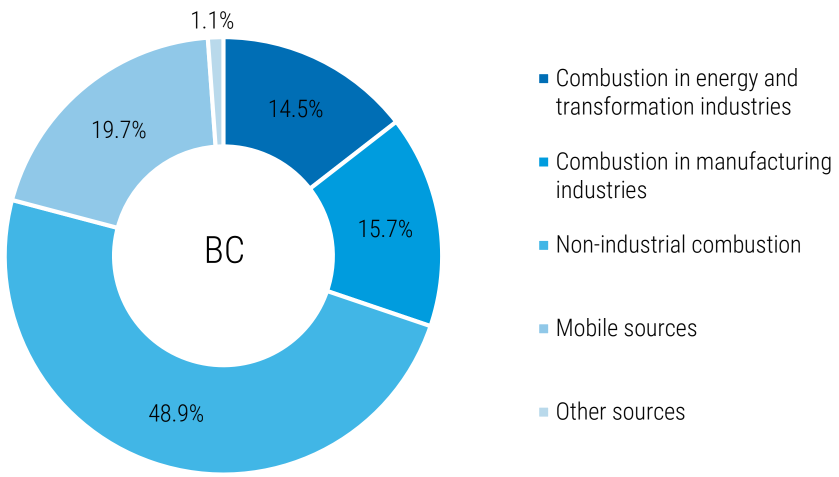

Figure 2.16 Black carbon emission by activities in 2018

The primary sources of black carbon emission in 2018 were non-industrial combustion (49%), mobile sources (20%), combustion in manufacturing industry (16%), combustion in energy and transformation industries (14%, mainly oil shale combustion) (see Figure 2.16). Other sources are mainly industrial processes.

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 47.5% in 2018 compared to 2005.

2.7. Heavy Metals

In 1990–2018, emissions of heavy metals dropped significantly, as can be seen in Table 2.2 and Figure 2.17.

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 emissions of lead decreased by 84% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production. A further reason is the discontinued use of leaded petrol in Estonia since 2000 (see Figure 2.19).

Table 2.2 Heavy metals emissions in the period of 1990–2018 (t)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
1990	207.114	4.561	1.201	18.919	18.422	10.981	27.412	106.017
1991	189.985	4.359	1.094	16.522	16.052	10.194	25.628	97.141
1992	126.237	3.156	0.909	14.103	13.817	7.062	17.018	79.446
1993	104.815	2.382	0.728	10.912	10.509	5.816	14.340	61.983
1994	125.162	3.079	0.736	10.757	10.388	6.528	12.870	66.241
1995	88.271	2.258	0.698	10.154	9.967	5.603	10.489	63.497
1996	68.875	1.386	0.697	10.438	10.235	5.140	10.857	61.978
1997	49.754	1.425	0.704	10.283	9.980	5.217	9.751	61.946
1998	44.091	1.305	0.638	9.230	8.926	4.977	8.800	55.360
1999	42.561	1.241	0.617	8.802	8.514	4.649	7.511	53.027
2000	39.553	0.864	0.619	8.661	8.377	4.333	6.496	49.342
2001	39.511	0.837	0.603	8.459	8.243	4.767	6.442	49.066
2002	38.731	0.855	0.603	8.431	8.361	4.924	6.202	48.441
2003	40.742	0.921	0.691	10.054	9.900	5.263	6.842	56.892
2004	38.936	0.856	0.633	9.747	9.571	5.273	6.757	55.570
2005	37.413	0.820	0.609	9.285	9.058	5.411	6.417	52.100
2006	34.261	0.809	0.613	8.661	8.482	5.438	5.791	48.321
2007	42.887	0.980	0.744	11.134	10.815	6.200	6.783	61.382
2008	37.498	0.900	0.657	9.466	9.342	5.610	5.956	54.608
2009	30.636	0.780	0.526	7.658	7.558	4.909	4.871	45.928
2010	40.953	0.966	0.710	11.018	10.608	5.829	6.628	62.047
2011	40.475	0.930	0.714	10.937	10.435	5.847	6.455	60.092
2012	36.001	0.865	0.637	9.653	9.193	5.643	5.677	54.361
2012	41.561	1.038	0.748	11.293	10.697	5.951	6.540	61.968
2014	38.772	0.970	0.739	10.302	9.870	6.003	6.069	56.820
2015	30.674	0.819	0.601	7.800	7.616	5.456	4.693	46.225
2016	34.649	0.882	0.668	9.036	8.696	5.796	5.359	51.930
2017	36.424	0.877	0.640	9.546	9.172	5.933	5.714	55.144
2018	33.207	0.813	0.599	8.656	8.284	4.709	5.038	49.169
Change 1990-2018, %	-84.0	-82.2	-50.1	-54.2	-55.0	-57.1	-81.6	-53.6
Change 2017-2018, %	-8.8	-7.3	-6.3	-9.3	-9.7	-20.6	-11.8	-10.8

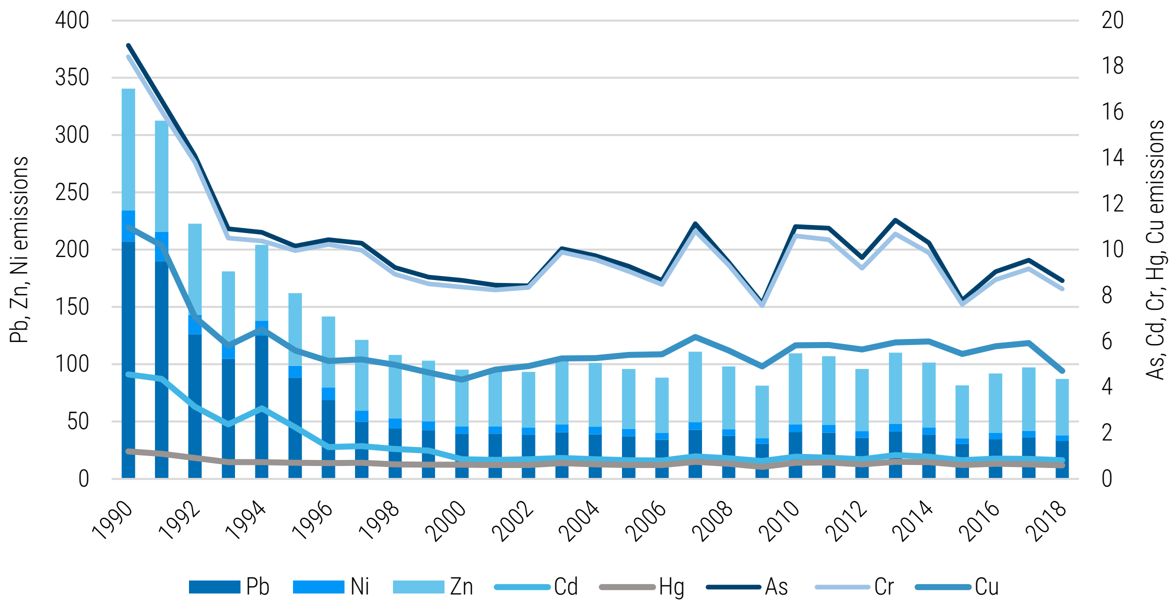

Figure 2.17 Heavy metals emissions in the period of 1990–2018 (t)

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The emissions of lead by sources of pollution in 1990 and 2018 are shown in Figure 2.18. The distribution of emissions by sector has considerably changed over the last 28 years. While in 1990 the main sources of lead pollution were almost equally road transport (35.4%), energy industries (30.5%) and industrial combustion (30.2%, mainly cement manufacturing), in 2018 the main source of pollution by all heavy metals was the energy industry (86%, mainly oil shale power plants).

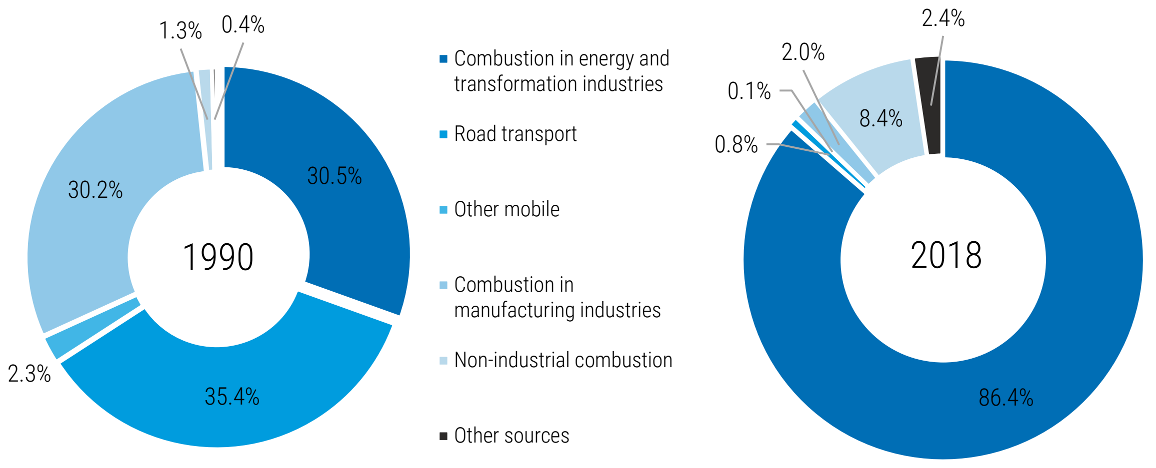

Figure 2.18 Pb emission by sources of pollution in the period of 1990 and 2018

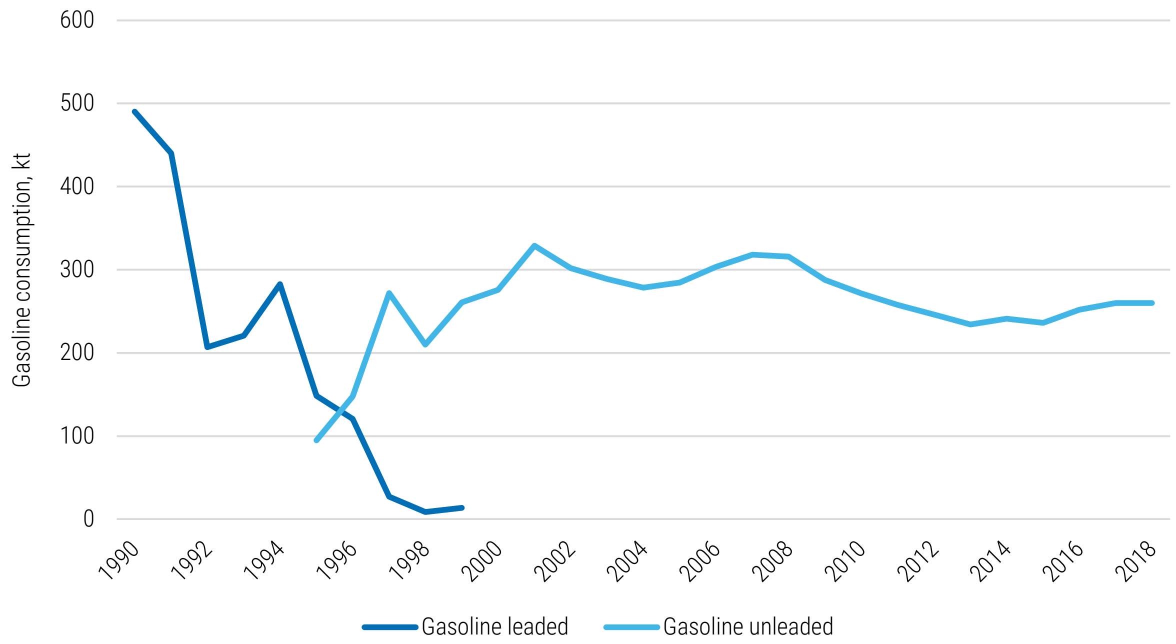

Figure 2.19 Petrol consumption in the period of 1990–2018

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2.8. Persistent Organic Pollutants

In the period of 1990–2018, dioxin, PAHs total and PCB emissions decreased by approximately 54.1%, 5.7% and 39.1% respectively. Only HCB emissions increased for the same period by 61.6% (the main reason is the increase in the share of wood burning), but decreased from 1995 to 2018 by 5.1%.

The emissions of POPs are shown in Table 2.3 and Figure 2.20.

Table 2.3 POPs emission in the period of 1990–2018

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	8.125	2.368	2.749	1.510	1.567	8.194	0.197	8.376
1991	8.016	2.349	2.772	1.498	1.540	8.158	0.191	8.539
1992	5.386	1.628	1.796	1.020	1.160	5.605	0.167	5.609
1993	4.363	1.384	1.483	0.897	1.065	4.830	0.144	5.048
1994	4.525	1.743	1.776	1.124	1.501	6.145	0.216	5.150
1995	5.641	2.820	2.755	1.826	2.621	10.022	0.334	4.123
1996	6.345	3.225	3.199	2.106	3.006	11.536	0.371	4.725
1997	6.313	3.223	3.189	2.105	3.024	11.542	0.384	4.317
1998	7.168	2.619	2.649	1.689	2.375	9.333	0.332	4.350
1999	7.134	2.549	2.629	1.638	2.259	9.075	0.316	3.773
2000	6.731	2.397	2.454	1.527	2.153	8.531	0.319	2.621
2001	6.551	2.337	2.436	1.484	2.059	8.316	0.326	4.198
2002	6.937	2.301	2.409	1.456	2.004	8.169	0.300	4.003
2003	6.873	2.307	2.435	1.448	1.999	8.188	0.313	4.753
2004	6.204	2.415	2.595	1.486	1.994	8.490	0.344	3.710
2005	5.686	2.124	2.310	1.290	1.694	7.418	0.283	3.457
2006	5.077	1.894	2.049	1.165	1.428	6.536	0.262	3.045
2007	6.698	1.898	1.972	1.223	1.712	6.804	0.322	1.806
2008	6.725	2.014	2.098	1.254	1.752	7.118	0.335	2.802
2009	6.102	2.135	2.249	1.314	1.821	7.520	0.308	3.057
2010	6.438	2.386	2.600	1.431	1.928	8.345	0.348	4.175
2011	6.355	2.022	2.231	1.210	1.600	7.063	0.314	3.618
2012	4.753	2.039	2.247	1.229	1.620	7.135	0.329	3.480
2013	3.666	2.090	2.210	1.274	1.566	7.140	0.335	3.940
2014	4.042	2.049	2.325	1.198	1.530	7.103	0.280	4.222
2015	4.136	2.029	2.327	1.177	1.491	7.024	0.280	4.232
2016	3.947	2.008	2.295	1.166	1.486	6.954	0.284	4.194
2017	4.322	2.242	2.618	1.278	1.587	7.725	0.310	5.042
2018	3.728	2.245	2.640	1.271	1.572	7.728	0.318	5.101
Change 1990-2018, %	-54.1	-5.2	-4.0	-15.8	0.3	-5.7	61.6	-39.1
Change 2017-2018, %	-13.8	0.1	0.8	-0.5	-1.0	0.03	2.5	1.2

The main sources of dioxin emission in 2018 are the waste sector (32.3%, mainly industrial and clinical waste incineration), combustion in energy industries (24.5%, includes also waste combustion as fuel), non-industrial combustion sector (22.7%), combustion in the manufacturing industry (13.2%, includes also waste combustion as fuel, mainly in the cement manufacturing industry) and road transport (7.2%) (see Figure 2.22).

The main source of PCBs emission is oil shale combustion, which directly depends on the amount of burned fuel.

The main contributors to the total PAHs emissions are combustion in energy industries and non-industrial combustion (44.3% and 38.5% respectively). The main source of HCB emission is the non-industrial combustion sector (53.2%, mainly wood combustion in residential sector) (see Figure 2.21 Figure 2.23 and Figure 2.24), which is followed by the energy sector. Currently, national POPs emission factors are being developed for the energy sector.

Figure 2.20 POPs emissions in the period of 1990–2018

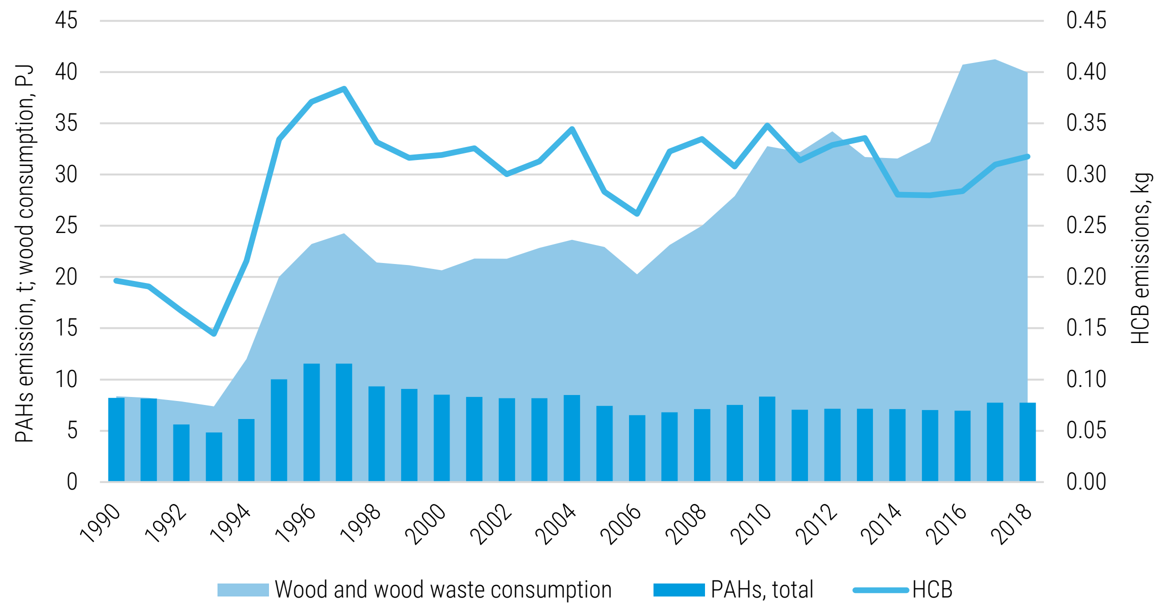


Figure 2.21 PAHs and HCB emissions and wood consumption in 1990–2018

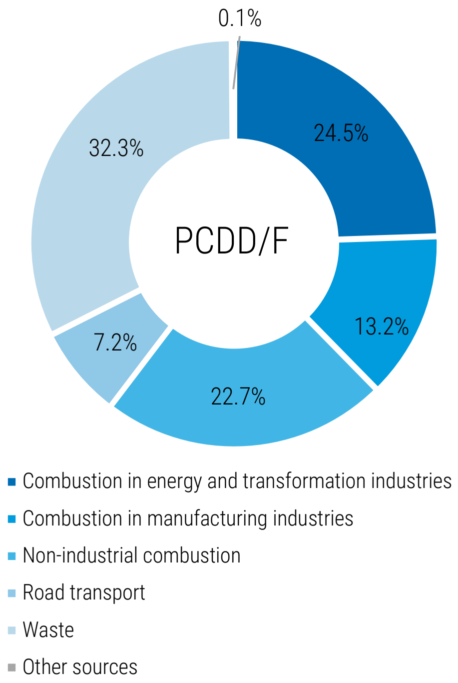


Figure 2.22 Dioxins/Furans (PCDD/F) emissions by activities in 2018

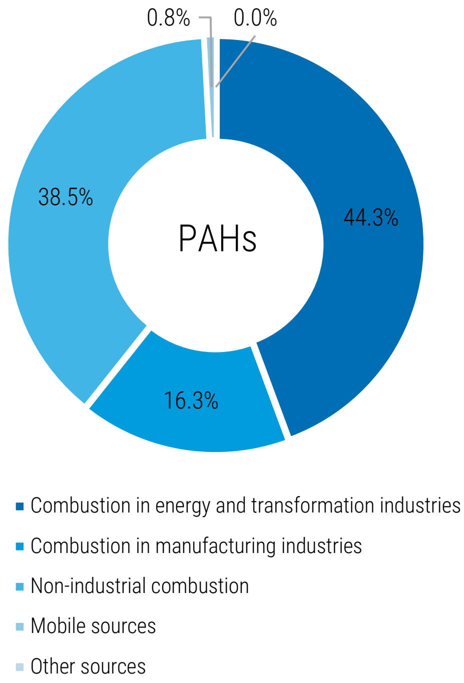


Figure 2.23 PAHs emissions by activities in 2018

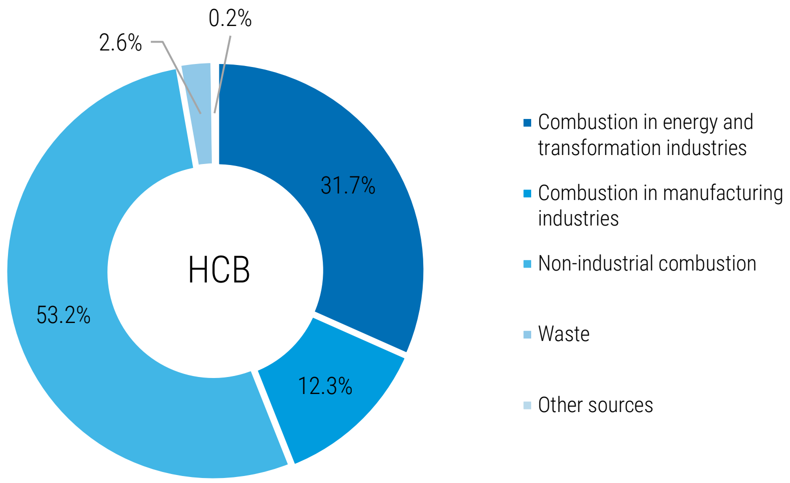
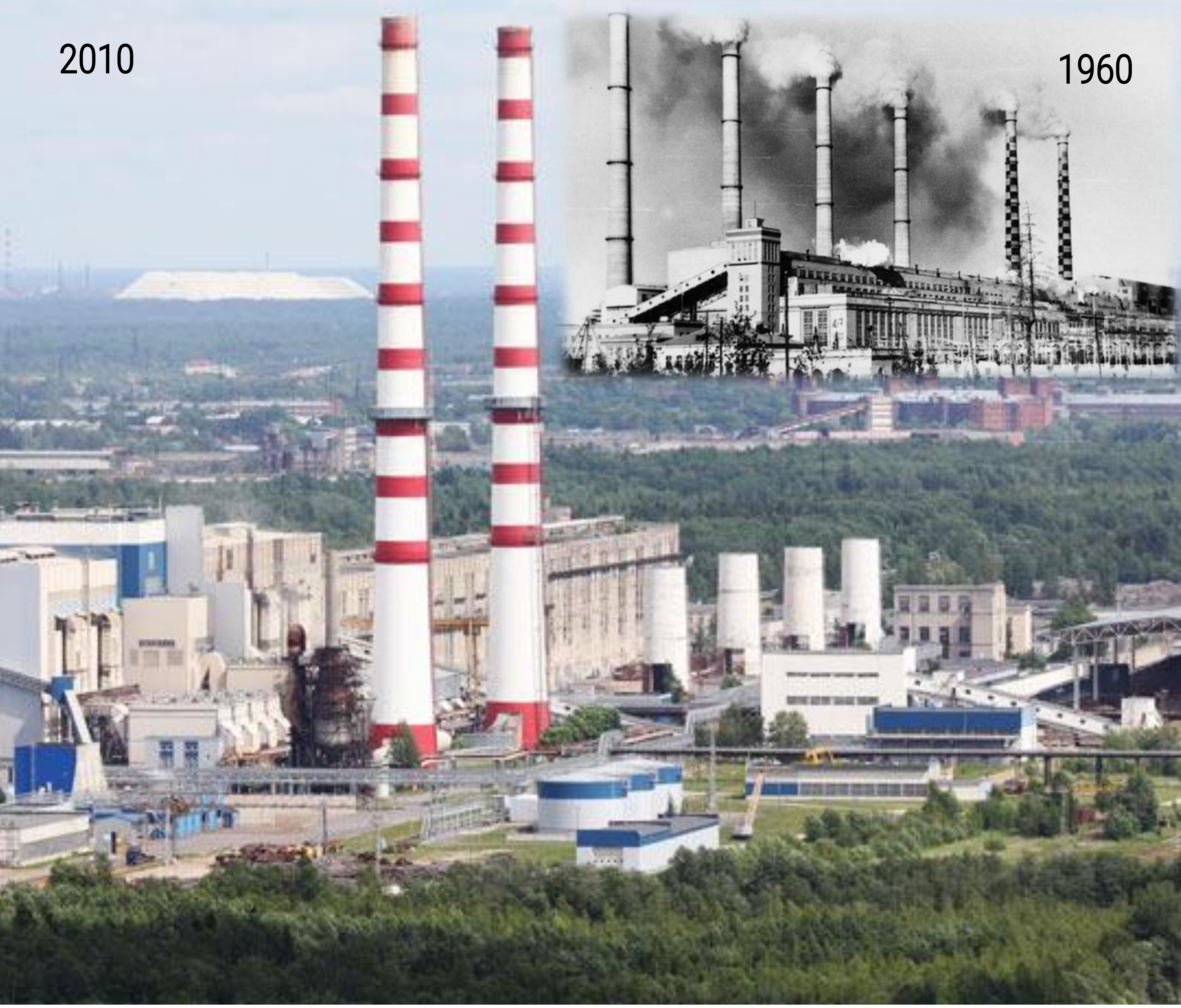


Figure 2.24 HCB emission by activities in 2018



Balti Power Plant in 1960 and in 2010 (Source: www.energia.ee)

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 2018, 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 2018. Imports of natural gas increased by about 2.4% compared to 2017. The imports of motor gasoline and diesel increased by about 11.4% and 0.2% respectively compared to the previous year. The imports of coal decreased by about 2.8% compared to 2017. Imported fuels (natural gas, fuel oils, coal, and motor fuels) made up 8.1% (see Figure 3.1).

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

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 (2018 saw a decrease from 26 GWh to 15 GWh). The share of wind energy in gross electricity production in 2018 is 5.1%, solar is 0.2% and hydro energy only 0.1% (Statistics Estonia). In 2005, electricity generated from renewable energy sources was only 1.1%, but in 2018, it accounted for 15.8% (Figure 3.3). 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.

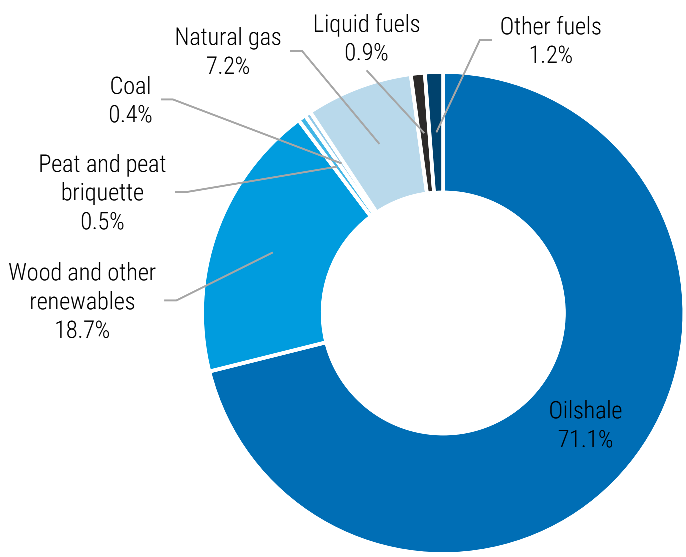


Figure 3.1 Structure of primary energy supply in Estonia in 2018

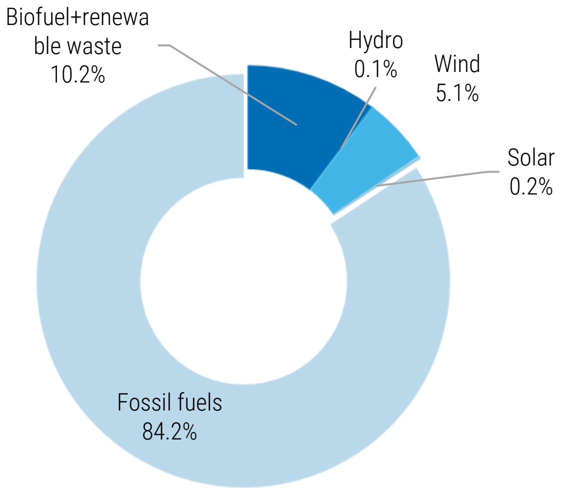


Figure 3.2 Gross electricity production by sources in 2018
(Source: Statistics Estonia)

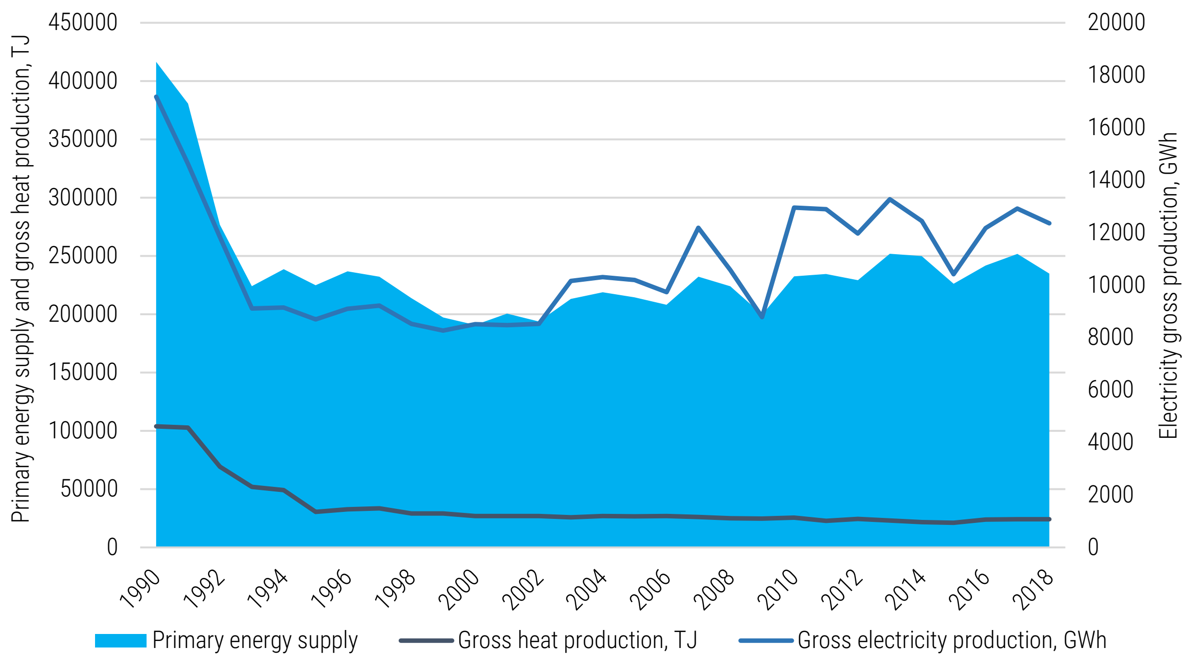


Figure 3.3 Total energy supply, electricity and heat production in the period of 1990–2018
(*Source: Statistics Estonia*)

The energy sector is the main source of SO_2, NO_x, CO, particulates, HMs and POPs in Estonia. In 2018, the energy sector contributed 99.7% of total SO2 emissions, 92.2% of total NO_x emissions, 71.9% of PM_{10} emissions, 36.5% of total NMVOC emissions, 99.5% of total CO emissions, and 97.6% 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 1990–2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	74.891	29.296	272.372	0.155	NR	NR	NR	269.448	235.667	206.318
1995	46.400	22.408	115.712	0.275	NR	NR	NR	124.135	212.028	87.168
2000	43.387	22.875	97.047	0.410	14.530	29.680	3.404	65.500	197.888	38.277
2005	40.254	17.392	76.155	0.720	11.957	17.490	3.099	25.974	152.211	36.659
2006	38.947	15.930	69.785	0.625	8.719	12.359	2.480	18.060	141.036	33.460
2007	43.378	14.491	88.015	0.655	11.688	18.869	2.960	23.712	156.728	42.081
2008	39.864	13.653	69.460	0.719	10.830	14.932	3.039	18.815	155.744	36.861
2009	34.797	12.888	54.845	0.616	8.919	12.533	2.538	15.747	155.256	30.206
2010	41.118	12.872	83.245	0.678	13.288	20.844	3.171	24.555	156.119	40.420
2011	39.474	11.717	72.681	0.691	17.735	32.057	3.532	37.429	130.963	39.928
2012	36.279	11.345	42.843	0.708	8.238	11.765	2.205	15.567	141.162	35.393
2013	34.943	10.725	41.646	0.735	11.468	17.490	2.545	20.004	133.784	40.864
2014	34.641	9.989	46.815	0.771	8.356	12.737	2.060	16.037	128.225	37.982
2015	30.552	9.603	36.038	0.980	9.214	12.042	2.575	13.832	128.329	29.994
2016	30.221	9.412	34.885	0.931	7.391	9.485	2.221	11.008	139.528	33.966
2017	31.071	9.234	38.640	1.104	8.765	11.241	2.571	12.790	137.635	35.728
2018	29.634	8.170	30.782	1.029	6.243	8.099	1.949	9.343	129.145	32.426
Change 1990-2018, %	-60.4	-72.1	-88.7	564.6	-57.0	-72.7	-42.7	-96.5	-45.2	-84.3

Table 3.1 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCDD/F	HCB	PCB
	t								g I-Teq	kg	
1990	4.513	1.168	18.891	18.421	10.956	27.411	106.010	8.193	7.295	0.181	8.335
1995	2.210	0.662	10.126	9.965	5.580	10.487	63.482	10.022	4.744	0.313	4.067
2000	0.813	0.576	8.630	8.355	4.263	6.479	49.294	8.531	3.866	0.296	2.559
2005	0.789	0.581	9.266	8.975	5.234	6.379	51.899	7.418	3.121	0.273	3.430
2006	0.779	0.584	8.642	8.379	5.230	5.762	48.121	6.535	3.063	0.251	3.018
2007	0.946	0.714	11.114	10.702	5.946	6.750	61.175	6.803	4.666	0.314	1.783
2008	0.878	0.634	9.452	9.222	5.445	5.906	54.424	7.118	4.695	0.326	2.780
2009	0.756	0.501	7.644	7.490	4.802	4.858	45.807	7.519	4.086	0.301	3.038
2010	0.949	0.689	11.007	10.473	5.678	6.607	61.929	8.345	4.970	0.341	4.157
2011	0.909	0.690	10.924	10.283	5.684	6.428	59.949	7.063	4.911	0.307	3.600
2012	0.844	0.613	9.641	9.114	5.439	5.648	54.193	7.134	3.490	0.322	3.462
2013	1.017	0.723	11.280	10.519	5.714	6.506	61.714	7.139	2.550	0.328	3.921
2014	0.948	0.713	10.288	9.781	5.730	6.035	56.582	7.102	2.751	0.273	4.203
2015	0.798	0.574	7.787	7.540	5.261	4.660	46.069	7.023	2.621	0.272	4.212
2016	0.860	0.642	9.023	8.639	5.593	5.334	51.702	6.954	2.479	0.276	4.173
2017	0.855	0.613	9.533	9.127	5.724	5.677	54.963	7.725	2.710	0.302	5.022
2018	0.791	0.573	8.643	8.237	4.462	5.008	48.977	7.727	2.519	0.309	5.079
Change 1990-2018, %	-82.5	-51.0	-54.2	-55.3	-59.3	-81.7	-53.8	-5.7	-65.5	70.7	-39.1

During the period of 1990–2018, the emissions of sulphur dioxide from the energy sector decreased by 88.7% and the emissions of nitrogen oxides by about 60.4% resulting from a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 231 PJ in 1990 to 167 PJ in 2018) (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 2018, SO_2 emissions from energy sector had decreased by about 20.3% compared to 2017. The main reason for the reduction of emissions was caused by a decrease in electricity production in oil shale power plants (by about 15%) and a higher proportion of cleaner and more efficient units.

In 2018, NO_x emissions decreased by 4.6% in comparison to 2017's figures. The primary reason for this change was decrease of electricity production. Also, the introduction of clearing devices at oil shale power plants played a role.

In 2018, particulate emissions decreased by 27% in comparison to 2017, due mainly to a decrease in the use of wood and wood waste in the industrial combustion sector and also due to a decrease in electricity production at oil shale power plants.

Decrease in electricity production and wood consumption in industrial combustion sector also 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 PAHs emissions in public electricity and heat production sector took place due to an increase of the wood consumption.

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 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 8^{th} 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.

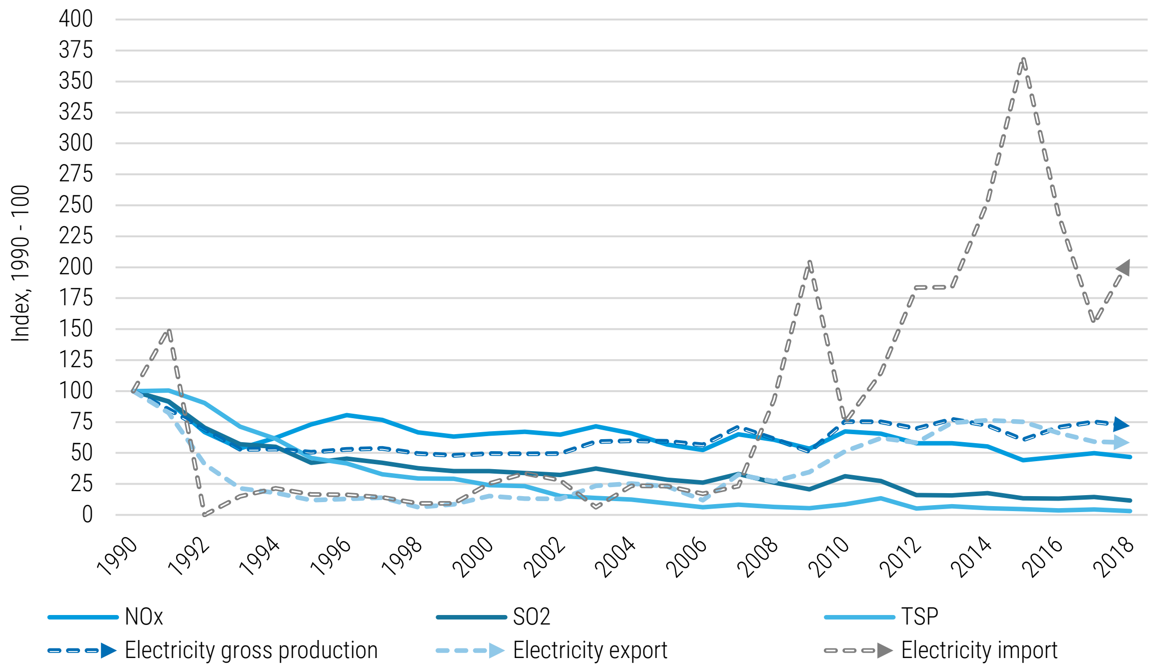


Figure 3.4 Pollutant emissions from stationary combustion, electricity production, and export in the period of 1990–2018

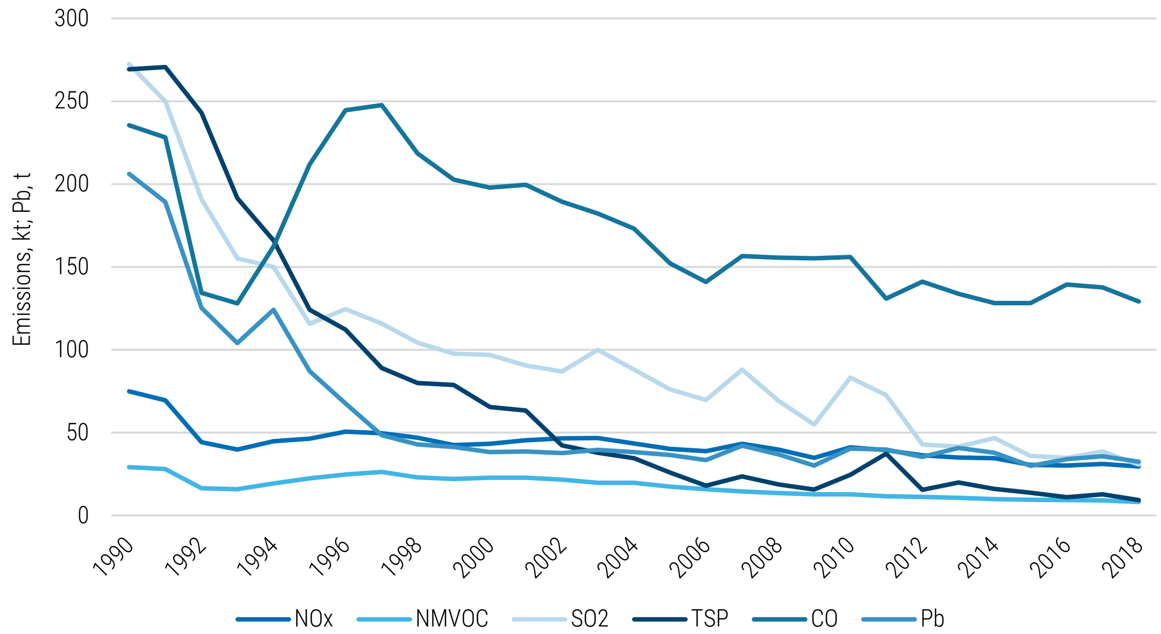


Figure 3.5 Pollutant emissions from the energy industry in the period of 1990–2018

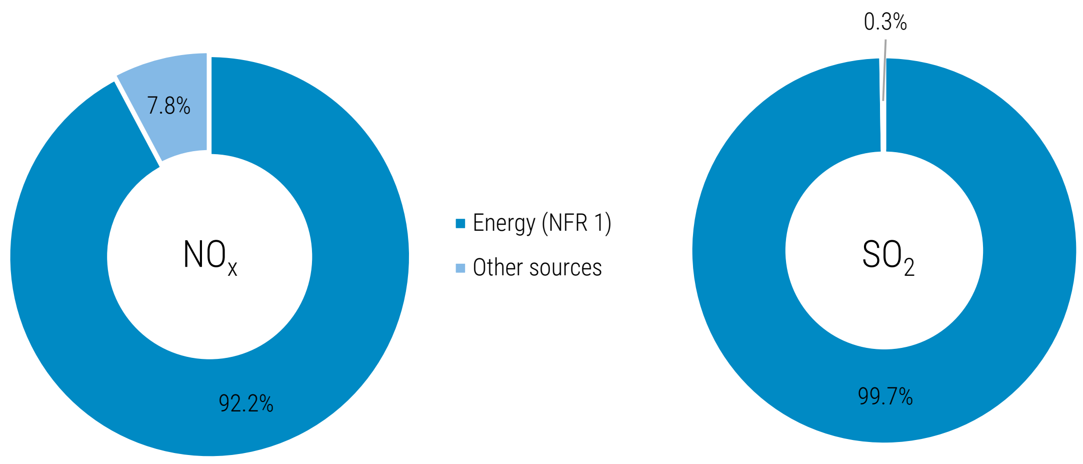


Figure 3.6 Share of SO_2 and NO_x emissions from the energy sector in total emissions in 2018

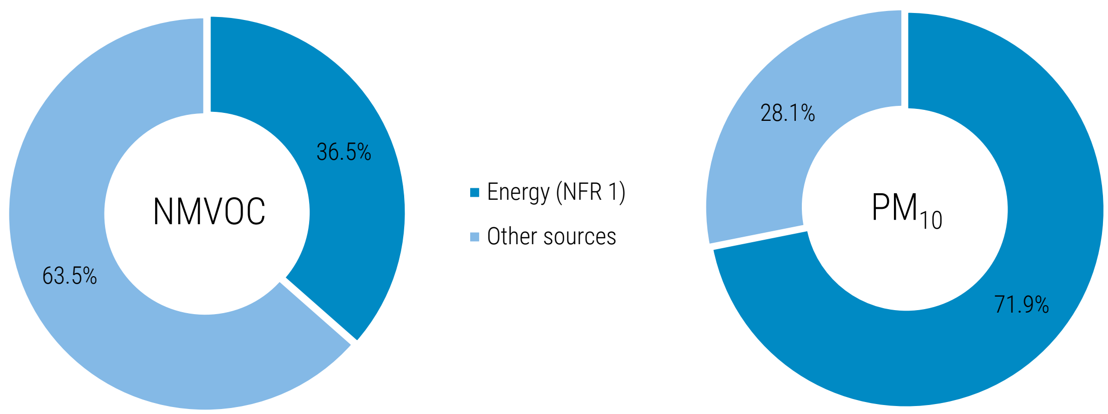


Figure 3.7 Share of NMVOC and PM_{10} emissions from the energy sector in total emissions in 2018

3.2. Stationary Fuel Combustion

3.2.1. Sector Overview

This chapter gives an overview of stationary fuel combustion, which includes energy industries (NFR 1A1), stationary combustion in manufacturing industries (NFR 1A2) and non-industrial combustion plants (NFR 1A4). Energy related activities (excluding transport) are the most significant contributors to SO_2 emissions – 99.5% in 2018. The share of mobile sources of the total emissions is very small – 0.1% (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 1990-2018 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
	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

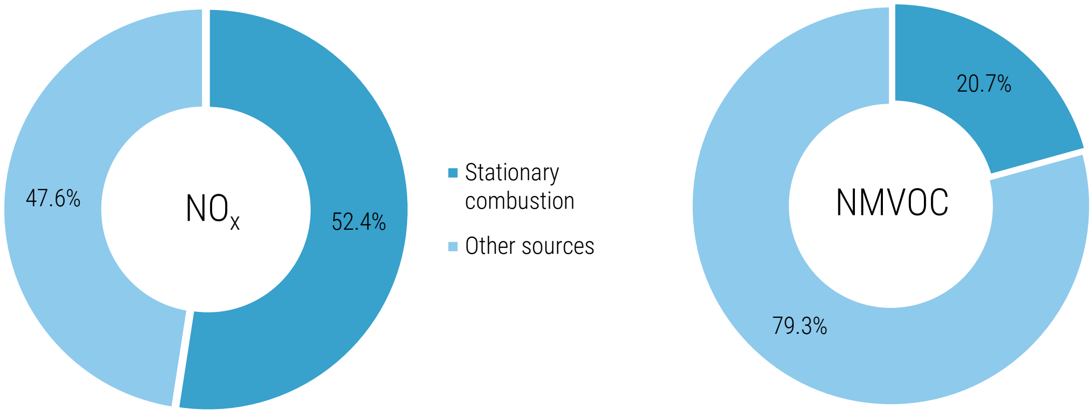


Figure 3.8 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2018

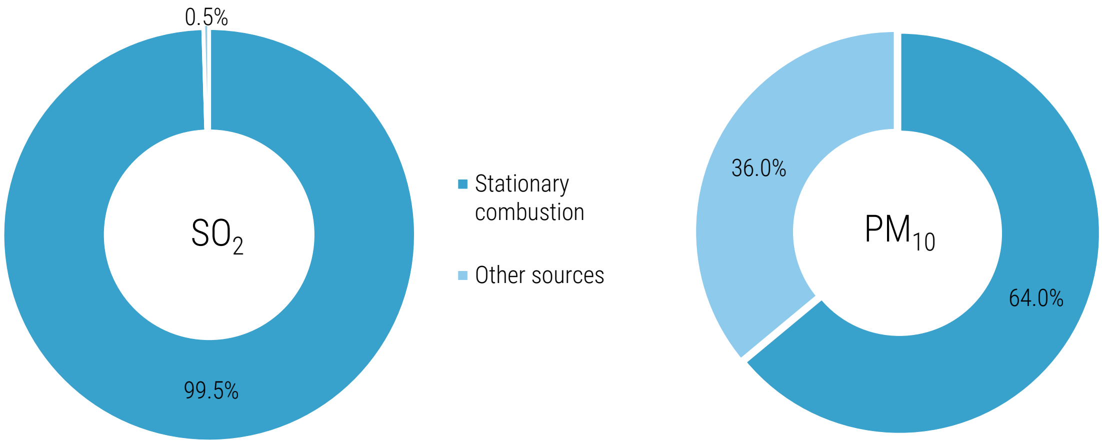


Figure 3.9 SO_2 and PM_{10} emissions from stationary fuel combustion and other sources in 2018

Table 3.3 Pollutant emissions from stationary fuel combustion in the period of 1990–2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	36.137	6.814	265.481	0.137	NR	NR	NR	267.734	86.482	128.244
1995	26.448	9.087	112.073	0.249	NR	NR	NR	123.138	145.682	62.756
2000	23.696	7.373	93.902	0.305	13.638	28.657	2.944	64.310	125.794	33.294
2005	20.585	6.794	75.774	0.470	11.020	16.357	2.584	24.614	107.734	34.530
2006	18.950	6.181	69.449	0.335	7.789	11.204	1.963	16.647	97.369	31.993
2007	23.546	6.682	87.696	0.319	10.764	17.734	2.444	22.330	115.789	40.540
2008	21.913	7.072	69.185	0.373	10.007	13.895	2.588	17.528	121.609	35.340
2009	19.334	6.555	54.679	0.307	8.168	11.556	2.128	14.506	123.714	28.811
2010	24.333	6.839	83.100	0.359	12.482	19.780	2.720	23.206	127.348	40.134
2011	23.690	5.872	72.538	0.321	16.950	31.003	3.100	36.061	105.981	39.638
2012	20.948	5.817	42.773	0.314	7.442	10.713	1.769	14.215	115.478	35.096
2013	20.903	6.081	41.567	0.385	10.765	16.582	2.143	18.861	112.705	40.581
2014	20.003	5.680	46.745	0.430	7.611	11.790	1.638	14.849	108.590	37.719
2015	15.927	5.539	35.972	0.635	8.464	11.091	2.150	12.637	109.852	29.727
2016	17.021	5.292	34.829	0.642	6.705	8.613	1.836	9.916	117.968	33.670
2017	18.019	5.359	38.574	0.792	8.085	10.363	2.193	11.677	117.023	35.421
2018	16.855	4.635	30.721	0.734	5.546	7.208	1.560	8.215	113.425	32.139
Change 1990-2018, %	-53.4	-32.0	-88.4	437.7	-59.3	-74.8	-47.0	-96.9	31.2	-74.9

Table 3.3 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	4.502	1.161	18.890	18.276	7.284	27.312	104.291	8.102	6.940	0.180	8.314
1995	2.205	0.658	10.125	9.885	3.590	10.439	62.558	9.980	4.523	0.313	4.060
2000	0.808	0.572	8.629	8.270	2.148	6.428	48.323	8.495	3.643	0.295	2.558
2005	0.781	0.576	9.265	8.863	2.406	6.308	50.563	7.368	2.809	0.272	3.429
2006	0.770	0.579	8.641	8.258	2.165	5.685	46.669	6.481	2.718	0.250	3.018
2007	0.937	0.708	11.113	10.575	2.715	6.665	59.641	6.747	4.299	0.312	1.782
2008	0.869	0.628	9.451	9.099	2.341	5.819	52.961	7.066	4.360	0.324	2.779
2009	0.748	0.496	7.643	7.376	1.925	4.785	44.449	7.470	3.768	0.299	3.037
2010	0.940	0.684	11.007	10.354	2.674	6.533	60.519	8.290	4.647	0.340	4.157
2011	0.901	0.686	10.923	10.162	2.608	6.358	58.516	7.006	4.580	0.306	3.600
2012	0.836	0.609	9.640	8.990	2.308	5.578	52.733	7.076	3.162	0.321	3.462
2013	1.009	0.718	11.280	10.398	2.655	6.438	60.286	7.082	2.238	0.328	3.921
2014	0.939	0.709	10.288	9.651	2.555	5.962	55.088	7.042	2.452	0.272	4.202
2015	0.789	0.570	7.786	7.408	1.983	4.584	44.524	6.960	2.310	0.271	4.212
2016	0.851	0.637	9.023	8.506	2.257	5.258	50.128	6.892	2.186	0.275	4.168
2017	0.845	0.608	9.533	8.991	2.261	5.597	53.326	7.661	2.430	0.301	5.021
2018	0.788	0.568	8.643	8.126	2.052	4.976	47.961	7.662	2.250	0.309	5.079
Change 1990-2018, %	**-82.5**	**-51.1**	**-54.2**	**-55.5**	**-71.8**	**-81.8**	**-54.0**	**-5.4**	**-67.6**	**72.0**	**-38.9**

The energy industry sector is responsible for the about 82% of Estonian total SO_2 emissions, 29.4% of NO_x, 28.6% of PM_{10}, and 86.4% of Pb. 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 65% 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.

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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.

2018 was the sixth 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 2018, 232.9 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.[1]

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

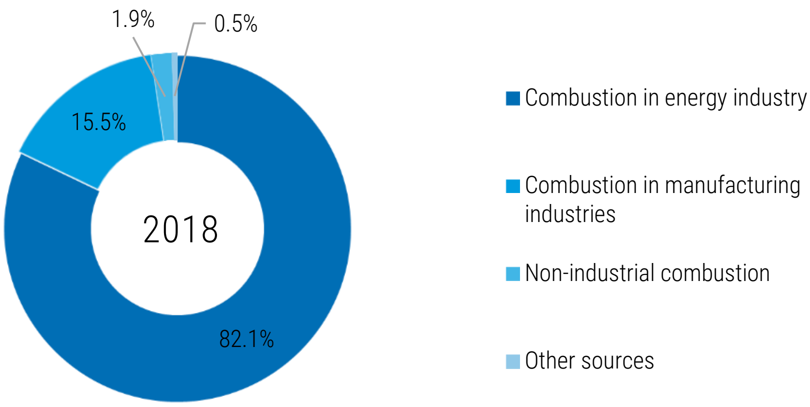

Figure 3.10 SO_2 emissions by sources of pollution in 2018

Non-industrial combustion is responsible for about 64.7% of the total NMVOC and 60% of CO emissions in stationary combustion, for approximately 1.1% of SO_2 and 28.2% of TSP emissions. Combustion in energy and transformation industries accounts for 84.2% of SO_2, for 42.1% of TSP and for the 32% of CO emissions in stationary combustion (the main part of carbon monoxide is emitted from shale oil production plant) (see Figure 3.10-3.15).

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

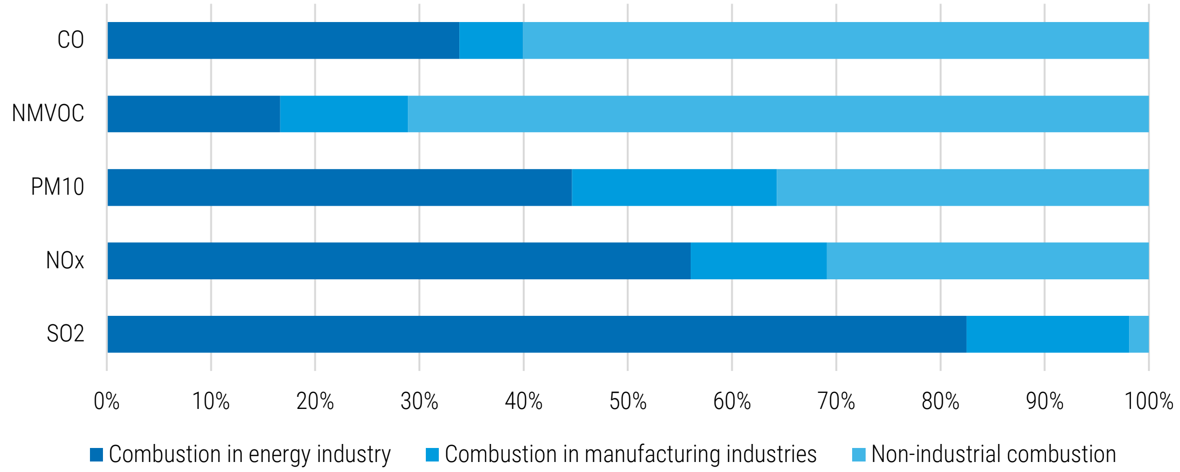

Figure 3.11 Distribution of pollutant emissions by sector in stationary combustion in 2018

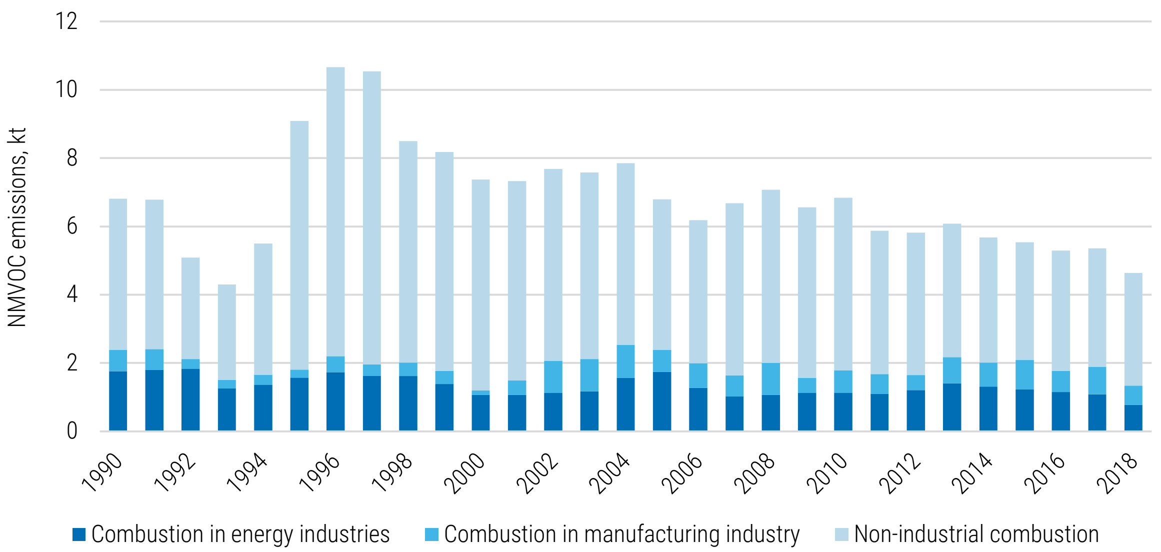

Figure 3.12 Distribution of NMVOC emissions by sector in stationary combustion in the period of 1990–2018

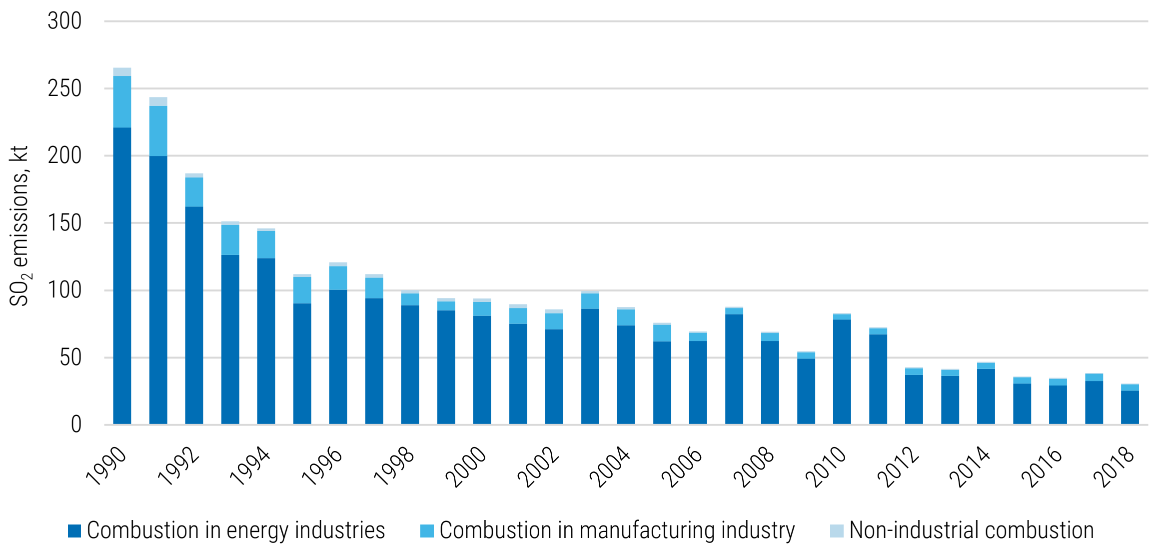

Figure 3.13 Distribution of SO_2 emissions by sector in stationary combustion in the period of 1990–2018

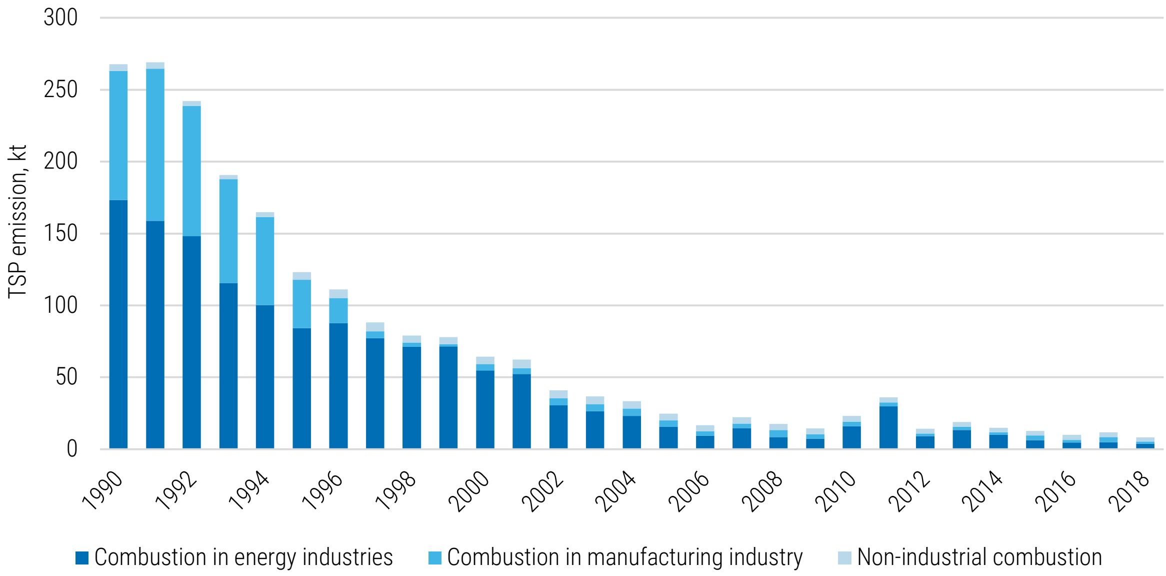

Figure 3.14 Distribution of TSP emissions by sector in stationary combustion in the period of 1990–2018

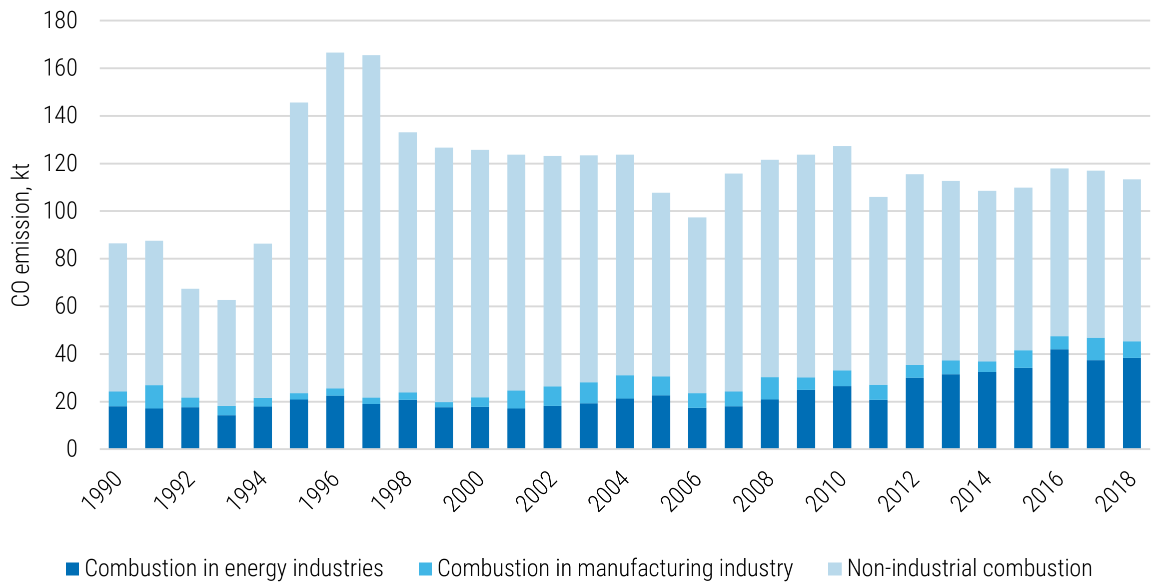

Figure 3.15 Distribution of CO emissions by sector in stationary combustion in the period of 1990–2018

3.2.1.2. Uncertainty

An uncertainty analysis was carried out to the year 2017 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, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	17.999	kt	54.21	9.53%	2.14%
NMVOC	5.355	kt	24.07	7.75%	2.00%
SO_x	38.574	kt	99.80	8.26%	0.33%
NH_3	0.792	kt	7.72	2.04%	0.90%
$PM_{2.5}$	7.975	kt	86.48	9.54%	4.52%
PM_{10}	10.111	kt	72.68	9.56%	4.04%
TSP	11.690	kt	59.35	6.50%	0.62%
CO	116.950	kt	84.57	11.11%	4.82%
Pb	33.062	t	97.02	186.09%	21.13%
Cd	0.772	t	96.09	135.55%	19.66%
Hg	0.548	t	93.39	181.01%	4.70%
PCDD/F	2.429	g I-TEQ	56.29	66.93%	39.64%
B(a)p	2.227	t	99.31	97.49%	63.50%
B(b)f	2.595	t	99.11	107.06%	79.04%
B(k)f	1.263	t	98.87	91.20%	51.53%
I(1,2,3-cd)p	1.576	t	99.30	83.62%	52.32%
HCB	0.301	kg	97.20	92.89%	104.62%
PCBs	5.021	kg	99.58	101.66%	7.09%

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
1A1c	Manufacture of solid fuels and other energy industries	Tier 3	Reported by operators	National methodologies; National EF; Measurements; Default EMEP/EEA Guidebook

The energy and transformation industries sector is responsible for about 82% of total SO_2 emissions, 29.4% of NO_x, 28.6% of PM_{10}, 29.6% of CO, and 86.4% 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 1990-2018 period, emissions of SO_2 decreased by 88.5% and NO_x emissions by 63.2%, 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%. 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.

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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 2018, SO_2, NO_x and PM_{10} emissions decreased by about 22%, 10.4% and 25.5% respectively compared to 2017'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 15%).

Table 3.6 Pollutant emissions from energy in the period of 1990-2018

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
2006	10.890	1.271	62.340	0.128	2.767	5.427	0.312	9.407	17.450	28.400
2007	14.100	1.022	82.360	0.130	5.707	11.947	0.663	14.687	18.000	36.700
2008	12.298	1.061	62.286	0.124	3.398	6.515	0.392	8.478	20.818	31.015
2009	10.637	1.125	49.138	0.133	3.201	5.808	0.357	7.394	24.955	25.115
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
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
Change 1990-2018, %	-63.2	-56.2	-88.5	420.8	-74.8	-85.0	-68.1	-97.9	113.1	-54.6

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	2.000	2.330	0.020	5.244
1995	0.621	0.552	9.972	9.460	2.502	7.550	48.031	1.870	1.300	0.030	2.724
2000	0.505	0.476	8.532	7.810	1.970	5.640	40.090	1.370	0.810	0.030	1.699
2005	0.531	0.507	9.155	8.188	2.230	5.639	42.385	1.654	0.564	0.031	1.828
2006	0.520	0.506	8.532	7.610	1.964	5.310	38.760	1.280	0.450	0.020	1.547
2007	0.620	0.615	10.972	9.780	2.454	6.250	50.330	1.020	1.870	0.020	1.096
2008	0.523	0.521	9.275	8.255	2.082	5.299	42.577	1.066	2.264	0.021	1.414
2009	0.426	0.418	7.490	6.679	1.694	4.376	34.470	1.921	2.184	0.047	2.100
2010	0.613	0.608	10.864	9.680	2.445	6.180	49.922	2.635	2.978	0.068	2.868
2011	0.611	0.611	10.804	9.646	2.428	6.102	49.433	2.184	3.120	0.056	2.472
2012	0.533	0.533	9.510	8.474	2.131	5.363	43.610	2.302	1.707	0.060	2.501
2013	0.709	0.643	11.165	9.888	2.492	6.257	51.020	2.500	0.810	0.077	2.695
2014	0.632	0.630	10.143	9.053	2.382	5.722	46.336	2.757	1.127	0.079	3.125
2015	0.492	0.494	7.668	6.854	1.839	4.358	35.126	2.584	1.023	0.073	2.817
2016	0.549	0.562	8.900	7.963	2.107	5.043	40.706	2.777	1.031	0.078	2.965
2017	0.534	0.531	9.437	8.430	2.113	5.368	43.069	3.116	1.004	0.089	3.295
2018	0.484	0.482	8.530	7.621	1.905	4.813	38.929	3.427	0.912	0.100	3.556
Change 1990-2018, %	-57.2	-52.5	-53.4	-56.3	-59.0	-76.3	-54.2	71.3	-60.8	402.5	-32.2

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 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.

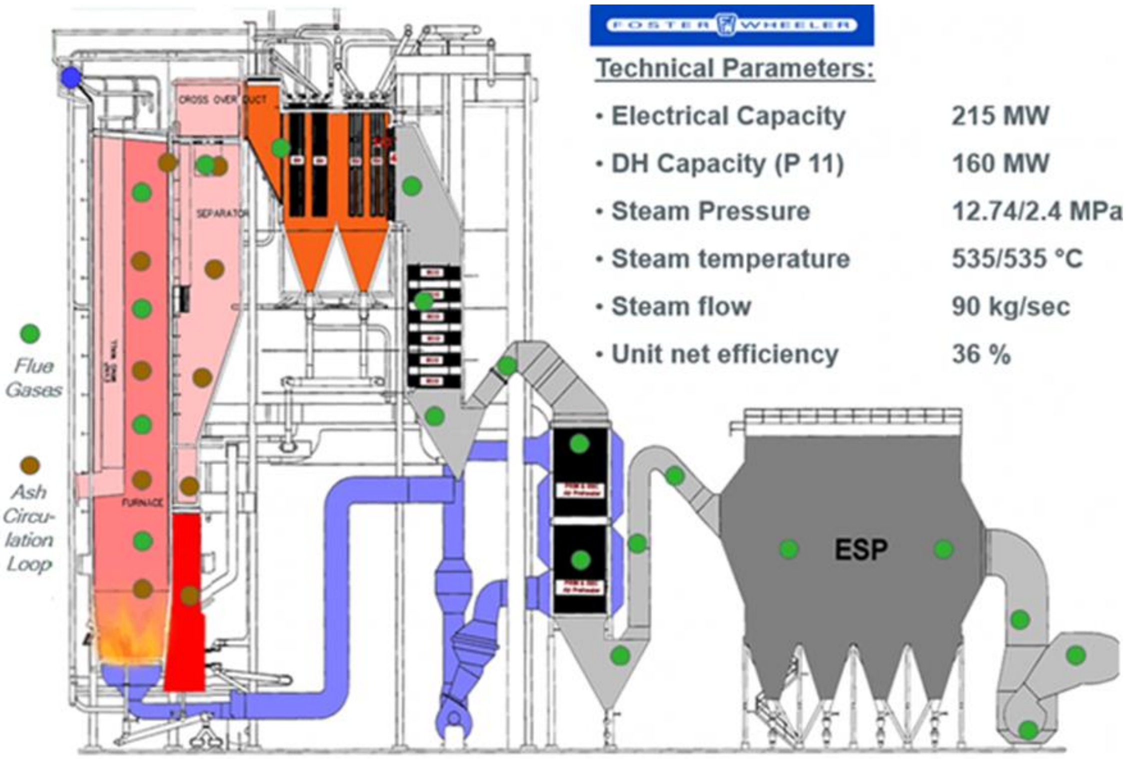

Figure 3.16 Existing EOS CFBC boiler drawing

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

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

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

Fuel used	CO_2, %	CO, mg/Nm³	NO_x, mg/Nm³	SO_2, mg/Nm³
OS + BIO	13.8	20 – 30	140 – 200	0
OS 8.5	14.4	20 – 45	200	15.0
OS 11.1	11.2	20 - 45	200	15.0

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

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

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

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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 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 2018 production figures have decreased by 16% compared to 2017 (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 50% in 2017 in comparison with 2010). In 2018, a total of 74% of shale oil was produced with the use of new SHC technologies.

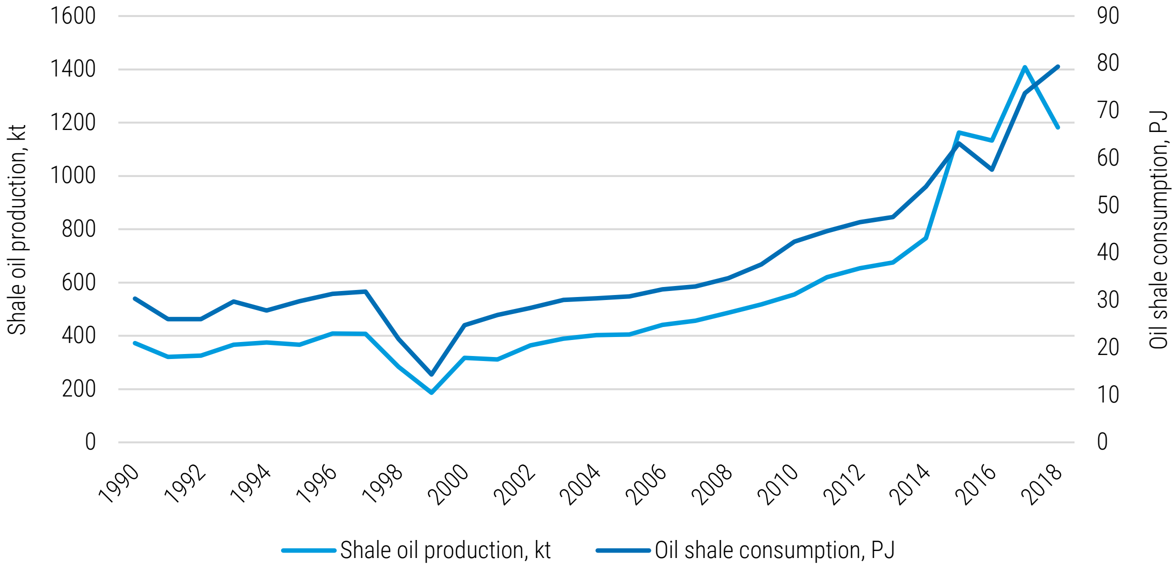

Figure 3.17 Shale oil production and oil shale consumption in the period 1990-2018

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					3000		
- electrostatic precipitator					1000		
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	1000		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

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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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Table 3.15 POPs emission factors

Fuel	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PCBs	HCB
	ng/GJ	mg/GJ					µg/GJ
Coal	10	63	70	32	25	0.13	0.6
Peat	50	60	80	30	30	NE	NE
Wood	50	60	80	30	30	0.19	6.34
Residual oil	2.5	5	6	4	2	0.09	NE
Shale-oil	2.5	5	6	4	2	NE	NE
Distillate oil	0.5	5	6	4	2	NE	NE
Natural gas	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

The national methodology is co-ordinated by the Ministry of the Environment, and the national methodology for boilers is being updated at present. Therefore, it was decided not to use the new EMEP/EEA Guidebook 2019 for NFR 1A1, 1A2, 1A4ai and 1A4ci sectors this year. Most probably, the national methodology will be used next year.

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, PAHs 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
2006	503.8	87.0	70.3	20.9	233.5
2007	551.4	92.6	92.2	36.5	247.6
2008	477.9	92.5	61.5	24.8	240.2
2009	432.9	92.0	58.4	25.8	223.9
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

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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).

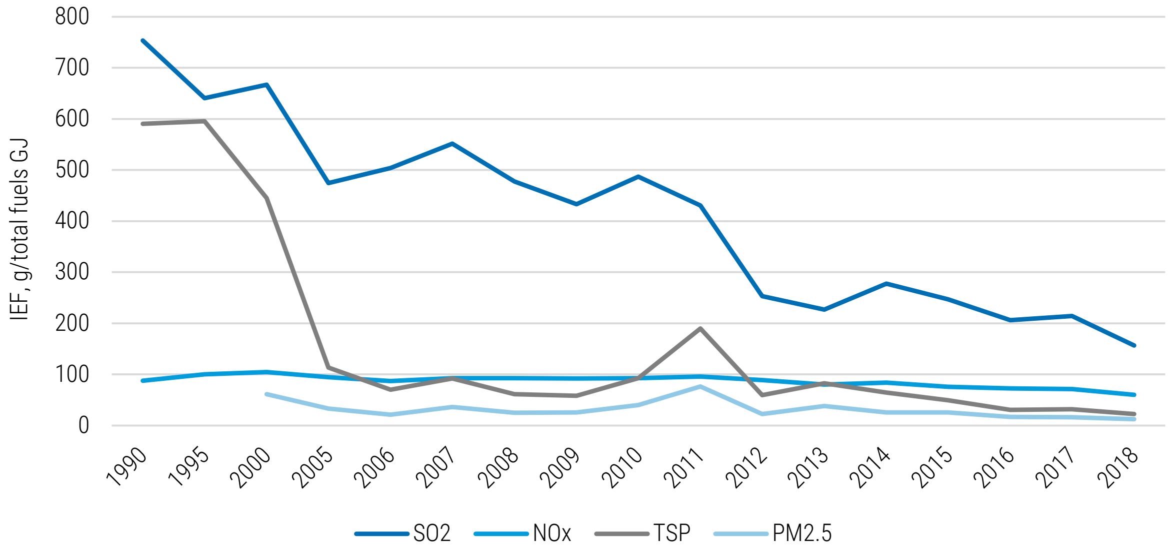

Figure 3.18 Implied emission factors for NFR 1A1a

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 (OSIS) (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 1990-2018. The biggest decrease has been in terms of liquid fuel, by 94%. The consumption of solid fuels decreased by about 52%, 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, from 3.8 PJ to 0.03 PJ.

The consumption of peat increased slightly – from the 0.5 PJ to 1.3 PJ. The combustion of biomass has grown approximately by six times.

Table 3.18 Fuel consumption in energy industries in the period of 1990–2018 (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
2006	2.31	96.89	3.64	15.25	4.80
2007	2.12	124.41	3.53	14.74	4.94
2008	2.29	104.91	3.49	13.69	5.45
2009	2.41	84.74	7.51	10.96	7.35
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
Change 1990-2018, %	-96.3	-39.9	656.0	-74.9	

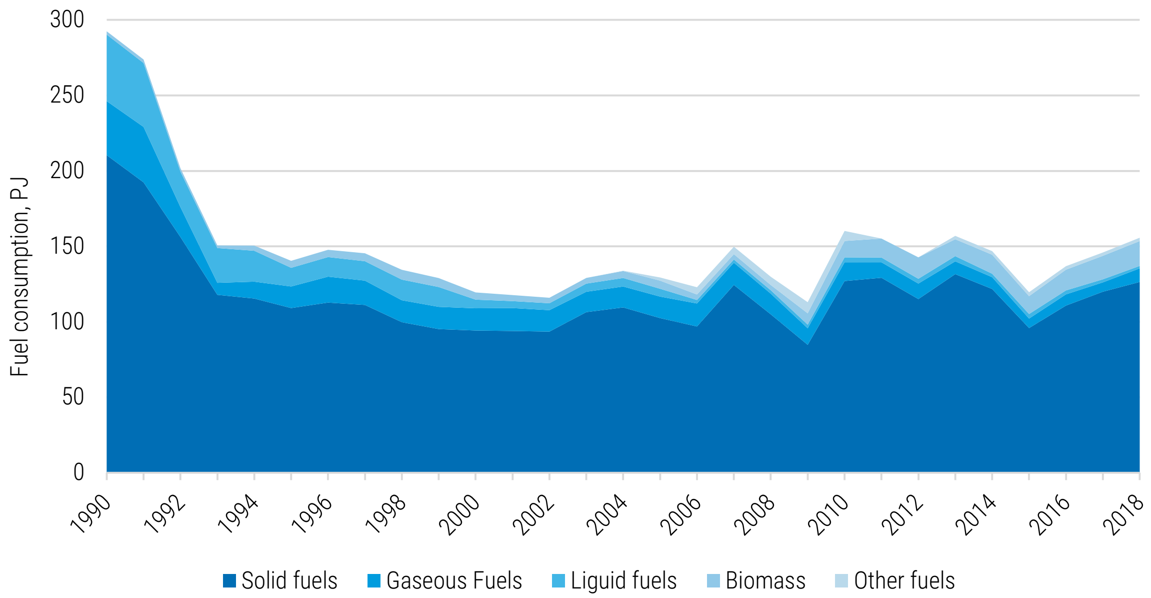

Figure 3.19 Fuel consumption by energy industries sector in the period 1990-2018

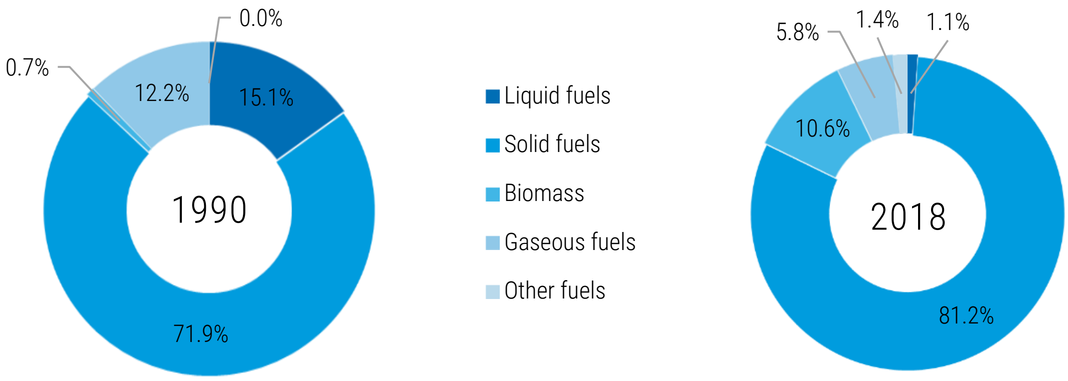

Figure 3.20 Distribution of fuel consumption in energy industries in 1990 and 2018

Table 3.19 Shale-oil production in the period of 1990-2018 (kt)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
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	
2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
402.23	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

Table 3.20 Oil-shale consumption for oil-shale production by different technologies, PJ[2]

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
2006	8.40	NO	NO	8.40	19.73	4.17	23.90	32.30
2007	7.96	NO	NO	7.96	20.72	4.26	24.98	32.94
2008	10.85	NO	NO	10.85	19.99	3.87	23.86	34.71
2009	13.07	NO	NO	13.07	20.45	4.04	24.49	37.56
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

3.2.2.3. Uncertainty

An uncertainty analysis for the stationary combustion sector alone (NFRs 1A1, 1A2, and 1A4) was carried out upon the 2017 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

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

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 2020 submission the following recalculations were carried out:

- Recalculated emissions of all substances for 2005 (NFR 1A1a). The reason for the recalculation was the correction of the fuels consumption data: in previous submissions, pollutants emissions from 81 TJ of biomass, 12 TJ of coke, 343 TJ of diesel were underestimated;
- In 2020 reporting year additional calculations $PM_{2.5}$ and PM_{10} were made for the oilshale oil production (NFR 1A1c), because in the period 2015-2017, emissions from shale oil production were not calculated by mistake.

3.2.2.6. Source-Specific Planned Improvements

- Correction of activity data for the period 1990-2009 (fuel groups);
- Recalculation of POPs emissions.

3.2.3. Manufacturing Industries and Construction (NFR 1A2)

This sector is a key source of $PM_{2.5}$ (15.4%), PM_{10} (11.3%), TSP (8.5%), PAHs (16.3%), SO_2 (14.3%), dioxins (13.2%).

Emissions of all pollutants from the NFR 1A2 sector have decreased across 1990-2018, with the exception of carbon monoxide, which can mainly be explained by the increase in biomass combustion (see Table 3.22). 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 decrease in emissions for all pollutants as produced by industrial combustion in 2018 when compared to 2017 is explained by an decrease in wood burning in industrial boilers by 8%; also the oil shale and coal consumption in cement production plan has decreased.

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

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.

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Table 3.22 Pollutants emissions from combustion in manufacturing industries in the period of 1990-2018

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
2006	2.131	0.720	6.024	0.133	1.589	2.088	0.427	2.993	6.072	0.775
2007	2.061	0.620	4.395	0.102	1.431	1.899	0.385	3.124	6.223	0.905
2008	2.330	0.943	6.030	0.174	3.211	3.773	0.872	4.939	9.419	1.447
2009	1.337	0.435	4.840	0.096	1.586	2.175	0.432	3.076	5.241	0.849
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
Change 1990-2018, %	-60.6	-8.6	-87.6	2 301.9	-29.2	-47.1	-27.3	-98.2	11.8	-99.0

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	0.286	2.470	6.070	15.390	0.741	1.440	0.064	2.000
1995	1.310	0.030	0.080	0.376	0.962	2.429	6.514	0.213	0.920	0.046	1.030
2000	0.030	0.010	0.021	0.391	0.040	0.289	0.578	0.386	0.530	0.060	0.380
2005	0.013	0.001	0.030	0.441	0.055	0.334	1.247	1.056	0.595	0.082	1.175
2006	0.010	0.004	0.031	0.371	0.070	0.219	1.080	0.867	0.790	0.074	0.990
2007	0.030	0.021	0.061	0.471	0.120	0.239	0.717	0.683	0.930	0.094	0.440
2008	0.057	0.034	0.104	0.439	0.127	0.389	1.648	1.051	0.600	0.107	1.040
2009	0.021	0.006	0.085	0.448	0.100	0.285	0.837	0.658	0.171	0.049	0.670
2010	0.020	0.005	0.072	0.473	0.090	0.219	1.102	0.822	0.246	0.068	0.940
2011	0.014	0.004	0.054	0.403	0.062	0.163	0.844	0.847	0.222	0.077	0.835
2012	0.015	0.004	0.063	0.414	0.053	0.130	0.489	0.793	0.216	0.080	0.753
2013	0.018	0.003	0.055	0.401	0.048	0.109	0.791	0.904	0.259	0.078	0.886
2014	0.018	0.004	0.080	0.393	0.061	0.172	0.577	0.780	0.222	0.023	0.779
2015	0.022	0.004	0.059	0.386	0.037	0.153	1.388	1.168	0.314	0.035	1.145
2016	0.013	0.004	0.054	0.451	0.028	0.094	0.893	0.928	0.250	0.028	0.949
2017	0.021	0.006	0.036	0.421	0.034	0.140	1.570	1.397	0.520	0.043	1.369
2018	0.015	0.015	0.041	0.415	0.029	0.087	0.401	1.262	0.491	0.039	1.240
Change 1990-2018, %	-99.5	-81.2	-91.7	45.1	-98.8	-98.6	-97.4	70.3	-65.9	-38.5	-38.0

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

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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.

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

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

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	
1995	1 463.3	175.5	2 520.8	
2000	841.8	205.9	375.6	138.5
2005	632.9	111.3	303.8	224.3
2006	428.0	151.4	212.8	113.0
2007	246.1	115.5	175.1	80.2
2008	287.2	111.0	235.3	153.0
2009	305.9	84.5	194.4	100.3
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

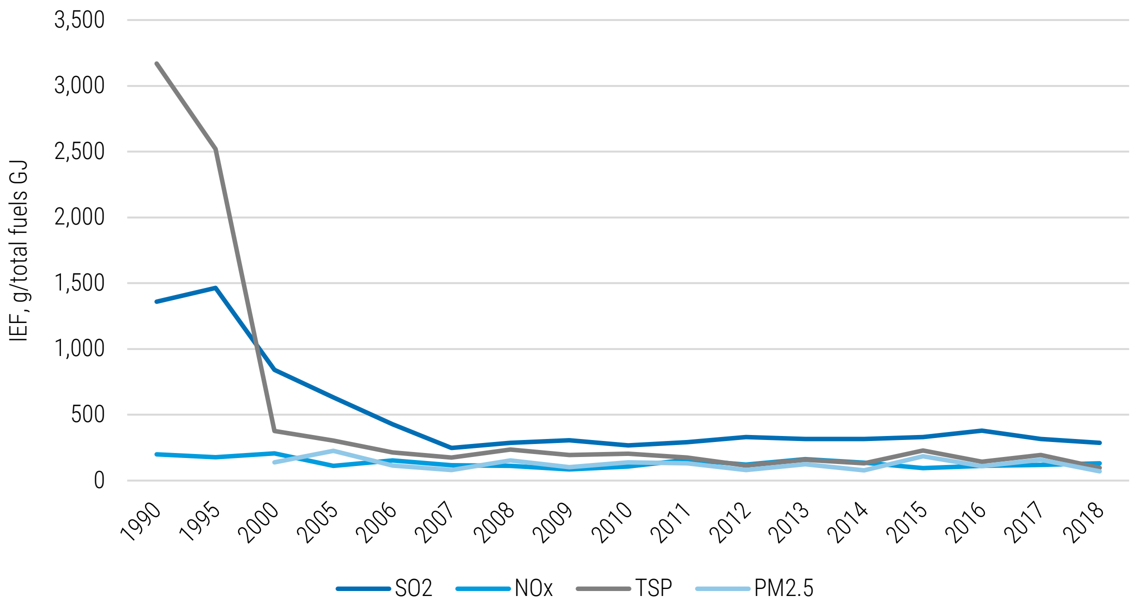

Figure 3.21 Implied emission factors for NFR 1A2

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

Table 3.24 Fuel consumption by manufacturing industries in the period of 1990-2018

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
2006	2.75	3.19	3.61	2.22	2.29
2007	2.21	6.15	2.77	5.19	1.52
2008	1.77	6.15	4.71	7.48	0.88
2009	1.39	5.40	2.61	4.60	1.82
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
Change 1990-2018, %	-94.8	-51.2	2 945.9	52.7	

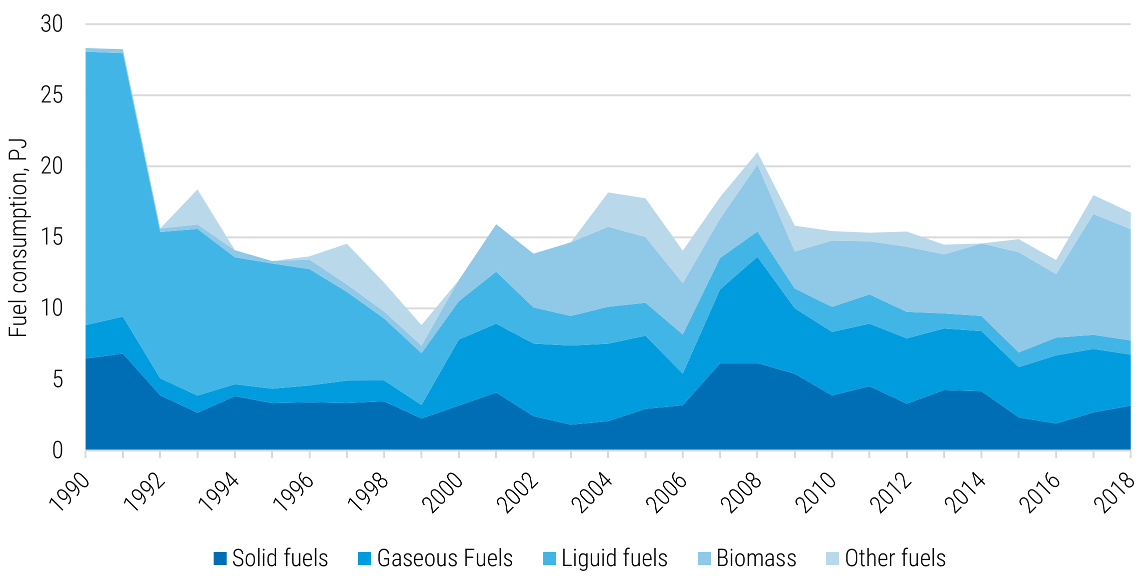

Figure 3.22 Fuel consumption by manufacturing industries in the period of 1990-2018

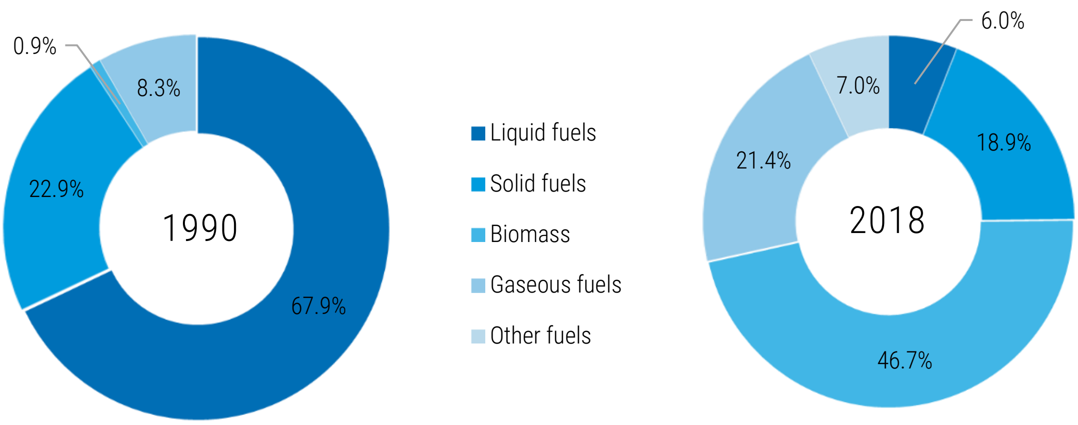

Figure 3.23 Distribution of fuel consumption in manufacturing industries in 1990 and 2018

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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 2020 submission the following recalculations were carried out:

- NFR 1A2b. Correction of lead emissions data for 2017 – emissions from one enterprise mistakenly reported 1,000 times less;
- NFR 1A2f. The emissions of particulates from glass production facility were reallocated from NFR 1A2f to NFR 2A3 for period 2004 – 2017;
- NFR 1A2gviii. The emissions of all substances were recalculated for 2005. Secondly, the change in the emissions of various substances for the period 2000 – 2009 was affected by the analysis of emissions of the metal industry carried out pursuant to the TERT recommendation in 2019.The reason for the recalculation is given in Chapter 8.

3.2.3.5. Source-Specific Planned Improvements

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

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.

The non-industrial combustion sector is a key source of CO (51.8%), $PM_{2.5}$ (32.9%), PM_{10} (20.7%), TSP (14.9%), NO_x (15%), NMVOC (14.5%), 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 1990-2018 period, the emission of some pollutants from this sector have decreased, and some pollutants such as NO_x, CO, NH_3, Cd, Cr, As, 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
1A4bi	Residential: Stationary plants	Tier 2	Energy balance of Statistics Estonia	National EF; Default EMEP/EEA Guidebook

NFR	Description	Method	Activity data	Emissions factor
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

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 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 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	4.847	4.431	6.091	0.046	NR	NR	NR	4.657	62.282	2.641
1995	10.028	7.283	2.293	0.072	NR	NR	NR	5.321	122.092	2.942
2000	8.446	6.178	2.688	0.073	4.309	4.582	1.623	5.107	103.954	3.300
2005	6.149	4.406	1.456	0.064	3.457	3.810	1.240	4.610	77.196	2.842
2006	5.929	4.190	1.085	0.074	3.433	3.690	1.224	4.247	73.846	2.818
2007	7.385	5.040	0.941	0.087	3.627	3.888	1.397	4.520	91.566	2.935
2008	7.285	5.069	0.869	0.075	3.399	3.606	1.324	4.111	91.373	2.878
2009	7.360	4.995	0.702	0.077	3.381	3.573	1.338	4.036	93.518	2.847
2010	7.429	5.048	0.750	0.084	3.491	3.676	1.359	4.141	94.300	2.866
2011	6.182	4.200	0.700	0.067	3.016	3.182	1.138	3.546	78.916	2.795
2012	6.298	4.172	0.679	0.065	2.869	3.010	1.110	3.391	80.139	2.802
2013	5.822	3.914	0.670	0.075	2.870	3.010	1.066	3.328	75.439	2.844
2014	5.543	3.666	0.622	0.084	2.585	2.717	0.987	3.041	71.762	2.782
2015	5.288	3.454	0.481	0.078	2.593	2.723	0.983	3.035	68.308	2.777
2016	5.422	3.519	0.507	0.084	2.786	2.974	1.051	3.446	70.485	2.880
2017	5.359	3.469	0.430	0.093	2.807	2.953	1.069	3.286	70.215	2.835
2018	5.205	3.296	0.584	0.086	2.438	2.573	0.964	2.894	68.117	2.800
Change 1990-2018, %	7.4	-25.6	-90.4	85.4	-43.4	-43.8	-40.6	-37.9	9.4	6.0

Table 3.26 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	0.141	0.066	0.075	0.286	0.162	0.906	3.980	5.361	3.170	0.096	1.071
1995	0.274	0.076	0.074	0.376	0.126	0.460	8.013	7.897	2.303	0.237	0.306
2000	0.273	0.085	0.076	0.391	0.138	0.499	7.655	6.739	2.303	0.205	0.479
2005	0.238	0.069	0.080	0.441	0.121	0.336	6.931	4.658	1.649	0.160	0.426
2006	0.240	0.070	0.079	0.371	0.130	0.156	6.829	4.334	1.478	0.156	0.481
2007	0.287	0.072	0.080	0.471	0.141	0.176	8.594	5.044	1.499	0.198	0.246
2008	0.289	0.073	0.072	0.439	0.132	0.130	8.736	4.949	1.496	0.196	0.325
2009	0.301	0.072	0.068	0.448	0.131	0.124	9.142	4.891	1.413	0.203	0.267
2010	0.307	0.071	0.070	0.473	0.139	0.133	9.495	4.833	1.424	0.204	0.349
2011	0.276	0.071	0.065	0.403	0.118	0.093	8.239	3.975	1.238	0.173	0.293
2012	0.288	0.072	0.067	0.414	0.124	0.084	8.633	3.980	1.239	0.182	0.208
2013	0.282	0.072	0.060	0.401	0.115	0.072	8.475	3.678	1.168	0.173	0.340
2014	0.290	0.075	0.065	0.393	0.112	0.069	8.176	3.505	1.103	0.171	0.299
2015	0.274	0.071	0.060	0.386	0.107	0.072	8.010	3.209	0.974	0.163	0.251

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
2016	0.289	0.071	0.069	0.451	0.121	0.121	8.530	3.187	0.905	0.169	0.254
2017	0.290	0.071	0.060	0.421	0.114	0.089	8.687	3.149	0.906	0.170	0.358
2018	0.289	0.071	0.071	0.415	0.118	0.076	8.631	2.973	0.846	0.169	0.284
Change 1990-2018, %	105.2	7.2	-5.7	45.1	-27.1	-91.6	116.9	-44.5	-73.3	76.2	-73.5

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
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

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
CO	g/GJ	3,295.845	2,574.958	24,264.87	758.454	4032.213	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 2018, an increase in the IEF of SO_x and NO_x was caused by a slight increase in the share of liquid fuel burned, while a decrease in the consumption of solid fuel and biomass caused a decrease in particulates IEF.

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

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	276.6	220.1	211.5	NR
1995	105.0	459.3	243.7	NR
2000	127.5	400.6	242.2	204.4
2005	72.8	307.5	230.5	172.9
2006	50.6	276.2	197.9	159.9
2007	37.4	293.3	179.5	144.0
2008	33.5	280.6	158.4	130.9
2009	28.7	301.2	165.2	138.4
2010	27.3	270.7	150.9	127.2
2011	29.6	261.3	149.9	127.5
2012	26.9	249.6	134.4	113.7
2013	28.0	243.2	139.0	119.9
2014	25.9	231.0	126.7	107.7
2015	20.9	230.4	132.2	113.0
2016	21.4	229.1	145.6	117.7
2017	17.6	219.6	134.6	115.0
2018	24.9	222.2	123.5	104.1

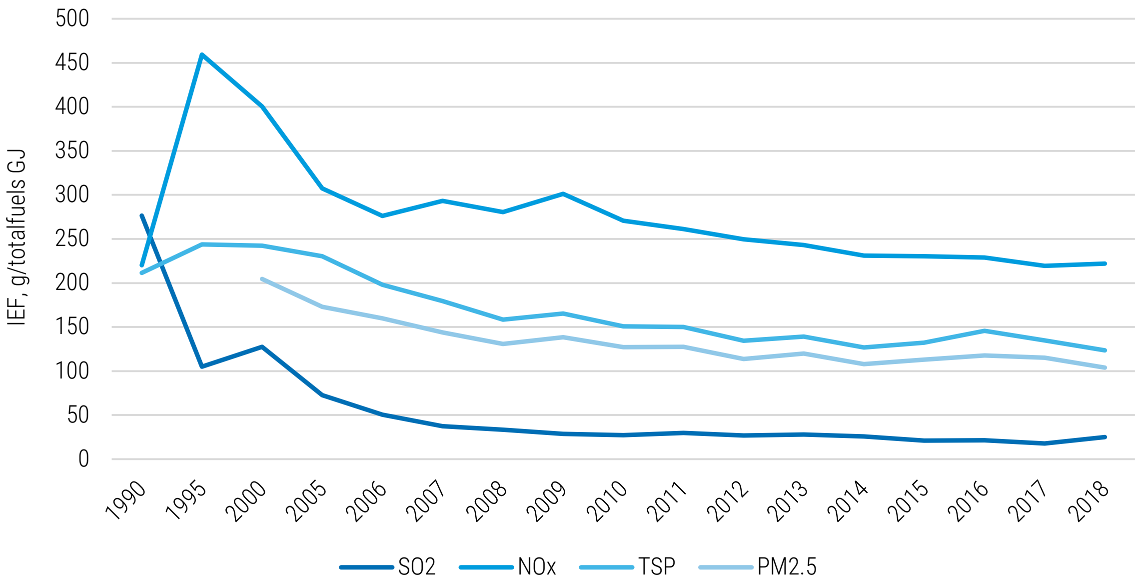

Figure 3.24 Implied emission factors for NFR 1A4

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 1990-2018, by about 89% and 98% respectively. At the same time, wood burning and natural gas consumption increased by about 199% and 116%. The distribution of fuel consumption rates in 1990 and 2018 are shown in Figure 3.26.

Table 3.32 Fuel consumption in non-industrial combustion plants in the period of 1990–2018 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	6.05	7.26	5.93	2.45	0.32
1995	1.66	2.53	15.20	2.01	0.44
2000	2.45	1.38	14.36	2.41	0.48
2005	1.19	1.40	12.81	4.16	0.44
2006	1.36	1.03	12.80	5.87	0.41
2007	1.24	0.72	16.55	6.20	0.47
2008	1.30	0.62	16.82	6.24	0.97
2009	1.10	0.44	17.31	5.11	0.47
2010	1.28	0.47	18.55	6.59	0.56
2011	0.99	0.55	15.21	6.52	0.40
2012	1.07	0.49	16.78	6.49	0.40
2013	0.72	0.50	16.56	5.76	0.40
2014	0.74	0.45	16.68	5.73	0.40
2015	0.80	0.30	16.11	5.31	0.44
2016	0.81	0.26	17.02	5.17	0.40
2017	0.82	0.18	17.71	5.29	0.40
2018	1.01	0.12	17.52	4.38	0.41
Change 1990-2018, %	-83.3	-98.4	195.4	78.6	26.2

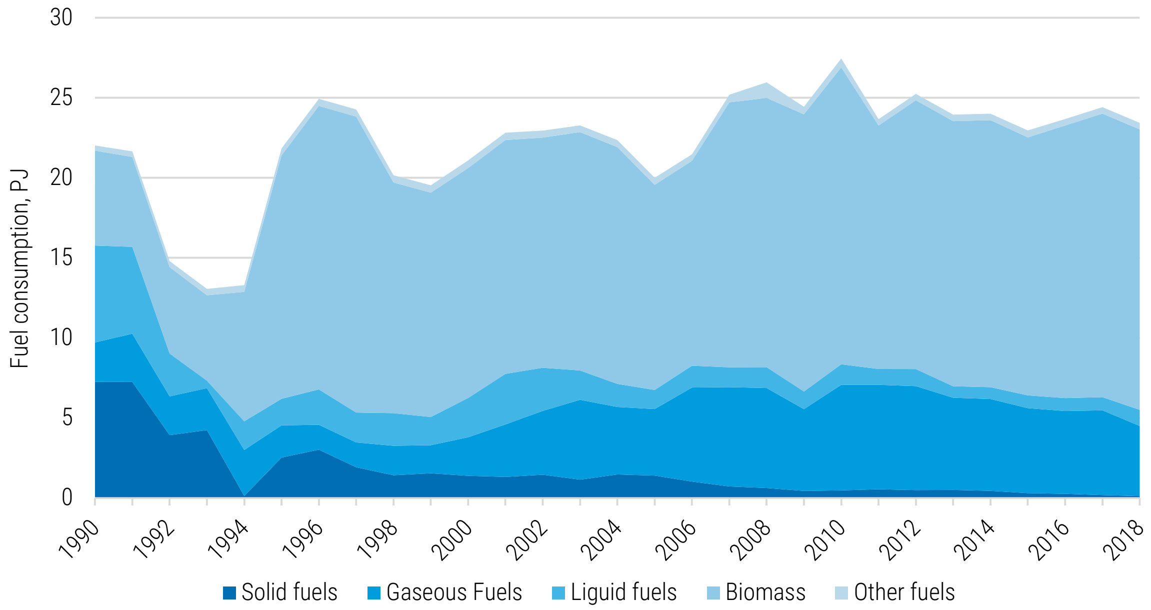

Figure 3.25 Fuel consumption by non-industrial combustion plants in the period of 1990–2018

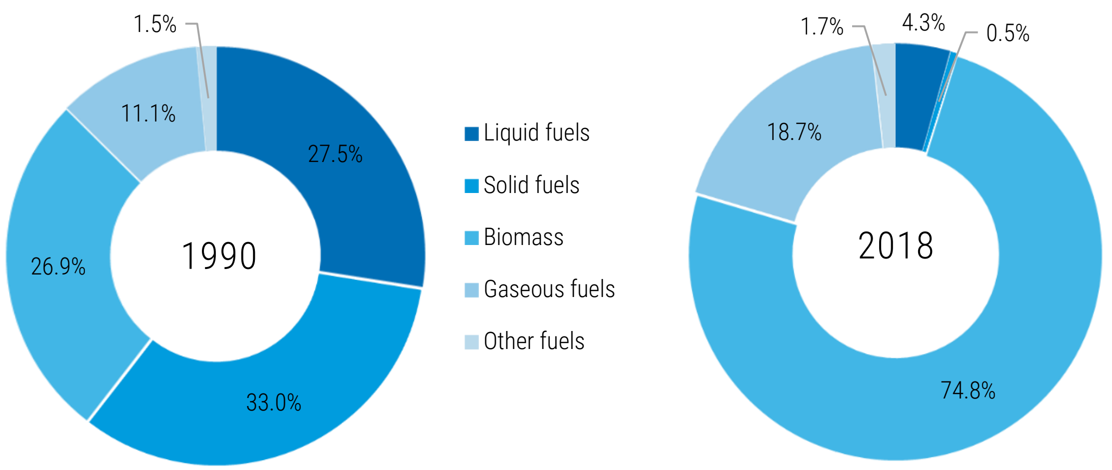

Figure 3.26 Distribution of fuel consumption in non-industrial combustion sector in 1990 and 2018

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 2018. 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 1990–2018, PJ

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels
1990	3.462	7.03	5.344	2.115
1995	0.269	2.483	15.007	1.998
2000	0.854	1.222	13.888	1.757
2005	0.368	0.969	12.254	1.871
2006	0.397	0.7725	11.945	1.907
2007	0.338	0.444	15.668	2.034
2008	0.451	0.479	16.26	2.062
2009	0.371	0.31	16.751	2.102
2010	0.333	0.36	17.701	2.299
2011	0.378	0.462	14.541	2.135
2012	0.331	0.406	16.297	2.294
2013	0.31	0.406	15.75	2.135

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels
2014	0.351	0.365	15.552	2.135
2015	0.435	0.229	15.133	2.079
2016	0.413	0.087	16.068	2.367
2017	0.381	0.109	16.346	2.251
2018	0.273	0.054	16.346	2.251
Change 1990-2018, %	-92.1	-99.2	205.9	6.4

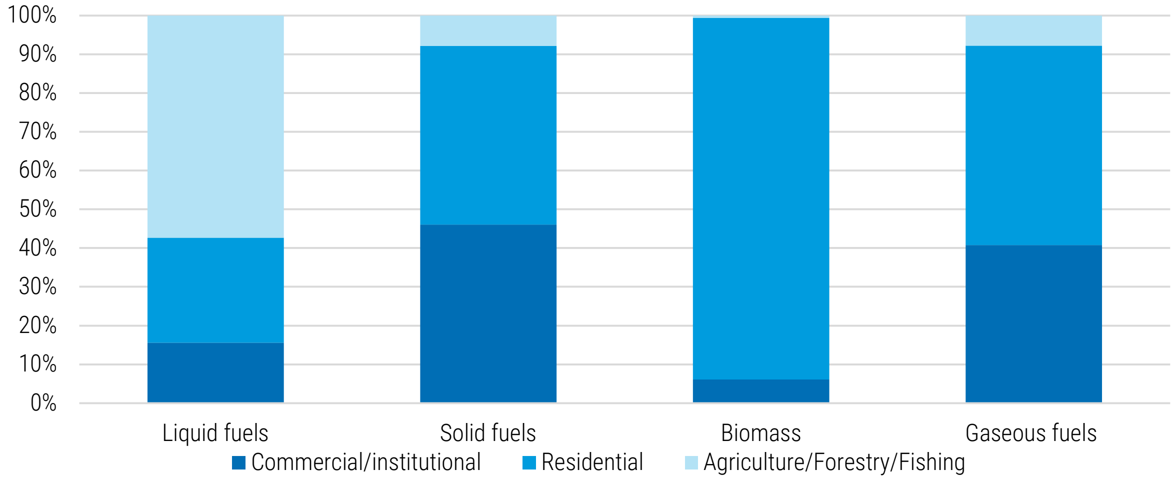

Figure 3.27 Fuel consumption by non-industrial sectors in 2018

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
2006	20,547.828
2007	21,005.810
2008	21,200.339
2009	21,104.040
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

3.2.4.3. Uncertainty

An uncertainty analysis for stationary fuel combustion sector was carried out to the year 2017 inventory. The uncertainty in the emission factors for main pollutants is estimated in the range from 20% to 250% (the higher EF for POPs); in the activity data in the range from 2% to 50%. Uncertainty estimates for stationary combustion sector are given in the table below.

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	17.999	kt	54.21	9.53%	2.14%
NMVOC	5.355	kt	24.07	7.75%	2.00%
SO_x	38.574	kt	99.80	8.26%	0.33%
NH_3	0.792	kt	7.72	2.04%	0.90%
$PM_{2.5}$	7.975	kt	86.48	9.54%	4.52%
PM_{10}	10.111	kt	72.68	9.56%	4.04%
TSP	11.690	kt	59.35	6.50%	0.62%

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
CO	116.950	kt	84.57	11.11%	4.82%
Pb	33.062	t	97.02	186.09%	21.13%
Cd	0.772	t	96.09	135.55%	19.66%
Hg	0.548	t	93.39	181.01%	4.70%
PCDD/F	2.429	g I-TEQ	56.29	66.93%	39.64%
B(a)P	2.227	t	99.31	97.49%	63.50%
B(b)F	2.595	t	99.11	107.06%	79.04%
B(k)F	1.263	t	98.87	91.20%	51.53%
I(1,2,3-cd)P	1.576	t	99.30	83.62%	52.32%
HCB	0.301	kg	97.20	92.89%	104.62%
PCB	5.021	kg	99.58	101.66%	7.09%

3.2.4.4. 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.

3.2.4.5. Recalculations

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

- The emissions of all substances from the LPG consumption in residential sector were additionally calculated for the period 1990-2017;
- Additionally calculated heavy metal emissions from waste incineration in domestic stoves;
- NH_3 emission for the period 1990-2016 from residual combustion (wood EF correction for conventional boilers);
- The emissions of all pollutants from NFR 1A4ai were recalculated for 2005 year due the correction of the fuels consumption data;
- Information on these and other recalculations are given in Chapter 8.

3.2.4.6. 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 1	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, 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 and heavy metal 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
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, 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, 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 1	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, 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 1	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, 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 1	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, 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, 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, HCB, PCBs

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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 2018 was the following: NO_x – 39.7%, BC – 19.7%, CO – 12.0% and NMVOC – 11.5%. 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 67.1%. The emissions of NMVOC and CO from the transport sector have decreased by 87.8% and 89.6% 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: road transport (NFR 1A3bi-vii), national navigation (NFR 1A3dii), agricultural machinery (NFR 1A4cii) and national fishing (NFR 1A4ciii) 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'.

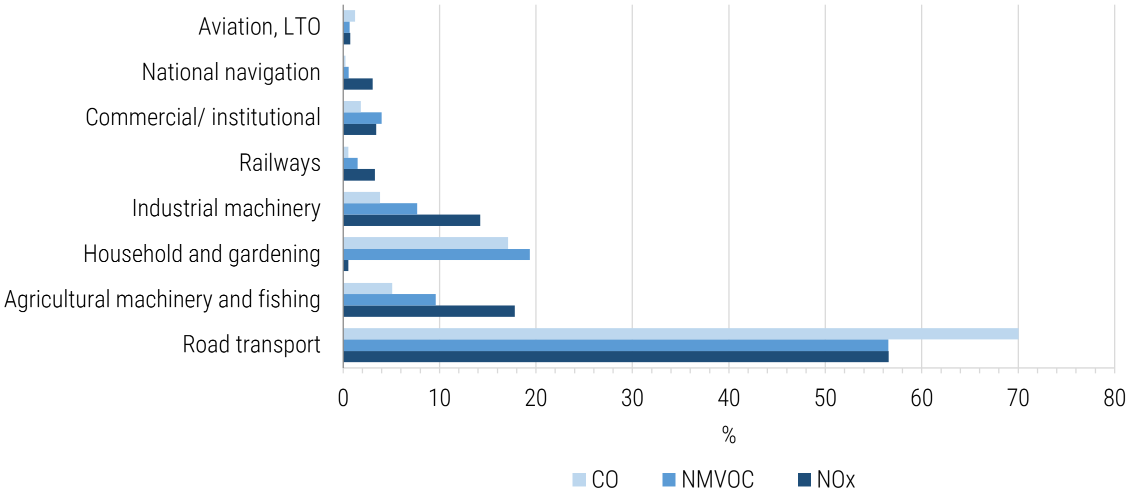

Figure 3.28 NO_x, NMVOC and CO emission shares in the transport sectors in 2018

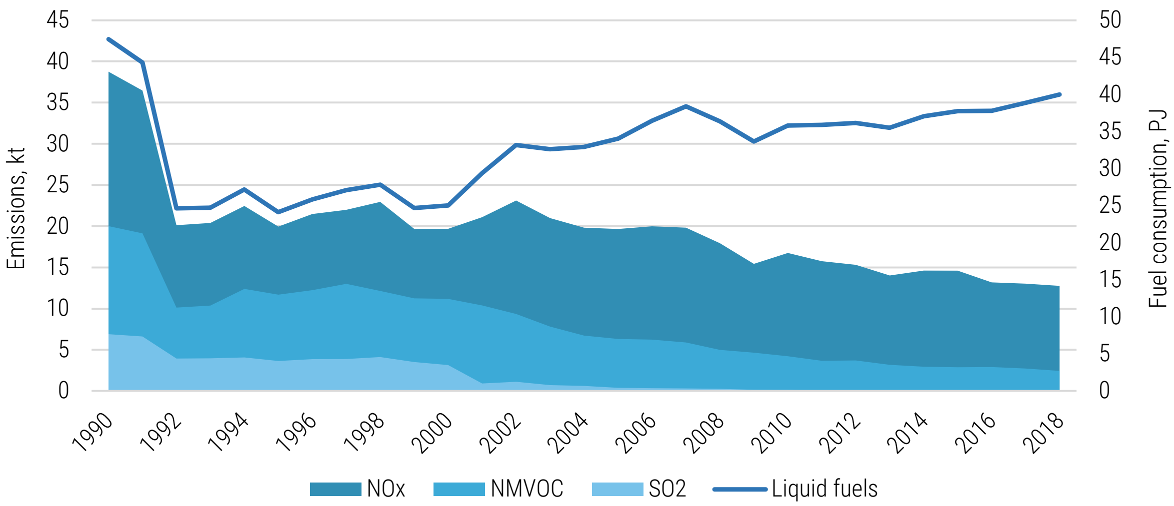

Figure 3.29 NO_x, NMVOC and CO emissions from the transport sector in the period of 1990-2018

Table 3.36 Total emissions from the transport sector in the period of 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	38.754	20.009	6.891	0.018	NR	NR	1.714	NR	149.186
1995	19.952	11.689	3.639	0.026	NR	NR	0.997	NR	66.346
2000	19.682	11.176	3.144	0.096	0.882	0.972	1.080	0.459	71.894
2005	19.660	6.314	0.381	0.199	0.927	1.042	1.180	0.515	44.308
2006	19.988	6.233	0.335	0.231	0.920	1.045	1.194	0.517	43.417
2007	19.822	5.887	0.309	0.246	0.914	1.045	1.202	0.516	40.719
2008	17.934	4.988	0.262	0.244	0.809	0.936	1.085	0.452	33.859
2009	15.427	4.649	0.139	0.220	0.719	0.835	0.973	0.410	31.374
2010	16.750	4.215	0.128	0.203	0.773	0.894	1.040	0.450	28.583
2011	15.751	3.666	0.066	0.195	0.743	0.868	1.018	0.432	24.169
2012	15.312	3.704	0.032	0.183	0.744	0.870	1.022	0.436	23.673
2013	14.015	3.173	0.029	0.158	0.682	0.805	0.953	0.401	19.726
2014	14.613	2.943	0.032	0.149	0.726	0.851	1.001	0.421	18.607
2015	14.602	2.877	0.034	0.150	0.733	0.861	1.015	0.424	18.293
2016	13.180	2.905	0.032	0.147	0.673	0.804	0.961	0.384	21.418
2017	13.027	2.731	0.036	0.145	0.667	0.802	0.965	0.377	20.442
2018	12.755	2.443	0.033	0.137	0.684	0.823	0.990	0.389	15.549
Trend 1990-2018, %	-67.1	-87.8	-99.5	654.6	-22.5	-15.3	-42.3	-15.2	-89.6

Table 3.36 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
		t		kg			t		
1990	78.074	0.011	0.007	1.357	0.145	3.672	0.099	0.013	1.719
1995	24.412	0.005	0.004	0.528	0.080	1.990	0.048	0.006	0.924
2000	4.983	0.005	0.004	0.484	0.084	2.115	0.051	0.007	0.971
2005	2.129	0.008	0.005	0.608	0.112	2.827	0.070	0.009	1.336
2006	1.467	0.008	0.005	0.654	0.121	3.066	0.077	0.010	1.452
2007	1.541	0.009	0.005	0.900	0.128	3.231	0.086	0.011	1.534
2008	1.520	0.008	0.006	1.107	0.123	3.104	0.088	0.011	1.463
2009	1.395	0.008	0.005	0.608	0.114	2.877	0.073	0.010	1.358
2010	0.286	0.008	0.005	0.577	0.119	3.004	0.074	0.010	1.410
2011	0.289	0.008	0.005	0.388	0.122	3.077	0.070	0.010	1.433
2012	0.297	0.008	0.005	0.369	0.124	3.131	0.071	0.010	1.460
2013	0.284	0.008	0.005	0.334	0.121	3.058	0.068	0.009	1.428
2014	0.263	0.009	0.005	0.393	0.125	3.175	0.073	0.010	1.493
2015	0.267	0.009	0.005	0.401	0.129	3.279	0.076	0.010	1.546
2016	0.296	0.009	0.005	0.397	0.131	3.336	0.076	0.010	1.574
2017	0.307	0.009	0.005	0.438	0.136	3.463	0.080	0.011	1.637
2018	0.287	0.010	0.005	0.352	0.141	3.585	0.080	0.011	1.696
Trend 1990-2018, %	-99.6	-8.8	-26.3	-74.1	-2.8	-2.4	-18.5	-14.4	-1.4

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	0.355	0.022	0.040	0.017	0.012	0.091	1.701	20.983
1995	0.222	0.009	0.016	0.010	0.007	0.041	0.705	6.932
2000	0.223	0.007	0.014	0.009	0.006	0.036	0.881	1.401
2005	0.312	0.011	0.019	0.012	0.008	0.050	1.227	0.521
2006	0.345	0.012	0.020	0.013	0.009	0.054	1.345	0.562
2007	0.367	0.012	0.021	0.013	0.009	0.056	1.851	0.794
2008	0.335	0.011	0.019	0.012	0.009	0.051	2.251	0.991
2009	0.317	0.011	0.018	0.012	0.008	0.049	1.388	0.580
2010	0.323	0.012	0.021	0.013	0.009	0.055	1.217	0.495

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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	
2011	0.332	0.012	0.021	0.014	0.009	0.056	0.856	0.321
2012	0.328	0.013	0.022	0.014	0.009	0.058	0.817	0.301
2013	0.312	0.013	0.021	0.014	0.010	0.057	0.740	0.268
2014	0.298	0.014	0.023	0.014	0.010	0.060	0.841	0.324
2015	0.310	0.015	0.023	0.014	0.010	0.063	0.865	0.331
2016	0.294	0.015	0.022	0.014	0.011	0.062	0.831	0.324
2017	0.280	0.015	0.023	0.014	0.011	0.063	0.895	0.361
2018	0.269	0.016	0.024	0.014	0.011	0.065	0.708	0.279
Trend 1990-2018, %	-24.2	-29.8	-41.3	-15.9	-4.9	-29.0	-58.4	-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 2018 was 0.7%, 0.7%, and 1.3% 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 1990–2018, the emission of NO_x, NMVOC, and CO from the LTO phase increased by 78.3%, 34.9%, and 61.6% respectively (see Figure 3.30 and Table 3.37), mainly due to changes in fuel consumption, which increased by 68.2% (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 2018, NO_x and SO_2 emissions increased by 4.7% and 4.3% respectively compared to 2017. At the same time, the emissions of NMVOC, CO and TSP decreased by 1.1%, 0.7% and 2.0% respectively. A decrease in some pollutant emissions took place within the context of the amount of fuel consumed, passenger traffic volumes, the number of passengers and landing and take-off operations increasing by 4.1%, 17.8%, 11.2%, and 5.2% respectively. Therefore, the increase in emissions occurred due to higher fuel consumption in 2018. The decrease in NMVOC, CO and TSP emissions has mainly been caused by the fact that the share of different aircraft types varies and therefore the average emission factor (see Table 3.39) changes from year to year in the LTO phase in the aviation sector.

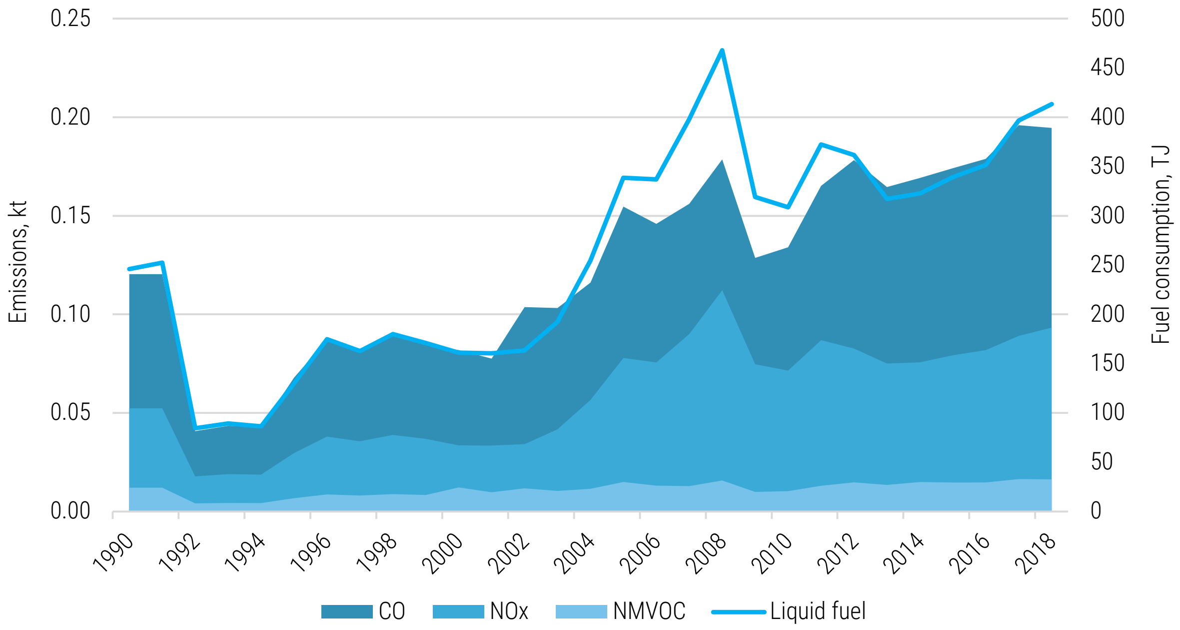

Figure 3.30 NO_x, NMVOC and CO emissions from the LTO cycle in aviation sector in the period of 1990-2018

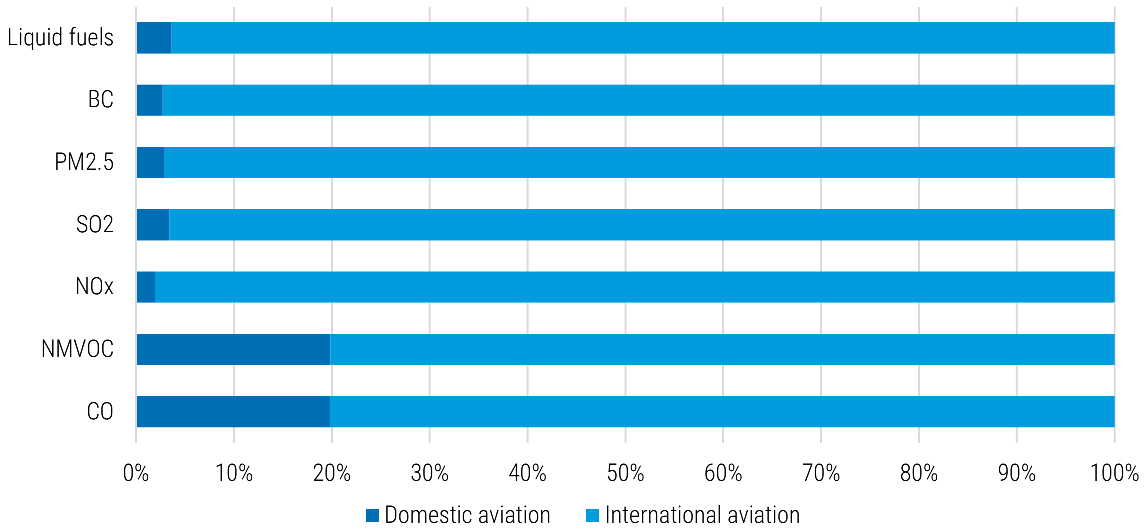

Figure 3.31 The share of pollutant emissions from the LTO cycle in aviation sector in 2018

Table 3.37 Emissions from the LTO cycle in the aviation sector in the period of 1990–2018

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	0.151	0.082
2005	0.078	0.015	0.008	0.652	0.652	0.652	0.312	0.155
2006	0.076	0.013	0.008	0.643	0.643	0.643	0.308	0.146
2007	0.090	0.013	0.009	0.780	0.780	0.780	0.373	0.156
2008	0.112	0.016	0.010	0.941	0.941	0.941	0.452	0.175
2009	0.075	0.010	0.007	0.603	0.603	0.603	0.289	0.129
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	0.306	0.165
2012	0.083	0.015	0.008	0.466	0.466	0.466	0.222	0.178
2013	0.075	0.013	0.007	0.463	0.463	0.463	0.222	0.165

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
		kt			t			kt
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
Trend 1990-2018, %	78.3	34.9	68.1	74.9	74.9	40.0	75.0	62.0

Table 3.38 Emissions from the cruise phase in the aviation sector in the period of 1990–2018 (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
2006	0.523	0.020	0.041	0.008	0.008	0.008	0.004	0.046
2007	0.636	0.024	0.050	0.010	0.010	0.010	0.005	0.056
2008	0.722	0.028	0.057	0.011	0.011	0.011	0.005	0.064
2009	0.373	0.014	0.029	0.006	0.006	0.006	0.003	0.033
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
Trend 1990-2018, %	96.7	100.8	95.4	236.6	236.6	95.4	5.2	90.3

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 2013 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 2017. Extrapolation has been done for 1990 and 1991.

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

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

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
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
2006	13.500	51.983	323.501	1,716.742	2,105.7
2007	12.510	60.352	385.527	2,089.154	2,547.5
2008	13.953	65.502	454.071	2,374.085	2,907.6
2009	12.214	32.197	306.777	1,228.779	1,580.0
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
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

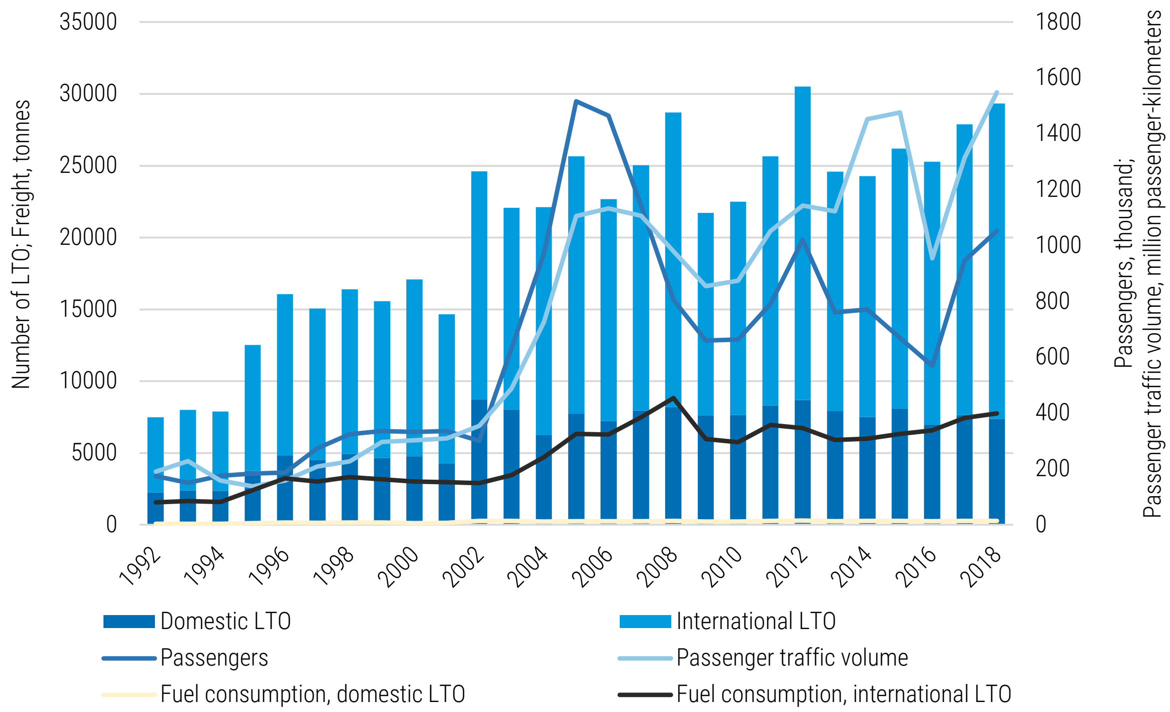

Figure 3.32 The number of LTO cycles, passengers carried and freight transported

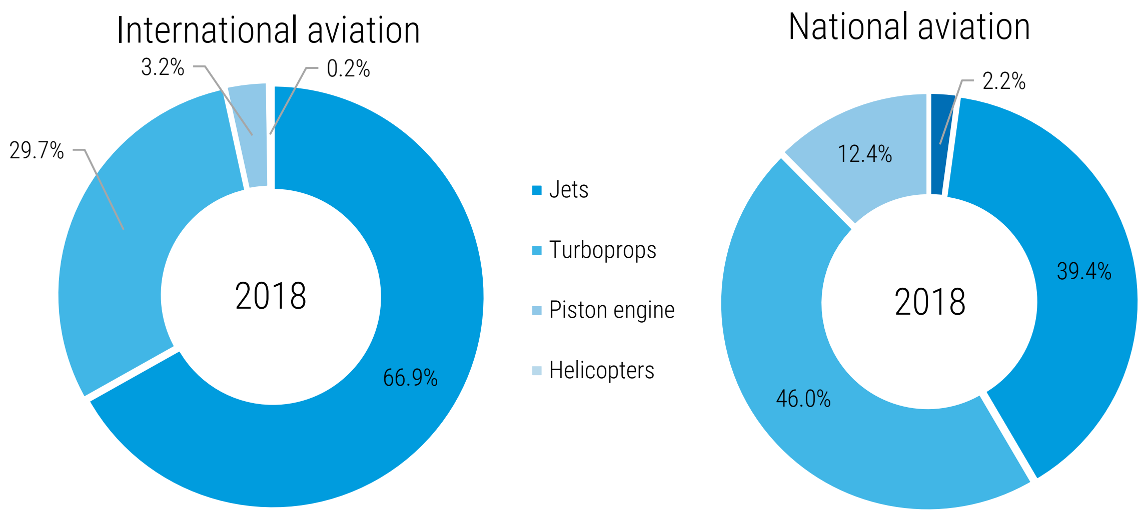

Figure 3.33 The share of different aircraft types in domestic and international civil aviation

3.3.2.3. Uncertainty

An uncertainty analysis was carried out for the 2017 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, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	0.089041	kt	0.268	0.079	0.025
NMVOC	0.016403	kt	0.074	0.018	0.005
SO_x	0.008895	kt	0.023	0.007	0.001
$PM_{2.5}$	0.000560	kt	0.006	0.002	0.001
PM_{10}	0.000560	kt	0.004	0.001	0.0004
TSP	0.000560	kt	0.003	0.001	0.0001
CO	0.195948	kt	0.142	0.035	0.014

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 2018, road transport contributed to the total national emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide by 22.5%, 6.5%, and 10.8% respectively, and in the transport sector, 56.6%, 56.6%, and 70.0% 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 0.8% in 2018.

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 99.7% between 1990 and 2018.

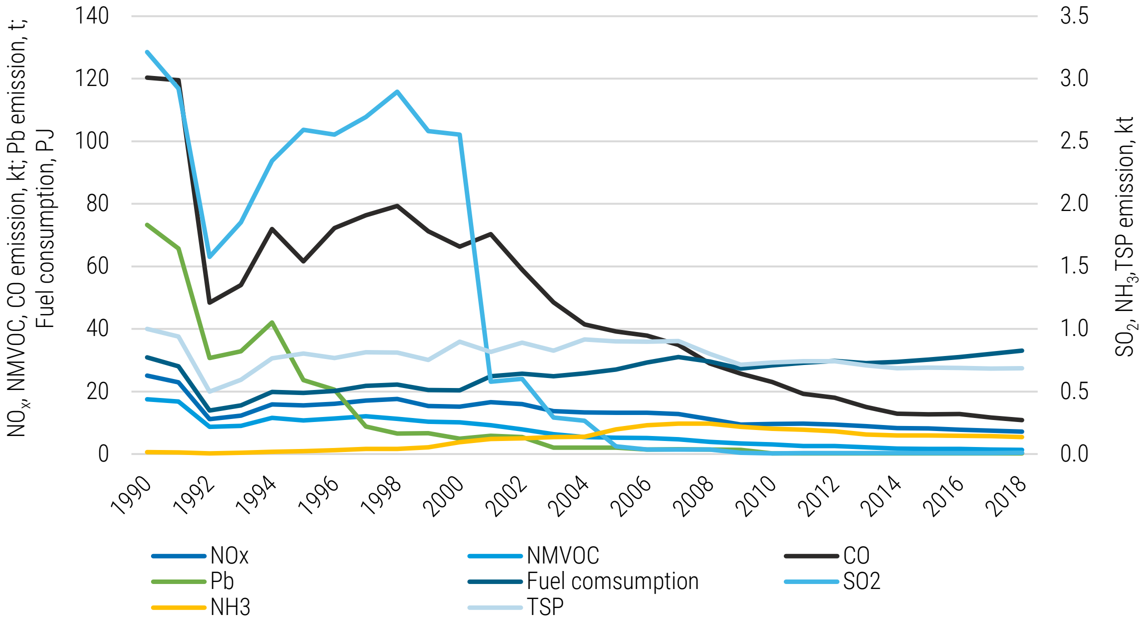

Figure 3.34 Fuel consumption and pollutant emissions from road transport in the period 1990-2018

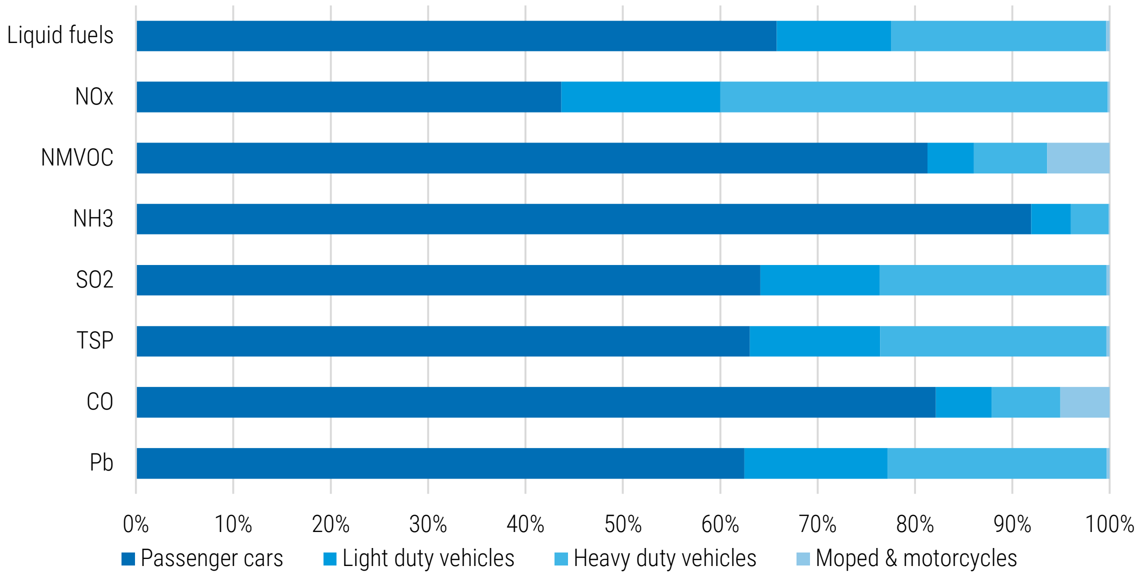

Figure 3.35 The share of pollutant emissions in the road transport sector in 2018

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 95% and 92% respectively between 1990 and 2018. 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 sixteen 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, NH3 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 44.3% in 2018 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 2018.

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 48.5% decrease in petrol consumption during the period of 1990–2018 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 2.2% in 2018 (see Table 3.49).

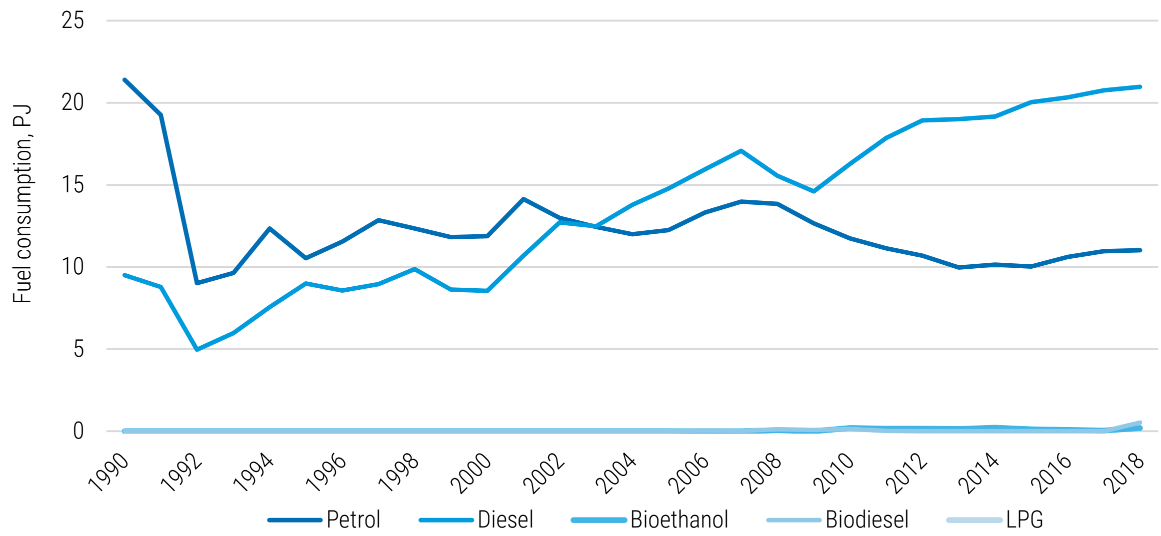

Figure 3.36 Fuel consumption in the road transport sector

TSP exhaust emissions from road transport vehicles have decreased by 59.9% during the 1990-2018 period. In 2018, petrol and diesel vehicles contributed 2.9% and 96.9% 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 28.3% between 1990 and 2018 (1.2 thousand tonnes to 1.5 thousand tonnes) which is directly linked with the change in annual mileage driven by the vehicles (an increase of 27.1%) 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 83.9% of Cd, 21.8% of Cr, 35.3% of Cu, 74.7% of Ni, 75.4% of Se, 44.1% of Zn, and only 0.02% of Pb across the entire total road transport sector in 2018.

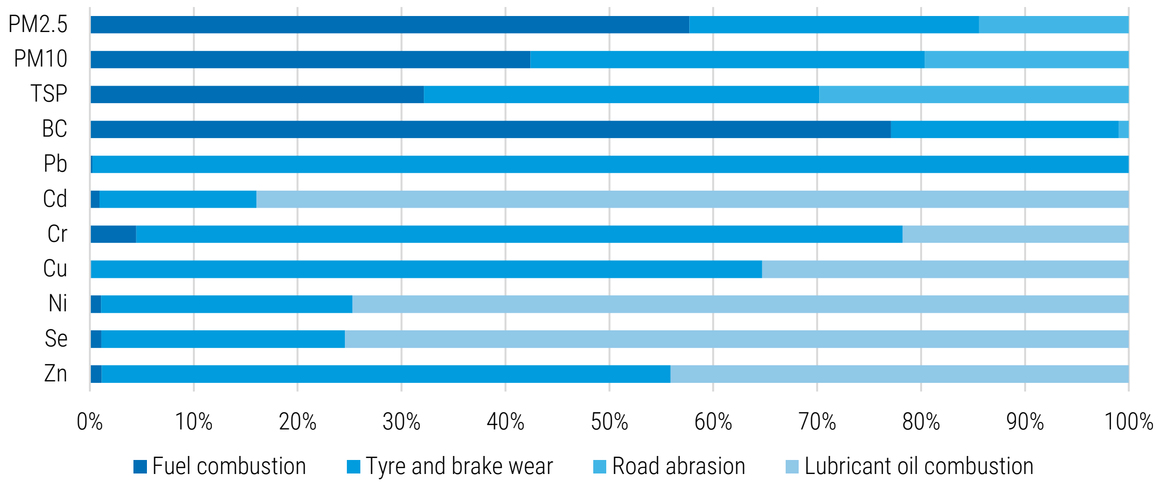

Figure 3.37 The share of different sources in pollutant emissions in 2018

The emission trend in recent years has been impacted by the improved fuel efficiency and minimised emissions of new vehicles. In 2018, statistics showed that the number of vehicles stayed at the same level as in 2017. Instead, the total mileage driven by vehicles and the amount of fuel consumed increased by 4.0% and 3.1% respectively. Although there has been an increase in activity data, the main pollutant emissions from road transport decreased compared to 2017: nitrogen oxides emissions by 3.9%, non-methane volatile organic compounds by 5.4%, and carbon monoxide by 6.9%.

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: 43.7% of NO_x, 81.4% of NMVOC, 64.2% of SO_2, 92.0% of NH_3, 63.2% of $PM_{2.5}$, 63.1% of PM_{10}, 63.1% of TSP, 64.8% of BC, 82.2% of CO in 2018.

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 582 thousand between 1990 and 2018. Cars with petrol engines make up a majority of registered passenger cars – 88% in 1990 and 55% in 2018 (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 4,262 million km) and annual mileage per petrol cars decreased by 25% (5,122 to 3,818 million km). Overall fuel consumption in this subsector increased by 38% between 1990 and 2018. In detail, fuel consumed by diesel cars increased approximately ten times and petrol fuel amount decreased by 27% during the same period.

During the period of 1990–2018, the pollutant emissions decreased significantly: 71.3% of NO_x, 91.4% of NMVOC, 99.7% 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 2018.

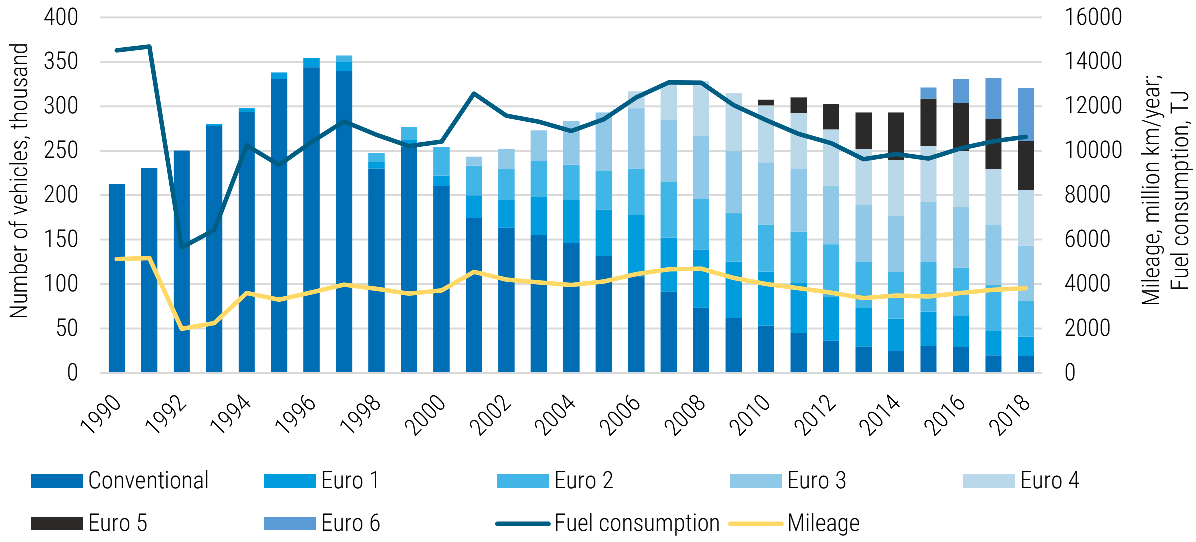

Figure 3.38 Petrol passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

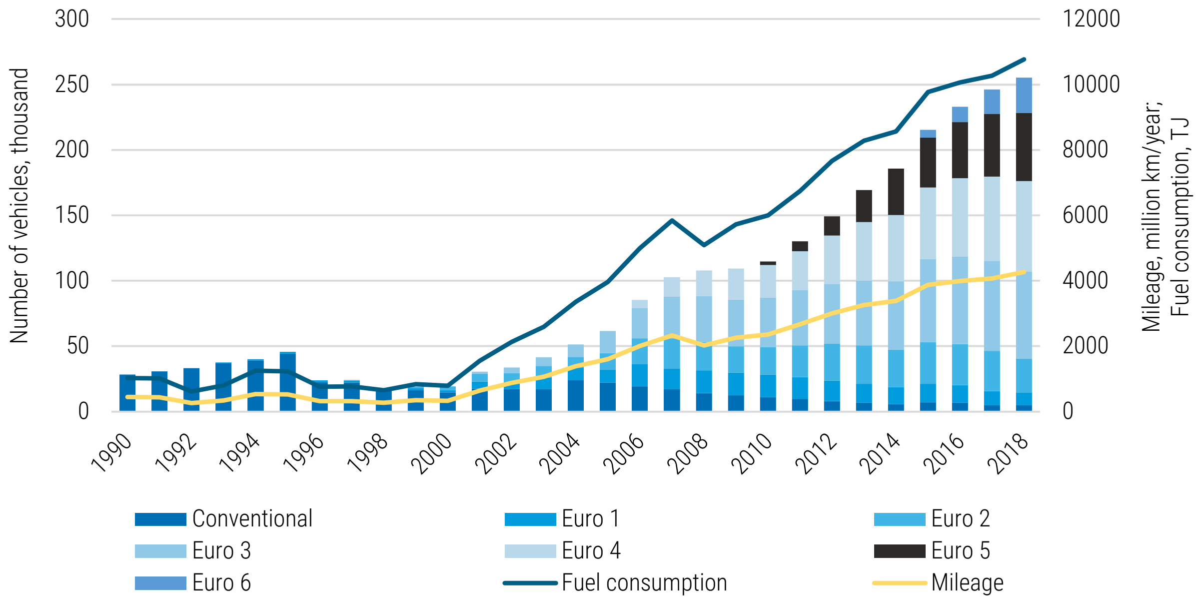

Figure 3.39 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

Light duty vehicles (1A3bii)

Light commercial vehicles contributed about 16.4% of NO_x, 4.7% of NMVOC, 12.2% of SO_2, 4.0% of NH_3, 14.2% of $PM_{2.5}$, 13.90% of PM_{10}, 13.4% of TSP, 15.4% of BC and 5.7% of CO in the total road transport sector in 2018.

The light commercial vehicle fleet has grown over the last decades from 31 thousand vehicles to 67 thousand between 1990 and 2018. 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 59 thousand vehicles in 2018 (see Figure 3.41). The petrol light duty vehicle fleet decreased by 35% 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 80% and 62% respectively in this subsector. As expected, annual mileage driven by petrol vehicles declined by 64% and the total annual kilometres driven by diesel vehicles increased more than three times. In addition, petrol fuel consumption decreased by 65% and diesel fuel consumption increased almost three times in this subsector during the same period.

The pollutant emissions decreased significantly: 25.0 of NO_x, 93.3% of NMVOC, 99.6% of SO_2, 47.3% of TSP and 93.0% of CO, although all the activity data increased in the period of 1990–2018. 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.

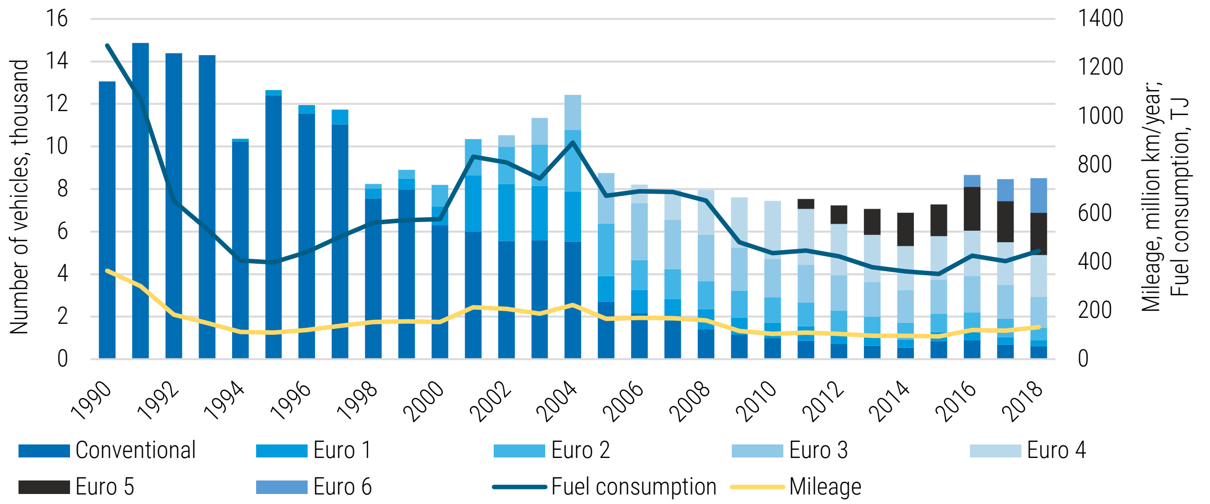

Figure 3.40 Petrol light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

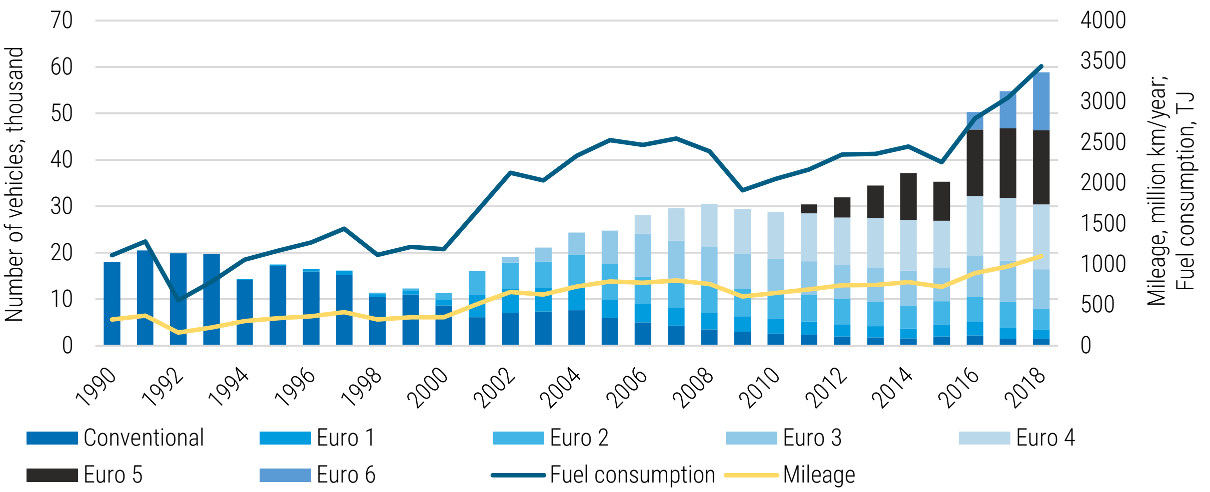

Figure 3.41 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

Heavy duty vehicles and buses (1A3biii)

Heavy duty vehicles contributed about 39.7% of NO_x, 7.5% of NMVOC, 23.3% of SO_2, 3.9% of NH_3, 22.2% $PM_{2.5}$, 22.7% of PM_{10}, 23.3% of TSP, 19.7% of BC and 7.1% of CO in the total road transport sector in 2018.

The heavy duty vehicle fleet has declined over the last decades from 45 thousand vehicles to 29 thousand between 1990 and 2018. Heavy duty vehicles with diesel engines make up the majority of registered vehicles – 60% in 1990 and 95% in 2018. The number of petrol vehicles has declined by 92% and the number of diesel vehicles increased by 1%. Total annual mileage and fuel consumption decreased by 48% and 41% respectively during this period. In detail, mileage driven by diesel vehicles increased by 2% and fuel consumed decreased approximately 1% (see Figure 3.43). However, the same indicators for petrol powered heavy duty vehicles decreased by 99.6% and 99.5% (see Figure 3.42).

During the period of 1990–2018, the pollutant emissions decreased significantly: 72.5% of NOx, 96.4% of NMVOC, 99.9% of SO_2, 67.3% of TSP and 81.2% of CO, although all the activity data increased in the same time. Therefore, the main pollutant emissions from heavy duty vehicles have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicle categories.

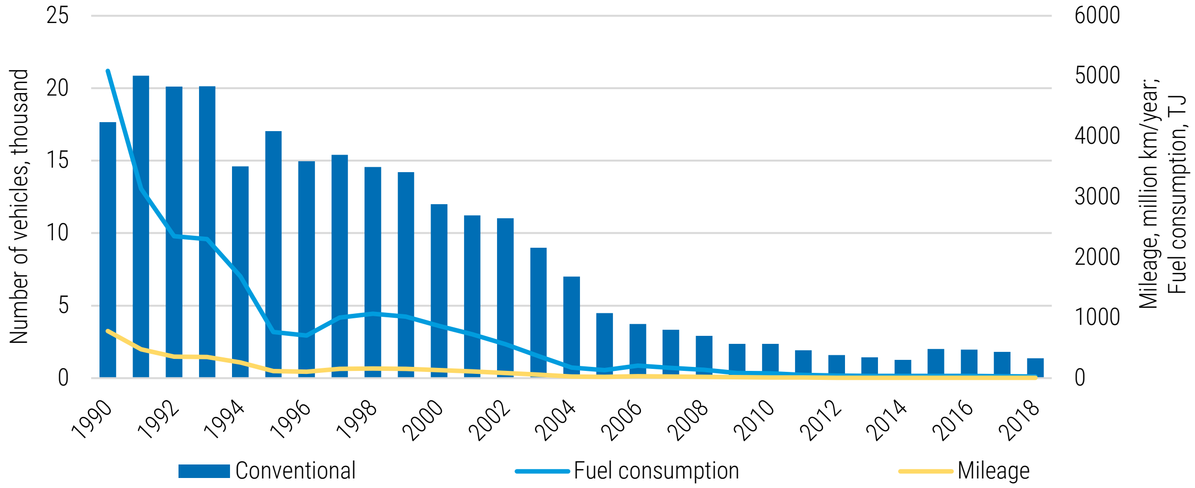

Figure 3.42 Petrol heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

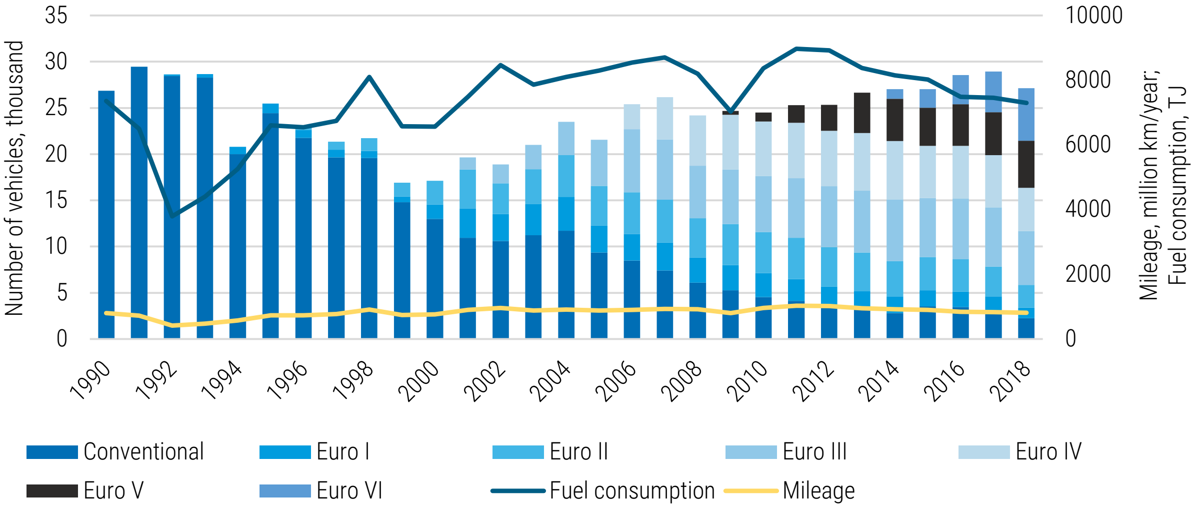

Figure 3.43 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

Motorcycles and mopeds (1A3biv)

This subsector contributes only a marginal share of the total road transport sector emissions: 0.2% of NO_x, 6.4% of NMVOC, 0.3% of SO_2, 0.1% of NH_3, 0.4% $PM_{2.5}$, 0.3% of PM10, 0.3% of TSP, 0.1% of BC and 5.1% of CO in 2018.

The number of motorcycles, annual mileage, and fuel consumption decreased by 64.5%, 75.1%, and 77.1% respectively between 1990 and 2018 (see Figure 3.44). During this period, NO_x emissions decreased by 87.0%, NMVOC emissions by 84.6%, SO_2 emissions by 99.9%, and CO emissions by 91.4%.

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.

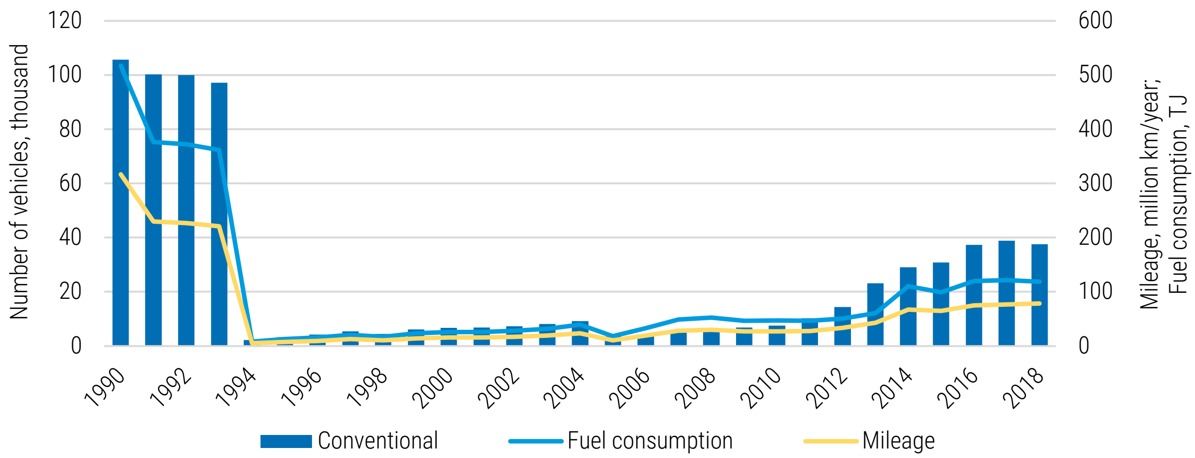

Figure 3.44 Motorcycles and mopeds: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2018

Recalculations

All the emissions from road transport have been recalculated for the period 1990-2017. 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 5.3.0) 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 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
1990	25.102	17.493	3.213	0.015	NR	NR	1.001	NR	120.377
1995	15.596	10.777	2.591	0.025	NR	NR	0.803	NR	61.594
2000	15.132	10.152	2.553	0.095	0.709	0.795	0.899	0.362	66.293
2005	13.200	5.257	0.063	0.198	0.656	0.767	0.901	0.359	39.219
2006	13.186	5.127	0.036	0.230	0.634	0.754	0.899	0.352	37.931
2007	12.798	4.767	0.037	0.245	0.623	0.749	0.903	0.350	34.898
2008	11.182	3.927	0.036	0.243	0.533	0.655	0.802	0.298	28.983
2009	9.465	3.441	0.012	0.219	0.466	0.578	0.714	0.268	25.681
2010	9.654	3.084	0.006	0.202	0.473	0.590	0.732	0.276	23.063
2011	9.772	2.602	0.008	0.194	0.472	0.594	0.742	0.276	19.282
2012	9.448	2.535	0.009	0.182	0.469	0.593	0.743	0.278	18.050
2013	8.882	2.213	0.008	0.157	0.442	0.563	0.709	0.263	15.109
2014	8.360	1.739	0.008	0.148	0.414	0.537	0.685	0.243	12.868
2015	8.244	1.663	0.009	0.149	0.412	0.538	0.690	0.241	12.725
2016	7.852	1.635	0.008	0.146	0.403	0.533	0.688	0.233	12.810
2017	7.506	1.460	0.009	0.144	0.389	0.523	0.684	0.219	11.697
2018	7.215	1.381	0.010	0.136	0.382	0.520	0.686	0.214	10.890
Trend 1990-2018, %	-71.3	-92.1	-99.7	780.5	-46.1	-34.6	-31.4	-40.9	-91.0

Table 3.43 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t			kg	t				
1990	73.240	0.007	0.005	0.168	0.124	3.035	0.054	0.007	1.310
1995	23.654	0.004	0.003	0.093	0.074	1.817	0.034	0.005	0.810
2000	4.900	0.004	0.003	0.102	0.079	1.947	0.036	0.005	0.864
2005	2.104	0.006	0.004	0.120	0.104	2.576	0.048	0.007	1.180
2006	1.439	0.007	0.005	0.129	0.113	2.801	0.053	0.007	1.287
2007	1.511	0.007	0.005	0.136	0.120	2.967	0.056	0.008	1.365
2008	1.495	0.007	0.005	0.134	0.116	2.862	0.054	0.008	1.304
2009	1.363	0.006	0.004	0.121	0.106	2.647	0.051	0.007	1.213
2010	0.259	0.006	0.004	0.120	0.110	2.725	0.051	0.007	1.238
2011	0.266	0.007	0.004	0.117	0.114	2.827	0.053	0.007	1.282
2012	0.268	0.007	0.005	0.118	0.116	2.881	0.054	0.008	1.309
2013	0.261	0.007	0.004	0.114	0.115	2.840	0.054	0.008	1.295
2014	0.235	0.007	0.004	0.116	0.117	2.898	0.055	0.008	1.325
2015	0.241	0.007	0.005	0.116	0.120	2.996	0.057	0.008	1.375
2016	0.248	0.008	0.005	0.121	0.124	3.095	0.060	0.008	1.427
2017	0.258	0.008	0.005	0.124	0.129	3.215	0.062	0.009	1.486
2018	0.266	0.008	0.005	0.127	0.133	3.328	0.064	0.009	1.541
Trend 1990-2018, %	-99.6	23.3	-9.4	-24.4	7.3	9.6	19.9	23.4	17.7

Table 3.43 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	g I-Teq	t					g	
1990	0.329	0.006	0.015	0.013	0.009	0.043	0.201	0.075
1995	0.213	0.004	0.009	0.007	0.006	0.026	0.123	0.038
2000	0.221	0.004	0.009	0.008	0.006	0.026	0.160	0.042
2005	0.311	0.007	0.012	0.010	0.008	0.037	0.252	0.057
2006	0.343	0.007	0.013	0.011	0.009	0.040	0.295	0.063
2007	0.364	0.008	0.014	0.012	0.009	0.043	0.323	0.067
2008	0.332	0.007	0.013	0.011	0.008	0.040	0.303	0.065
2009	0.315	0.007	0.012	0.010	0.008	0.038	0.295	0.060
2010	0.321	0.008	0.013	0.012	0.008	0.040	0.304	0.061
2011	0.331	0.008	0.014	0.012	0.009	0.043	0.314	0.062
2012	0.327	0.009	0.014	0.013	0.009	0.045	0.312	0.062
2013	0.312	0.009	0.014	0.013	0.009	0.046	0.297	0.059
2014	0.298	0.009	0.015	0.013	0.010	0.046	0.285	0.060
2015	0.309	0.010	0.015	0.014	0.010	0.049	0.298	0.062
2016	0.293	0.011	0.016	0.014	0.011	0.050	0.281	0.062
2017	0.279	0.011	0.016	0.014	0.011	0.051	0.269	0.064
2018	0.268	0.011	0.016	0.014	0.011	0.053	0.259	0.064
Trend 1990-2018, %	-18.3	100.6	6.4	11.5	20.3	23.2	28.5	-14.4

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 5.3.0), 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

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	5,564.6	684.6	1,578.0	316.6	8,143.8
1995	3,813.6	445.3	841.8	7.6	5,108.3
2000	4,044.6	501.1	894.7	15.6	5,456.0
2005	5,726.3	954.0	895.8	10.6	7,586.6
2006	6,453.5	946.0	933.9	19.3	8,352.6
2007	6,984.7	971.4	952.2	28.2	8,936.6
2008	6,723.3	918.6	938.1	30.1	8,610.0
2009	6,537.6	720.6	809.0	26.9	8,094.0
2010	6,360.5	752.5	967.3	26.8	8,107.1
2011	6,487.5	800.2	1,034.5	27.5	8,349.6
2012	6,623.1	847.4	1,027.2	33.4	8,531.1
2013	6,633.0	843.6	953.7	43.1	8,473.3
2014	6,873.9	877.2	924.9	67.2	8,743.2
2015	7,327.7	817.0	909.5	64.8	9,119.0
2016	7,594.1	1,012.8	845.9	75.0	9,527.7
2017	7,947.1	1,091.9	839.9	76.4	9,955.4
2018	8,229.0	1,231.2	815.7	78.5	10,354.5

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
2006	402.1	36.3	29.1	4.2	471.7
2007	429.2	37.5	29.5	5.8	502.0
2008	436.3	38.5	27.1	6.1	507.9
2009	424.0	36.9	27.0	6.9	494.8
2010	422.1	36.3	26.9	7.5	492.8
2011	440.2	37.9	27.2	10.2	515.5
2012	452.2	39.1	26.9	14.3	532.6
2013	462.2	41.5	28.1	23.1	554.9
2014	478.6	44.1	28.3	29.1	580.0
2015	536.5	42.5	29.0	30.8	639.0
2016	563.8	58.9	30.5	37.3	690.5
2017	584.0	63.2	30.8	38.8	716.8
2018	582.1	67.3	28.5	37.5	715.4

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

Year	Petrol	Diesel	Bioethanol	Biodiesel	LPG	Total
1990	21,406.3	9,499.9	-	-	-	30,906.2
1995	10,527.3	8,999.8	-	-	-	19,527.1
2000	11,872.0	8,539.9	-	-	-	20,411.9
2005	12,248.7	14,780.8	0.0	6.5	-	27,036.0
2006	13,322.7	15,959.2	0.0	46.9	-	29,328.8
2007	13,977.2	17,073.1	0.5	21.6	-	31,072.5
2008	13,845.1	15,560.6	58.1	120.4	-	29,584.2
2009	12,661.0	14,598.0	4.0	69.7	-	27,332.7
2010	11,744.8	16,283.5	185.2	136.4	-	28,349.8
2011	11,143.6	17,849.3	160.0	27.5	-	29,180.4
2012	10,695.0	18,934.9	151.9	0.0	-	29,781.8
2013	9,967.3	19,017.0	128.9	0.0	-	29,113.2
2014	10,144.9	19,157.1	215.4	0.0	-	29,517.5
2015	10,033.0	20,042.6	107.8	0.0	-	30,183.4
2016	10,604.8	20,337.4	84.7	0.0	-	31,026.9
2017	10,971.6	20,767.6	39.7	6.5	306.5	32,091.8
2018	11,028.6	20,969.1	204.4	526.3	369.4	33,097.7

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, BC emissions from the road abrasion, 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 (see Table 3.50).

Table 3.50 BC fractions of TSP for road abrasion, tyre and brake wear

Transport Category	f-BC		
	Road abrasion	Road tyre wear	Road brake wear
Passenger cars	0.0106	0.153	0.0261
Light duty vehicles	0.0106	0.153	0.0261
Heavy duty vehicles	0.0106	0.153	0.0261
Motorcycles	0.0106	0.153	0.0261

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 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 2017 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%, 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, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	7.509	kt	26.62	2.83	0.67
NMVOC	1.465	kt	6.59	0.93	0.87
SO_x	0.009	kt	0.02	0.003	0.02
NH_3	0.144	kt	1.40	0.26	0.12
$PM_{2.5}$	0.389	kt	4.22	0.43	0.24
PM_{10}	0.523	kt	3.76	0.39	0.13
TSP	0.685	kt	3.47	0.37	0.02
CO	11.770	kt	8.51	1.43	4.18
Pb	0.258	t	0.76	0.23	0.85
Cd	0.008	t	0.98	0.14	0.02
Hg	0.005	t	0.81	0.12	0.03
PCDD/F	0.279	g I-TEQ	6.47	12.59	3.52
B(a)p	0.011	t	0.48	0.75	0.45
B(b)f	0.016	t	0.60	0.80	0.41
B(k)f	0.014	t	1.08	1.39	0.81
I(1,2,3-cd)p	0.011	t	0.69	1.05	0.31
HCB	0.0003	kg	0.09	0.17	0.06
PCBs	0.0001	kg	0.001	0.001	0.0004

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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 3.3%, 1.5% and 0.6% respectively (see Figure 3.28), in the transport sector in 2018. The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 82.8%, 83.4 and 85.8% respectively. The trend of all the emissions is given in Table 3.53. During the same period, fuel consumption decreased 83.7%.

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 2018, despite the increasing trend in the volume of goods carried and freight turnover figures, the emissions decrease in the railway sector. Liquid fuel consumption decreased by 50.1% in 2018 when compared to 2017, 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 48.7% during that period (see Figure 3.45).

Recalculations

SO_x emissions have been recalculated for the period 2012-2014. An overview of the updated data is given in Chapter 8.

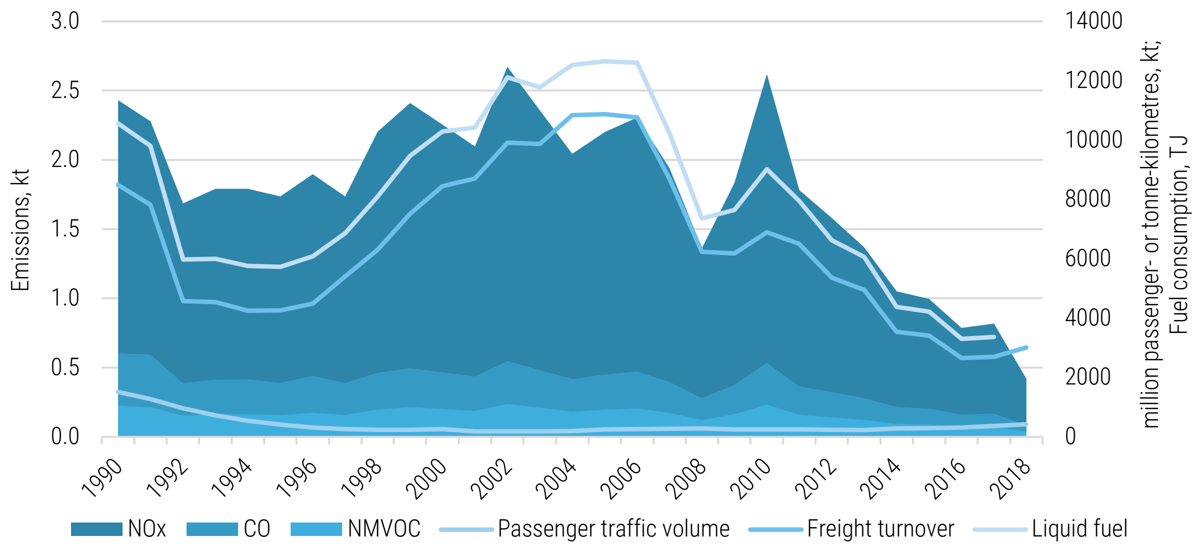

Figure 3.45 NO_x, NMVOC and CO emissions from the railway sector

Table 3.53 Emissions from railway transport in the period of 1990-2018

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
2006	2.306	0.205	0.168	0.308	0.060	0.063	0.067	0.039	0.471
2007	1.939	0.172	0.121	0.259	0.051	0.053	0.056	0.033	0.396
2008	1.362	0.121	0.050	0.182	0.036	0.037	0.040	0.023	0.278
2009	1.834	0.163	0.050	0.245	0.048	0.050	0.053	0.031	0.375
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	1.581	0.140	0.001	0.211	0.041	0.043	0.046	0.027	0.323
2013	1.368	0.121	0.001	0.183	0.036	0.038	0.040	0.023	0.279
2014	1.050	0.093	0.000	0.140	0.027	0.029	0.030	0.018	0.215
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	0.419	0.037	0.000	0.056	0.011	0.012	0.012	0.007	0.086
Trend 1990-2018, %	-82.8	-83.4	-100.0	-82.6	-81.6	-81.6	-85.6	-81.4	-85.8

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
2006	NE	0.440	NE	NE	0.002	0.075	0.003	0.440	0.044
2007	NE	0.370	NE	NE	0.002	0.063	0.003	0.370	0.037
2008	NE	0.260	NE	NE	0.001	0.044	0.002	0.260	0.026
2009	NE	0.350	NE	NE	0.002	0.060	0.002	0.350	0.035
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	0.302	NE	NE	0.002	0.051	0.002	0.302	0.030
2013	NE	0.261	NE	NE	0.001	0.044	0.002	0.261	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	0.080	NE	NE	0.000	0.014	0.001	0.080	0.008
Trend 1990-2018, %	-100.0	-88.1	-100.0	-100.0	-89.8	-83.1	-88.3	-88.1	-88.5

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
2006	NE	0.001	0.002	0.002	0.000	0.005	NA	NA
2007	NE	0.001	0.002	0.001	0.000	0.005	NA	NA
2008	NE	0.001	0.001	0.001	0.000	0.003	NA	NA
2009	NE	0.001	0.002	0.001	0.000	0.004	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	0.000	0.000	0.000	0.001	NA	NA
Trend 1990-2018, %	-100.0	-96.5	-95.7	-93.7	-97.5	-95.8	-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 2016 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
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	1,951	1,510.0	6,977
1995	39	0	1,425	408.2	3,851
2000	6	0	1,842	260.5	8,186
2005	0	243	1,531	247.0	10,629
2006	0	95	1,757	255.9	10,504
2007	0	279	1,249	271.7	8,425
2008	0	45	1,076	274.4	5,961
2009	0	415	1,048	249.4	5,934
2010	0	634	1,491	247.9	6,642
2011	0	1,442	0	241.3	6,261
2012	0	1,248	7	235.8	5,126
2013	0	1,105	5	224.9	4,722
2014	0	835	2	281.9	3,256
2015	0	814	0	288.7	3,114
2016	0	645	0	315.7	2,339
2017	0	677	0	366.0	2,325
2018	0	338	0	416.8	2,594

3.3.4.3. Uncertainty

An uncertainty analysis was carried out for the 2017 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 3.66.

3.3.4.4. Source-Specific QA/QC and Verification

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

3.3.4.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

3.3.5. National Navigation (NFR 1A3dii)

3.3.5.1. Source Category Description

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

(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 2018 was: NO_x – 3.1%, NMVOC – 0.6%, 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 28.5% in 2018 compared to 2017, therefore all the emissions decreased also.

Recalculations

In the national navigation sector, main pollutants and particulate matter emissions have been recalculated for the period 1990-2017. The reason for the recalculation was correction of emission factors used for emission calculations. An overview of the updated data is given in Chapter 8.

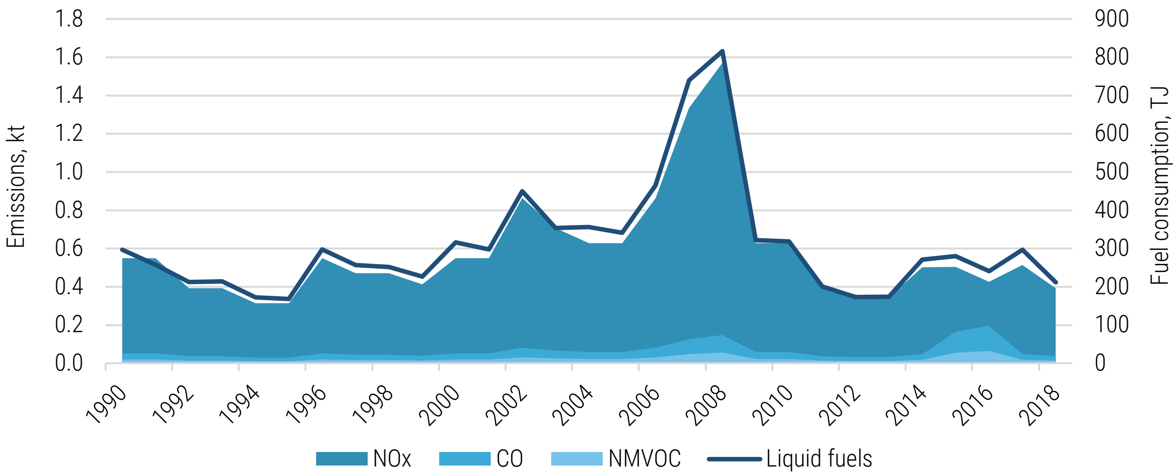

Figure 3.46 NO_x, NMVOC and CO emissions from the national navigation sector

Table 3.57 Emissions from national navigation in the period of 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt			t	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
2006	0.864	0.031	0.044	NE	0.015	0.017	0.017	0.005	0.081
2007	1.335	0.048	0.068	NE	0.024	0.026	0.026	0.008	0.126
2008	1.570	0.056	0.080	NE	0.028	0.030	0.030	0.009	0.148
2009	0.628	0.022	0.032	NE	0.011	0.012	0.012	0.004	0.059
2010	0.628	0.022	0.016	NE	0.011	0.012	0.012	0.004	0.059
2011	0.393	0.014	0.010	NE	0.007	0.008	0.008	0.002	0.037
2012	0.345	0.012	0.009	NE	0.006	0.007	0.007	0.002	0.033
2013	0.347	0.012	0.009	NE	0.006	0.007	0.007	0.002	0.033
2014	0.502	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.047
2015	0.504	0.055	0.013	NE	0.011	0.012	0.012	0.003	0.165
2016	0.426	0.065	0.011	NE	0.010	0.011	0.011	0.003	0.196
2017	0.514	0.018	0.013	NE	0.009	0.010	0.010	0.003	0.048
2018	0.393	0.014	0.010	NE	0.007	0.008	0.008	0.002	0.037
Trend 1990-2018, %	-28.6	-28.6	-85.7	NE	-28.6	-28.6	-28.6	-28.6	-28.6

Table 3.57 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t	kg				t			
1990	0.001	0.070	0.210	0.280	0.350	0.006	0.007	0.001	0.008
1995	0.001	0.040	0.120	0.160	0.200	0.004	0.004	0.000	0.005
2000	0.001	0.070	0.210	0.280	0.350	0.006	0.007	0.001	0.008
2005	0.001	0.080	0.240	0.320	0.400	0.007	0.008	0.001	0.010
2006	0.001	0.110	0.330	0.440	0.550	0.010	0.011	0.001	0.013
2007	0.002	0.170	0.510	0.680	0.850	0.015	0.017	0.002	0.020
2008	0.003	0.200	0.600	0.800	1.000	0.018	0.020	0.002	0.024
2009	0.001	0.080	0.240	0.320	0.400	0.007	0.008	0.001	0.010
2010	0.001	0.080	0.240	0.320	0.400	0.007	0.008	0.001	0.010
2011	0.001	0.050	0.150	0.200	0.250	0.004	0.005	0.001	0.006
2012	0.001	0.044	0.132	0.176	0.220	0.004	0.004	0.000	0.005
2013	0.001	0.044	0.133	0.177	0.221	0.004	0.004	0.000	0.005
2014	0.001	0.064	0.192	0.256	0.320	0.006	0.006	0.001	0.008
2015	0.001	0.064	0.192	0.256	0.320	0.006	0.006	0.001	0.008
2016	0.001	0.054	0.162	0.216	0.270	0.005	0.005	0.001	0.006
2017	0.001	0.065	0.196	0.262	0.327	0.006	0.007	0.001	0.008
2018	0.001	0.050	0.150	0.200	0.250	0.004	0.005	0.001	0.006
Trend 1990-2018, %	-28.6	-28.6	-28.6	-28.6	-28.6	-28.6	-28.6	-28.6	-28.6

Table 3.57 continues

Year	PCDD/F	B(a)p	B(b)f	Total PAHs	HCB	PCBs
	g I-Teq	kg				g
1990	0.001	NE	NE	NE	0.001	0.266
1995	0.001	NE	NE	NE	0.000	0.152
2000	0.001	NE	NE	NE	0.001	0.266
2005	0.001	NE	NE	NE	0.001	0.304
2006	0.001	NE	NE	NE	0.001	0.418
2007	0.002	NE	NE	NE	0.001	0.646
2008	0.003	NE	NE	NE	0.002	0.760
2009	0.001	NE	NE	NE	0.001	0.304
2010	0.001	NE	NE	NE	0.001	0.304
2011	0.001	NE	NE	NE	0.000	0.190
2012	0.001	NE	NE	NE	0.000	0.167

Year	PCDD/F	B(a)p	B(b)f	Total PAHs	HCB	PCBs
	g I-Teq	kg				g
2013	0.001	NE	NE	NE	0.000	0.168
2014	0.001	NE	NE	NE	0.001	0.243
2015	0.001	NE	NE	NE	0.001	0.243
2016	0.001	NE	NE	NE	0.000	0.205
2017	0.001	NE	NE	NE	0.001	0.249
2018	0.001	NE	NE	NE	0.000	0.190
Trend 1990-2018, %	-28.6	NE	NE	NE	-28.6	-28.6

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	0.466	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	0.88	NE
Ni	g/t	1.00	NE
Se	g/t	0.10	NE
Zn	g/t	1.20	NE
PCDD/F	TEQµg /tonne	0.13	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 1990-2018 (TJ)

Year	Marine gas oil	Marine diesel oil	Petrol	Total
1990	0	297	0	297
1995	0	168	0	168
2000	91	225	0	316
2005	106	235	0	341
2006	193	272	0	465
2007	523	217	0	740
2008	537	279	0	816
2009	64	258	0	322
2010	70	249	0	319
2011	0	201	0	201
2012	17	156	0	173
2013	18	156	0	174
2014	17	254	0	271
2015	17	254	9	280
2016	17	211	12	240
2017	0	297	0	297
2018	0	212	0	212

3.3.5.3. Uncertainty

An uncertainty analysis was carried out for the 2017 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 3.66.

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 and all the emission calculations are made by using Tier 1 methodology.

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 36.3%, 40.7% and 27.9% respectively, in the transport sector in 2018.

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 2018, where the emissions of nitrogen oxides, non-methane volatile compounds, sulphur oxide and carbon monoxide have decreased by approximately 56.3%, 56.0%, 99.9% and 84.5% compared to 1990. Also, the amount of fuel consumed decreased by 57.7% 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 2018, fuel consumption increased by approximately 9.3% when compared to 2017's figures. As a result of this, nitrogen oxides emissions increased by 13.0%. In opposition to this, NMVOC, SO_2 and CO emissions decreased by 14.5%, 20.4 and 47.9% respectively. The significant increase in NO_x emissions was due to the increase in diesel consumption in the industrial sector, which was approximately 46.6%

higher compared to 2017 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 85.8% of total energy use in these sectors, with diesel being the dominant fuel type, accounting for 95.3% of the total energy use in 2018.

Recalculations

Recalculations have been carried out for the agricultural and national fishing sector for the period 1990-2002. The reason for the recalculations was the need to subtract the emission estimates of the national fishing sector from the emissions of the agricultural sector for the period 1990–2002. A detailed overview is given in Chapter 8.

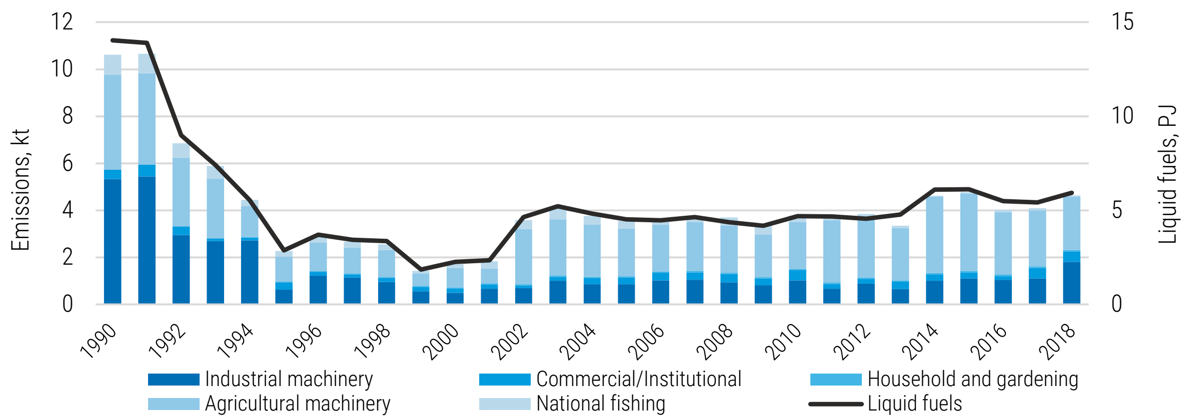

Figure 3.47 NO_x emissions from other non-road machinery

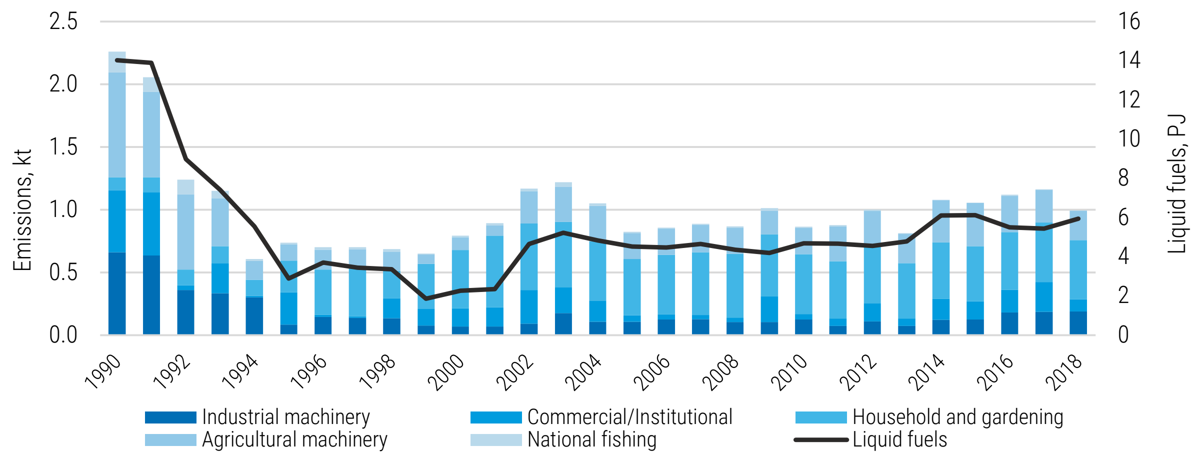

Figure 3.48 NMVOC emissions from other non-road machinery

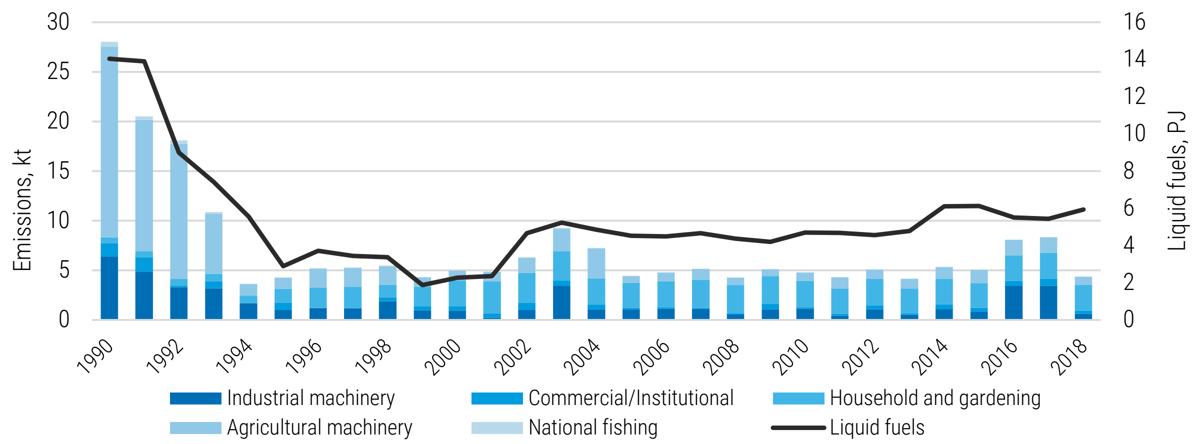

Figure 3.49 CO emissions from other non-road machinery

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Table 3.61 Emissions from other non-road machinery in the period of 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	10.619	2.260	3.036	0.002	NR	NR	0.618	NR	28.034
1995	2.276	0.737	0.640	0.000	NR	NR	0.133	NR	4.265
2000	1.712	0.792	0.382	0.000	0.104	0.104	0.104	0.056	5.001
2005	3.553	0.825	0.111	0.001	0.202	0.202	0.202	0.115	4.426
2006	3.557	0.857	0.079	0.001	0.210	0.210	0.210	0.120	4.789
2007	3.661	0.888	0.074	0.001	0.216	0.216	0.216	0.124	5.143
2008	3.707	0.868	0.086	0.001	0.212	0.212	0.212	0.120	4.272
2009	3.426	1.014	0.038	0.001	0.193	0.194	0.194	0.107	5.130
2010	3.777	0.865	0.028	0.001	0.219	0.220	0.220	0.126	4.792
2011	3.719	0.879	0.040	0.001	0.216	0.216	0.216	0.123	4.321
2012	3.853	1.001	0.006	0.001	0.227	0.227	0.227	0.129	5.090
2013	3.343	0.813	0.004	0.001	0.198	0.198	0.198	0.113	4.140
2014	4.625	1.078	0.004	0.001	0.275	0.275	0.275	0.158	5.308
2015	4.778	1.057	0.004	0.001	0.283	0.283	0.283	0.163	5.026
2016	4.034	1.120	0.005	0.001	0.239	0.239	0.239	0.135	8.073
2017	4.101	1.163	0.005	0.001	0.246	0.246	0.246	0.141	8.333
2018	4.636	0.994	0.004	0.001	0.283	0.283	0.283	0.166	4.342
Trend 1990-2018, %	-56.3	-56.0	-99.9	-54.3	173.5	173.0	-54.1	196.6	-84.5

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	0.551	0.033	0.004	0.3310
1995	0.752	0.001	0.089	0.119	0.003	0.113	0.008	0.001	0.069
2000	0.082	0.001	0.056	0.078	0.003	0.089	0.006	0.001	0.054
2005	0.024	0.001	0.126	0.168	0.005	0.173	0.011	0.001	0.104
2006	0.026	0.001	0.064	0.085	0.005	0.180	0.009	0.001	0.107
2007	0.028	0.001	0.063	0.084	0.006	0.186	0.010	0.001	0.111
2008	0.023	0.001	0.131	0.174	0.005	0.180	0.012	0.001	0.109
2009	0.030	0.001	0.170	0.227	0.005	0.164	0.012	0.001	0.100
2010	0.026	0.001	0.103	0.137	0.006	0.187	0.011	0.001	0.113
2011	0.022	0.001	0.054	0.071	0.006	0.187	0.009	0.001	0.111
2012	0.028	0.001	0.057	0.076	0.006	0.195	0.010	0.001	0.116
2013	0.022	0.001	0.033	0.044	0.005	0.171	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	0.245	0.011	0.002	0.144
2016	0.047	0.001	0.044	0.059	0.006	0.211	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	0.021	0.001	0.019	0.025	0.007	0.239	0.010	0.001	0.141
Trend 1990-2018, %	-99.6	-57.2	-94.2	-94.2	-57.2	-56.6	-68.4	-65.6	-57.4

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	NE	NE	0.025	0.866	0.412
1995	0.387	0.002	0.003	NE	NE	0.005	0.238	0.113
2000	0.255	0.002	0.003	NE	NE	0.004	0.157	0.074
2005	0.546	0.003	0.005	NE	NE	0.008	0.336	0.159
2006	0.277	0.003	0.005	NE	NE	0.008	0.170	0.081
2007	0.273	0.003	0.005	NE	NE	0.009	0.168	0.080
2008	0.566	0.003	0.005	NE	NE	0.008	0.348	0.166
2009	0.736	0.003	0.005	NE	NE	0.007	0.453	0.215
2010	0.445	0.003	0.005	NE	NE	0.009	0.274	0.130
2011	0.232	0.003	0.005	NE	NE	0.009	0.143	0.068
2012	0.248	0.003	0.006	NE	NE	0.009	0.153	0.073

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	
2013	0.144	0.003	0.005	NE	NE	0.008	0.088	0.042
2014	0.071	0.004	0.007	NE	NE	0.011	0.044	0.021
2015	0.090	0.004	0.007	NE	NE	0.011	0.055	0.026
2016	0.192	0.004	0.006	NE	NE	0.010	0.118	0.056
2017	0.166	0.004	0.006	NE	NE	0.010	0.102	0.048
2018	0.082	0.004	0.007	NE	ŃE	0.011	0.050	0.024
Trend 1990-2018, %	**-94.2**	**-56.9**	**-55.3**	**NE**	**NE**	**-55.9**	**-94.2**	**-94.2**

3.3.6.2. Methodological Issues

All the emission calculations are based on the Tier 1 method. Emissions from these transport sectors are calculated by multiplying the statistical fuel consumption (see Table 3.65) 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 3.62.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (see Table 3.65) by emission factors (see Table 3.63). 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 3.64). Equation:

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

Table 3.62 Emission factors for other mobile sources

Pollutant	Unit	1A2gii, 1A4aii, 1A4bii			1A4cii		1A4ciii	
		Diesel/ light fuel oil	Petrol 2-stroke	Petrol 4-stroke	Diesel /light fuel oil	Petrol	Diesel/ light fuel oil	Petrol
NO_x	kg/t	32.629	2.765	7.117	34.457	7.117	78.5	9.4
NMVOC	kg/t	3.377	227.289	18.893	3.542	18.893	2.8	181.5
NH_3	kg/t	0.008	0.003	0.004	0.008	0.004	NE	NE
$PM_{2.5}$	kg/t	2.104	3.762	0.157	1.913	0.157	1.4	9.5
PM_{10}	kg/t	2.104	3.762	0.157	1.913	0.157	1.5	9.5
TSP	kg/t	2.104	3.762	0.157	1.913	0.157	1.5	9.5
BC	kg/t	1.306	0.188	0.008	1.111	0.008	0.434	0.475
CO	kg/t	10.774	620.793	770.368	11.469	770.368	7.4	573.9
Cd	g/t	0.01	0.01	0.01	0.01	0.01	0.01	NE
Hg	g/t	NE	NE	NE	NE	NE	0.03	NE
As	g/t	NE	NE	NE	NE	NE	0.04	NE
Cr	g/t	0.05	0.05	0.05	0.05	0.05	0.05	NE
Cu	g/t	1.7	1.7	1.7	1.7	1.7	0.88	NE
Ni	g/t	0.07	0.07	0.07	0.07	0.07	1.0	NE
Se	g/t	0.01	0.01	0.01	0.01	0.01	0.1	NE
Zn	g/t	1.0	1.0	1.0	1.0	1.0	1.2	NE
PCDD/F	TEQµg /t	NE	NE	NE	NE	NE	0.13	NE
B(a)p	g/t	0.03	0.04	0.04	0.03	0.04	NE	NE
B(b)f	g/t	0.05	0.04	0.04	0.05	0.04	NE	NE
HCB	mg/t	NA	NA	NA	NA	NA	0.08	NA
PCB	mg/t	NA	NA	NA	NA	NA	0.038	NA

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Table 3.63 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 3.64 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 3.65 Total fuel consumption in other mobile sectors for the period of 1990-2018 (TJ)

Year	Diesel	Light fuel oil	Petrol	Total
1990	12,219	383	1,435	14,037
1995	2,526	152	205	2,883
2000	1,321	679	267	2,267
2005	3,401	926	199	4,526
2006	3,572	703	202	4,477
2007	3,767	661	223	4,651
2008	3,464	705	196	4,365
2009	3,725	217	245	4,187
2010	4,034	446	209	4,688
2011	3,807	671	196	4,674
2012	4,325	10	224	4,559
2013	4,085	501	190	4,776
2014	5,746	109	251	6,105
2015	5,665	233	219	6,117
2016	4,875	220	402	5,497
2017	4,918	85	429	5,432
2018	5,662	69	207	5,938

3.3.6.3. Uncertainty

An uncertainty analysis was carried out for the 2017 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%, for SO_x 20%, for POPs 100-250% and in the activity data 2%. All uncertainty estimates for this source are given in Table 3.66.

Table 3.66 Uncertainties in non-road mobile machinery sector

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	5.170	kt	15.57	8.34	1.63
NMVOC	1.284	kt	5.77	2.34	0.68
SO_x	0.022	kt	0.06	0.02	0.05
NH_3	0.001	kt	0.01	0.003	0.001
$PM_{2.5}$	0.298	kt	3.23	0.83	0.38
PM_{10}	0.299	kt	2.15	0.55	0.20
TSP	0.300	kt	1.52	0.39	0.02
CO	8.630	kt	6.24	1.70	2.19

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
Pb	0.049	t	0.15	0.04	0.15
Cd	0.002	t	0.19	0.05	0.01
Hg	0.0002	t	0.04	0.02	0.02
PCDD/F	0.001	g I-TEQ	0.02	0.05	0.40
B(a)p	0.005	t	0.20	0.22	0.62
B(b)f	0.007	t	0.28	0.31	0.78
B(k)f	0.001	t	0.04	0.08	0.42
I(1,2,3-cd)p	0.0001	t	0.01	0.02	0.32
HCB	0.001	kg	0.20	0.17	0.20
PCBs	0.0003	kg	0.01	0.01	0.15

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 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.

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 increased by 67.6% between 1990 and 2018. As of 2012, a significant increase in fuel consumption is apparent: fuel consumption is more than twice higher (7 838 to 16 665 TJ) compared to 2011. This can be explained by the structural changes in the statistical information collection by Statistics Estonia – since 2012, data for imports and exports also include re-exports data.

As emission levels depend upon the amount of fuel being used, emissions from the international maritime navigation sector show trends similar to those for fuel consumption. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have increased by approximately 55.8%, 72.9%, and 66.9% in comparison to 1990's figures. Therefore, emissions from maritime transport are an increasing concern. However, sulphur oxide emissions have decreased by 46.4% 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 3.67.

According to Statistics Estonia, in 2018, Estonian sea transport enterprises carried 9.4 million passengers, which is almost as much as in 2017. The number of passengers carried was 2.5 million in domestic sea traffic (up by 3%) 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 2018. International sea traffic accounted for 98% of the passenger traffic volume.

In 2018, emissions from the international maritime navigation sector have decreased compared to 2017. This decrease in emissions occurred due to lower fuel consumption in 2018 (6.0%). The emissions of NO_x, NMVOC, SO_x and CO decreased by 8.0%, 5.4%, 29.8% and 6.9% respectively during the same period.

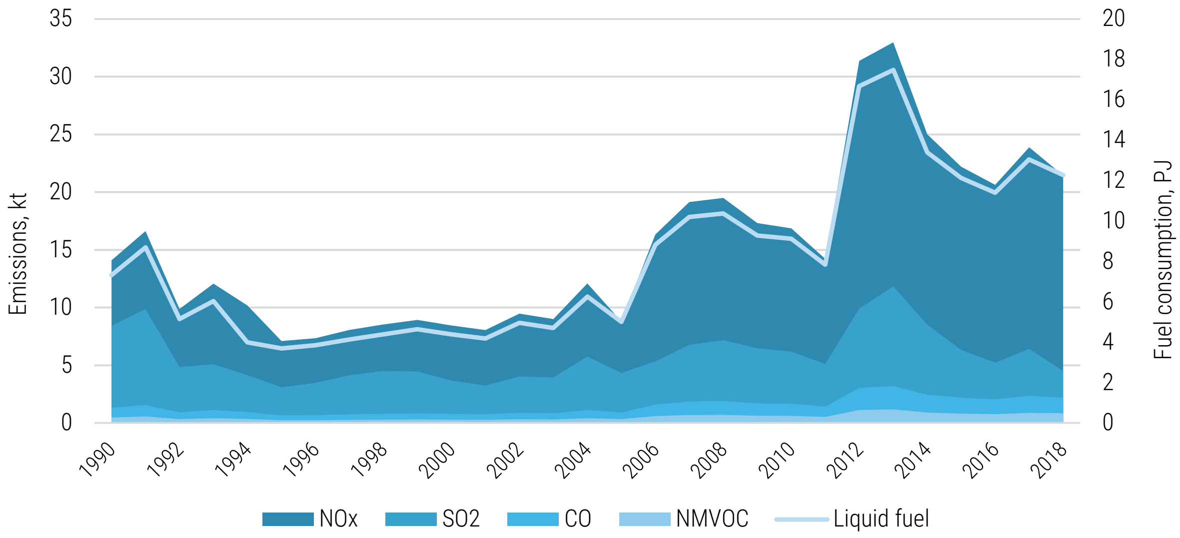

Figure 3.50 NO_x, NMVOC, SO_x and CO emissions from the international navigation sector

Table 3.67 Emissions from the international maritime navigation sector in the period of 1990-2018

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
	kt									t	
1990	14.094	0.483	8.424	NE	NR	NR	0.977	NR	1.317	0.031	0.003
1995	7.105	0.247	3.100	NE	NR	NR	0.370	NR	0.666	0.014	0.001
2000	8.452	0.293	3.678	NE	0.423	0.466	0.466	0.062	0.792	0.017	0.002
2005	8.810	0.345	4.338	NE	0.491	0.522	0.522	0.071	0.903	0.020	0.002
2006	16.330	0.602	5.340	NE	1.023	1.110	1.110	0.135	1.606	0.037	0.004
2007	19.140	0.697	6.784	NE	1.283	1.397	1.397	0.163	1.872	0.044	0.005
2008	19.496	0.708	7.180	NE	1.355	1.477	1.477	0.168	1.909	0.045	0.005
2009	17.319	0.633	6.480	NE	1.220	1.329	1.329	0.151	1.702	0.041	0.004
2010	16.864	0.623	6.192	NE	1.173	1.274	1.274	0.147	1.672	0.040	0.004
2011	14.218	0.535	5.118	NE	0.975	1.055	1.055	0.124	1.428	0.034	0.004
2012	31.365	1.130	9.922	NE	1.934	2.112	2.112	0.256	3.041	0.070	0.007
2013	32.975	1.182	11.840	NE	2.244	2.455	2.455	0.281	3.197	0.076	0.008
2014	25.009	0.910	8.530	NE	1.637	1.783	1.783	0.210	2.449	0.057	0.006
2015	22.197	0.822	6.334	NE	1.268	1.371	1.371	0.177	2.198	0.049	0.005
2016	20.631	0.772	5.232	NE	1.081	1.163	1.163	0.160	2.057	0.044	0.004
2017	23.884	0.883	6.434	NE	1.307	1.413	1.413	0.187	2.361	0.052	0.005
2018	21.963	0.836	4.514	NE	0.999	1.065	1.065	0.163	2.198	0.046	0.004
Trend 1990-2018, %	55.8	72.9	-46.4	NE	136.2	128.4	9.0	162.6	66.9	48.6	32.8

Table 3.67 continues

Year	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	HCB	PCBs
	t							g I-Teq	kg	
1990	0.004	0.104	0.110	0.213	4.859	0.034	0.214	0.074	0.023	0.087
1995	0.002	0.036	0.038	0.098	1.640	0.015	0.108	0.029	0.010	0.030
2000	0.003	0.046	0.049	0.118	2.122	0.018	0.128	0.036	0.012	0.039
2005	0.003	0.054	0.058	0.136	2.509	0.021	0.146	0.042	0.014	0.046
2006	0.005	0.119	0.126	0.255	5.549	0.041	0.260	0.087	0.028	0.100
2007	0.005	0.152	0.161	0.305	7.135	0.050	0.304	0.108	0.034	0.128
2008	0.005	0.163	0.172	0.315	7.636	0.052	0.310	0.114	0.035	0.136
2009	0.005	0.147	0.156	0.282	6.895	0.047	0.276	0.103	0.031	0.123
2010	0.005	0.140	0.149	0.275	6.581	0.045	0.271	0.099	0.030	0.118
2011	0.004	0.116	0.123	0.232	5.432	0.038	0.232	0.083	0.026	0.097
2012	0.009	0.224	0.238	0.482	10.,486	0.077	0.493	0.164	0.052	0.189
2013	0.009	0.268	0.284	0.525	12.584	0.086	0.518	0.189	0.058	0.225
2014	0.007	0.193	0.205	0.395	9.042	0.064	0.397	0.139	0.043	0.162
2015	0.007	0.143	0.152	0.337	6.652	0.052	0.356	0.108	0.036	0.120
2016	0.007	0.118	0.126	0.306	5.455	0.046	0.334	0.093	0.032	0.099
2017	0.008	0.145	0.155	0.357	6.736	0.055	0.383	0.112	0.038	0.122
2018	0.008	0.101	0.109	0.313	4.637	0.045	0.356	0.086	0.032	0.086
trend 1990-2018, %	**96.1**	**-2.2**	**-1.3**	**47.4**	**-4.6**	**31.1**	**66.9**	**15.7**	**38.0**	**-1.5**

3.3.7.2. Methodological Issues

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

Emission calculations from hotelling and manoeuvring activities are calculated by using statistical data, such as the number of vessels and vessel size per category (see Tables 3.70-3.71). 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 3.72) is multiplied by respective emission factors (see Table 3.68). 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 3.72) by emission factors (see Table 3.69). SO_2 emissions are estimated based on the assumption that all sulphur in the fuel is completely converted into SO_2. Equation:

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

Table 3.68 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	0.68	0.04
Cr	g/t	0.72	0.05
Cu	g/t	1.25	0.88
Ni	g/t	32	1
Se	g/t	0.21	0.1
Zn	g/t	1.2	1.2
PCDD/F	TEQµg /tonne	0.47	0.13
HCB	mg/t	0.14	0.08
PCBs	mg/t	0.57	0.038

Table 3.69 Sulphur content of fuel (by weight)

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

Table 3.70 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2018

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
2006	1,121	2,017	444	1,724	9,931	0	3	15,240
2007	1,004	2,061	435	1,825	9,088	0	30	14,443
2008	753	1,910	428	1,787	7,323	27	9	12,237
2009	886	1,384	399	1,702	5,831	54	15	10,271
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

Table 3.71 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2018 (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
2006	20,751	10,382	2,698	12,623	115,955	0	2	162,410
2007	18,911	8,352	3,073	13,948	131,809	0	26	176,119
2008	16,699	5,543	3,158	13,489	158,100	3	9	197,001
2009	18,881	7,426	4,262	13,673	157,074	9	25	201,350
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	24,027	10	2,071	295,431

Table 3.72 Fuel consumption in the international maritime navigation sector in the period of 1990-2018 (TJ)

Year	Bunker fuel oil	Marine diesel oil/ Marine gas oil	Total
1990	6,172	1,145	7,317
1995	2,008	1,690	3,698
2000	2,605	1,788	4,393
2005	3,087	1,917	5,004
2006	6,904	1,921	8,825
2007	8,904	1,289	10,193
2008	9,563	813	10,376
2009	8,644	639	9,283
2010	8,216	898	9,114
2011	6,809	1,029	7,838
2012	13,042	3,623	16,665
2013	15,744	1,738	17,482
2014	11,279	2,116	13,395
2015	8,230	3,892	12,122
2016	6,705	4,695	11,400
2017	8,311	4,738	13,049
2018	5,621	6,641	12,262

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 hotelling 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.

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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:

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

Table 3.73 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
	1b Fugitive emission from solid fuels: Solid fuel transformation	Includes emissions from coke oven. Only point sources data.	TSP, PM_{10}, $PM_{2.5}$, BC, CO, Cr
	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, TSP, PM_{10}, $PM_{2.5}$, CO
	2av Distribution of oil products	Includes emissions from liquid fuel distribution. Data of point and diffuse sources.	NMVOC
	2b Natural gas	Includes emissions from gas distribution networks. Only diffuse sources data.	NMVOC
	2c Venting and flaring	Waste gas incineration. Only two point sources data.	NO_x, SO_x, NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, Pb, Cu, Cr, Ni, Zn, PCDD/F, PAHs

NMVOC emissions from this sector contribute about 5% to total national emissions and have decreased by about 59% up to 2018 compared to 1990 due to decreasing emissions from gasoline distribution and also has slightly decreased (by 4.7%) in comparison with 2017 due to decreasing emissions from terminals (see Figure 3.51, Figure 3.53 and Table 3.75). Emissions of other pollutants are very small compared to the emissions from the other sectors (see Table 3.74).

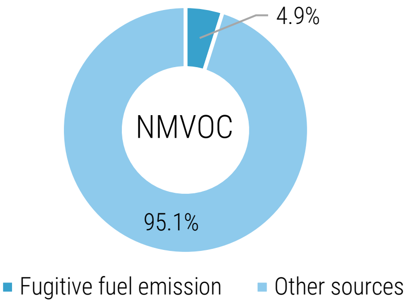

Figure 3.51 NMVOC emission distribution in 2018

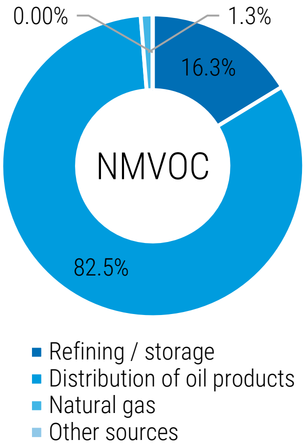

Figure 3.52 NMVOC emission distribution within the fuel fugitive emission sector in 2018

Figure 3.52 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (86%).

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Table 3.74 Fugitive emission in the period of 1990-2018(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	0.010	0.090	0.180	NA	0.170
2006	0.010	3.516	NA	0.060	0.010	0.110	0.220	NA	0.250
2007	0.010	1.922	0.010	0.090	0.010	0.090	0.180	NA	0.220
2008	0.017	1.593	0.013	0.102	0.014	0.102	0.202	NA	0.276
2009	0.036	1.684	0.026	0.089	0.031	0.142	0.267	0.0001	0.168
2010	0.035	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	0.024	1.186	0.032	0.196	0.018	0.090	0.181	0.0001	0.183
2016	0.020	1.215	0.024	0.142	0.013	0.068	0.131	0.0001	0.142
2017	0.024	1.145	0.029	0.168	0.013	0.076	0.148	0.0000	0.171
2018	0.024	1.093	0.029	0.157	0.013	0.067	0.138	0.0000	0.171
Change 1990-2018, %		**-55.8**		**1 468.3**	**28.1**	**34.3**	**25.3**		**-14.3**

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.

(Photo by Ilmar Saabas)

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[3] (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. 23 terminals presented reports on emissions in 2018. In the table below NMVOC

[3] 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

emissions from gasoline distribution and terminals are presented.

Table 3.75 NMVOC emissions from liquid fuel distribution in the period of 1990-2018 (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	1990-2018, %
Gasoline distribution	0,478	0,511	0,46	0,427	0,397	0,404	0,418	0,416	-79,7
Terminals	1,265	0,854	0,74	0,737	0,594	0,642	0,521	0,474	46,7

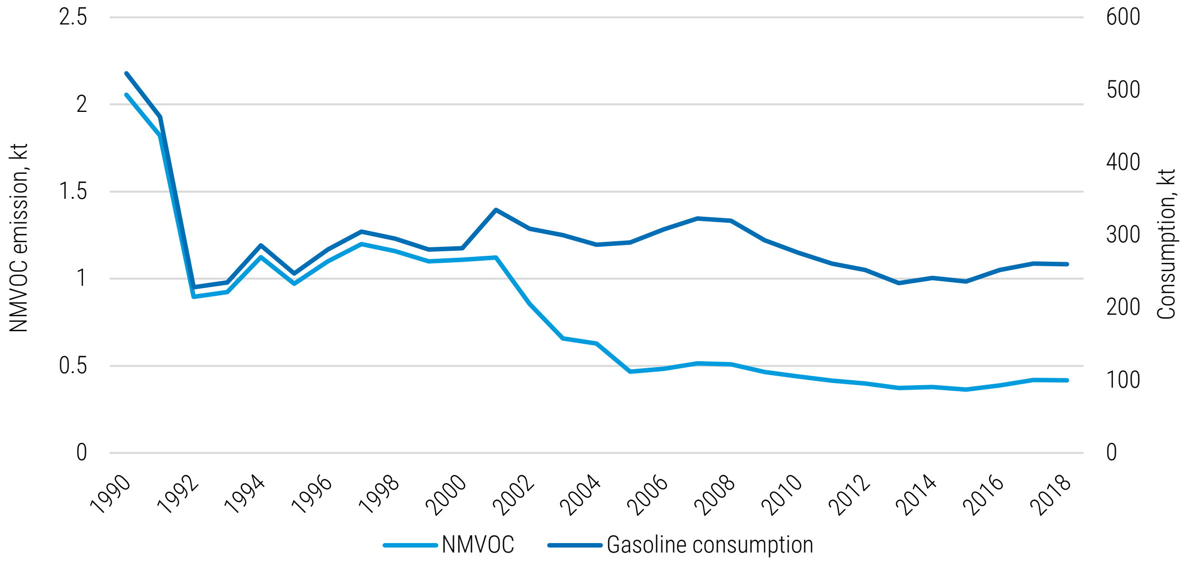

Figure 3.53 NMVOC emission and gasoline distribution in the period of 1990-2018

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

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

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

3.4.2.2. 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 2005-2018, 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 2005-2018, 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[4].

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 3.76.

Table 3.76 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.

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

Table 3.77 Total Tier 2 emission factor for emissions from gasoline handling in service stations

Category	Emission source	NMVOC emission factor, g/m³ throughput/kPa TVP	Abatement efficiency ($\eta_{abatement}$), %	True Vapour Pressure (TVP), kPa	NMVOC emission factor for gasoline, g/m³ 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	1006
	Automobile refuelling Drips and minor spillage	2	-	27.2	54
	Emission factor for all the activities total	66	-	-	1175

Activity data

Activity data on the subject of gasoline consumption is available from Statistics Estonia (see Table 3.78).

Table 3.78 Consumption of motor gasoline in the period of 1990-2018 (kt)

Year	Gasoline consumption
1990	523
1995	247
2000	282
2005	290
2006	308
2007	323
2008	320
2009	293
2010	276
2011	261
2012	252
2013	234
2014	241
2015	236
2016	252
2017	261
2018	260

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.[5]

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[6]. Nitrofert halted operations since 2014.

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 2018 compared to 1990 is a decrease in gas consumption over the same period (see Table 3.79, Table 3.82 and Figure 3.55).

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

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Table 3.79 NMVOC emissions from gas distribution in the period of 1990-2018 (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	1990-2018, %
NMVOC	0.018	0.019	0.019	0.015	0.013	0.014	0.0138	0.0139	-85.5

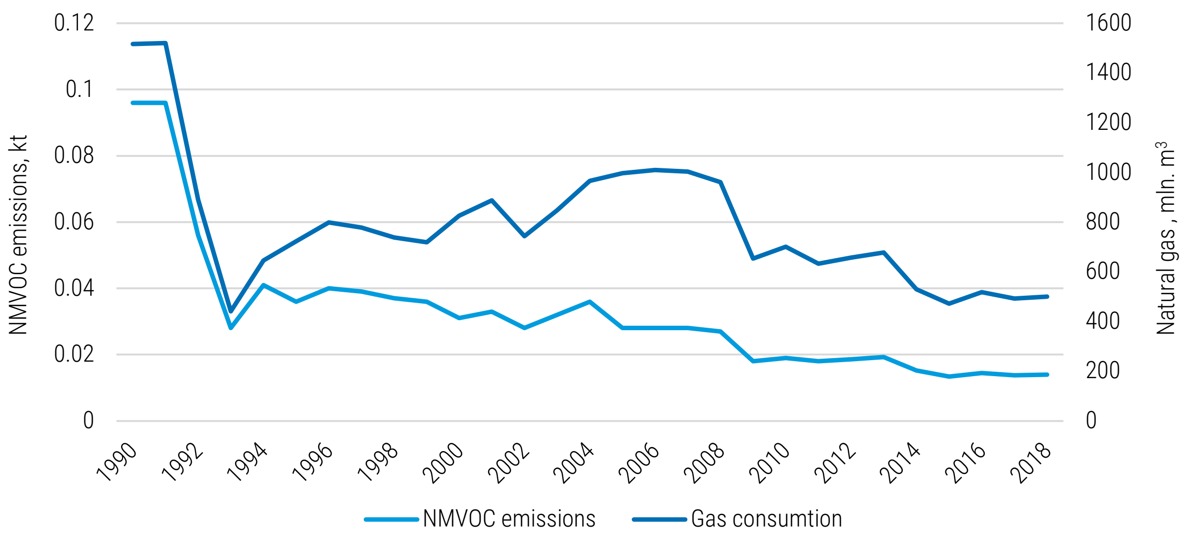

Figure 3.55 NMVOC emission from natural gas distribution in the period of 1990-2018

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 3.80-3.81. 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 3.80 Tier 1NMVOC 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 3.81 Tier 1emission 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 3.82).

Table 3.82 Gas consumption in the period 1990-2018 (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	1990-2018, %
Gas consumption	632	657	678	530	471	518	492	500	-67

3.4.3.3. Uncertainty

An uncertainty analysis was carried out to the year 2017 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 3.83.

Table 3.83 Uncertainties in fugitive emission sector

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	0.026	kt	0.08	0.04%	0.02%
NMVOC	1.144	kt	5.14	2.13%	0.11%
SO_x	0.029	kt	0.08	0.01%	0.00%
NH_3	0.168	kt	1.64	0.82%	0.39%
$PM_{2.5}$	0.014	kt	0.15	0.10%	0.05%
PM_{10}	0.077	kt	0.56	0.44%	0.13%
TSP	0.151	kt	0.77	0.63%	0.04%
CO	0.171	kt	0.12	0.12%	0.07%

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

- To check of point sources data for NFRs 1B1b,c and 1B2aiv regarding correctness of SNAP codes.

Kunda Nordic Tsement (Source: www.knc.ee)

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 is somewhat smaller than the EU average based on value added (approx. 16%).

The output of the manufacturing industry grew relatively fast in 2018, however, the developments varied across sectors. The number of employed people did not change significantly, i.e. the growth was caused by increased productivity. The financial indicators of the industrial sector were good. The prospects of industry began to worsen in the EU, but the Estonian industrial sector continued at a growth in 2019.

The production volume of the manufacturing industry grew at a modest rate in the EU in 2018 (under 2%). The situation in Estonia was better, across the countries, Estonia was part of the upper half of the ranking list of the growth of production volumes, together with e.g. Lithuania, Poland and Sweden.

According to short-term statistics, production volume of the Estonian manufacturing industry grew nearly 4% in 2018.

The growth of production volume of the industry was also strongly supported by the wood industry and manufacture of shale oil, whereas beverage and textile production decreased.

The investment volume was nearly as big in the manufacturing industry in 2018 as the year before, however, there may be a sizable difference between short-term and final statistics. Investments decreased in comparison with the very large volumes of the previous year in the wood and paper industry, production of electrical appliances, and machinery and equipment repair, other sectors generally invested more. In comparison with the year before, a larger change occurred in construction and reconstruction, where investments dropped by a tenth.[7]

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 in Table 4.1.

Table 4.1 Industrial processes reporting activities

NFR		Source	Description	Emissions reported
2A		Mineral Products		
	2A1	Cement production	Includes emissions from cement production. Data reported by one operator. 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

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

NFR		Source	Description	Emissions reported
	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			
	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, TSP, PM_{10}, $PM_{2.5}$, BC, CO, 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
	2C7a	Copper production	Includes emission from secondary copper production. Data reported by operators.	TSP, PM_{10}, $PM_{2.5}$, BC
	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
	2C6	Zinc production	Includes emission from zinc plating. Data reported by operators.	TSP, PM_{10}, $PM_{2.5}$, Zn
	2C7c	Other metal production	Includes emission from galvanizing and electroplating. Data reported by operators.	NO_x, NMVOC, SO_x, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO, BC, Pb, Cr, Ni, Zn
2D	Product use			
	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 15 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 95 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 2000–2018.

The share of industry sources in total emissions in 2018 was: NMVOC – 3.6%, $PM_{2.5}$ – 4.3%, PM_{10} – 16% and TSP about 34%. 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 94.8%, 81.8% and 71.6%, respectively. The main reason is that during the period of 1990–2018, the production of chemical products fell.

The emissions of PM_{10} and TSP increased in 2018 compared to 2017 by 11% and 14.3%. The growth in construction sector (both, residential and non-residential building) was the cause of increase in emissions of particulates. Emissions of other substances remained approximately at the level of 2017.

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 2018 are shown in Figure 4.2 and Figure 4.3. The biggest polluter of NMVOC emissions were Pulp, paper and food industries – 91% (mainly food production), the chemistry industry is responsible for the 5% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (82%, 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 1990-2018 (kt; heavy metals in t)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.190	15.341	NA	0.530	NR	NR	6.172	NR	0.340
1995	0.070	4.379	NA	0.240	NR	NR	1.390	NR	0.000
2000	0.201	2.082	0.042	0.134	0.322	1.037	2.776	0.005	0.534
2005	0.178	1.570	0.131	0.197	0.583	2.270	6.473	0.008	0.344
2006	0.264	1.299	0.121	0.163	0.631	2.503	7.235	0.009	0.346
2007	0.246	1.068	0.021	0.137	0.549	2.357	7.069	0.006	0.444
2008	0.295	0.959	0.020	0.181	0.702	2.790	7.833	0.011	0.477
2009	0.058	0.881	0.026	0.083	0.367	1.805	5.209	0.004	0.423
2010	0.037	0.861	0.030	0.070	0.340	1.400	3.982	0.004	0.462
2011	0.062	0.919	0.022	0.093	0.234	1.209	3.605	0.002	0.420
2012	0.047	0.909	0.001	0.103	0.198	1.142	3.510	0.001	0.336
2013	0.200	0.892	0.000	0.162	0.366	1.736	4.989	0.005	0.381
2014	0.032	0.860	0.001	0.052	0.238	1.338	4.150	0.001	0.413
2015	0.045	0.809	0.002	0.065	0.230	1.300	4.042	0.002	0.405
2016	0.045	0.768	0.001	0.071	0.225	1.315	4.149	0.001	0.378
2017	0.057	0.790	0.0002	0.082	0.325	1.627	5.044	0.002	0.451
2018	0.054	0.805	0.0002	0.097	0.289	1.806	5.767	0.001	0.553
Change 1990-2018, %	-71.6	-94.8	-99.6	-81.8	-10.1	74.1	-6.6	-75.6	62.6

Table 4.2 continues

Year	Pb	Cr	Cu	Ni	Zn
1990	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA
2000	0.034	0.018	0.014	0.014	0.020
2005	0.008	0.075	0.012	0.027	0.110
2006	0.006	0.094	0.018	0.017	0.094
2007	0.008	0.103	0.012	0.017	0.074
2008	0.010	0.112	0.011	0.039	0.098
2009	0.007	0.065	0.010	0.008	0.064
2010	0.014	0.129	0.009	0.013	0.043
2011	0.012	0.144	0.011	0.018	0.063
2012	0.010	0.071	0.009	0.017	0.042
2013	0.011	0.169	0.009	0.020	0.048
2014	0.017	0.079	0.008	0.017	0.052
2015	0.010	0.069	0.003	0.021	0.051
2016	0.011	0.048	0.002	0.012	0.051
2017	0.015	0.037	0.006	0.023	0.051
2018	0.009	0.037	0.003	0.014	0.045
Change 1990-2018, %	-74.7	108.4	-79.7	-3.3	126.2

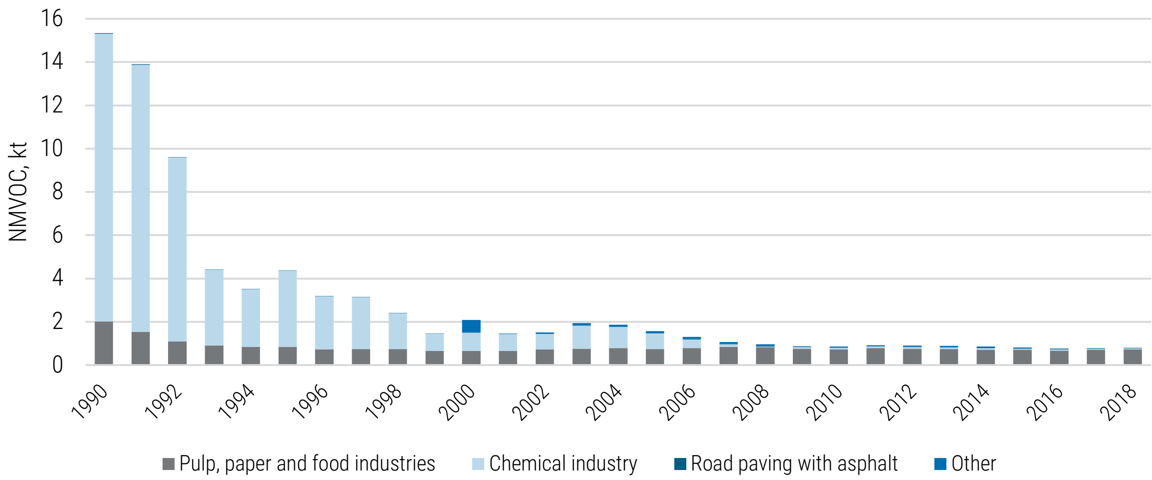

Figure 4.1 NMVOC emissions from the industrial sector in the period of 1990-2018

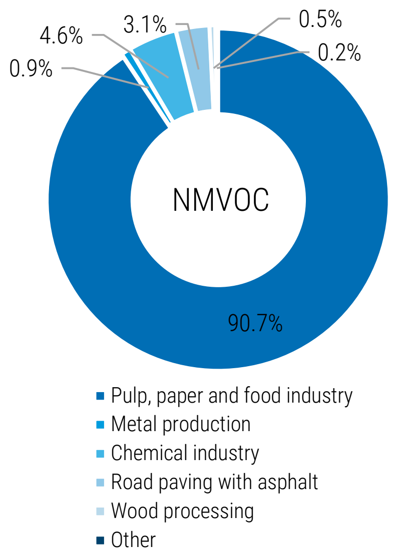

Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2018

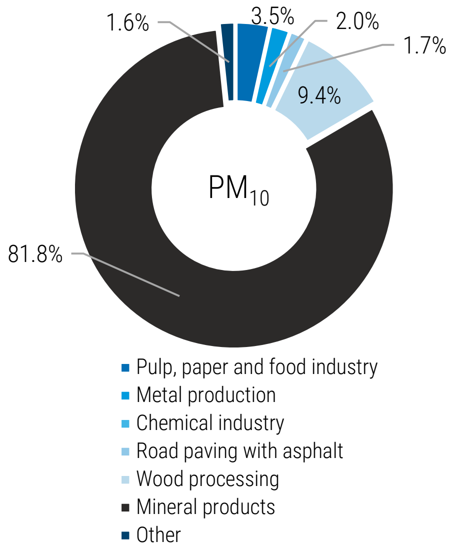

Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2018

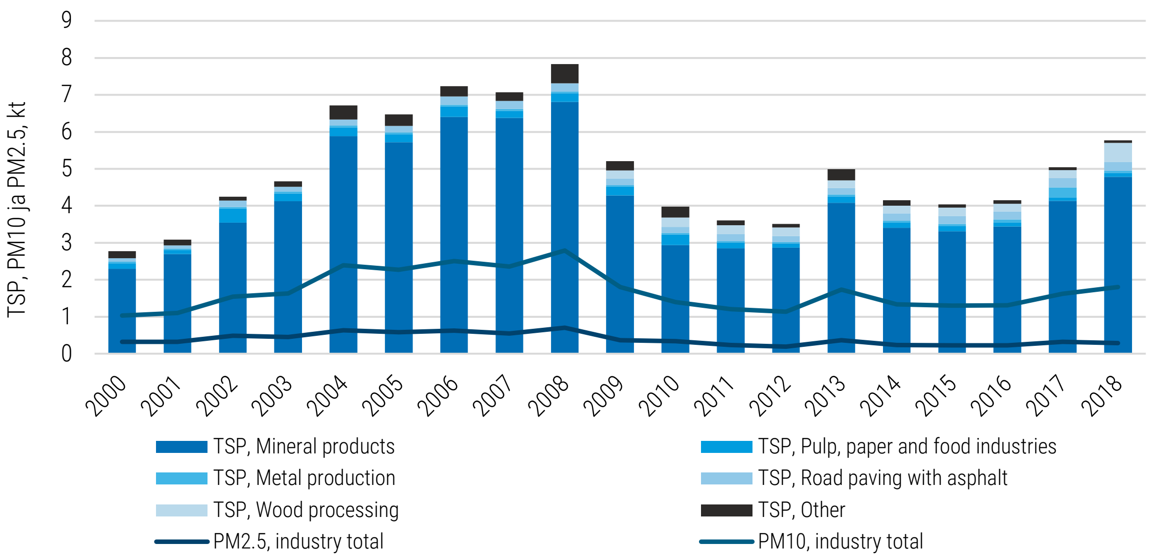

Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2018

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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 and before 2020 submission all substances emissions were reported under NFR 1A2f. This year, an analysis of emissions were carried out and particlulates 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.[8]

The completed residential dwelling has increased by about 18% in 2018 comparing to 2017, non-residential has increased in the same period by 21.7%. It is a primary reason of the increasing of particulates emissions from the mineral industry. The TSP, PM_{10} and $PM_{2.5}$ emissions increased in 2018 compared to 2017 by the same period by 15.7%, 15.3% and 15.2% respectively.

Table 4.3 Pollutant emissions from mineral products in the period of 1990-2018 (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
2006	0.010	0.080	NA	NA	0.314	1.987	6.400	0.0003	NA
2007	0.010	NA	NA	NA	0.313	1.963	6.379	0.0003	NA
2008	0.000	NA	0.0022	NA	0.301	2.107	6.814	0.0001	NA
2009	0.007	NA	0.0005	NA	0.145	1.394	4.279	0.0001	0.006
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
Change 1990-2018, %							-3.9		
Change 2000-2018, %					21.0	104.6	108.3	-31.0	-81.9

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 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

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

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 also 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	0.6000	0.5630	185.000	0.07	0.0130	541.401	0.2	0.108
1995	417.600	0.6000	0.2510	16.800	0.07	0.0010	81.343	0.2	0.016
2000	329.100	0.0700	0.0230	21.200	0.07	0.0010	45.072	0.2	0.009
2005	726.000	0.0700	0.0510	37.200	0.07	0.0020	69.342	0.2	0.014
2006	848.900	0.0700	0.0590	39.700	0.07	0.0027	82.667	0.2	0.016
2007	936.200	0.0700	0.0650	43.500	0.07	0.0030	143.485	0.2	0.029
2008	806.100	0.0700	0.0560	59.400	0.07	0.0041	113.081	0.2	0.023
2009	326.000	0.0700	0.0230	30.200	0.07	0.0021	38.938	0.2	0.007
2010	536.700	0.0700	0.0370	27.200	0.07	0.0019	56.500	0.2	0.011
2011	719.002	0.0040	0.0030	36.100	0.07	0.0025	84.544	0.2	0.017
2012	714.600	0.0060	0.0040	72.000	0.07	0.0050	107.213	0.2	0.021
2013	691.400	0.0110	0.0070	69.600	0.07	0.0049	118.148	0.2	0.024
2014	720.480	0.0070	0.0050	69.600	0.07	0.0049	118.148	0.2	0.024
2015	356.287	0.0360	0.0130	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	502.920	0.3230	0.1625	69.324	0.07	0.0049	54.940	0.2	0.011
2018	527.000	0.2380	0.1253	53.714	0.07	0.0038	49.870	0.2	0.010

Construction and demolition sector is a key source of emissions of TSP (20% of total emission, Figure 4.5) and PM_{10} (8.6% of total emission).

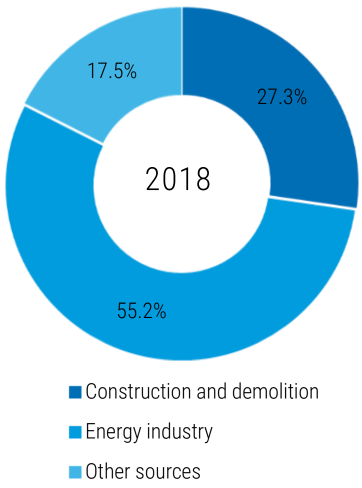

Figure 4.5 The share of construction and demolition sector in total TSP emissions

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 2000-2018 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).

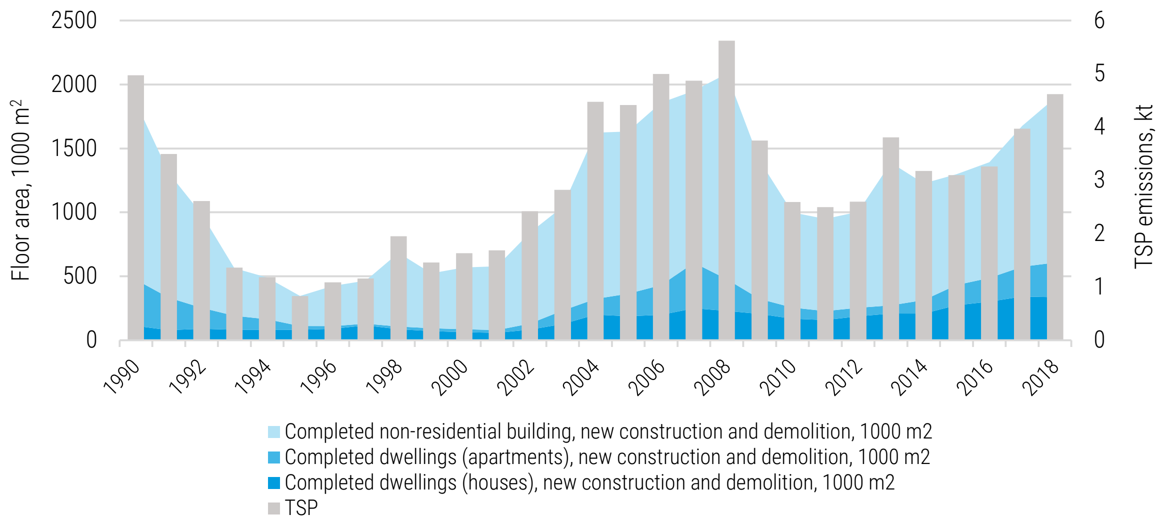

Figure 4.6 The completed dwelling and non-residential building, new construction and demolition and TSP emission in the period of 1990-2018

Table 4.7 Activity data for PM emission calculations from the construction sector in the period of 1990-2018 (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
2006	198.3	232.5	1,427.4
2007	249.5	356.4	1,345.7
2008	229.5	247.8	1,608.1
2009	205.3	117.6	1,082.5
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

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).

Big investments in the oil industry allow for the creation of new jobs, but the sector is strongly dependent on the global oil prices and therefore, it is difficult to assess whether the plans for building additional oil plants and refinement plan will come true or not. There is no significant increase of employment expected in the sector as a whole in upcoming years. The growth of production volumes also relies mainly on increased productivity in the future. The need for increased effectiveness is caused by the appreciation of production input, the rise of expenses related to environmental aspects also plays an important part in the chemical industry.

The year 2018 was successful for the chemical industry, the shale oil industry continued a rapid growth.[9]

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

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 21% in 1990, and only 0.2% in 2018 (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 1990-2018 emissions of all substances were reduced considerably, except carbon monoxide emission. The main source of CO emissions is facility for benzoic acid, sodium benzoate and plasticizers production.

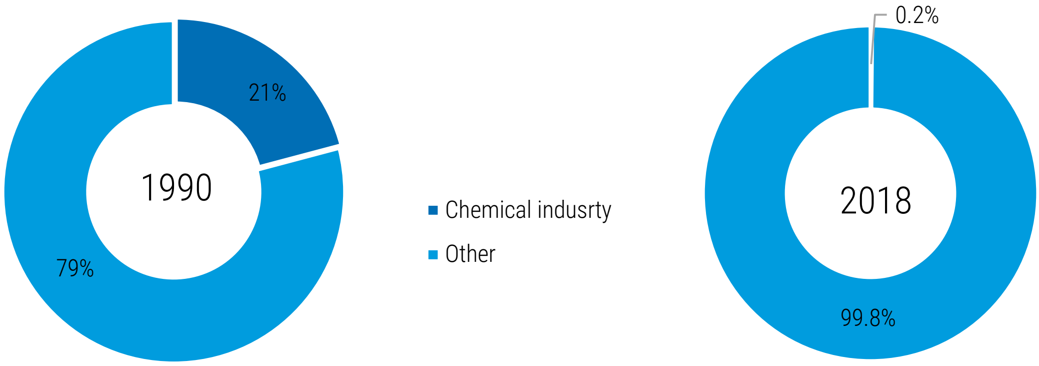

Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2018

Table 4.8 Emissions from the chemical industry in the period of 1990-2018 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.190	13.300	NA	0.37	NR	NR	0.940	NR	0.340
1995	0.070	3.530	NA	0.14	NR	NR	0.490	NR	NA
2000	0.190	0.840	NA	0.04	0.090	0.163	0.190	0.0027	0.340
2005	0.160	0.720	0.000	0.08	0.146	0.266	0.310	0.0044	0.290
2006	0.230	0.410	NA	0.06	0.126	0.232	0.280	0.0037	0.330
2007	0.200	0.120	0.000	0.07	0.099	0.184	0.230	0.0029	0.360
2008	0.255	0.041	0.002	0.116	0.246	0.447	0.522	0.0073	0.398
2009	0.025	0.068	0.0003	0.009	0.026	0.052	0.082	0.0007	0.364
2010	NO	0.071	0.000005	0.01	0.005	0.014	0.042	0.0001	0.405
2011	NO	0.073	0.000006	0.017	0.004	0.013	0.038	0.0001	0.374
2012	0.024	0.073	0.000006	0.021	0.004	0.012	0.036	0.0001	0.305
2013	0.134	0.074	0.000005	0.066	0.092	0.171	0.213	0.0027	0.327
2014	0.00000	0.073	0.000005	0.008	0.004	0.012	0.037	0.0001	0.367
2015	0.00020	0.046	0.000005	0.007	0.001	0.002	0.007	0.00001	0.353
2016	0.00000	0.054	0.000005	0.007	0.001	0.003	0.009	0.00001	0.353
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
Change 1990-2018, %	-100.0	-99.7		-96.3	-99.2	-98.7	-99.3	-99.6	51.2

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.

According to a recommendation which was made by the expert team following the 2018 review ('A comprehensive technical review of national emissions inventories'), the ammonia emissions for the year 1990-1999 were splited between NFRs 2B1 and 2B10a.

4.1.4. Metal Production (NFR 2C)

4.1.4.1. Source Category Description

Metals industry is related to several fields, such as manufacturing and construction of machinery and equipment. Companies of metals industry employ about 12,000 people in Estonia, which makes it one of the largest industries after food industry and the timber industry. More than one thousand companies operate in this sector. Metals industry is concentrated in Tallinn and its vicinity (60% of employees) and Ida-Viru County and Tartu County (tenth of the staff).

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

The year 2017 was the best in recent years for the metal industry. Output increased, the number of employed persons grew and financial results improved.[10]

In 2018, the production volume of the metal industry remained at the level of the year before. Producer prices and sales grew by a few percentage points. Similar developments characterised export as well as sales on the domestic market.

In 2018, the output of the machinery industry continued to grow at a fast pace, production increased by more than a tenth. Due to the slight growth of producer prices (1.1%), sales increased even more. The growth was caused by export, the demand of the domestic market remained at the level of the year before.[11]

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

Emissions from the metal industry are presented in Table 4.9.

Table 4.9 Emissions from the metal production sector in the period of 1990-2018 (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
2006	0.026	0.001	0.010	0.084	0.020	0.026	0.043	0.00007	0.016

[10] Overview of Economy 2017. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2018
[11] Overview of Economy 2018. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2019

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Year	NO_x	SO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2007	0.016	0.001	0.010	0.062	0.022	0.028	0.047	0.00009	0.024
2008	0.015	0.0005	0.008	0.034	0.023	0.030	0.049	0.00009	0.023
2009	0.008	0.0003	0.004	0.066	0.016	0.022	0.036	0.00006	0.012
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

Table 4.9 continues

Year	Pb	Cr	Cu	Ni	Zn
1990	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA
2000	0,034	0,018	0,014	0,014	0,020
2005	0,008	0,075	0,012	0,027	0,110
2006	0,006	0,094	0,018	0,017	0,094
2007	0,008	0,103	0,012	0,017	0,074
2008	0,010	0,112	0,011	0,039	0,096
2009	0,007	0,065	0,010	0,008	0,064
2010	0,014	0,129	0,009	0,013	0,043
2011	0,012	0,144	0,011	0,018	0,063
2012	0,010	0,071	0,009	0,017	0,042
2013	0,011	0,169	0,009	0,020	0,048
2014	0,017	0,079	0,008	0,017	0,052
2015	0,010	0,069	0,003	0,021	0,051
2016	0,011	0,048	0,002	0,012	0,051
2017	0,015	0,037	0,006	0,023	0,051
2018	0,009	0,037	0,003	0,014	0,045
Change 1990-2018, %	**-74,7**	**108,4**	**-79,7**	**-3,3**	**126,2**

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.

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 4.10 and Figure 4.8.

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

Table 4.10 Emissions from the road paving with asphalt in the period of 1990-2018 (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
2006	0.0237	0.0015	0.0296	0.2223	0.00008
2007	0.0238	0.0015	0.0297	0.2230	0.00009
2008	0.0241	0.0015	0.0301	0.2260	0.00009
2009	0.0188	0.0012	0.0235	0.1762	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
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
Change 2000-2018, %	-7.8			-3.5	
Change 1990-2018, %		136.6	136.6		136.8

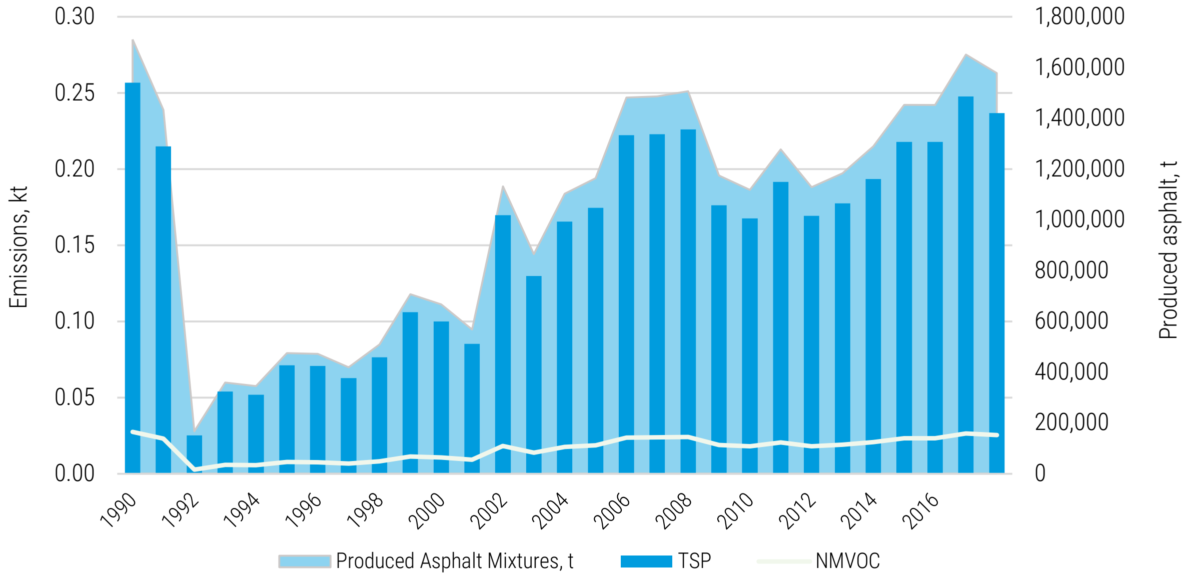

Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production in the period of 1990-2018

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 4.11). For particles 99% abatement efficiencies are used.

Table 4.11 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 1990-2018 (see Table 4.12). 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 4.12 Activity data for NMVOC emission calculations from asphalt production in the period of 1990-2018 (tonnes)

Year	Produced Asphalt Mixtures
1990	1,711.000
1995	475.000
2000	667.000
2005	1,164.000
2006	1,481.908
2007	1,486.572
2008	1,506.846
2009	1,174.624
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

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 2018, sales volumes in the paper industry grew by nearly a tenth thanks to strong export. The growth was caused by increased prices; production volumes calculated in constant prices actually dropped by a few percentage points.[12]

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

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

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 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.[13]

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 also one of the largest industries in Estonia in terms of production volume. It is the primary economic activity of nearly 500 companies. Along with the increase in the competitiveness, the share of exports in the sector has reached more than one-third of the turnover. In food production, 36.6% of the production was exported and this percentage has grown year by year. The food industry consists of two major sectors: food production and beverage production. The year 2018 turned out to be successful for food and beverage production, the growth of export volumes stabilized but the domestic market took a large step forward.[14]

The emissions from sector NFR 2H are presented in Table 4.13. Emissions of all pollutants has increased in 2018 compared to 2017 due to increase of emissions in food and pulp industry.

Table 4.13 Pollutant emissions from the pulp, paper and food industries in the period of 1990-2018 (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
2006	0,0	0.779	0.120	0.169	0.227	0.290	0.004	0.000
2007	0.010	0.848	0.020	0.114	0.152	0.190	0.003	0.020
2008	0.018	0.823	0.018	0.132	0.176	0.221	0.003	0.028
2009	0.017	0.758	0.024	0.160	0.186	0.247	0.003	0.027
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

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

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Year	NO_x	NMVOC	SO_x	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2014	0.003	0.761	0.0004	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	0.0009	0.037	0.059	0.104	0.0008	0.002
2017	0.015	0.708	0.0000	0.032	0.052	0.094	0.0007	0.011
2018	0.002	0.730	0.0000	0.040	0.062	0.105	0.0009	0.017

The emissions of NMVOC and particulates from the wood processing are presented in Table 4.14; 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 4.14 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

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 4.15). 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 4.15 NMVOC emission factors for the food and drink industries

Product group (food and drink)	Emission factor	Unit
Bread	4.5	kg/Mg bread
Cakes, biscuits and breakfast cereals	1	kg/Mg product
Meat, fish and poultry etc. frying/curing	0.3	kg/Mg product
Meat processed	0.3	kg/Mg product
Fish processed	0.3	kg/Mg product
Margarine and solid cooking fats	10	kg/Mg product
Solid cooking fats	10	kg/Mg product
Margarine	10	kg/Mg feed
Animal feed	1	kg/Mg product
Wine	0.08	kg/hl wine
Beer	0.035	kg/hl beer
Other sprits	0.4	kg/hl alcohol
Crude spirits	0.4	kg/hl alcohol
Distilled spirits	0.4	kg/hl alcohol

4.1.6.3. Activity Data

Information regarding food and drink production is available from Statistics Estonia (www.stat.ee) for the years 1990-2018 (Table 4.16-4.17).

Table 4.16 Activity data for the food industries in the period of 1990-2018 (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
2006	74.4	9.4	69.4	90.6	..	..	208.9
2007	78.8	9.7	70.5	98.5	..	..	214.2
2008	77.6	8.9	74.6	101.7	..	..	229.5
2009	74.1	7.1	76	98.2	..	..	203.1
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

Table 4.17 Activity data for the drinks industries in the period of 1990-2018 (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
2006	77.5	1,431.1	61.6	183.1
2007	53.5	1,411.6	39.3	216.0
2008	38.8	1,281.8	15.5	202.8
2009	40.4	1,223.0	1.3	186.6
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

4.1.7. Uncertainty

An uncertainty analysis was carried out to the year 2017 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 4.18.

Table 4.18 Uncertainties in industrial processes sector

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	0.055	kt	0.17	0.05%	0.05%
NMVOC	0.790	kt	3.55	1.57%	3.49%
SO_x	0.000	kt	0.00	0.00%	0.00%
NH_3	0.082	kt	0.79	1.30%	0.20%
$PM_{2.5}$	0.277	kt	3.01	1.60%	0.85%
PM_{10}	1.537	kt	11.04	8.68%	3.11%
TSP	5.039	kt	25.59	20.27%	1.31%
CO	0.451	kt	0.33	0.15%	0.05%
Pb	0.0004	t	0.00	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 2020 submission the following recalculations were carried out:

- In comparison with the previous submission, the emissions of particulates from glass production facilities were reallocated from NFR 1A2f to NFR 2A3 for the period 2004–2017.

- This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out.
- Emissions of black carbon have been recalculated for the whole period of 1990–2017 due to a correction of emission factor.

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 4.19.

Table 4.19 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

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NFR	Source	Description	Method	Emissions reported
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 and the use of fireworks	Tier 2	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

4.2.2. Quantitative Overview of NMVOCs

In 2018, the solvent and other product use sector, which was the largest pollution source of NMVOC emissions in Estonia, accounted for 37.3% of total NMVOC emissions. The largest share within the solvent and other product sector was for coating application at 45.7%, with the others being domestic solvent use at 34.6%, other solvent use 10.3%, printing 6.9%, chemical products 1.3%, degreasing 1.1%, other product use and dry cleaning 0.1% (see Figure 4.9).

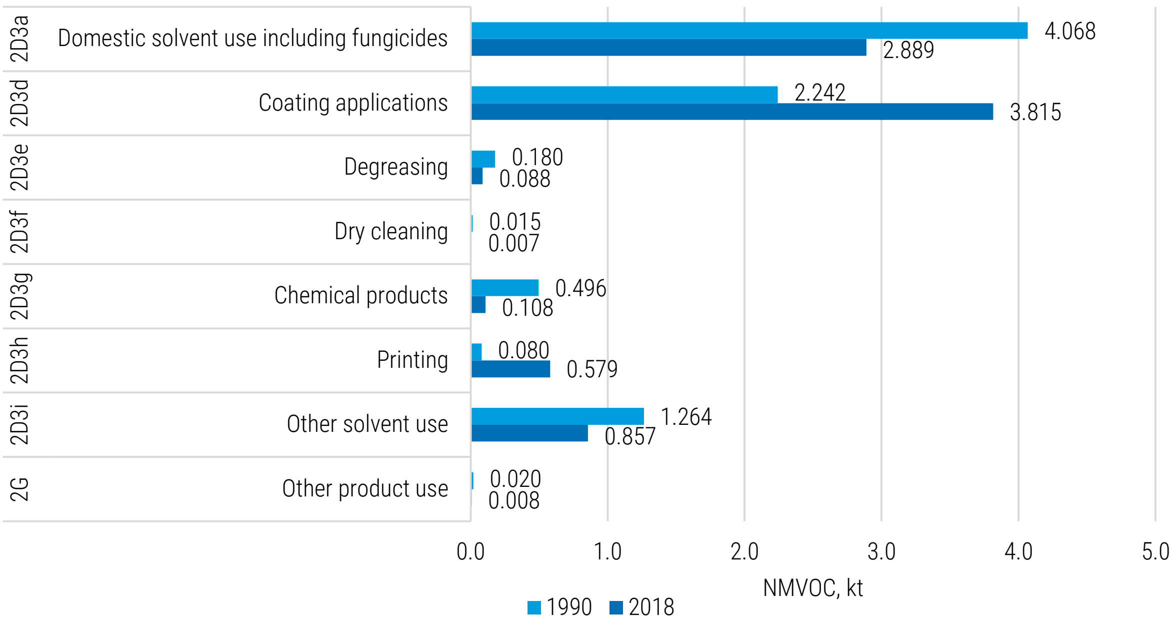

Figure 4.9 NMVOC emissions by sectors in 1990 and 2018

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 slightly decreased in the solvent sector by 0.2% (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 1990-2018 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

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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 a 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.

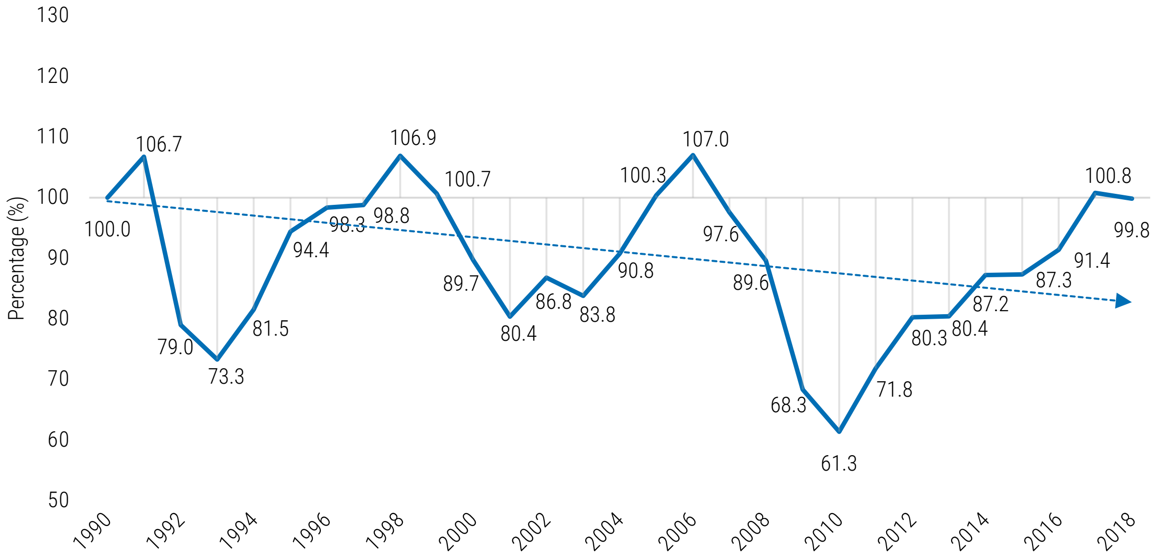

Figure 4.10 The dynamics of NMVOC emissions from the solvent and other product use sector in the period of 1990-2018 (1990 = 100%)

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.

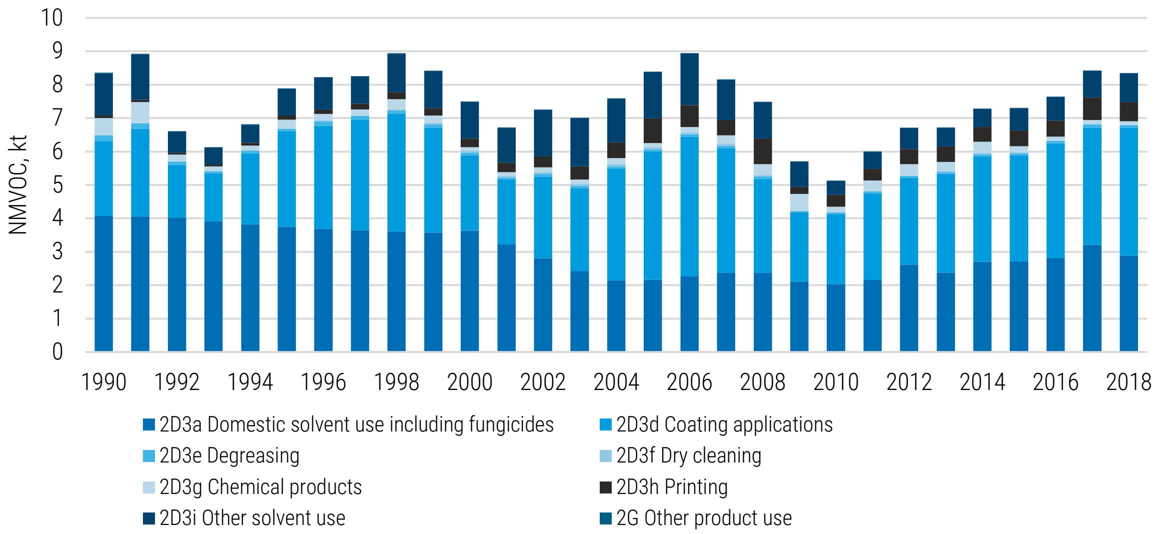

Figure 4.11 NMVOC emissions from the solvent and other product use sector in the period of 1990-2018

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Table 4.20 NMVOC emissions from the solvent and other product use sector in the period of 1990-2018 (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	0.020
1995	3.751	2.848	0.077	0.025	0.250	0.126	0.810	0.011
2000	3.629	2.258	0.084	0.050	0.107	0.248	1.115	0.009
2005	2.168	3.842	0.053	0.062	0.125	0.745	1.384	0.013
2006	2.261	4.177	0.073	0.063	0.158	0.658	1.550	0.012
2007	2.364	3.742	0.065	0.054	0.265	0.454	1.199	0.017
2008	2.371	2.815	0.068	0.051	0.314	0.766	1.098	0.007
2009	2.112	2.066	0.036	0.022	0.497	0.206	0.763	0.012
2010	2.034	2.092	0.047	0.012	0.164	0.354	0.423	0.006
2011	2.153	2.600	0.054	0.019	0.313	0.344	0.512	0.009
2012	2.617	2.599	0.058	0.008	0.337	0.456	0.630	0.009
2013	2.375	2.961	0.051	0.039	0.268	0.461	0.563	0.009
2014	2.699	3.167	0.051	0.041	0.338	0.439	0.551	0.009
2015	2.711	3.179	0.058	0.030	0.179	0.473	0.665	0.009
2016	2.812	3.432	0.075	0.007	0.125	0.479	0.705	0.009
2017	3.210	3.508	0.093	0.007	0.129	0.663	0.810	0.009
2018	2.889	3.815	0.088	0.007	0.108	0.579	0.857	0.008
Trend 1990-2018, %	-29.0	70.2	-51.1	-53.3	-78.2	623.8	-32.2	-60.0

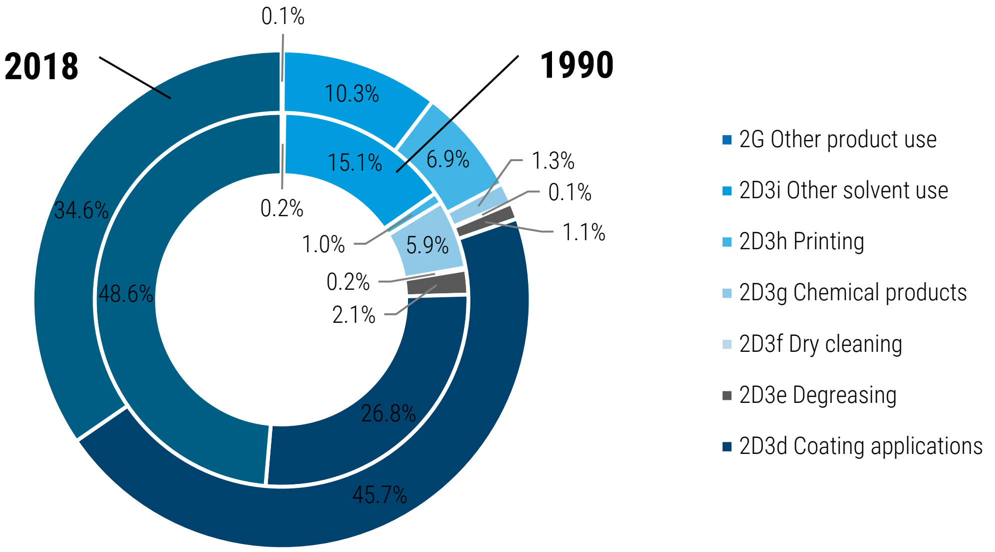

Figure 4.12 The share of NMVOC emissions in 1990 and 2018 by NFR solvent subcategory codes

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 (OSIS) 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 Table 4.21 together with emission sources not included in the inventory.

Table 4.21 Information sources for the NMVOC inventory in solvents sector
**PS – point sources*
**DS – diffuse sources*
**GB - Guidebook*

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
2D3a	Personal care, household cleaning agents, car care products, cosmetics and toiletries, adhesives and sealants, pharmaceutical products	060408	Domestic solvent use (other than paint application)	Statistics Estonia	DS: 2,59 kg/person/year (1990-2000, GB2007); EFs for the years 2001-2003 are interpolated; EFs from Tables 3.4 and 3.5 (2004-2018, GB2019)
		060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: EF from Table 3.5 (2004-2018, 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), 2007-2018 IEF from the PS; Table 3-7 in combination with Table 3-19 (1990-2007, GB2019, water based), 2008-2018 IEF from the PS; PS: facility specific
		060103	Construction and buildings	Statistics Estonia and expert estimate	DS: Tables 3-4 and 3-5 (1990-2018, GB2019, solvent based); Tables 3-4 and 3-5 in combination with Table 3-17 (1990-2018, GB2016, water based); 149.5 g/kg of paint applied (1990-2018, 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

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		060308	Inks manufacturing	Reported by operators (2007-2010)	PS: facility specific
		060309	Glues manufacturing	Reported by operators (2006-2014)	PS: facility specific
		060310	Asphalt blowing	Not occurring	NO
		060311	Adhesive, magnetic tapes, films and photographs manufacturing	Not included	NA
		060312	Textile finishing	Reported by operators (since 2006)	PS: facility specific
		060313	Leather tanning	Reported by operators (since 2006)	PS: facility specific
		060314	Other	Reported by operators (since 2006)	PS: facility specific
2D3h	Printing ink and solvents in printing houses	060403	Printing industry	Statistics Estonia; reported by operators (since 2001)	DS: Table 3-1 (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	Not included	NA

Emissions, other than NMVOC, are taken from the OSIS database (reported by operators and are facility specific), except emissions from fluorescent tubes, fireworks and tobacco use, where Tier 2 emission factors are taken from the EMEP/EEA Guidebook 2019.

The facilities that are obliged to have an ambient air pollution permit or IPPC permit, submit their annual air emissions and activity data into OSIS database by point sources. The ambient air pollution permit is required for facilities where 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 2017 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 4.22.

Table 4.22 Uncertainties in solvent and other product use sector

Pollutant	Emission, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	0.003414	kt	0.010	0.01%	0.0003%
NMVOC	5.218813	kt	23.460	9.33%	2.36%
SO_x	0.001424	kt	0.004	0.002%	0.0003%
NH_3	0.010505	kt	0.102	0.05%	0.01%
$PM_{2.5}$	0.073476	kt	0.797	0.40%	0.13%
PM_{10}	0.096088	kt	0.691	0.35%	0.11%
TSP	0.115668	kt	0.587	0.26%	0.02%
CO	0.106558	kt	0.077	0.04%	0.01%
Pb	0.367648	t	1.079	0.54%	0.09%
Cd	0.010519	t	1.309	0.66%	0.07%
Hg	0.004939	t	0.841	0.49%	0.07%
PCDD/F	0.000182	g I-TEQ	0.004	0.01%	0.001%
B(a)p	0.000202	t	0.009	0.02%	0.02%
B(b)f	0.000082	t	0.003	0.01%	0.01%
B(k)f	0.000082	t	0.006	0.01%	0.01%
I(1,2,3-cd)p	0.000082	t	0.005	0.01%	0.01%
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 4.23.

Table 4.23 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.

Category	Description
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 2018, NMVOC emissions from the NFR sector 2D3a had decreased by 29% compared to the year 1990.

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 4.24 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 4.24 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 4.25).

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 4.25 NMVOC and Hg emissions from domestic solvent use (other than paint application) and the population of Estonia in the period of 1990-2018

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	4134.571	14122.796	3752.046	766.440	1301.627
2005	1.3589	4619.914	14026.552	3711.227	766.440	1140.390
2006	1.3507	4593.534	13309.968	4076.885	440.920	1578.672
2007	1.3429	5035.226	14125.825	3525.030	2684.246	1499.403
2008	1.3384	5451.388	14697.239	3437.025	2372.177	1388.616
2009	1.3357	4418.794	14693.429	2833.510	2779.013	1087.816
2010	1.3333	3810.263	11815.882	3006.139	3103.142	1042.520
2011	1.3297	3029.784	17004.347	3244.642	3456.409	1512.685
2012	1.3252	3666.114	37906.788	2999.132	3734.204	2016.795
2013	1.3202	3862.264	15340.151	3030.801	4446.274	2304.206
2014	1.3158	3892.606	23952.504	4706.692	3304.468	2022.482
2015	1.3133	3851.297	34237.736	4021.843	2391.283	2272.225
2016	1.3159	3523.506	54517.063	2400.419	2797.990	2821.454
2017	1.3156	3272.336	60235.090	4745.382	3297.790	2044.741
2018	1.3191	5420.198	17550.693	4795.665	5418.211	1640.724

Table 4.25 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
2006	0.5834	0.2130	0.7338	0.0291	0.0311	0.2769	0.0918	0.2368	0.0648	2.2607
2007	0.6395	0.2260	0.6345	0.1772	0.0309	0.2753	0.0913	0.2249	0.0645	2.3640
2008	0.6923	0.2352	0.6187	0.1566	0.0308	0.2744	0.0910	0.2083	0.0642	2.3714
2009	0.5612	0.2351	0.5100	0.1834	0.0307	0.2738	0.0908	0.1632	0.0641	2.1124
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	0.4156	0.9638	0.8542	0.2177	0.0303	0.2697	0.0895	0.3067	0.0632	3.2105
2018	0.6884	0.2808	0.8632	0.3576	0.0303	0.2697	0.0895	0.2461	0.0632	2.8887

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 2018, NMVOC emissions from this sector had increased by 70.2% compared to 1990.

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 OSIS air emissions 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 OSIS 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 OSIS database has been available since 2006. The share of paint used in point sources against the entire amount of paint used in Estonia comprises between 4.5% in 2006 up to 24.3% in 2018. 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 4.26 provides an overview of emission factors used in calculating NMVOC emissions from coating application activities.

Table 4.26. 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 application = 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 2017 also depends upon the marketing policy, and
3. in the years 2004-2007, an increase in paint use was caused mainly by a rapid increase in developments and construction; the increased use of paint was caused mainly by professional painters and construction companies.

As a result of discussions, it is estimated that up to 60% of paint can be assigned to professional painters and the remaining 40% to private customers.

The Tier 2 emission factors of the EMEP/EEA Guidebook 2019 (see Table 4.26) 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 223.2 tonnes in 2018. 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 4.27) 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 4.27 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
WB	-	181	255	234	76	110	113	114	133	151	143	174
SB	569	443	448	341	349	332	364	421	449	456	453	443

Emissions

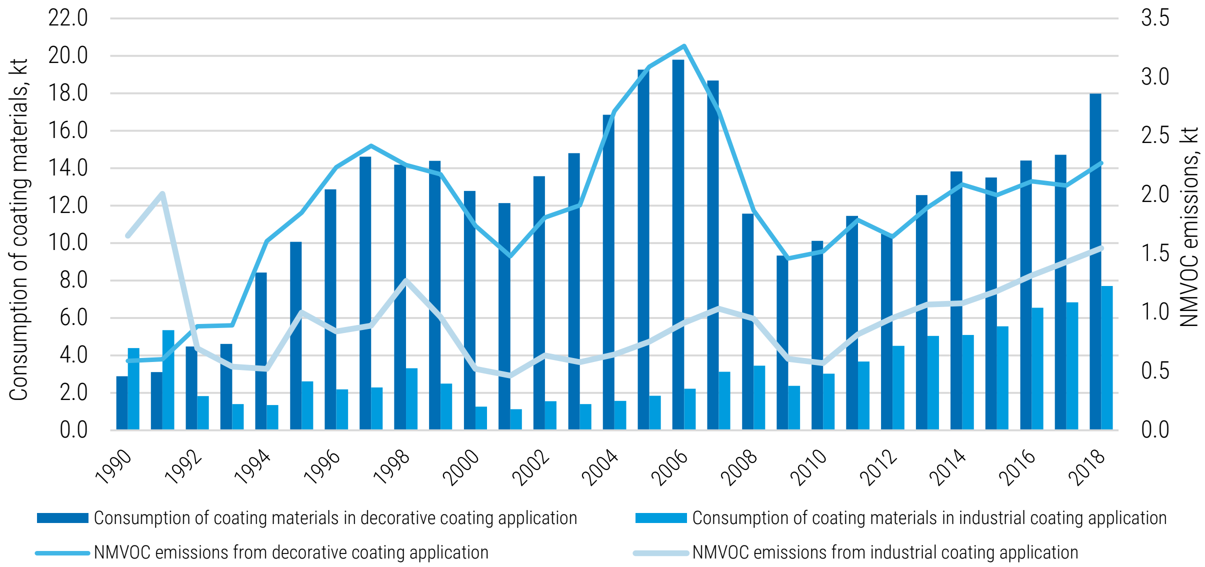

Figure 4.13 The consumption of coating materials and NMVOC emissions from decorative and industrial coating applications in the period of 1990-2018

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 4.28 NMVOC emissions and the consumption of coating materials from decorative paint application by SNAP codes in the period of 1990-2018 (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
2006	1.959	11.881	1.306	7.921
2007	1.626	11.205	1.084	7.470
2008	1.120	6.941	0.747	4.628
2009	0.876	5.598	0.584	3.732
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	10.784	0.908	7.189

Table 4.29 NMVOC emissions and consumption of coating materials from industrial paint application by SNAP codes in the period of 1990-2018 (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
2006	--	--	0.003	0.006	0.088	0.168	NA	NA	0.171	0.505	0.400	0.883	0.250	0.650
2007	--	--	0.002	0.002	0.089	0.147	NA	NA	0.357	1.126	0.437	1.191	0.147	0.659
2008	--	--	NA	NA	0.074	0.182	NA	NA	0.335	1.024	0.369	1.188	0.170	1.050
2009	--	--	NA	NA	0.061	0.186	NA	NA	0.160	0.477	0.299	1.362	0.084	0.343
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

NMVOC emissions presented in the Table 4.29 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 into the OSIS database.

For some years, the coating application sector also includes fine and 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.

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 emission data from the OSIS database are compared to the previous years to detect calculation errors, 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 OSIS database by operators are firstly checked by specialists from the Estonian Environmental Board and then by the specialists in the Estonian Environment Agency.

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 2018, NMVOC emissions from this sector had decreased by 51.2% 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;
- 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 4.30 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 4.30 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 4.31). The shares of different technologies within the pillar years have been interpolated (see Figure 4.14).

Table 4.31 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%

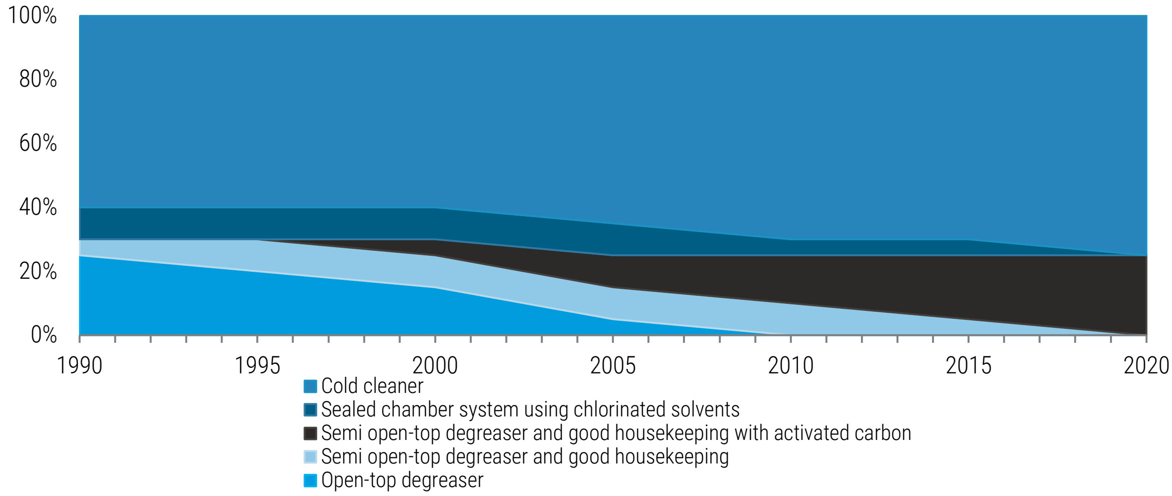

Figure 4.14 The shares of different technologies within the degreasing industry for the period of 1990-2020

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 1995-2018. 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 OSIS database provides some information regarding xylenes production between 2006 and 2018.

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 2018, the OSIS database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2018, 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 1990-2018 are presented in the Table 4.32.

Table 4.32 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2018

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
2006	0.048	0.388	0.002	0.003	0.018	0.056	0.005	0.006
2007	0.037	0.303	0.005	0.006	0.009	0.021	0.014	0.014
2008	0.023	0.229	0.001	0.001	0.013	0.026	0.032	0.038
2009	0.012	0.128	0.006	0.007	0.005	0.008	0.012	0.018
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

SNAP code	060200		060201		060203		060204	
Year	NMVOC (vapour and cold cleaning)	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
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

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 2000-2018.

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 emission data from the OSIS database are compared to previous years in order to detect calculation errors, 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 OSIS database by operators are firstly 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[15]; UBA, 1989[16]). Also, a significant amount of the solvent goes back to the producers and to the recyclers, along with the sludge.

[15] Passant N.R. (1993). Emissions of Volatile Organic Compounds from Stationary Sources in the United Kingdom: A Review of Emission Data by Process.
[16] UBA (1989). Luftreinhaltung '89 – Tendenzen – Probleme – Lösungen. Edited by the German Federal Protection Agency (Umweltbundesamt), Erich Schmidt Verlag GmbH, Berlin 1989.

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Solvent consumption data may be available from the industry and can be compared with a per capita emission factor. In addition, the proportion of solvent lost directly from the machine can also be estimated.

The Tier 1 default emission factors for NMVOC emissions from dry cleaning are a weighted average, calculated from the sum of all activity and emission data from the GAINS model (IIASA, 2008[17]) – 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 4.33.

Table 4.33 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.

[17] IIASA (2008). Greenhouse Gas and Air Pollution Integrations and Synergies (GAINS) model, www.iiasa.ac.at/rains/gains-online.html.

According to OSIS, no production of tetrachloroethylene/PER is reported for the years 2006-2018.

According to OSIS, 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.

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 4.34 NMVOC emissions and the consumption of solvents from dry cleaning in the period of 1990-2018 (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
2006	0.063	0.158
2007	0.054	0.131
2008	0.051	0.124
2009	0.022	0.052
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

For the dry cleaning sector for the years 1990 to 2001, only statistical data is used, whereas for the period of 2002 to 2018, 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 emission data from the OSIS database are compared to previous years in order to detect calculation errors, 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 OSIS database by operators are firstly 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 0.4% to the total national NMVOC emissions in 2018 and only 1.3% to the whole solvent sector.

By 2018, NMVOC emissions from the chemical products sector had decreased by 78.2% 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 2006-2018 from the chemical products sector are based on emission data reported by operators in the OSIS 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 2006-2018.

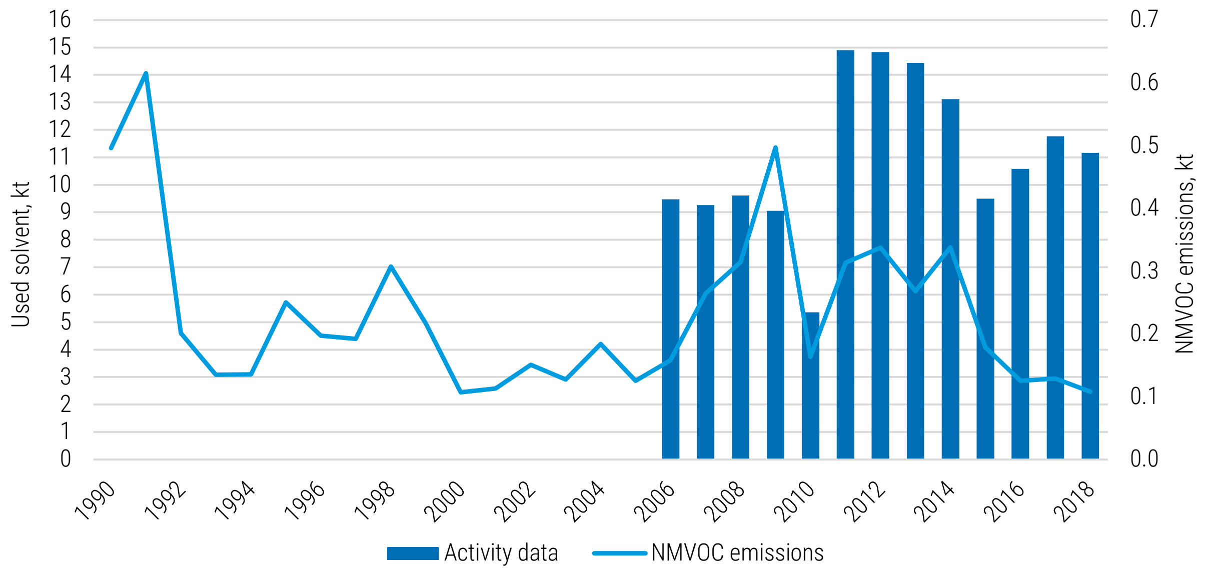

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 1990-2018

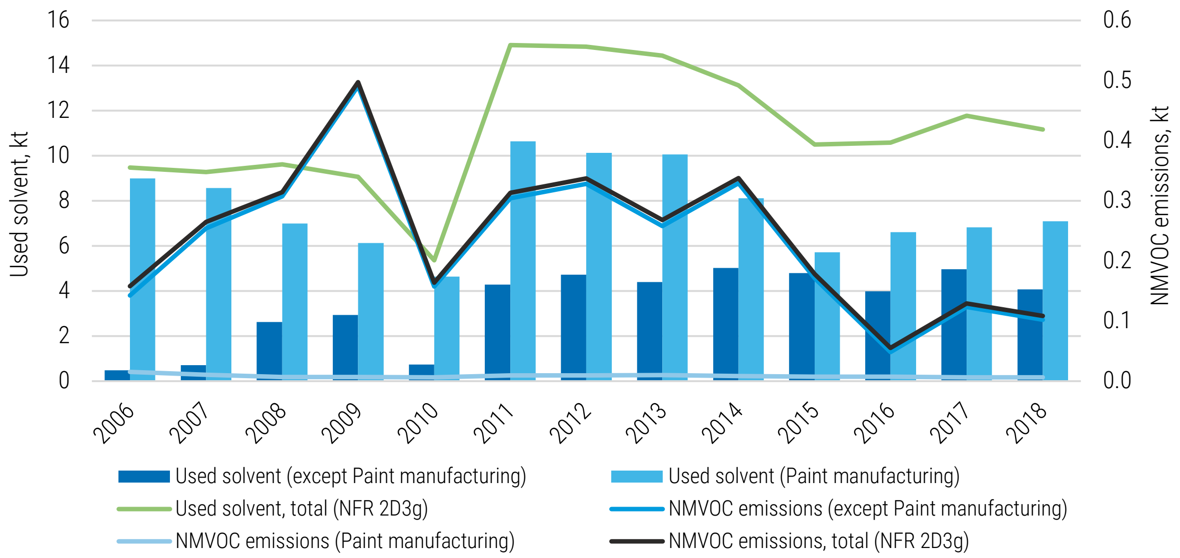

Figure 4.16 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 2006-2018

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 1990-2018 are presented in the Table 4.35.

Table 4.35 NMVOC emissions and the consumption of solvents from chemical products manufacturing or processing by SNAP codes in the period of 1990-2018 (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
2006	--	--	0.0014	NA	0.079	0.136	0.032	0.022	0.015	8.987
2007	--	--	0.0001	0.001	0.123	0.089	0.019	0.326	0.010	8.560
2008	--	--	0.0039	0.001	0.109	2.165	0.008	0.014	0.007	6.988
2009	--	--	0.0061	0.004	0.043	1.680	0.006	0.021	0.007	6.126
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

Table 4.35 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
2006	NA	NA	0.00198	0.088	0.001727	NA	0.00004	0.001	0.026	0.236
2007	0.0005	0.041	0.00154	NA	0.000154	NA	0.00004	0.001	0.111	0.248
2008	0.0007	0.053	0.00064	NA	0.000005	NA	0.00006	0.003	0.186	0.383
2009	0.0003	0.026	0.00045	0.001	0.000002	NA	0.00025	0.008	0.434	1.187
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

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. Emission data from the OSIS database is 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. The data reported and entered into the OSIS database by operators are firstly 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 2018, NMVOC emissions from the NFR 2D3h sector had increased by 626.5% compared to the year 1990.

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 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[18], 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 (1995-2018). 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 2018, activity data regarding ink use in point sources were collected in the OSIS 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 4.36 NMVOC emissions and the consumption of solvents from the printing industry by SNAP code in the period of 1990-2018 (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
2006	0.658	1.745
2007	0.454	2.015
2008	0.766	2.317
2009	0.206	1.663
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	0.579	2.701

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

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. Emission data from the OSIS database 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. The data reported and entered into the OSIS database by operators are firstly checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

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[19]).

In 2018, NMVOC emissions from the NFR 2D3i sector had decreased by 32.2% 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 4.38.

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

[19] 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.

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[20] for the period of 1990-2000, 522 g/kg adhesive[21] for the period of 2005 and onward. The emission factors for the period of 2001-2004 are interpolated.

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 and Eurostat. Production data are available from the OSIS database for the years 2006-2018. 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 2018, activity data regarding adhesives use in point sources are collected in the OSIS database (SNAP 060405).

For the years 2006-2018, 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[22]). 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

[20] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[21] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019
[22] 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.

(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 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 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 4.37 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 2000-2018 are gathered from OSIS and CollectER databases, and are reported by operators.

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4.2.11.3. Results

Table 4.38 NMVOC emissions from other solvent use and the activity data by SNAP codes in the period of 1990-2018

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
2006	--	--	0.0018	NA	1.517	3.353	0.00306	0.069	NO	--	0.028	0.238
2007	--	--	0.0017	NA	1.177	3.903	0.01457	0.029	NO	--	0.005	0.289
2008	--	--	0.0017	NA	1.068	2.516	0.00736	0.017	NO	--	0.020	0.353
2009	--	--	0.0016	NA	0.736	1.794	0.01376	0.026	NO	--	0.013	0.052
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

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 emission data from the OSIS database 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. The data reported and entered into the OSIS database by operators are firstly checked by specialists from the Environmental Board and then by specialists in 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 4.39).

Table 4.39 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 4.40).

Table 4.40 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	kg/t tobacco
PM_{10}	27.0	kg/t tobacco
$PM_{2.5}$	27.0	kg/t tobacco
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	g/t tobacco
Ni	2.7	g/t tobacco
Zn	2.7	g/t tobacco
Cu	5.4	g/t tobacco

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 1990-2018 are presented in Table 4.41.

Table 4.41 The use of fireworks and pollutant emissions in the period of 1990-2018

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
2006	388.849	1.174	2.780	0.101	42.707	38.854	20.197
2007	492.507	1.487	3.521	0.128	54.092	49.211	25.581
2008	313.097	0.946	2.239	0.081	34.387	31.285	16.262
2009	127.661	0.386	0.913	0.033	14.021	12.756	6.631
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
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

Table 4.41 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
2006	388.849	0.517	0.575	6.066	172.649	0.022	11.665	304.858	101.101
2007	492.507	0.655	0.729	7.683	218.673	0.028	14.775	386.125	128.052
2008	313.097	0.416	0.463	4.884	139.015	0.018	9.393	245.468	81.405
2009	127.661	0.170	0.189	1.992	56.681	0.007	3.830	100.086	33.192
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

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 1990-2018 are presented in Table 4.42.

Table 4.42 The use of tobacco and pollutant emissions from tobacco combustion in the period of 1990-2018

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	0.112	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	0.053	0.053	0.053	0.024	0.0002
2005	2.598	0.013	0.005	0.143	0.011	0.070	0.070	0.070	0.032	0.0003
2006	2.461	0.012	0.004	0.136	0.010	0.066	0.066	0.066	0.030	0.0002
2007	3.552	0.017	0.006	0.196	0.015	0.096	0.096	0.096	0.043	0.0004
2008	1.548	0.007	0.003	0.085	0.006	0.042	0.042	0.042	0.019	0.0002
2009	2.389	0.012	0.004	0.132	0.010	0.064	0.064	0.064	0.029	0.0002
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	0.051	0.051	0.051	0.023	0.0002
2012	1.798	0.009	0.003	0.099	0.007	0.049	0.049	0.049	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	0.051	0.051	0.051	0.023	0.0002
2015	1.879	0.009	0.003	0.104	0.008	0.051	0.051	0.051	0.023	0.0002
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	0.049	0.049	0.049	0.022	0.0002
2018	1.656	0.008	0.003	0.091	0.007	0.045	0.045	0.045	0.020	0.0002

Table 4.42 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	22.490	11.245	11.245	22.490
1995	2.218	0.246	0.100	0.100	0.100	11.980	5.990	5.990	11.980
2000	1.949	0.216	0.088	0.088	0.088	10.524	5.262	5.262	10.524
2005	2.598	0.288	0.117	0.117	0.117	14.027	7.013	7.013	14.027
2006	2.461	0.273	0.111	0.111	0.111	13.291	6.645	6.645	13.291
2007	3.552	0.394	0.160	0.160	0.160	19.182	9.591	9.591	19.182
2008	1.548	0.172	0.070	0.070	0.070	8.358	4.179	4.179	8.358
2009	2.389	0.265	0.107	0.107	0.107	12.899	6.449	6.449	12.899
2010	1.231	0.137	0.055	0.055	0.055	6.647	3.324	3.324	6.647
2011	1.884	0.209	0.085	0.085	0.085	10.173	5.087	5.087	10.173
2012	1.798	0.200	0.081	0.081	0.081	9.710	4.855	4.855	9.710
2013	1.825	0.203	0.082	0.082	0.082	9.854	4.927	4.927	9.854
2014	1.880	0.209	0.085	0.085	0.085	10.150	5.075	5.075	10.150
2015	1.879	0.209	0.085	0.085	0.085	10.145	5.072	5.072	10.145
2016	1.903	0.211	0.086	0.086	0.086	10.275	5.138	5.138	10.275
2017	1.819	0.202	0.082	0.082	0.082	9.825	4.912	4.912	9.825
2018	1.656	0.184	0.075	0.075	0.075	8.941	4.470	4.470	8.941

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 lubricants and aeroplane de-icing agents into the inventory as soon as the activity data becomes available for the inventory team.

Source: www.public.delfi.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

NFR	Source	Description	Emissions reported	Method
3Df	Use of pesticides	According to Estonian National Implementation Plan Under the Stockholm Convention[23] most organochlorine pesticides either were not used at all (Aldrin, Chlordane, DDT, Dieldrin, Endrin, Hetachlor) or were discontinued before 1990 years (Toxaphene, HCB). Lindane was used only for seed treatment. The use of organochlorine pesticides has been banned in Estonia since 1999.	NO	
3F	Field burning of agricultural residues	Since 2004, the burning of crop residues was prohibited	NO	

The share of agricultural sources in total emissions in 2018 was as follows: NO_x – 7.5%, NH_3 – 88.5%, NMVOC – 21.8%, and TSP – 9%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 49.2%, 50.9%, 57.4% and 52.8% 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 2018, NMVOC, $PM_{2.5}$, and NO_x emissions increased by 2.8%, 2.5%, and 4% respectively when compared to the results for 2017, mainly due to an increase in the number of non-dairy cattle. 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 10% when compared to 2014's figures for Estonia as a result of an outbreak of African swine fever.

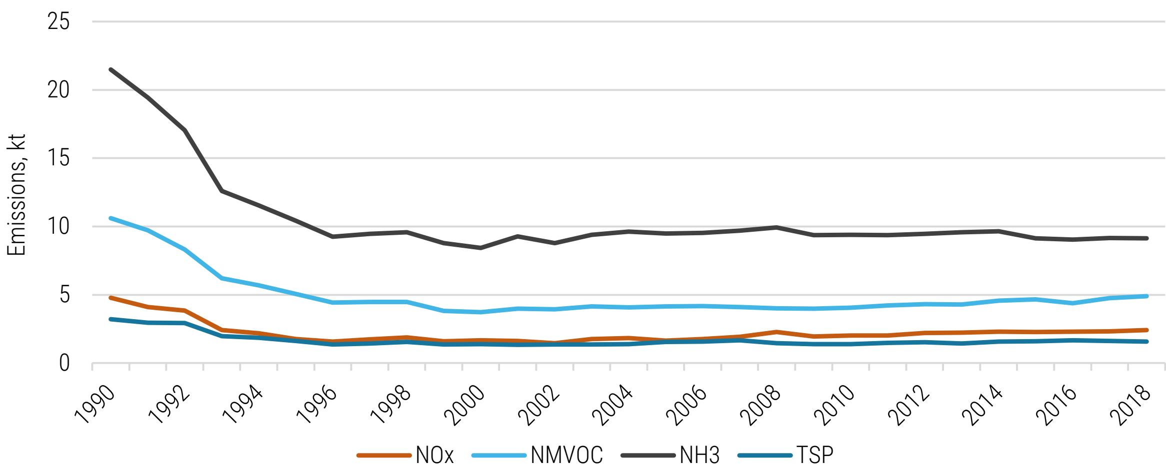

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector in the period of 1990-2018 (kt)

[23] http://chm.pops.int/Implementation/NationalImplementationPlans/NIPTransmission/tabid/253/Default.aspx
[24] Estonian University of Life Sciences. (2011). Maaelu arengu aruanne.

Table 5.2 Total emissions from the agriculture sector in the period of 1990-2018 (kt)

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
1990	4.773	10.601	21.484	3.210	NR	NR
1991	4.111	9.718	19.440	2.951	NR	NR
1992	3.851	8.305	17.032	2.927	NR	NR
1993	2.409	6.207	12.587	1.971	NR	NR
1994	2.175	5.686	11.546	1.859	NR	NR
1995	1.768	5.058	10.422	1.620	NR	NR
1996	1.583	4.431	9.255	1.354	NR	NR
1997	1.731	4.485	9.449	1.437	NR	NR
1998	1.876	4.485	9.577	1.544	NR	NR
1999	1.606	3.830	8.788	1.367	NR	NR
2000	1.656	3.716	8.427	1.392	0.111	0.939
2001	1.619	3.977	9.261	1.348	0.108	0.825
2002	1.464	3.947	8.785	1.357	0.106	0.867
2003	1.766	4.144	9.399	1.362	0.108	0.866
2004	1.821	4.075	9.635	1.393	0.109	0.902
2005	1.639	4.154	9.472	1.541	0.111	1.065
2006	1.769	4.159	9.532	1.561	0.113	1.107
2007	1.916	4.092	9.695	1.656	0.110	1.176
2008	2.273	4.018	9.930	1.444	0.106	0.986
2009	1.954	3.971	9.366	1.375	0.101	0.906
2010	2.008	4.064	9.389	1.397	0.103	0.925
2011	2.009	4.209	9.359	1.471	0.108	1.003
2012	2.195	4.312	9.461	1.527	0.110	1.037
2013	2.238	4.296	9.583	1.437	0.106	0.967
2014	2.294	4.562	9.647	1.571	0.115	1.072
2015	2.285	4.653	9.128	1.605	0.119	1.123
2016	2.307	4.382	9.045	1.664	0.121	1.227
2017	2.328	4.752	9.167	1.609	0.109	1.167
2018	2.424	4.893	9.134	1.577	0.112	1.160
Trend 1990-2018, %	-49.2	-53.8	-57.5	-50.9	0.8	23.5

More than half of NH_3 emissions comes from the agricultural soil sector (including animal manure application to soils and grazing) – 51% – and 49% 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).

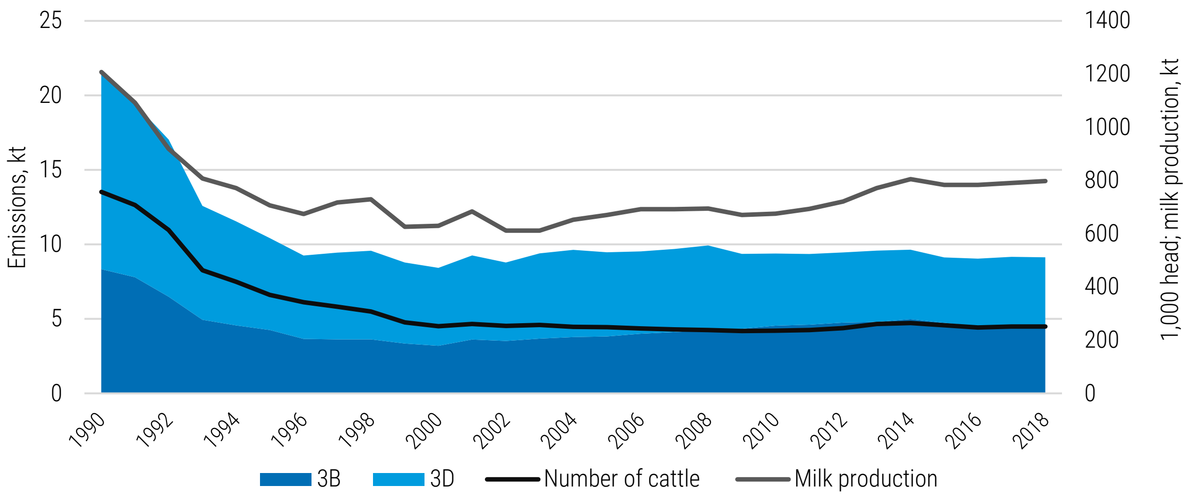

Figure 5.2 NH_3 emission distributions by the agriculture sector activities in the period of 1990-2018

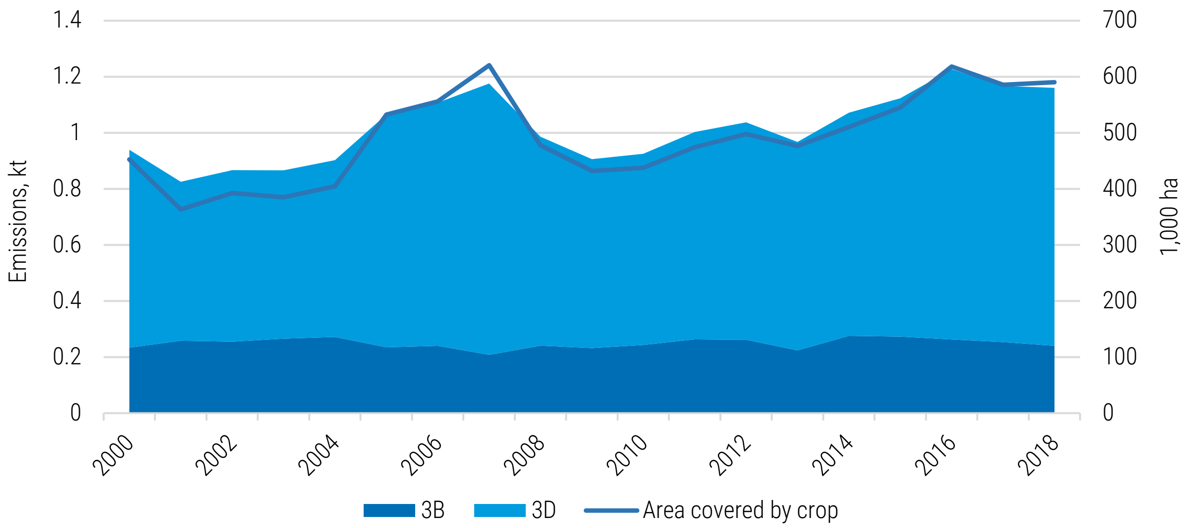

Figure 5.3 PM_{10} emissions from livestock (3B) and agricultural soils (3D) in in the period of 2000-2018

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 2018. 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 cattle-dairy, cattle non-dairy, laying hens, boilers, other poultry and swine animal manure applied to soils are reported under NFR 3D2a, and emissions from grazing under NFR 3Da3.

(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.

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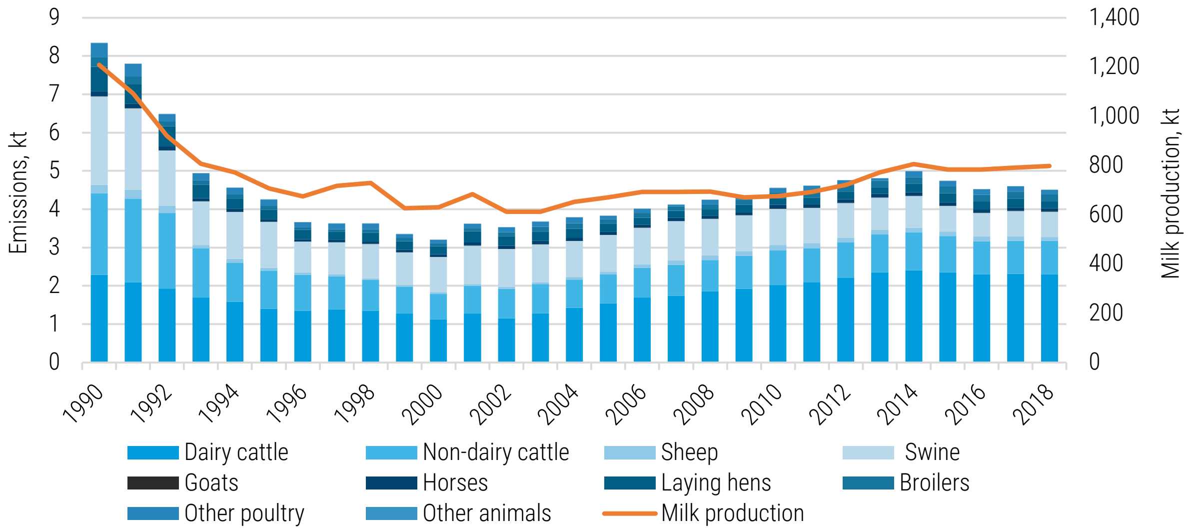

Figure 5.4 NH_3 emissions from manure management in the period of 1990-2018

During the period of 1990–2018, the emission of NH_3 decreased by 46% (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 1990-2018 the annual average nitrogen production per head of dairy cattle was increased by 46%.

In 2018, ammonia emissions decreased by 2% in comparison to 2017 figures, due to the decrease in the numbers of dairy cattle, sheep, poultry and fur animals during the same period.

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

Table 5.3 Total emissions of NO_x from manure management in the period of 1990-2018 (kt)

Year	Dairy cattle*	Non-dairy cattle*	Sheep	Swine *	Goats	Horses	Laying hens*	Broilers*	Other poultry*	Other animals
1990	0.070	0.034	0.001	0.006	0.00002	0.002	0.011	0.006	0.004	0.00007
1995	0.043	0.018	0.000	0.004	0.00002	0.001	0.004	0.003	0.002	0.00004
2000	0.035	0.012	0.000	0.004	0.00003	0.001	0.004	0.002	0.001	0.00002
2005	0.029	0.013	0.000	0.004	0.00003	0.001	0.004	0.003	0.001	0.00004
2006	0.028	0.013	0.001	0.004	0.00003	0.001	0.003	0.003	0.001	0.00003
2007	0.025	0.013	0.001	0.004	0.00004	0.001	0.003	0.003	0.000	0.00004
2008	0.024	0.013	0.001	0.004	0.00004	0.001	0.003	0.003	0.001	0.00003
2009	0.022	0.014	0.001	0.004	0.00004	0.001	0.003	0.003	0.001	0.00003
2010	0.020	0.014	0.001	0.004	0.00004	0.001	0.003	0.004	0.001	0.00003
2011	0.017	0.013	0.001	0.004	0.00004	0.001	0.003	0.004	0.001	0.00003
2012	0.015	0.013	0.001	0.003	0.00005	0.001	0.003	0.004	0.001	0.00003
2013	0.013	0.014	0.001	0.002	0.00005	0.001	0.003	0.004	0.001	0.00003
2014	0.010	0.013	0.001	0.002	0.00004	0.001	0.004	0.004	0.001	0.00003
2015	0.007	0.012	0.001	0.001	0.00004	0.001	0.004	0.004	0.001	0.00003
2016	0.007	0.010	0.001	0.001	0.00005	0.001	0.004	0.004	0.001	0.00002
2017	0.007	0.010	0.001	0.001	0.00005	0.001	0.004	0.005	0.001	0.00002
2018	0.007	0.010	0.001	0.001	0.00005	0.001	0.003	0.005	0.001	0.00001
Trend 1990-2018, %	-90.4	-69.9	-53.5	-81.6	150.0	-33.5	-72.6	-25.6	-67.5	-85.7

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

Table 5.4 Total emissions of NMVOC from manure management in the period of 1990-2018(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
2006	1.667	1.214	0.019	0.372	0.002	0.038	0.105	0.106	0.180	0.201
2007	1.626	1.224	0.023	0.393	0.003	0.041	0.106	0.103	0.062	0.231
2008	1.614	1.224	0.025	0.376	0.003	0.041	0.091	0.111	0.193	0.177
2009	1.595	1.228	0.025	0.380	0.003	0.042	0.106	0.117	0.154	0.201
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	0.098
2018	2.299	1.484	0.020	0.320	0.003	0.044	0.100	0.157	0.200	0.080
Trend 1990-2018, %	-26.9	-65.1	-53.9	-100.0	148.1	-33.7	-72.7	-25.6	-67.5	-82.0

Table 5.5 Total emissions of NH_3 from manure management in the period of 1990-2018 (kt)

Year	Dairy cattle*	Non-dairy cattle *	Sheep	Swine*	Goats	Horses	Laying hens*	Broilers*	Other poultry	Other animals
1990	2.291	2.124	0.222	2.308	0.003	0.127	0.643	0.240	0.376	0.005
1995	1.399	0.996	0.078	1.198	0.003	0.068	0.239	0.106	0.168	0.003
2000	1.127	0.659	0.047	0.920	0.005	0.062	0.209	0.076	0.094	0.001
2005	1.545	0.751	0.078	0.955	0.004	0.071	0.210	0.127	0.084	0.003
2006	1.692	0.778	0.096	0.949	0.005	0.073	0.184	0.121	0.110	0.002
2007	1.739	0.809	0.114	1.027	0.006	0.078	0.186	0.118	0.038	0.002
2008	1.854	0.815	0.126	0.956	0.006	0.078	0.159	0.127	0.118	0.002
2009	1.920	0.858	0.128	0.938	0.007	0.080	0.186	0.133	0.094	0.002
2010	2.017	0.910	0.134	0.951	0.007	0.101	0.167	0.149	0.113	0.002
2011	2.088	0.896	0.132	0.918	0.007	0.096	0.164	0.160	0.153	0.002
2012	2.205	0.927	0.127	0.901	0.008	0.092	0.200	0.156	0.136	0.002
2013	2.358	0.984	0.116	0.845	0.007	0.093	0.171	0.168	0.057	0.002
2014	2.403	0.992	0.120	0.828	0.006	0.093	0.217	0.172	0.151	0.002
2015	2.357	0.939	0.120	0.667	0.007	0.093	0.238	0.170	0.142	0.002
2016	2.303	0.862	0.128	0.610	0.008	0.084	0.210	0.175	0.139	0.001
2017	2.311	0.863	0.113	0.661	0.007	0.084	0.237	0.179	0.142	0.001
2018	2.300	0.875	0.102	0.660	0.007	0.084	0.176	0.179	0.122	0.001
Trend 1990-2018, %	0.4	-58.8	-53.9	-71.4	147.6	-33.7	-72.7	-25.6	-67.5	-82.0

** 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 2000-2018 (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
2001	0.053	0.018	0.001	0.002	0.0001	0.001	0.003	0.001	0.007	0.0003
2002	0.047	0.019	0.001	0.002	0.0001	0.001	0.003	0.002	0.008	0.0003
2003	0.048	0.019	0.001	0.002	0.0001	0.001	0.002	0.002	0.009	0.0004
2004	0.048	0.019	0.001	0.002	0.0001	0.001	0.003	0.002	0.010	0.0004
2005	0.046	0.019	0.001	0.002	0.0001	0.001	0.002	0.002	0.006	0.0005
2006	0.044	0.019	0.001	0.002	0.0001	0.001	0.002	0.002	0.007	0.0004
2007	0.042	0.020	0.002	0.002	0.0001	0.001	0.002	0.002	0.003	0.0005
2008	0.041	0.020	0.002	0.002	0.0001	0.001	0.002	0.002	0.008	0.0004
2009	0.040	0.020	0.002	0.002	0.0001	0.001	0.002	0.002	0.006	0.0004
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
Trend 2000-2018, %	-34.9	43.0	119.4	-12.8	37.5	35.6	-15.9	135.4	30.7	-15.0

Table 5.7 Total emissions of PM_{10} from manure management in the period of 2000-2018 (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
2001	0.081	0.028	0.002	0.041	0.0003	0.001	0.040	0.014	0.050	0.0005
2002	0.073	0.030	0.002	0.040	0.0003	0.001	0.033	0.018	0.057	0.0006
2003	0.074	0.030	0.002	0.040	0.0003	0.001	0.032	0.022	0.063	0.0008
2004	0.073	0.029	0.003	0.038	0.0002	0.001	0.034	0.023	0.069	0.0008
2005	0.071	0.030	0.003	0.039	0.0002	0.001	0.029	0.021	0.039	0.0010
2006	0.068	0.030	0.004	0.039	0.0002	0.001	0.026	0.020	0.052	0.0008
2007	0.065	0.030	0.005	0.043	0.0003	0.001	0.026	0.019	0.018	0.0010
2008	0.063	0.030	0.005	0.042	0.0003	0.001	0.022	0.021	0.055	0.0007
2009	0.061	0.030	0.005	0.041	0.0003	0.001	0.026	0.022	0.044	0.0008
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
Trend 2000-2018, %	**-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 2016 as the last available version at the time of inventory preparation, 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 2016 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 2018 was 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 2016, 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

NFR	NO_x slurry	NO_x solid	NMVOC	NH_3 slurry	NH_3 solid	$PM_{2.5}$	PM_{10}	TSP
	kg/capita							
Cattle dairy	0.011	0.236	17.937	39.300	28.700	0.410	0.630	1.380
Cattle non-dairy	0.003	0.144	8.902	13.400	9.200	0.180	0.270	0.590
Calves						0.100	0.160	0.340
Sheep		0.008	0.279		1.400	0.020	0.060	0.140
Goats		0.008	0.624		1.400	0.017	0.056	0.139
Horses		0.201	7.781		14.800	0.140	0.220	0.480
Fattening pigs	0.002	0.069	0.551	6.700		0.060	0.340	0.750
Weaners						0.020	0.100	0.210
Sows	0.006	0.204	1.704	15.800		0.120	0.040	1.530
Laying hens		0.005	0.165		0.480	0.003	0.040	0.190
Broilers		0.002	0.108		0.220	0.002	0.020	0.040
Turkeys		0.008	0.489		0.950	0.020	0.110	0.110
Ducks		0.004	0.489		0.680	0.020	0.140	0.140
Geese		0.002	0.489		0.350	0.030	0.240	0.240
Fur animals		0.000	1.941		0.020	0.004	0.008	0.018

The Tier 2 methods from the EMEP/EEA Guidebook 2016 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 5.11) and the emission factor from the EMEP/EEA Guidebook 2016 (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 2016 were used to calculate NH3 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 2016 were used to calculate NO and NH3 emissions from manure management and NH3 emissions from urine and dung deposited by grazing animals (NFR 3Da3), and from animal manure applied to soils (NFR 3D2a) by boilers,

[26] Estonian GHG National Inventory Report 2020, Ch. 5 Agriculture (CFR 3)

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 Tables5.11-5.12.

NH_3 emission from dairy cattle, non-dairy cattle, broilers, laying hens, other poultry and swine 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 5.10-5.11. 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 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 5.17).

According to the EMEP/EEA Guidebook 2016, there are different emissions factors for housing, manure storage, and grazing (see Table 5.18).

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock in 1990-2018[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
2006	107.6	106,945
2007	108.1	108,770
2008	109.8	110,960
2009	110.5	111,690
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

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

[27] Estonian GHG National Inventory Report 2020, Ch. 5 Agriculture (CFR 3)
[28] https://www.riigiteataja.ee/akt/122122016004
[29] https://www.riigiteataja.ee/akt/122122016004

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

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 Estonian, Latvian, & Lithuanian Environment Ltd[30]. For further insight regarding leakage and N-excretion estimations, see the Estonian GHG National Inventory Report 2019.

Table 5.13 Manure management system usage for swine and cattle in 1990, 1995, 2000, 2005, 2010, 2015 and 2018[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
	2018	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
	2018	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
	2018	0.0	0.0	0.0	0.0	4.8	29.1	14.0	44.3	44.3

[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

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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

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	0.200	0.066	0.200	0.270	0	0.008	0.550	0.79	0.100
Other cattle	0.200	0.190	0.200	0.270	0	0.008	0.550	0.79	0.600
Fattening pigs	0.280	0.270	0.140	0.450	0	0.008	0.400	0.81	0.000
Sows	0.220	0.025	0.140	0.450	0	0.008	0.290	0.81	0.000

Activity data

Information regarding the numbers of livestock in agriculture is available from Statistics Estonia (www.stat.ee) for the years 1990-2018. 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
2006	108.4	136.4	68.6	3.6	4.9	308.4	37.4	637.6	980.9	369.0	71.0
2007	103.0	137.5	81.1	4.5	5.3	343.3	35.7	643.3	956.0	125.9	80.1
2008	100.4	137.5	90.2	4.2	5.3	330.8	34.1	550.1	1 031.0	395.6	78.6
2009	96.7	138.0	91.2	4.6	5.4	331.0	34.1	644.8	1 083.2	314.4	90.6
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

5.2.3. Uncertainty

An uncertainty analysis was carried out for the 2017 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, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	2.3	kt	7.0	0.048	0.004
NMVOC	5.1	kt	22.8	0.122	0.020
NH_3	9.0	kt	87.7	0.382	0.100
$PM_{2.5}$	0.1	kt	8.0	0.006	0.001
PM_{10}	1.2	kt	1.2	0.066	0.019
TSP	1.6	kt	8.0	0.049	0.003

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.

The share of agricultural soils in the total NH_3 emissions in 2018 was at 44.8%.

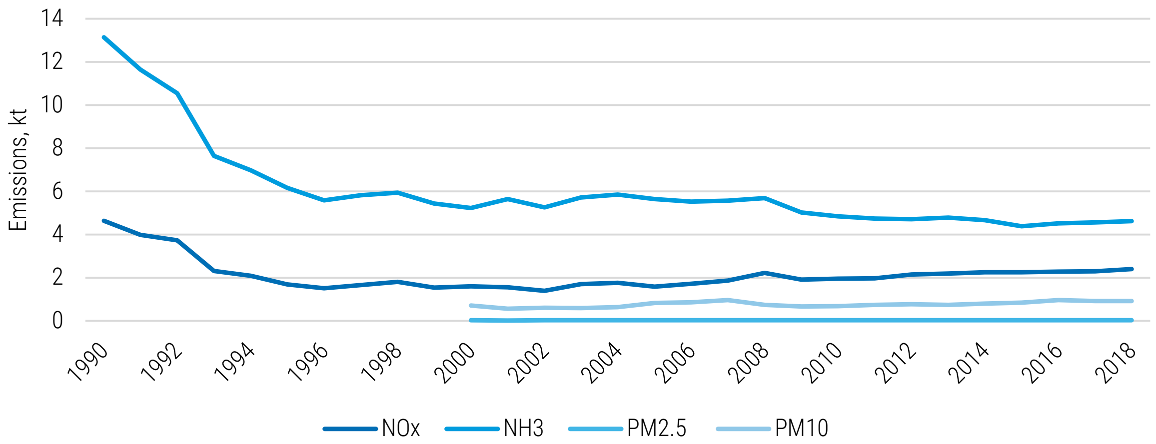

Figure 5.5 NOx, NH_3 and PM_{10} emissions from agricultural soils in the period of 1990-2018

During the 1990-2018 period, emissions of NH_3 decreased to 64.8% (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 2018, NH_3 emissions increased by 1% 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 1990-2018 (kt)

Year	NOx	NMVOC	NH_3	$PM_{2.5}$
1990	4.639	0.606	13.145	NR
1995	1.693	0.298	6.165	NR
2000	1.598	0.293	5.227	0.027
2005	1.584	0.245	5.645	0.032
2006	1.715	0.254	5.523	0.033
2007	1.865	0.281	5.578	0.037
2008	2.222	0.162	5.688	0.029
2009	1.905	0.120	5.021	0.026
2010	1.959	0.123	4.839	0.026
2011	1.964	0.151	4.743	0.028
2012	2.153	0.136	4.706	0.030
2013	2.200	0.101	4.782	0.029
2014	2.258	0.121	4.661	0.031
2015	2.253	0.147	4.392	0.033
2016	2.278	0.216	4.526	0.037
2017	2.298	0.181	4.568	0.035
2018	2.395	0.184	4.628	0.035
Trend 1990-2018, %	-48.4	-69.5	-64.8	30.4

Table 5.20 NH_3 emissions from agricultural soils in the period 1990-2018 (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	8.897	0.011	0.010	0.585
1995	0.982	4.856	0.010	0.013	0.304
2000	1.145	3.838	0.010	0.028	0.207
2005	1.085	4.200	0.009	0.137	0.214
2006	1.174	4.013	0.009	0.142	0.184
2007	1.338	3.799	0.009	0.281	0.151
2008	1.783	3.513	0.009	0.262	0.120
2009	1.379	3.242	0.009	0.300	0.092
2010	1.432	3.026	0.009	0.285	0.086
2011	1.491	2.956	0.009	0.195	0.092
2012	1.439	2.940	0.009	0.217	0.101
2013	1.486	2.906	0.009	0.268	0.114

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

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
2014	1.562	2.780	0.009	0.188	0.122
2015	1.583	2.458	0.009	0.219	0.123
2016	1.588	2.501	0.009	0.298	0.130
2017	1.633	2.548	0.009	0.247	0.131
2018	1.701	2.468	0.009	0.317	0.133
Trend 1990-2018, %	-53.3	-72.3	-16.0	3 095.3	-77.2

Table 5.21 NO_x emissions from agricultural soils in the period 1990-2018 (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	1.337	0.003	0.005	0.426
1995	0.756	0.729	0.003	0.007	0.199
2000	0.896	0.550	0.003	0.014	0.136
2005	0.803	0.567	0.003	0.068	0.143
2006	0.904	0.611	0.003	0.071	0.125
2007	0.999	0.616	0.003	0.141	0.106
2008	1.418	0.583	0.003	0.131	0.088
2009	1.093	0.588	0.003	0.150	0.071
2010	1.145	0.601	0.003	0.143	0.068
2011	1.192	0.599	0.003	0.098	0.073
2012	1.319	0.643	0.003	0.109	0.080
2013	1.346	0.626	0.003	0.134	0.091
2014	1.432	0.631	0.003	0.094	0.098
2015	1.451	0.591	0.003	0.110	0.099
2016	1.456	0.565	0.003	0.149	0.106
2017	1.493	0.565	0.003	0.123	0.114
2018	1.555	0.569	0.003	0.158	0.110
Trend 1990-2018, %	-45.8	-57.4	-16.0	3 095.3	-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 2016 as the last available version at the time of inventory preparation.

For calculating NMVOC emissions from cultivated crops sector, the Tier 2 methodology was used instead of Tier 1 for the first time. Detailed sector by sector explanations concerning the recalculations are presented in Chapter 8.

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

The Tier 1 method uses readily available statistical data (see Table 5.23) 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
	NMVOC	kg ha^{-1}	0.860
	NMVOC	kg wheat ha^{-1}	0.110
	NMVOC	kg rye ha^{-1}	0.050
	NMVOC	kg rape ha^{-1}	0.130
	NMVOC	kg grass ha^{-1}	0.100

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 1990-2018.

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 2014-2018 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 5.23 Active data for agricultural soil sector in the period of 1990-2018

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	…	6,775	1,571
1995	18,905	873.0	415,952	32,000	38,600	600.0	…	8,899	1,448
2000	22,396	592.9	452,538	28,900	68,900	28,800	…	19,010	1,401
2005	20,083	1 919.7	532,319	7,400	85,400	46,600	143,400	93,578	1,359
2006	22,610	1 041.1	556,083	7,300	90,900	62,500	137,300	97,332	1,351
2007	24,982	2 117.5	620,449	16,800	99,500	73,600	146,000	192,256	1,343
2008	35,455	251.7	477,786	21,400	107,600	77,700	123,500	179,204	1,338
2009	27,328	304.0	432,051	15,300	113,600	82,100	124,300	204,876	1,336
2010	28,628	10.3	437,302	12,600	119,400	98,200	107,400	195,002	1,333
2011	29,803	14.6	474,102	13,300	128,400	89,000	111,100	133,383	1,336
2012	32,978	35.4	497,269	16,900	124,300	87,100	159,300	148,362	1,325
2013	33,659	498.9	476,623	11,500	124,200	86,100	189,200	183,237	1,320
2014	35,803	31.7	510,317	15,400	154,400	80,000	172,300	128,368	1,316
2015	36,276	37.9	545,010	14,300	169,700	70,800	172,300	149,984	1,313
2016	36,390	34.5	617,919	12,400	164,500	70,100	172,300	203,611	1,316
2017	37,333	139.5	585,712	13,300	169,700	73,800	172,300	168,825	1,316
2018	38,867	181.2	589,894	13,300	169,700	73,800	172,300	216,483	1,319

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2017 inventory. 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 OSIS 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
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

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The waste sector in the emission inventory is mostly an insignificant sector, except dioxins emissions, which in 2018 comprised about 32.3% of the total dioxins emissions. Over the years that share has been decreasing, reaching the peak of 44.9% in 2002. The main reason for that decrease is over 3 times less unintentional car and building fires in 2018 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 2017 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, 2017	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2017, %
NO_x	0.020327	kt	0.061	0.03	0.001
NMVOC	0.318225	kt	1.431	1.24	0.22
SO_x	0.008062	kt	0.021	0.01	0.001
NH_3	0.060448	kt	0.589	0.29	0.14
$PM_{2.5}$	0.085736	kt	0.930	0.68	0.47
PM_{10}	0.101042	kt	0.726	0.51	0.12
TSP	0.117183	kt	0.595	0.42	0.03
CO	0.011325	kt	0.008	0.003	0.002
Pb	0.341141	t	1.001	1.00	0.10
Cd	0.011503	t	1.431	1.39	0.15
Hg	0.021513	t	3.664	1.88	0.18
PCDD/F	1.606176	g I-TEQ	37.213	57.79	29.80
B(a)p	0.000014107	t	0.001	0.001	0.001
B(b)f	0.000010058	t	0.0004	0.001	0.001
B(k)f	0.000010052	t	0.001	0.002	0.001
I(1,2,3-cd)p	0.000000056	t	0.000004	0.00001	0.00001
HCB	0.007763	kg	2.507	5.31	22.54
PCBs	0.020672	kg	0.410	0.53	0.14

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 2018, 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

[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

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 1990-2018

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
2006	0.239	NE	0.016	0.108	0.227
2007	0.225	0.036	0.017	0.115	0.243
2008	0.220	0.038	0.015	0.098	0.485
2009	0.231	0.038	0.012	0.077	0.173
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

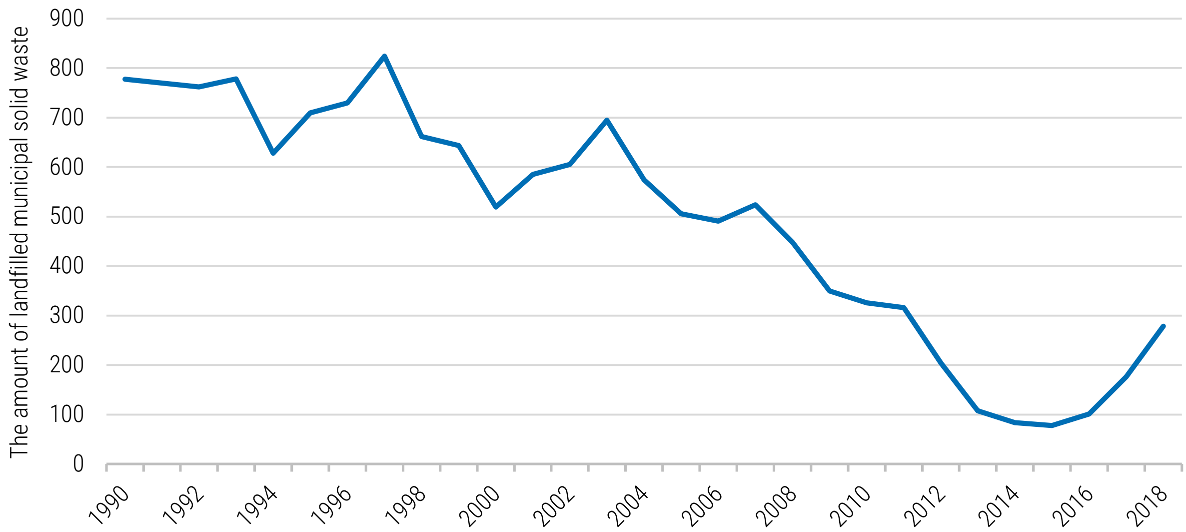

Figure 6.1 The amount of landfilled solid waste in the period of 1990-2018 (kt)

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 OSIS database, reported by operators, are used. In 2018 there were 6 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 1990-2018

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	11922.902	33.458	23845.804	66.916	NO	23845.804
1995	423.457	11.884	16574.571	39.141	33149.143	78.282	4392.149	28756.993
2000	487.411	19.053	26572.951	54.519	53145.901	109.037	3927.098	49218.803
2005	279.936	18.575	25907.083	92.547	51814.166	185.093	7699.180	44114.986
2006	157.472	18.359	25604.982	162.601	51209.965	325.201	8990.988	42218.976
2007	182.722	17.408	24279.506	132.877	48559.012	265.753	8729.904	39829.108
2008	209.404	16.738	23344.096	111.479	46688.192	222.958	7688.060	39000.132
2009	173.019	16.365	22824.036	131.916	45648.071	263.833	4819.518	40828.553
2010	142.604	16.070	22412.355	157.165	44824.709	314.329	4174.470	40650.239
2011	122.895	15.589	21741.501	176.911	43483.002	353.823	5314.929	38168.073
2012	61.585	15.014	20940.502	340.023	41881.004	680.047	6153.318	35727.686
2013	30.568	14.048	19592.765	640.959	39185.530	1281.919	7449.901	31735.629
2014	21.434	12.963	18079.772	843.516	36159.543	1687.032	7906.530	28253.013
2015	19.908	11.949	16665.303	837.136	33330.606	1674.272	6172.077	27158.529
2016	33.216	11.046	15406.486	463.832	30812.973	927.664	6257.996	24554.977
2017	54.058	10.342	14424.142	266.829	28848.284	533.658	4817.974	24030.310
2018	63.371	9.872	13768.176	217.262	27536.352	434.525	4799.821	22736.531

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).

[34] https://www.engineeringtoolbox.com/gas-density-d_158.html

6.3.3. Source-Specific QA/QC and Verification

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

6.3.4. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

6.4. 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 1990-2018 (kt)

Year	Amount of organic waste composted	NMVOC	NH_3
1990	6.775	NE	0.002
1995	8.901	NE	0.002
2000	19.010	NE	0.005
2005	105.216	0.001	0.025
2006	115.327	0.003	0.028
2007	185.529	0.004	0.045
2008	207.259	0.003	0.050
2009	230.810	0.004	0.055
2010	217.633	0.004	0.052
2011	157.165	0.004	0.038
2012	148.086	0.004	0.036
2013	180.038	0.004	0.043
2014	140.086	0.004	0.031
2015	172.575	0.003	0.039
2016	248.490	0.003	0.058
2017	247.299	0.003	0.059
2018	169.445	0.003	0.041

Table 6.6 Emissions from anaerobic digestion at biogas facilities in the period of 2011-2018

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

6.4.2. Methodological Issues

Point sources emissions are based on operator reports. In 2018 there were reports from 4 anaerobic digestion operators and 3 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 1990-2018.

Table 6.8 Emissions from industrial waste incineration in the period of 2000-2018

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
2001	NA	NA	NA	NA	NE	NA	NA	NA	NA
2002	NA	NA	NA	NA	NE	NA	NA	NA	NA
2003	NA	NA	NA	NA	NE	NA	NA	NA	NA
2004	NA	NA	NA	NA	NE	NA	NA	NA	NA
2005	NA	NA	NA	NA	NE	NA	NA	NA	NA
2006	NA	NA	NA	NA	NE	NA	NA	NA	NA
2007	NA	NA	0.010	NA	NE	NA	NA	NA	NA
2008	0.006	0.000	0.005	0.003	NE	0.022	0.039	0.055	0.001
2009	0.016	0.001	0.017	0.013	0.118	0.042	0.074	0.106	0.001
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	0.001	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	0.009	0.001	0.070	0.003	0.122	0.142	0.249	0.356	0.005

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
2001	NA	NA	NE	NE	NA	NE	NE	0.136
2002	NA	NA	NE	NE	NA	NE	NE	0.134
2003	NA	NA	NE	NE	NA	NE	NE	0.129
2004	NA	NA	NE	NE	NA	NE	NE	0.160
2005	NA	NA	NE	NE	NA	NE	NE	0.117
2006	NA	NA	NE	NE	NA	NE	NE	0.013
2007	NA	NA	NE	NE	NA	NE	NE	0.263
2008	NA	NA	NE	3.000	NA	NE	NE	0.426
2009	NA	NA	NE	24.000	NA	NE	NE	0.508
2010	NA	NA	NE	9.400	NA	NE	NE	0.255

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Year	Pb	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F
				kg				g I-Teq
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	0.790	0.014	0.035	0.145	0.024	NE	NE	0.348

The Table 6.9 will give an overview of dioxins emissions from clinical waste incineration in the period of 1990-2018.

Table 6.9 PCDD/F emissions from clinical waste incineration in the period of 1990-2018 (g I-TEQ)

Year	PCDD/F
1990	0.470
1995	0.430
2000	0.280
2005	0.520
2006	0.040
2007	0.040
2008	0.026
2009	0.074
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

The first crematorium was established in Estonia in 1993. By the year 2018 there were already 9 crematoriums. As in 1993 there were only 39 cremations then in 2018 the number of cremations was over 8,100 which is about 52% 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 1993-2018

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	3063	2.527	0.040	0.346	NA	0.106	0.106	0.118	NE	0.429
2005	4768	3.934	0.062	0.539	NA	0.165	0.165	0.184	NE	0.668
2006	5342	4.407	0.069	0.604	NA	0.185	0.185	0.206	NE	0.748
2007	5603	4.622	0.073	0.633	NA	0.194	0.194	0.216	NE	0.784
2008	5602	4.622	0.073	0.633	NA	0.194	0.194	0.216	NE	0.784
2009	5735	4.731	0.075	0.648	1.543	0.199	0.199	0.221	NE	0.803
2010	6211	5.124	0.081	0.702	1.619	0.216	0.216	0.239	NE	0.870
2011	6816	5.623	0.089	0.770	1.678	0.237	0.237	0.263	NE	0.954
2012	6969*	5.749	0.091	0.787	0.004	0.242	0.242	0.269	NE	0.976
2013	7404*	6.108	0.096	0.837	0.007	0.257	0.257	0.285	NE	1.037
2014	7616*	6.283	0.099	0.861	0.007	0.264	0.264	0.294	NE	1.066
2015	7824*	6.455	0.102	0.884	0.013	0.271	0.271	0.302	NE	1.095
2016	7861*	6.485	0.102	0.888	0.008	0.273	0.273	0.303	NE	1.101
2017	8065*	6.654	0.105	0.911	0.008	0.280	0.280	0.311	NE	1.129
2018	8126*	6.704	0.106	0.918	0.008	0.282	0.282	0.313	NE	1.138

** 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
2006	0.160	0.027	7.960	0.073	0.072	0.066	0.093	0.106	0.855
2007	0.168	0.028	8.348	0.076	0.076	0.070	0.097	0.111	0.897
2008	0.168	0.028	8.347	0.076	0.076	0.070	0.097	0.111	0.897
2009	0.172	0.029	8.545	0.078	0.078	0.071	0.099	0.113	0.918
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
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	0.244	0.041	12.108	0.111	0.110	0.101	0.141	0.161	1.301

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
2006	0.144	0.071	0.039	0.034	0.037	0.801	2.190
2007	0.151	0.074	0.040	0.036	0.039	0.840	2.297
2008	0.151	0.074	0.040	0.036	0.039	0.840	2.297
2009	0.155	0.076	0.041	0.037	0.040	0.860	2.351
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	0.219	0.107	0.059	0.052	0.057	1.219	3.332

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- 2018 (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
2006	470,257.1	4702.6
2007	395,304.7	3953.0
2008	365,630.1	3656.3
2009	310,382.1	3103.8
2010	289,423.3	2894.2

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Year	Total MSW	MSW burned
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

Table 6.12 Pollutants emissions from domestic waste burning in the period of 1990-2018

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
2006	8.465	0.094	7.994	43.264	64.425	86.057	1.514	3.292
2007	7.115	0.079	6.720	36.368	54.157	72.341	1.273	2.767
2008	6.581	0.073	6.216	33.638	50.091	66.910	1.177	2.559
2009	5.587	0.062	5.276	28.555	42.522	56.800	0.999	2.173
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

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
2006	489.067	15.989	13.167	10.064	0.870	0.437	0.564	4.232
2007	411.117	13.440	11.069	8.460	0.731	0.368	0.474	3.558
2008	380.255	12.431	10.238	7.824	0.676	0.340	0.439	3.291
2009	322.797	10.553	8.691	6.642	0.574	0.289	0.372	2.793
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

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
2006	0.188	0.020	0.015	0.015	0.009	0.025
2007	0.158	0.017	0.013	0.012	0.008	0.021
2008	0.146	0.015	0.012	0.011	0.007	0.019
2009	0.124	0.013	0.010	0.010	0.006	0.016
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

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 data management information system 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 the 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, in Guidebook there is no emission factor applicable for this category and therefore the calculation method is applied for uncontrolled municipal waste incineration (NFR source category 5C1a). Emission factors are presented in mass per unit 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 1994-2018

Year	Wastewater handled	NO_x	NMVOC	SO_x	NH_3
	thousand m^3	t			
1994	1961.8	NA	29.427	NA	NE
1995	1849.0	NA	27.735	NA	NE
2000	1495.2	NA	22.428	NA	NE
2005	1619.7	NA	24.296	NA	NE
2006	1615.0	NA	24.225	NA	NE
2007	1880.2	NA	28.204	NA	NE
2008	1659.0	0.128	24.886	0.068	NE
2009	1478.2	0.128	22.173	0.068	0.096
2010	1899.4	0.128	28.490	0.068	0.077
2011	1933.0	0.128	28.995	0.068	0.014
2012	1698.5	0.128	25.478	0.068	0.014
2013	1795.7	0.128	26.936	0.068	0.173
2014	1762.1	0.128	26.432	0.068	0.032
2015	1641.7	0.128	24.625	0.068	0.042
2016	1820.1	0.128	27.301	0.068	0.191
2017	1870.6	NE	28.059	NE	NE
2018	1658.8	NE	24.882	NE	NE

Table 6.15 Emissions from industrial wastewater handling in the period of 1994-2018 (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
2006	NA	IE	NA	NE
2007	NA	IE	NA	NE
2008	1.234	5.753	0.124	0.979
2009	0.444	4.663	0.124	1.074
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

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 2018 the annual reports were received from 6 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.

6.6.3. Source-Specific QA/QC and Verification

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

6.6.4. Source-Specific Planned Improvements

To recalculate emissions from waste water treatment by using data from the waste management information system JATS and to compare the data with the GHG inventory data. Also, specify data for latrines and include those emissions in the inventory in future submissions.

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 (2 operators in 2018) 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 1998-2018

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
2006	NE	NE	NE	NE	NE	0.172	0.172	0.172
2007	NE	NE	NE	NE	NE	0.153	0.153	0.153
2008	NE	5.409	NE	NE	NE	0.138	0.138	0.138
2009	NE	3.692	NE	NE	NE	0.129	0.129	0.129
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	0.059	0.059	0.059

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
2006	0.503	1.013	1.013	1.604	1.531	3.559	NE	NE
2007	0.449	0.904	0.904	1.432	1.366	3.175	NE	NE
2008	0.403	0.811	0.811	1.284	1.225	2.849	NE	NE
2009	0.376	0.756	0.756	1.197	1.142	2.656	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	0.172	0.346	0.346	0.549	0.524	1.217	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
2006	1.740	NE	NE	NE	NE
2007	1.545	NE	NE	NE	NE
2008	1.396	NE	NE	NE	NE
2009	1.301	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	0.604	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

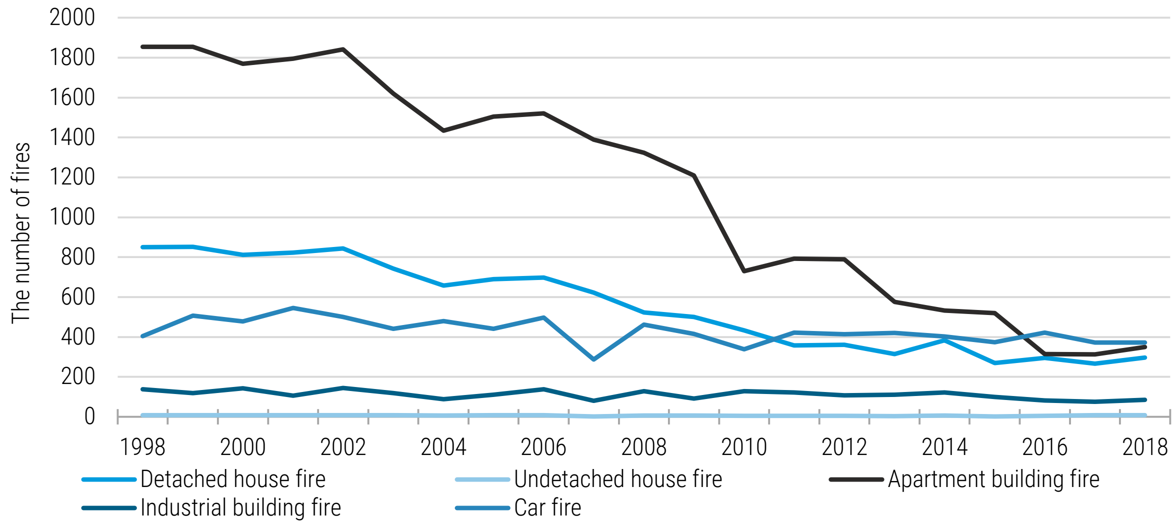

Figure 6.2 The number of fires according to the Estonian Rescue Board in the period of 1998-2018

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 1990–2018

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	0.269	0.329	0.509	0.024	0.582
1995	0.019	0.056	0.004	0.004	0.258	0.315	0.488	0.023	0.558
2000	0.068	0.205	0.014	0.014	0.931	1.138	1.759	0.084	2.051
2005	0.009	0.026	0.002	0.002	0.122	0.149	0.230	0.011	0.260
2006	0.310	0.929	0.062	0.062	4.422	5.405	8.353	0.398	9.287
2007	0.029	0.088	0.006	0.006	0.423	0.518	0.800	0.038	0.877
2008	0.128	0.384	0.026	0.026	1.904	2.327	3.596	0.171	3.839
2009	0.006	0.018	0.001	0.001	0.090	0.110	0.169	0.008	0.178
2010	0.002	0.007	0.000	0.000	0.038	0.046	0.071	0.003	0.074
2011	0.002	0.006	0.000	0.000	0.029	0.036	0.055	0.003	0.058
2012	0.000	0.001	0.000	0.000	0.004	0.005	0.007	0.000	0.008
2013	0.008	0.024	0.002	0.002	0.119	0.145	0.224	0.011	0.236
2014	0.008	0.023	0.002	0.002	0.116	0.142	0.220	0.010	0.233
2015	0.008	0.025	0.002	0.002	0.124	0.151	0.234	0.011	0.249
2016	0.012	0.037	0.002	0.002	0.183	0.224	0.346	0.016	0.369
2017	0.003	0.010	0.001	0.001	0.049	0.060	0.092	0.004	0.099
2018	0.034	0.101	0.007	0.007	0.462	0.564	0.872	0.042	1.015

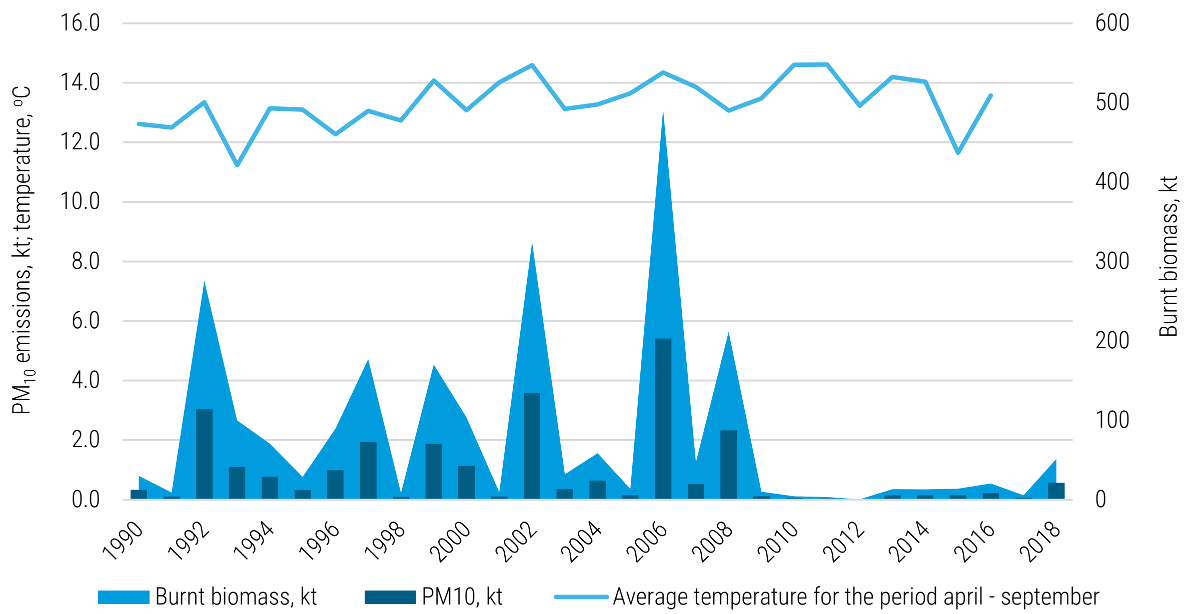

Figure 7.1 Burnt biomass, particulates emission and average temperature in the period 1990-2018

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]

Compared to 2017, the area of burned forest increased in 2018 by 10 times, which accordingly led to an increase in pollutants emissions.

The emissions of NO_x, NMVOC, SO_x, NH_3 and CO are calculated using EMEP/EEA Guidebook 2019 Tier 1emissioon factors (see Table 7.3) and burnt forest area (1990–2017) 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 1emissioon factors and biomass burnt. Data about biomass amount are available in statistical database only for the years 2000-2018. Data for 1990-1999 are expert estimates on the base of surrogate data.

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.

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

[35] Yearbook Forest 2017, Estonian Environment Agency, 2018, https://www.keskkonnaagentuur.ee/et/aastaraamat-mets-2017

Activity Data

Table 7.4 Forest burnt area and burnt biomass in the period 1990-2018

Year	Forest burnt area	Burnt biomass
	ha	t
1990	194.0	29928.9
1995	185.9	28679.3
2000	683.8	103481.5
2005	86.5	13556.8
2006	3095.6	491334.9
2007	292.4	47051.0
2008	1279.8	211535.3
2009	59.3	9962.9
2010	24.8	4188.7
2011	19.3	3261.1
2012	2.5	421.7
2013	78.5	13168.4
2014	77.8	12924.3
2015	83.1	13744.8
2016	122.9	20345.7
2017	33.0	5419.7
2018	338.3	51295.3

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 1990–2015 (kt)

Year	NMVOC
1990	35.438
1995	34.730
2000	39.621
2005	38.348
2006	38.166
2007	38.281
2008	38.163
2009	37.567
2010	37.313
2011	37.821
2012	37.889
2013	38.541
2014	39.312
2015	39.840
Trend 1990-2015, %	12.421

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 (m²) – area used per vegetation type;
D (g/m²) – foliar biomass density per vegetation type;

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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 1990-2015. These data were used for calculating the total emission. Information on permanent grasslands is available for the years 2005-2015. 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 1990-2015, 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
2006	710.6	354.5	639.0	111.6	62.7	196.5	38.3
2007	733.6	345.0	637.0	109.6	65.6	185.7	38.9
2008	724.7	340.6	628.2	112.4	65.5	174.5	35.6
2009	718.2	327.3	637.5	111.1	65.5	175.4	35.1
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

Table 7.8 Activity data used for NMVOC emission calculation in 1990-2015, 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
2006	280.300	193.600
2007	292.300	215.700
2008	309.300	196.600
2009	316.412	195 381
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

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 2017. 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 2020 and 2019 are made by using exact calculation numbers.

1A1a Public electricity and heat production

In comparison with the previous submission, the emissions of all substances from NFR 1A1a were recalculated for 2005.

The reason for the recalculation was the correction of fuel consumption data: in previous submissions, pollutant emissions from 81 TJ of biomass, 12 TJ of coke, and 343 TJ of diesel were underestimated.

The differences in the public electricity and heat production sector emissions between the 2019 and 2020 submissions are presented in Table 8.1.

Table 8.1 The differences in the sector NFR 1A1a emissions for 2005 between 2019 and 2020 submissions

Substance	Unit	2019	2020	Difference	
				in units	%
NO_x	kt	12.090	12.135	0.045	0.37
NMVOC	kt	0.860	0.877	0.017	2.02
SO_x	kt	60.650	60.709	0.059	0.10
NH_3	kt	0.158	0.158	0.000	0.00
$PM_{2.5}$	kt	4.196	4.309	0.113	2.69
PM_{10}	kt	8.406	8.529	0.123	1.46
TSP	kt	14.486	14.631	0.144	1.00
BC	kt	0.511	0.551	0.040	7.83
CO	kt	9.370	9.574	0.204	2.18
Pb	t	30.700	30.728	0.028	0.09
Cd	t	0.520	0.521	0.001	0.15
Hg	t	0.501	0.502	0.000	0.02
As	t	9.142	9.145	0.003	0.04
Cr	t	8.160	8.168	0.008	0.10
Cu	t	2.220	2.225	0.005	0.24
Ni	t	5.600	5.609	0.009	0.15
Se	t	0.00016	0.00018	0.00002	15.29
Zn	t	42.310	42.355	0.045	0.11
PCDD/F	g I-Teq	0.510	0.514	0.004	0.85
B(a)p	t	0.430	0.437	0.007	1.70
B(b)f	t	0.560	0.569	0.009	1.67
B(k)f	t	0.230	0.234	0.004	1.82
I(1,2,3-cd)p	t	0.210	0.213	0.003	1.63
PAHs total	t	1.430	1.454	0.024	1.70
HCB	kg	0.020	0.021	0.001	2.60
PCBs	kg	1.681	1.698	0.017	1.01

1A1c Manufacture of solid fuels and other energy industries

In comparison with the 2019 submission, $PM_{2.5}$ and PM_{10} emissions of the sector 1A1c for 2015–2017 have been recalculated. In the reporting year 2020, additional calculations for particulates were made for shale oil production, because in the period 2015–2017, emissions from shale oil production were not calculated by mistake.

The differences in the emissions from the manufacture of solid fuels and other energy industries between the 2019 and 2020 submissions are presented in Table 8.2.

Table 8.2 The differences in the sector NFR 1A1c emissions between 2019 and 2020 submissions

Year	$PM_{2.5}$				PM_{10}			
	2019	2020	kt	%	2019	2020	kt	%
2015	0.00395	0.12031	0.11636	2 943	0.11703	0.25780	0.14078	120
2016	0.00360	0.14997	0.14636	4 062	0.00442	0.32136	0.31693	7 164
2017	0.00478	0.12578	0.12100	2 531	0.00572	0.26953	0.26381	4 611

1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals

In the last reporting year, one enterprise mistakenly reported 1,000 times less lead emissions for 2017. The corresponding correction is presented in Table 8.3.

Table 8.3 The differences in the sector NFR 1A2b emissions (t) for 2017 between 2019 and 2020 submissions

Year	Pb			As			Cu		
	2019	2020	%	2019	2020	%	2019	2020	%
2017	0.00013	0.12800	99900	0.00000006	0.00006	99900	0.0000001	0.0001	99900

1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals

In comparison with the previous submission, the emissions of particulates from glass production facilities were reallocated from NFR 1A2f to NFR 2A3 for the period 2004–2017.

This year, an analysis of particle emissions from a glass production facility for the period 2000–2017 was carried out. Unfortunately, at the moment, there is data starting only from 2004. Emissions from all processes were under SNAP code 030315 (NFR 1A2f). As a result of the correction, emissions from processes not related to fuel combustion were reallocated to SNAP 040613 and, accordingly, to the correct NFR code 2A3.

The differences in the emissions from the Stationary combustion in manufacturing industries and construction between the 2019 and 2020 submissions are presented in Table 8.4.

Table 8.4 The differences in the sector NFR 1A2f emissions (kt) for 2004-2017 between 2019 and 2020 submissions

Year	$PM_{2.5}$			PM_{10}			TSP			BC		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2004	0.265	0.265	-0.1	0.596	0.596	0.0	0.662	0.662	0.0	0.0606	0.0606	-0.0002
2005	0.258	0.257	-0.3	0.369	0.368	-0.3	0.596	0.594	-0.2	0.0591	0.0591	-0.001
2006	0.142	0.141	-0.6	0.225	0.224	-0.4	0.398	0.397	-0.3	0.0328	0.0328	-0.002
2007	0.117	0.116	-0.7	0.184	0.183	-0.5	0.395	0.394	-0.3	0.0271	0.0271	-0.002
2008	0.136	0.135	-0.6	0.220	0.219	-0.4	0.356	0.355	-0.3	0.0313	0.0313	-0.002
2009	0.041	0.040	-1.9	0.070	0.069	-1.3	0.149	0.148	-0.7	0.0094	0.0094	-0.005
2010	0.033	0.032	-2.5	0.050	0.049	-1.8	0.218	0.217	-0.5	0.0075	0.0075	-0.007

Year	$PM_{2.5}$			PM_{10}			TSP			BC		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2011	0.032	0.031	-2.6	0.047	0.046	-1.9	0.210	0.209	-0.5	0.0072	0.0072	-0.007
2012	0.036	0.035	-2.2	0.046	0.045	-2.0	0.154	0.153	-0.7	0.0083	0.0083	-0.006
2013	0.038	0.037	-2.1	0.060	0.059	-1.5	0.201	0.200	-0.5	0.0088	0.0088	-0.006
2014	0.042	0.041	-1.4	0.050	0.049	-1.4	0.181	0.180	-0.4	0.0096	0.0096	-0.004
2015	0.018	0.017	-3.6	0.024	0.023	-3.1	0.081	0.080	-1.0	0.0079	0.0079	-0.005
2016	0.031	0.030	-2.6	0.035	0.034	-2.6	0.071	0.070	-1.4	0.0083	0.0083	-0.006
2017	0.025	0.024	-2.1	0.032	0.032	-1.8	0.092	0.091	-0.7	0.0125	0.0125	-0.002

1A2giii Stationary combustion in manufacturing industries and construction: Other

First, in comparison with the previous submission, the emissions of all pollutants from NFR 1A2gviii were recalculated for 2005.

The reason for the recalculation was the correction of fuel consumption data: in previous submissions, pollutant emissions from 1500 TJ of biomass were overestimated (previous reports did not take into account the change in the energy balance of the statistics department) and from 1 TJ of wood briquette underestimated.

Secondly, the change in the emissions of various substances for the period 2000–2009 was affected by the analysis of emissions of the metal industry carried out pursuant to the TERT recommendation in 2019. For some activities, some pollutant emissions were moved from NFR 1A2gviii to NFR 2C; for some, on the contrary, emissions from combustion processes were moved under code 1A2gviii. A more detailed description is given for the industry section.

The differences in the emissions of stationary combustion in manufacturing industries and construction (other) between the 2019 and 2020 submissions are presented in Table 8.5.

Table 8.5 The differences in the sector NFR 1A2gviii emissions (kt) for 2000-2009 between 2019 and 2020 submissions

Year	NO_x			NMVOC			SO_x			$PM_{2.5}$		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	0.844	0.844	0.018	0.112	0.112	0.009	9.160	9.165	0.048	1.068	1.068	0.004
2001	1.313	1.313	0.011	0.387	0.387	0.003	11.386	11.390	0.038	2.578	2.578	0.002
2002	1.178	1.178	0.013	0.891	0.891	0.001	9.521	9.525	0.046	3.288	3.288	0.001
2003	1.319	1.319	0.011	0.928	0.928	0.001	8.195	8.199	0.053	3.945	3.945	0.001
2004	1.245	1.246	0.090	0.883	0.883	0.014	9.385	9.433	0.503	4.108	4.108	0.010
2005	1.309	1.160	-11.388	0.860	0.575	-33.100	10.197	10.196	-0.016	4.054	2.705	-33.267
2006	1.014	1.014	0.067	0.620	0.621	0.027	4.050	4.054	0.104	1.448	1.448	0.029
2007	0.903	0.904	0.070	0.547	0.547	0.029	3.329	3.333	0.139	1.314	1.315	0.034
2008	1.046	1.046	0.000	0.879	0.879	-0.010	4.944	4.944	0.000	3.076	3.076	-0.021
2009	0.837	0.837	0.002									

Table 8.5 continues

Year	PM10			TSP			BC			CO		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	1.278	1.278	0.006	1.625	1.625	0.006				3.081	3.081	0.006
2001	2.886	2.886	0.003	3.450	3.450	0.003				6.047	6.047	0.003
2002	3.658	3.658	0.002	4.374	4.374	0.002				6.779	6.779	0.003
2003	4.137	4.137	0.002	4.504	4.504	0.002				7.937	7.937	0.002
2004	4.297	4.297	0.019	4.530	4.531	0.022				8.841	8.843	0.021
2005	4.524	3.100	-31.463	5.247	3.749	-28.551	1.108	0.730	-34.108	9.713	6.867	-29.300
2006	1.863	1.864	0.045	2.595	2.596	0.041				4.906	4.908	0.051
2007	1.715	1.716	0.043	2.729	2.730	0.029				4.584	4.586	0.062
2008	3.556	3.554	-0.045	4.587	4.584	-0.049				7.664	7.664	0.000
2009										4.331	4.331	0.000

Table 8.5 continues

Year	Pb			Cd			Hg			As		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	0.255	0.279	9.3							0.016	0.016	3.5
2001	0.691	0.714	3.4							0.035	0.036	1.6
2002	0.774	0.797	3.1							0.045	0.045	1.2
2003	0.925	0.949	2.6							0.067	0.068	0.8
2004	0.809	1.047	29.4							0.030	0.030	1.9
2005	0.905	0.876	-3.3	0.020	0.012	-38.2	0.002	0.001	-49.5	0.031	0.030	-2.8
2006	0.505	0.710	40.6							0.023	0.024	2.1
2007	0.583	0.798	36.9							0.054	0.054	1.3
2008	1.359	1.352	-0.5							0.090	0.090	0.0

Table 8.5 continues

Year	Cr			Cu			Zn		
	2019	2020	%	2019	2020	%	2019	2020	%
2000				0.021	0.022	0.9			
2001				0.036	0.036	0.5			
2002				0.039	0.039	0.5			
2003	0.330	0.269	-18.5	0.058	0.058	0.3	2.004	1.956	-2.4
2004	0.271	0.269	-0.7	0.030	0.030	0.6	2.162	1.960	-9.3
2005	0.278	0.224	-19.6	0.048	0.041	-15.1	2.027	1.193	-41.1
2006	0.290	0.258	-11.0	0.038	0.039	0.4	1.148	1.058	-7.8
2007	0.349	0.312	-10.4	0.062	0.063	0.7	0.762	0.691	-9.3
2008	0.414	0.378	-8.8	0.074	0.074	0.0	1.695	1.609	-5.1
2009	0.258	0.236	-8.5				0.784	0.773	-1.3

1A4ai Commercial/institutional: Stationary

In comparison with the previous submission, the emissions of all pollutants from NFR 1A4ai were recalculated for 2005.

The reason for the recalculation was the correction of fuel consumption data: in previous submissions, pollutant emissions from 2 TJ of biomass were underestimated.

The differences in the emissions of stationary combustion in the commercial/institutional sector between the 2019 and 2020 submissions are presented in Table 8.6.

Table 8.6 The differences in the sector NFR 1A4ai emissions for 2005 between 2019 and 2020 submissions

Substance	Unit	2019	2020	Difference	
				in units	%
NOx	kt	0.410	0.410	0.0002	0.05
NMVOC	kt	0.080	0.080	0.0004	0.48
SOx	kt	0.560	0.560	0.0000	0.00
NH3	kt	0.014	0.014	0.0000	0.00
PM2.5	kt	0.611	0.613	0.0018	0.29
PM10	kt	0.831	0.833	0.0019	0.23
TSP	kt	1.351	1.353	0.0020	0.15
BC	kt	0.172	0.172	0.0005	0.29
CO	kt	1.200	1.204	0.0038	0.32
Pb	t	0.284	0.285	0.0004	0.14
Cd	t	0.007	0.007	0.0000	0.13
Hg	t	0.001	0.001	0.0000	0.07
As	t	0.030	0.030	0.0000	0.01
Cr	t	0.126	0.126	0.0001	0.06
Cu	t	0.022	0.022	0.0000	0.05

Substance	Unit	2019	2020	Difference	
				in units	%
Ni	t	0.282	0.282	0.0001	0.02
Se	t	0.00002	0.00002	0.0000	0.00
Zn	t	0.281	0.282	0.0010	0.36
PCDD/F	g I-Teq	0.040	0.040	0.0001	0.25
B(a)p	t	0.055	0.055	0.0001	0.22
B(b)f	t	0.066	0.066	0.0002	0.24
B(k)f	t	0.027	0.027	0.0001	0.22
I(1,2,3-cd)p	t	0.026	0.026	0.0001	0.23
PAHs total	t	0.174	0.174	0.0004	0.23
HCB	kg	0.003	0.003	0.0000	0.48
PCBs	kg	0.190	0.190	0.0004	0.20

1A4bi Residential: Stationary

Compared with the previous submission, the following changes were made for the residential sector:

- For the period 1990–2017, the emissions of all substances from LPG consumption were additionally calculated.
- In accordance with the TERT requirements, the emissions of heavy metals from waste incineration in stoves were additionally calculated, which caused a significant increase in emissions, especially lead.
- The amount of wood used in 2001 was corrected (10,865 TJ instead of 10,862 TJ).
- SO_2 emissions are recalculated for 2003–2017. The reason is the correction of emission factors for wood briquette and pellet: pellets – 12.34, briquette – 10.89 (previously, it was the other way around).
- NH_3 emissions have been recalculated for the period 1990–2016. Recalculations entail the use of updated national emission factors for wood combustion in conventional boilers (in the previous submissions, the wrong WF was mistakenly used: 9.869 instead of 9.8604.
- All wood briquette and pellet emissions were additionally calculated for the period 2011–2017.
- Slightly increased black carbon emissions as a result of correction of the emission factor for conventional stoves for peat.

The differences in the residential sector emissions between the submissions for 2019 and 2020 are presented in Table 8.7.

Table 8.7 The differences in the sector NFR 1A4bi emissions (kt; HMs in t) for 1990–2017 between 2019 and 2020 submissions (%)

Year	NO_x			NMVOC			SO_x			NH_3		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
1990	4.142	4.217	1.81	4.328	4.331	0.06	3.010	3.011	0.01	0.025	0.025	-0.04
1991	3.916	3.995	2.03	4.264	4.267	0.06	3.065	3.065	0.01	0.023	0.023	-0.04
1992	3.382	3.409	0.80	2.873	2.874	0.03	1.019	1.019	0.01	0.022	0.022	-0.04
1993	3.469	3.484	0.45	2.737	2.737	0.02	0.634	0.634	0.01	0.022	0.022	-0.04
1994	5.286	5.302	0.31	3.803	3.803	0.01	0.238	0.238	0.03	0.035	0.035	-0.04
1995	9.715	9.728	0.13	7.242	7.243	0.01	0.693	0.693	0.01	0.064	0.064	-0.04
1996	11.068	11.085	0.16	8.416	8.416	0.01	1.121	1.121	0.01	0.074	0.074	-0.04
1997	11.242	11.259	0.15	8.544	8.545	0.01	1.151	1.152	0.01	0.076	0.076	-0.04
1998	8.570	8.588	0.22	6.452	6.453	0.01	0.868	0.868	0.01	0.058	0.058	-0.04
1999	8.128	8.144	0.19	6.371	6.371	0.01	1.366	1.367	0.01	0.056	0.056	-0.04
2000	7.970	7.986	0.20	6.128	6.128	0.01	1.148	1.148	0.01	0.055	0.055	-0.04
2001	7.479	7.498	0.25	5.656	5.657	0.03	0.891	0.891	0.01	0.053	0.053	-0.02
2002	7.228	7.237	0.12	5.497	5.497	0.01	1.023	1.023	0.00	0.052	0.052	-0.04
2003	7.187	7.197	0.15	5.344	5.344	0.01	0.784	0.784	0.01	0.053	0.053	-0.04

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Year	NO_x			NMVOC			SO_x			NH_3		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2004	6.886	6.895	0.14	5.221	5.221	0.01	0.974	0.974	0.00	0.052	0.052	-0.04
2005	5.692	5.699	0.12	4.295	4.295	0.01	0.856	0.856	0.00	0.044	0.043	-0.03
2006	5.422	5.429	0.13	4.030	4.030	0.01	0.715	0.715	0.00	0.042	0.042	-0.03
2007	6.809	6.815	0.09	4.900	4.900	0.00	0.541	0.541	0.01	0.054	0.054	-0.03
2008	6.785	6.794	0.13	4.886	4.886	0.01	0.575	0.575	0.01	0.055	0.054	-0.03
2009	6.927	6.936	0.13	4.939	4.939	0.01	0.463	0.463	0.01	0.057	0.057	-0.03
2010	6.882	6.891	0.14	4.926	4.926	0.01	0.490	0.490	0.01	0.057	0.057	-0.03
2011	5.715	5.714	-0.02	4.125	4.109	-0.38	0.529	0.529	0.03	0.049	0.049	-0.28
2012	5.861	5.858	-0.05	4.144	4.127	-0.41	0.498	0.498	0.03	0.051	0.051	-0.29
2013	5.405	5.413	0.15	3.800	3.800	0.01	0.484	0.484	0.01	0.048	0.048	-0.03
2014	5.150	5.161	0.21	3.609	3.609	0.01	0.453	0.453	0.01	0.047	0.047	-0.03
2015	4.882	4.896	0.30	3.368	3.369	0.01	0.364	0.364	0.02	0.045	0.045	-0.02
2016	5.008	5.026	0.36	3.409	3.410	0.02	0.275	0.275	0.03	0.047	0.047	-0.02
2017	4.932	4.952	0.41	3.362	3.367	0.12	0.287	0.287	0.02	0.047	0.047	0.03

Table 8.7 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
1990										3.264	3.267	0.08
1991										3.274	3.277	0.09
1992										2.247	2.248	0.04
1993										2.125	2.125	0.03
1994										2.756	2.756	0.02
1995										4.911	4.911	0.01
1996										5.660	5.661	0.01
1997										5.741	5.741	0.01
1998										4.449	4.449	0.02
1999										4.453	4.453	0.01
2000	3.828	3.829	0.02	3.971	3.971	0.01	1.485	1.486	0.04	4.296	4.297	0.01
2001	3.528	3.529	0.04	3.660	3.662	0.03	1.388	1.389	0.04	3.960	3.961	0.03
2002	3.426	3.427	0.01	3.555	3.555	0.01	1.331	1.331	0.02	3.846	3.847	0.01
2003	3.283	3.283	0.01	3.407	3.407	0.01	1.313	1.313	0.02	3.685	3.685	0.01
2004	3.215	3.215	0.01	3.336	3.336	0.01	1.250	1.250	0.02	3.610	3.610	0.01
2005	2.684	2.685	0.01	2.787	2.787	0.01	1.020	1.020	0.02	3.017	3.017	0.01
2006	2.531	2.531	0.01	2.628	2.628	0.01	0.965	0.966	0.01	2.845	2.845	0.01
2007	2.965	2.965	0.01	3.076	3.076	0.01	1.209	1.209	0.01	3.328	3.328	0.01
2008	2.948	2.948	0.01	3.059	3.059	0.01	1.196	1.196	0.02	3.310	3.310	0.01
2009	2.940	2.940	0.01	3.050	3.050	0.01	1.213	1.213	0.01	3.300	3.301	0.01
2010	2.897	2.897	0.01	3.006	3.006	0.01	1.191	1.191	0.01	3.253	3.254	0.01
2011	2.476	2.528	2.10	2.570	2.625	2.13	0.975	1.000	2.53	2.784	2.844	2.16
2012	2.516	2.573	2.25	2.612	2.671	2.28	1.000	1.026	2.69	2.829	2.894	2.31
2013	2.342	2.342	0.01	2.431	2.431	0.01	0.914	0.914	0.01	2.634	2.634	0.01
2014	2.338	2.338	0.02	2.429	2.429	0.02	0.862	0.918	6.40	2.636	2.635	-0.04
2015	2.229	2.230	0.02	2.316	2.316	0.02	0.814	0.880	8.14	2.513	2.514	0.02
2016	2.282	2.282	0.03	2.370	2.371	0.03	0.826	0.920	11.37	2.573	2.574	0.03
2017	2.317	2.306	-0.46	2.408	2.397	-0.46	0.808	0.929	15.04	2.616	2.604	-0.47

Table 8.7 continues

Year	CO			Pb			Cd			Hg			As		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
1990	61.034	61.072	0.06	0.579	2.321	301.2	0.074	0.131	77.0	0.019	0.066	244.1	0.009	0.045	382.6
1991	59.206	59.246	0.07	0.596	2.503	319.8	0.070	0.132	89.4	0.020	0.072	256.7	0.010	0.049	396.9
1992	44.575	44.588	0.03	0.277	2.335	742.8	0.063	0.130	106.6	0.008	0.064	663.1	0.004	0.046	1 065.7
1993	43.739	43.747	0.02	0.222	2.384	971.5	0.065	0.136	108.0	0.006	0.064	931.6	0.003	0.047	1 507.9
1994	64.233	64.241	0.01	0.171	2.502	1 365.0	0.103	0.178	71.8	0.005	0.067	1 137.0	0.002	0.049	2 662.0

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Year	CO			Pb			Cd			Hg			As		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
1995	121.645	121.652	0.01	0.482	2.862	494.3	0.196	0.274	39.7	0.011	0.076	562.3	0.005	0.054	1 083.4
1996	140.648	140.656	0.01	0.611	3.014	393.4	0.229	0.308	34.2	0.015	0.080	429.9	0.006	0.056	812.2
1997	143.428	143.437	0.01	0.638	3.068	381.2	0.240	0.319	33.2	0.016	0.081	416.2	0.006	0.056	788.4
1998	108.941	108.950	0.01	0.488	2.955	505.0	0.186	0.267	43.3	0.012	0.078	551.1	0.005	0.056	1 041.9
1999	105.676	105.683	0.01	0.557	3.057	449.0	0.180	0.262	45.3	0.015	0.082	452.5	0.006	0.058	814.0
2000	103.086	103.094	0.01	0.526	3.126	494.1	0.182	0.267	46.7	0.014	0.084	511.8	0.006	0.059	940.7
2001	96.689	96.718	0.03	0.484	2.969	513.3	0.179	0.260	45.5	0.012	0.079	547.8	0.005	0.056	1 028.8
2002	94.226	94.230	0.00	0.504	2.874	470.6	0.179	0.257	43.2	0.013	0.077	491.5	0.005	0.054	919.1
2003	93.617	93.622	0.01	0.482	2.749	469.9	0.188	0.262	39.4	0.012	0.073	515.2	0.005	0.051	998.8
2004	91.136	91.141	0.01	0.521	2.681	414.1	0.188	0.258	37.6	0.013	0.072	434.4	0.005	0.050	816.3
2005	75.639	75.642	0.00	0.453	2.508	453.8	0.162	0.229	41.5	0.012	0.067	470.3	0.005	0.047	879.1
2006	71.923	71.926	0.00	0.421	2.558	507.2	0.158	0.228	44.1	0.011	0.068	538.9	0.004	0.048	1 022.9
2007	89.813	89.816	0.00	0.483	2.668	452.2	0.207	0.278	34.5	0.011	0.070	522.7	0.004	0.049	1 049.1
2008	90.059	90.063	0.00	0.498	2.703	442.8	0.212	0.284	34.0	0.012	0.071	509.5	0.004	0.050	1 021.7
2009	92.330	92.335	0.01	0.503	2.698	436.0	0.224	0.296	32.0	0.011	0.070	518.9	0.004	0.049	1 064.1
2010	92.644	92.649	0.01	0.522	2.675	412.3	0.231	0.301	30.5	0.012	0.070	486.9	0.004	0.049	991.7
2011	77.960	77.671	-0.37	0.471	2.653	463.2	0.200	0.271	35.7	0.011	0.070	530.3	0.004	0.049	1 060.4
2012	79.681	79.365	-0.40	0.490	2.702	451.5	0.212	0.285	34.0	0.011	0.071	524.1	0.004	0.050	1 057.0
2013	74.095	74.100	0.01	0.475	2.711	470.6	0.205	0.278	35.6	0.011	0.071	544.8	0.004	0.050	1 099.9
2014	70.983	70.989	0.01	0.465	2.694	479.5	0.203	0.276	36.0	0.011	0.071	558.7	0.004	0.050	1 132.1
2015	67.207	67.215	0.01	0.437	2.661	509.3	0.197	0.270	36.9	0.010	0.070	609.1	0.004	0.049	1 253.8
2016	69.123	69.131	0.01	0.445	2.673	501.4	0.209	0.282	34.9	0.010	0.070	620.3	0.004	0.049	1 297.3
2017	68.660	68.733	0.11	0.455	2.686	490.7	0.213	0.286	34.3	0.010	0.070	605.3	0.004	0.050	1 267.0

Table 8.7 continues

Year	Cr			Cu			Ni			Se			Zn		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
1990	0.163	0.166	1.9	0.111	0.112	1.4	0.054	0.056	3.7	0.008	0.008	0.2	3.524	3.540	0.4
1991	0.157	0.160	2.2	0.113	0.115	1.5	0.056	0.058	3.9	0.009	0.009	0.2	3.396	3.412	0.5
1992	0.122	0.126	3.0	0.055	0.057	3.3	0.024	0.027	9.7	0.004	0.004	0.1	2.694	2.712	0.7
1993	0.122	0.126	3.2	0.046	0.047	4.2	0.019	0.021	13.3	0.004	0.004	0.1	2.698	2.717	0.7
1994	0.132	0.188	42.8	0.037	0.053	42.3	0.013	0.020	54.6	0.004	0.004	0.1	2.927	4.112	40.5
1995	0.352	0.356	1.2	0.104	0.106	2.1	0.038	0.040	7.3	0.009	0.009	0.0	7.822	7.843	0.3
1996	0.416	0.420	1.0	0.130	0.132	1.7	0.049	0.052	5.7	0.011	0.011	0.0	9.231	9.251	0.2
1997	0.434	0.439	1.0	0.135	0.138	1.6	0.051	0.054	5.5	0.011	0.011	0.0	9.636	9.657	0.2
1998	0.337	0.341	1.3	0.104	0.106	2.1	0.039	0.042	7.3	0.009	0.009	0.0	7.478	7.500	0.3
1999	0.332	0.337	1.3	0.115	0.117	1.9	0.046	0.049	6.3	0.009	0.009	0.0	7.360	7.381	0.3
2000	0.333	0.338	1.4	0.110	0.112	2.1	0.043	0.046	7.0	0.009	0.009	0.0	7.385	7.407	0.3
2001	0.324	0.329	1.4	0.102	0.104	2.2	0.039	0.042	7.4	0.008	0.008	0.1	7.193	7.216	0.3
2002	0.327	0.331	1.3	0.105	0.107	2.0	0.041	0.044	6.7	0.009	0.009	0.0	7.250	7.271	0.3
2003	0.340	0.344	1.2	0.102	0.105	2.0	0.038	0.041	6.9	0.009	0.009	0.0	7.543	7.562	0.3
2004	0.342	0.346	1.1	0.109	0.111	1.8	0.042	0.045	5.9	0.009	0.009	0.0	7.582	7.601	0.2
2005	0.295	0.298	1.2	0.094	0.096	1.9	0.037	0.039	6.5	0.008	0.008	0.0	6.536	6.554	0.3
2006	0.287	0.291	1.3	0.089	0.090	2.2	0.034	0.036	7.3	0.007	0.007	0.0	6.370	6.389	0.3
2007	0.370	0.374	1.1	0.104	0.106	1.9	0.037	0.040	6.8	0.009	0.009	0.0	8.221	8.240	0.2
2008	0.379	0.383	1.0	0.107	0.109	1.8	0.038	0.041	6.6	0.009	0.009	0.0	8.432	8.451	0.2
2009	0.400	0.403	1.0	0.110	0.112	1.8	0.038	0.041	6.6	0.009	0.009	0.0	8.886	8.905	0.2
2010	0.411	0.415	0.9	0.114	0.115	1.7	0.040	0.042	6.2	0.010	0.010	0.0	9.143	9.162	0.2
2011	0.358	0.362	1.1	0.101	0.103	1.9	0.036	0.039	6.9	0.009	0.009	0.0	7.958	7.977	0.2
2012	0.379	0.383	1.0	0.106	0.108	1.9	0.038	0.040	6.8	0.009	0.009	0.0	8.435	8.454	0.2
2013	0.367	0.371	1.1	0.103	0.105	1.9	0.036	0.039	7.1	0.009	0.009	0.0	8.155	8.174	0.2
2014	0.362	0.366	1.1	0.101	0.103	2.0	0.036	0.038	7.2	0.008	0.008	0.0	8.044	8.063	0.2
2015	0.351	0.355	1.1	0.095	0.097	2.1	0.033	0.036	7.8	0.008	0.008	0.0	7.799	7.818	0.2
2016	0.371	0.375	1.1	0.098	0.100	2.0	0.033	0.036	7.7	0.008	0.008	0.0	8.246	8.266	0.2
2017	0.377	0.381	1.1	0.100	0.102	2.0	0.034	0.037	7.6	0.008	0.008	0.0	8.393	8.413	0.2

Table 8.7 continues

Year	PCDD/ PCDF, g I-Teq			PAHs total, t		
	2019	2020	%	2019	2020	%
1990	3.128	3.130	0.06	5.151	5.151	0.0001
1991	3.229	3.231	0.06	5.108	5.108	0.0001
1992	1.446	1.446	0.05	3.216	3.216	0.0000
1993	1.114	1.114	0.04	2.963	2.963	0.0000
1994	0.814	1.094	34.36	4.033	4.033	0.0000
1995	2.282	2.283	0.01	7.817	7.817	0.0000
1996	2.858	2.858	0.02	9.126	9.126	0.0000
1997	2.910	2.911	0.01	9.240	9.240	0.0000
1998	2.172	2.173	0.02	6.923	6.923	0.0000
1999	2.500	2.500	0.02	6.921	6.921	0.0000
2000	2.273	2.273	0.02	6.585	6.585	0.0000
2001	1.988	1.988	0.04	6.007	6.009	0.0197
2002	2.013	2.013	0.01	5.835	5.835	0.0000
2003	1.783	1.784	0.01	5.548	5.548	0.0000
2004	1.908	1.908	0.01	5.453	5.453	0.0000
2005	1.599	1.599	0.01	4.450	4.450	0.0000
2006	1.418	1.418	0.01	4.100	4.100	0.0000
2007	1.469	1.469	0.01	4.855	4.855	0.0000
2008	1.472	1.472	0.02	4.796	4.796	0.0000
2009	1.388	1.388	0.02	4.742	4.742	0.0000
2010	1.389	1.390	0.02	4.653	4.653	0.0000
2011	1.226	1.226	-0.01	3.841	3.841	-0.0003
2012	1.215	1.215	-0.02	3.876	3.876	-0.0003
2013	1.125	1.125	0.02	3.516	3.516	0.0000
2014	1.048	1.048	0.03	3.279	3.279	0.0000
2015	0.923	0.923	0.04	3.012	3.012	0.0000
2016	0.855	0.855	0.05	2.957	2.957	0.0000
2017	0.846	0.847	0.06	2.879	2.879	0.0001

1B1b Fugitive emissions from solid fuels: Solid fuel transformation

In comparison with the previous submission, the emissions of NO_x, particulates, and CO for 2017 from one enterprise were reallocated from NFR 1B1b to NFR 2C1 and replaced with the notation key 'NA'. The reason was the wrong SNAP code.

For the same reason, the part of particulate emissions for 2016 were changed. The differences in the fugitive emissions from the solid fuels sector between the submissions for 2019 and 2020 are presented in Table 8.8.

Table 8.8 The differences in the sector NFR 1B1b emissions (kt) for 2016–2017 between 2019 and 2020 submissions

Year	NO_x			$PM_{2.5}$			PM_{10}		
	2019	2020	%	2019	2020	%	2019	2020	%
2016	0.00189	NA	-100	0.0006	NA	-100	0.0015	NA	-100
2017				0.0002	0.00001	-97.3	0.0004	0.00001	-97.2

Table 8.8 continues

Year	BC			TSP			CO		
	2019	2020	%	2019	2020	%	2019	2020	%
2016	0.0003	NA	-100	0.0035	NA	-100	0.0004	NA	-100
2017	0.00009	0.00000	-97.8	0.00104	0.00003	-97.1			

1B2av Oil distribution

Compared with last year's report, the amount of distributed gasoline in 2017 and the corresponding emission of NMVOC were corrected.

The differences in the emissions of the oil distribution sector between the submissions for 2019 and 2020 are presented in Table 8.9.

Table 8.9 The differences in the sector NFR 1B2av emissions (kt) for 2017 between 2019 and 2020 submissions

Year	NMVOC		
	2019	2020	%
2017	0.94771	0.94932	0.2

8.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2019 and 2020 are made by using exact calculation numbers.

1A3b Road transport

All emissions from road transport have been recalculated for the period between 1990-2017. Recalculations entail taking into use an improved new edition (version 5.3.0) 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 comparison with the previous submission, the emissions have change to a small extent. The differences in road transport emissions between the submissions for 2019 and 2020 are presented in Table 8.10.

Table 8.10 The differences in road transport emissions between the 2019 and 2020 submissions (%)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As
1990	0.0	-0.3	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1991	0.0	-0.3	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1992	0.0	-0.7	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1993	0.0	-0.5	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	-0.1	NR	NR	0.1	NR	0.0	0.0	-0.1	0.0	0.0
1996	0.0	0.0	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	NR	NR	0.0	NR	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0.0	0.5	0.0	-0.1	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0
2015	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
2016	0.0	0.7	0.0	-0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0
2017	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	-0.6	-0.1	-0.1	0.0	0.0

Table 8.10 continues

Year	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
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	-0.2	-0.1	-0.1	-0.1	-0.1	0.2	0.2	0.3	0.3	0.2	0.3	0.0	0.1
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1

1A3c Railways

In the national navigation sector, SO2 emissions have been recalculated for the period between 2012-2014 due to the correction of sulphur content in light fuel oil.

The differences in the railway sector emissions between the submissions for 2019 and 2020 are presented in Table 8.11.

Table 8.11 The differences in railway pollutant emissions between the 2019 and 2020 submissions (%)

Year	1A3c			
	2018	2019	Difference	Difference
	kt		Gg	%
2012	0.000926	0.000603	-0.000323	-34.9
2013	0.000752	0.000522	-0.000230	-30.5
2014	0.000494	0.000401	-0.000093	-18.8

1A3dii National navigation (shipping)

In the national navigation sector, emissions have been recalculated for the period between 1990-2017.

According to an observation which was made by the expert team following the 2019 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 national navigation sector. There was an underestimation of NO_x emissions and an overestimation of NMVOC, PM, and CO emissions. In addition, NH_3 and PAHs emissions were removed from the NFR table and are reported as NE pursuant to the Tier 1 methodology described in the EMEP/EEA Guidebook.

Therefore, emission factors and emission calculations have been corrected and recalculated. Table 8.12 provides a short overview of emission factors that have changed, where older emission factors were used to calculate emissions in the 2019 submission, and with emission factors in the Tier 1 methodology described in the EMEP/EEA Guidebook being used in the 2020 submission.

The differences in the national navigation sector emissions between the 2019 and 2020 submissions are presented in Table 8.13.

Table 8.12 Emission factors for the national navigation sector

Pollutant	Unit	Diesel / Light fuel oil		Petrol	
		2018	2019	2018	2019
NO_x	g/t	38.5	78.5	3.27	9.4
NMVOC	g/t	7.45	2.8	233	181.5
NH_3	g/t	0.007	NE	0.003	NE
$PM_{2.5}$	g/t	4.6	1.4	12.6	9.5
PM_{10}	g/t	4.6	1.5	12.6	9.5
TSP	g/t	4.6	1.5	12.6	9.5
BC	g/t	2.53	0.465	0.63	0.475
CO	g/t	19.8	7.4	481	573.9
B(a)p	g/t	0.03	NE	NE	NE
B(b)f	g/t	0.05	NE	NE	NE

Table 8.13 The differences in national navigation emissions between the 2019 and 2020 submissions (%)

Year	NOx	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	PAHs
1990	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1991	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1992	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1993	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1994	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1995	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1996	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1997	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1998	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
1999	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2000	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2001	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2002	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2003	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2004	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2005	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2006	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2007	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2008	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2009	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2010	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2011	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2012	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2013	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2014	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE
2015	104.7	-42.2	NE	-65.9	--65.9	-65.9	-81.2	-26.8	NE
2016	104.8	-37.7	NE	-64.1	-64.1	-64.1	-80.9	-17.5	NE
2017	104.4	-62.4	NE	-69.6	-69.6	-69.6	-81.6	-62.6	NE

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1A4cii Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

In the agricultural mobile sector, all emissions have been recalculated for the period between 1990-2002.

A separation of emissions has been made for the 1A4cii and 1A4ciii sectors for the period 1990–2002, which was recommended by the expert team following the 2017 review ('A comprehensive technical review of national emissions inventories'). Therefore, all the emissions have decreased in the period 1990 to 2002.

The differences in the agricultural mobile sector emissions between the submissions for 2019 and 2020 are presented in Table 8.14.

Table 8.14 The differences in agricultural mobile emissions between the 2019 and 2020 submissions (%)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-8.6	-5.9	-8.6	-8.3	-8.7	-8.7	-8.8	-8.8	-3.5
1991	-8.7	-6.4	-8.7	-8.5	-8.8	-8.8	-8.8	-8.8	-3.6
1992	-8.6	-5.9	-8.6	-8.3	-8.7	-8.7	-8.7	-8.8	-3.5
1993	-8.7	-7.0	-8.7	-8.6	-8.8	-8.8	-8.8	-8.8	-3.9
1994	-8.7	-8.1	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7	-5.2
1995	-8.7	-8.0	-8.7	-8.7	-8.7	-8.7	-8.7	-8.8	-5.0
1996	-8.6	-7.5	-8.6	-8.6	-8.7	-8.7	-8.7	-8.7	-4.3
1997	-8.7	-7.4	-8.7	-8.6	-8.7	-8.7	-8.7	-8.8	-4.2
1998	-8.5	-7.3	-8.5	-8.4	-8.6	-8.6	-8.6	-8.6	-4.2
1999	-8.2	-7.0	-8.2	-8.1	-8.3	-8.3	-8.3	-8.3	-4.1
2000	-7.5	-6.8	-8.2	-7.5	-7.5	-7.5	-7.5	-7.5	-4.3
2001	-18.0	-15.2	-21.9	-17.8	-18.1	-18.1	-18.1	-18.2	-6.8
2002	-7.1	-6.8	-6.3	-7.1	-7.1	-7.1	-7.1	-7.1	-5.2

Table 8.14 continues

Year	Pb	Cd	Cr	Cu	Ni	Se	Zn	B(a)p	B(b)f	PAHs total	FC
1990	-3.1	-7.9	-7.9	-7.9	-7.9	-7.9	-7.9	-7.6	-8.0	-7.9	-7.8
1991	-3.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.1	-8.0	-8.3	-8.1	-8.1
1992	-3.1	-7.9	-7.9	-7.9	-7.9	-7.9	-7.9	-7.6	-8.0	-7.9	-7.9
1993	-3.1	-8.3	-8.3	-8.3	-8.3	-8.3	-8.3	-8.2	-8.4	-8.3	-8.3
1994	-3.1	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.5	-8.6	-8.6	-8.6
1995	-3.1	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.5	-8.6	-8.6	-8.5
1996	-3.1	-8.4	-8.4	-8.4	-8.4	-8.4	-8.4	-8.3	-8.5	-8.4	-8.5
1997	-3.1	-8.5	-8.5	-8.5	-8.5	-8.5	-8.5	-8.4	-8.5	-8.5	-8.5
1998	-3.1	-8.3	-8.3	-8.3	-8.3	-8.3	-8.3	-8.2	-8.4	-8.3	-8.3
1999	-3.1	-8.0	-8.0	-8.0	-8.2	-8.0	-8.0	-7.9	-8.0	-8.0	-8.1
2000	-3.1	-7.4	-7.4	-7.4	-7.4	-7.4	-7.4	-7.3	-7.4	-7.4	-7.4
2001	-3.1	-17.5	-17.5	-17.5	-17.5	-17.5	-17.5	-17.3	-17.6	-17.5	-17.6
2002	-3.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.0	-7.1	-7.1	-7.0

1A4ciii Agriculture/ Forestry/ Fishing: National fishing

In the national fishing sector, all emissions have been calculated for the period between 1990-2002.

Pollutant emissions from the national fishing sector were not calculated separately and were reported as IE in previous submissions. A separation of emissions has been made for the 1A4ciii sectors for the period 1990–2002, which was recommended by the expert team following the 2017 review. Therefore, all the emissions have calculated for the national fishing sector for the period 1990-2002 and reported for the first time (see Table 8.15).

Table 8.15 Pollutant emissions from the national fishing sector in the period of 1990–2002

Year	NO_x	NMVOC	SO_x	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg
	kt								kg		
1990	0.857	0.164	0.110	0.022	0.022	0.022	0.005	0.503	1.408	0.108	0.325
1991	0.836	0.119	0.107	0.019	0.019	0.019	0.005	0.360	1.377	0.106	0.318
1992	0.619	0.117	0.079	0.016	0.016	0.016	0.004	0.357	1.017	0.078	0.235
1993	0.547	0.058	0.070	0.012	0.012	0.012	0.003	0.175	0.903	0.069	0.208
1994	0.281	0.016	0.036	0.005	0.005	0.005	0.002	0.044	0.465	0.036	0.107
1995	0.234	0.014	0.030	0.004	0.004	0.004	0.001	0.040	0.387	0.030	0.089
1996	0.260	0.020	0.033	0.005	0.005	0.005	0.001	0.060	0.430	0.033	0.099
1997	0.241	0.020	0.031	0.005	0.005	0.005	0.001	0.058	0.399	0.031	0.092
1998	0.243	0.020	0.031	0.005	0.005	0.005	0.001	0.058	0.402	0.031	0.093
1999	0.111	0.010	0.014	0.002	0.002	0.002	0.001	0.028	0.183	0.014	0.042
2000	0.154	0.011	0.008	0.003	0.003	0.003	0.001	0.032	0.255	0.020	0.059
2001	0.314	0.017	0.016	0.006	0.006	0.006	0.002	0.047	0.519	0.040	0.120
2002	0.406	0.020	0.021	0.008	0.008	0.008	0.002	0.056	0.672	0.052	0.155

Table 8.15 continues

Year	As	Cr	Cu	Ni	Se	Zn	PCDD/F	HCB	PCBs	FC
	kg						mg	g		TJ
1990	0.433	0.541	9.530	10.830	1.083	12.996	1.408	0.866	0.412	491.6
1991	0.424	0.530	9.320	10.591	1.059	12.709	1.377	0.847	0.402	475.2
1992	0.313	0.391	6.882	7.820	0.782	9.384	1.017	0.626	0.297	354.5
1993	0.278	0.347	6.115	6.949	0.695	8.338	0.903	0.556	0.264	302.2
1994	0.143	0.179	3.148	3.577	0.358	4.293	0.465	0.286	0.136	151.8
1995	0.119	0.149	2.620	2.977	0.298	3.572	0.387	0.238	0.113	127.4
1996	0.132	0.165	2.909	3.306	0.331	3.967	0.430	0.264	0.126	140.9
1997	0.123	0.153	2.699	3.067	0.307	3.681	0.399	0.245	0.117	131.6
1998	0.124	0.155	2.722	3.093	0.309	3.711	0.402	0.247	0.118	137.2
1999	0.056	0.070	1.238	1.407	0.141	1.688	0.183	0.113	0.053	57.8
2000	0.078	0.098	1.725	1.960	0.196	2.352	0.255	0.157	0.074	81.8
2001	0.160	0.200	3.516	3.995	0.400	4.794	0.519	0.320	0.152	172.7
2002	0.207	0.258	4.547	5.167	0.517	6.201	0.672	0.413	0.196	221.4

8.2. Industry Sector (NFR 2)

8.2.1. Industrial Processes

2A3 Glass production

In comparison with the previous submission, the emissions of particulates from glass production facilities were reallocated from NFR 1A2f to NFR 2A3 for the period 2004–2017.

This year, an analysis of particle emissions from a glass production facility for the period 2000–2017 was carried out. Some sources not related to fuel combustion were with the incorrect SNAP codes and, as a result of the correction, emissions were allocated to the correct NFR code 2A3.

The differences in the emissions of the glass production sector between the submissions for 2019 and 2020 are presented in Table 8.16.

Table 8.16 The differences in the sector NFR 2A3 emissions (kt) for 2004–2017 between 2019 and 2020 submissions

Year	$PM_{2.5}$			PM_{10}			TSP			BC		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2004	IE	0.0002	100	IE	0.0003	100	IE	0.00030	100	IE	0.0000001	100
2005	IE	0.0008	100	IE	0.0009	100	IE	0.00105	100	IE	0.0000005	100
2006	IE	0.0008	100	IE	0.0009	100	IE	0.00104	100	IE	0.0000005	100
2007	IE	0.0008	100	IE	0.0009	100	IE	0.00101	100	IE	0.0000005	100
2008	IE	0.0008	100	IE	0.0009	100	IE	0.00099	100	IE	0.0000005	100

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Year	PM2.5			PM10			TSP			BC		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2009	IE	0.0008	100	IE	0.0009	100	IE	0.00097	100	IE	0.0000005	100
2010	IE	0.0008	100	IE	0.0009	100	IE	0.00101	100	IE	0.0000005	100
2011	IE	0.0008	100	IE	0.0009	100	IE	0.00101	100	IE	0.0000005	100
2012	IE	0.0008	100	IE	0.0009	100	IE	0.00101	100	IE	0.0000005	100
2013	IE	0.0008	100	IE	0.0009	100	IE	0.00101	100	IE	0.0000005	100
2014	IE	0.0006	100	IE	0.0007	100	IE	0.0008	100	IE	0.0000004	100
2015	IE	0.0007	100	IE	0.0007	100	IE	0.0008	100	IE	0.0000004	100
2016	IE	0.0008	100	IE	0.0009	100	IE	0.0010	100	IE	0.0000005	100
2017	IE	0.0005	100	IE	0.0006	100	IE	0.0007	100	IE	0.0000003	100

2A5a Quarrying and mining of minerals other than coal

This year, the submission additionally calculated PM10 emissions for some enterprises, which were not calculated last year.

The differences in the emissions of quarrying and mining of minerals other than coal between the submissions for 2019 and 2020 are presented in Table 8.17.

Table 8.17 The differences in the sector NFR 2A5a emissions (kt) for 2017 between 2019 and 2020 submissions

Year	PM10		
	2019	2020	%
2017	0.0313	0.0614	96.3

2C1 – 2C7c Metal industry

This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out.

The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the emissions were distributed between the corresponding codes from 2C1 to 2C7a. In some cases, emissions were also corrected. In addition, particulate emissions were recalculated using the Guidebook 2019 EF ($PM_{2.5}$ and PM_{10} % of the TSP, as TSP is calculated by the operator).

NFR	PM2.5	PM10	BC	Guidebook 2019 Chapter
	% TSP		% PM2.5	
2C1	46,7	60	0,36	2.C.1, Table 3.1
2C3	27,5	70	2,3	2.C.3, Table 3.4
2C6	81,3	90,6	NE	2.C.6, Table 3.5
2C7c	46,7	60	0,36	Not available in the Guidebook, calculated on the base of Chapter 2.C.1 EF

In addition, PCCD and PCB emissions from zinc production (NFR 2C6) were calculated by using the emission factors of Guidebook 2019 (PCCD – 5 µg I-TEQ/Mg zinc; PCB – 3.6 µg/Mg zinc).

The differences in the emissions of the metal industry between the submissions for 2019 and 2020 are presented in Tables 8.18-8.22.

Table 8.18 The differences in the sector NFR 2C1 emissions (kt; HMs in t) for 2004–2017 between 2019 and 2020 submissions

Year	NOx			NMVOC			SOx			NH3		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	NA	0.0024	100	NA	0.0059	100	NA	0.0009	100	NA	0.0007	100
2001	NA	0.0088	100	NA	0.0074	100	NA	0.0001	100	NA	0.0007	100
2002	NA	0.0112	100	NA	0.0183	100	NA	0.0001	100	NA	0.0008	100
2003	NA	0.0113	100	NA	0.0141	100	NA	0.0001	100	NA	0.0008	100
2004	NA	0.0117	100	NA	0.0146	100	NA	0.0002	100	NA	0.0009	100
2005	NA	0.0121	100	NA	0.0106	100	NA	0.0000	100	NA	0.0006	100

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Year	NO_x			NMVOC			SO_x			NH_3		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2006	NA	0.0258	100	NA	0.0101	100	NA	0.0001	100	NA	0.0007	100
2007	0.0200	0.0158	-21.15	0.0100	0.0092	-8.3000	NA	0.0001	100	NA	0.0007	100
2008	0.0151	0.0151	0.00	0.0079	0.0079	0.000	0.0002	0.0002	0.0000	0.0009	0.0009	0.0000
2009	0.0082	0.0082	0.00	0.0043	0.0043	0.000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000
2010	0.0126	0.0126	0.00	0.0062	0.0062	0.000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
2011	0.0142	0.0143	0.08	0.0074	0.0074	0.000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
2012	0.0137	0.0138	0.09	0.0064	0.0064	0.000	NA	0.00001	100	NA	0.0001	100
2013	0.0001	0.0145	16 051	NA	0.0062	100	NA	0.00002	100	NA	0.0001	100
2014	0.0001	0.0203	27 685	NA	0.0060	100	NA	0.00003	100	NA	0.0001	100
2015	0.0001	0.0224	24 839	NA	0.0071	100	NA	0.00003	100	NA	0.0001	100
2016	0.0245	0.0245	0.00	0.0090	0.0090	0.000	NA	0.00004	100	NA	0.0000	100
2017	0.0311	0.0330	6.07	0.0100	0.0100	0.000	NA	0.00004	100	NA	0.0000	100

Table 8.18 continues

Year	$PM_{2.5}$			PM_{10}			BC			TSP			CO		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	NA	0.0186	100	NA	0.0239	100	NA	0.0001	100.00	NA	0.0398	100	NA	0.0134	100
2001	NA	0.0188	100	NA	0.0241	100	NA	0.0001	100.00	NA	0.0402	100	NA	0.0113	100
2002	NA	0.0203	100	NA	0.0261	100	NA	0.0001	100.00	NA	0.0435	100	NA	0.0134	100
2003	NA	0.0211	100	NA	0.0271	100	NA	0.0001	100.00	NA	0.0452	100	NA	0.0099	100
2004	NA	0.0260	100	NA	0.0335	100	NA	0.0001	100.00	NA	0.0558	100	NA	0.0163	100
2005	NA	0.0224	100	NA	0.0287	100	NA	0.0001	100.00	NA	0.0479	100	NA	0.0142	100
2006	NA	0.0156	100	NA	0.0201	100	NR	0.0001	100.00	NA	0.0334	100	NA	0.0151	100
2007	0.0187	0.0193	3.4	0.0240	0.0248	3.3	NA	0.0001	100.00	0.0400	0.0413	3.4	0.0200	0.0231	15.5
2008	0.0207	0.0204	-1.7	0.0266	0.0262	-1.7	0.0001	0.0001	-2.7	0.0444	0.0437	-1.7	0.0228	0.0228	0.0
2009	0.0149	0.0148	-1.2	0.0192	0.0190	-1.2	0.0001	0.0001	-1.9	0.0320	0.0316	-1.2	0.0118	0.0118	0.0
2010	0.0176	0.0174	-1.1	0.0226	0.0224	-1.1	0.0001	0.0001	0.0	0.0377	0.0373	-1.1	0.0085	0.0085	0.0
2011	0.0122	0.0121	-0.6	0.0156	0.0155	-0.6	0.0000	0.0000	-2.3	0.0260	0.0259	-0.6	0.0081	0.0082	1.3
2012	0.0130	0.0130	0.0	0.0167	0.0167	0.0	0.0000	0.0000	0.0	0.0278	0.0278	0.0	0.0076	0.0077	1.5
2013	0.0001	0.0184	17 730.1	0.0001	0.0236	17 775.8	NA	0.0001	100	0.0002	0.0393	17 775.5	0.0002	0.0104	6 005.3
2014	0.0001	0.0229	18 258.4	0.0001	0.0295	20 663.4	0.0000	0.0001	100	0.0002	0.0491	27 506.7	0.0001	0.0201	15 370.8
2015	0.0002	0.0241	15 547.4	0.0002	0.0310	17 490.9	0.0000	0.0001	8 600.0	0.0002	0.0516	23 354.5	0.0002	0.0259	16 083.1
2016	0.0260	0.0378	45.7	0.0349	0.0488	40.0	0.0001	0.0002	139.8	0.0811	0.0817	0.7	0.0249	0.0249	0.0
2017	0.0760	0.1231	61.9	0.0996	0.1589	59.5	0.0003	0.0007	171.5	0.2627	0.2659	1.2	0.0101	0.0105	4.4

Table 8.18 continues

Year	Pb			Cr			Cu			Ni			Zn		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	NA	0.0110	100	NA	0.0127	100	NA	0.0115	100	NA	0.0030	100	NA	0.0030	100
2001	NA	0.0094	100	NA	0.0158	100	NA	0.0093	100	NA	0.0035	100	NA	0.0030	100
2002	NA	0.0104	100	NA	0.0396	100	NA	0.0037	100	NA	0.0222	100	NA	0.0030	100
2003	NA	0.0038	100	NA	0.0682	100	NA	0.0009	100	NA	0.0439	100	NA	0.0065	100
2004	NA	0.0040	100	NA	0.0370	100	NA	0.0100	100	NA	0.0340	100	NA	0.0100	100
2005	NA	0.0034	100	NA	0.0210	100	NA	0.0100	100	NA	0.0210	100	NA	0.0100	100
2006	NA	0.0028	100	NA	0.0116	100	NA	0.0167	100	NA	0.0110	100	NA	0.0100	100
2007	NA	0.0022	100	0.0100	0.0116	15.5	0.0100	0.0100	0.1	0.0100	0.0103	3.4	0.0100	0.0100	0
2008	NA	0.0016	100	0.0122	0.0122	0	NA	0.0088	100	0.0105	0.0105	0	0.00002	NA	-100
2009	NA	0.0010	100	0.0025	0.0025	0	NA	0.0076	100	0.0007	0.0007	0	0.00001	NA	-100
2010	0.0005	0.0005	0	0.0110	0.0110	0	0.0064	0.0064	0	0.0040	0.0040	0	0.00001	NA	-100
2011	0.0009	0.0009	0	0.0133	0.0133	0	0.0106	0.0106	0	0.0064	0.0064	0	0.00001	NA	-100
2012	0.0005	0.0005	0	0.0084	0.0084	0	0.0064	0.0064	0	0.0046	0.0046	0	0.00000	NA	-100
2013	NA	0.0005	100	NA	0.0993	100	NA	0.0052	100	NA	0.0049	100	NA	NA	0

Year	Pb			Cr			Cu			Ni			Zn		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2014	NA	0.0005	100	NA	0.0059	100	NA	0.0041	100	NA	0.0035	100	NA	NA	0
2015	NA	0.0003	100	NA	0.0018	100	NA	0.0031	100	NA	0.0004	100	NA	NA	0
2016	0.0002	0.0002	0	0.0016	0.0016	0	0.0022	0.0022	0	0.0016	0.0016	0	0.00001	NA	-100
2017	0.0003	0.0003	0	0.0048	0.0048	0	0.0056	0.0056	0	0.0025	0.0025	0	0.00001	NA	-100

Table 8.19 The differences in the sector NFR 2C3 emissions (kt) for 2007–2017 between 2019 and 2020 submissions

Year	NMVOC			$PM_{2.5}$			PM_{10}			BC		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2007	NA	0.0000	100	NA	0.0003	100	NA	0.0007	100	NA	0.0000	100
2008	NA	0.0001	100	NA	0.0006	100	NA	0.0014	100	NA	0.0000	100
2009	0.0000	0.0000	0	0.0004	0.0003	-17.7	0.0008	0.0008	4.9	0.0000	0.0000	-22.2
2010	0.0001	0.0001	0	0.0012	0.0010	-17.6	0.0024	0.0026	5.0	0.0000	0.0000	-17.9
2011	0.0001	0.0001	0	0.0014	0.0012	-17.7	0.0028	0.0030	5.0	0.0000	0.0000	-18.2
2012	0.0000	0.0000	0	0.0014	0.0011	-17.7	0.0028	0.0029	4.9	0.0000	0.0000	-18.8
2013	0.0000	0.0000	0	0.0013	0.0010	-17.7	0.0025	0.0027	5.0	0.0000	0.0000	-17.2
2014	0.0000	0.0000	0	0.0014	0.0011	-17.7	0.0028	0.0029	5.0	0.0000	0.0000	-18.8
2015	0.0000	0.0000	0	0.0023	0.0009	-58.8	0.0027	0.0024	-10.0	0.0001	0.0000	-58.5
2016	NA	0.0000	100	0.0028	0.0011	-58.8	0.0032	0.0029	-10.0	0.0001	0.0000	-59.4
2017	0.0023	0.0023	0	0.0001	0.0000	-59.1	0.0001	0.0001	-10.2	0.0000	0.0000	-50.0

Table 8.20 The differences in the sector NFR 2C5 emissions (kt) for 2000–2017 between 2019 and 2020 submissions

Year	SO_x			$PM_{2.5}$			PM_{10}			TSP			Pb		
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%
2000	NA	0.000001	100	NA	0.00002	100	NA	0.00003	100	NA	0.00004	100	NA	0.0061	100
2001	NA	0.000001	100	NA	0.00002	100	NA	0.00003	100	NA	0.00004	100	NA	0.0061	100
2002	NA	0.000001	100	NA	0.00002	100	NA	0.00003	100	NA	0.00004	100	NA	0.0061	100
2003	NA	0.000001	100	NA	0.00002	100	NA	0.00003	100	NA	0.00004	100	NA	0.0061	100
2004	NA	0.000001	100	NA	0.00002	100	NA	0.00004	100	NA	0.00005	100	NA	0.0060	100
2005	NA	0.000001	100	NA	0.00005	100	NA	0.00011	100	NA	0.00013	100	NA	0.0030	100
2006	NA	0.000001	100	NA	0.00002	100	NA	0.00005	100	NA	0.00006	100	NA	0.0021	100
2007	NA	0.000001	100	NA	0.00004	100	NA	0.00009	100	NA	0.00011	100	NA	0.0047	100
2008	NA	0.000001	100	NA	0.00007	100	NA	0.00014	100	NA	0.00017	100	NA	0.0070	100
2009	0.000001	0.000001	0	0.00002	0.00015	886.7	0.00003	0.00030	886.7	0.00004	0.00037	0	0.0053	0.0053	0
2010	0.000002	0.000002	0	0.00002	0.00002	0.0	0.00004	0.00004	0.0	0.00005	0.00005	0	0.0132	0.0132	0
2011	0.000002	0.000002	0	0.00002	0.00002	0.0	0.00004	0.00004	0.0	0.00005	0.00005	0	0.0103	0.0103	0
2012	0.000002	0.000002	0	0.00003	0.00003	0.0	0.00007	0.00007	0.0	0.00008	0.00008	0	0.0080	0.0080	0
2013	0.000001	0.000001	0	0.00006	0.00006	1.6	0.00012	0.00012	0.0	0.00015	0.00015	0	0.0105	0.0105	0
2014	0.000005	0.000005	0	0.00006	0.00006	0.0	0.00011	0.00011	0.0	0.00014	0.00014	0	0.0165	0.0165	0
2015	0.000003	0.000003	0	0.00003	0.00003	-3.7	0.00006	0.00005	-3.6	0.00007	0.00007	0	0.0098	0.0098	0
2016	0.000002	0.000002	0	0.00003	0.00003	-3.6	0.00006	0.00005	-3.6	0.00007	0.00007	0	0.0107	0.0107	0
2017	0.000002	0.000002	0	0.00005	0.00005	-5.9	0.00010	0.00010	-4.0	0.00012	0.00012	0	0.0000	0.0148	98 567

Table 8.20 continues

Year	NO_x			NH_3		
	2019	2020	%	2019	2020	%
2009	0,00001	NA	-100	0,0661	NA	-100
2010	0,00001	NA	-100	0,0516	NA	-100

Table 8.21 The differences in the sector NFR 2C6 emissions (kt) for 2002–2017 between 2019 and 2020 submissions

Year	$PM_{2.5}$			PM_{10}			TSP			Zn			PCDD	PCB
	2019	2020	%	2019	2020	%	2019	2020	%	2019	2020	%	%	%
2002	NA	0.00009	100	NA	0.00010	100	NA	0.00011	100	NA	0.08800	100		
2003	NA	0.00009	100	NA	0.00010	100	NA	0.00011	100	NA	0.08500	100		
2004	NA	0.00010	100	NA	0.00011	100	NA	0.00012	100	NA	0.15400	100	100	100
2005	NA	0.00011	100	NA	0.00012	100	NA	0.00013	100	NA	0.07400	100	100	100
2006	NA	0.00012	100	NA	0.00013	100	NA	0.00014	100	NA	0.08100	100	100	100
2007	NA	0.00012	100	NA	0.00013	100	NA	0.00014	100	NA	0.06800	100	100	100
2008	NA	0.00012	100	NA	0.00013	100	NA	0.00014	100	NA	0.08400	100	100	100
2009	0.00003	0.00004	32.3	0.00004	0.00005	17.9	0.00005	0.00005	0.0	0.00004	0.05980	133 382	100	100
2010	0.00004	0.00005	35.9	0.00005	0.00006	18.0	0.00007	0.00007	0.0	0.00001	0.07200	719 900	100	100
2011	0.00035	0.00006	-84.4	0.00045	0.00006	-86.3	0.00059	0.00007	-88.4	0.00003	0.09400	348 048	100	100
2012	0.00005	0.00006	36.2	0.00006	0.00007	18.0	0.00008	0.00008	0	0.00002	0.05300	353 233	100	100
2013	0.00005	0.00007	35.4	0.00006	0.00007	16.1	0.00008	0.00008	0	0.00001	0.01400	99 900	100	100
2014	0.00005	0.00006	34.0	0.00006	0.00007	18.3	0.00008	0.00008	0	0.01400	0.01400	0	100	100
2015	0.00006	0.00006	1.6	0.00007	0.00007	4.4	0.00008	0.00008	0	0.01400	0.01400	0	100	100
2016	0.00006	0.00006	1.6	0.00007	0.00007	5.9	0.00008	0.00008	0	0.01500	0.01500	0	100	100
2017	0.00006	0.00007	1.6	0.00007	0.00007	4.3	0.00008	0.00008	0	0.01460	0.01460	0	100	100

Table 8.22 The differences in the sector NFR 2C7c emissions for 2000–2017 between 2019 and 2020 submissions

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb	Cr	Cu	Ni	Zn
2000	100	-83.4	100	23.2	-98.7	-98.7	-98.0	-98.7	-98.6	72.0	-50.0	100	100	-15.0
2001	-99.9	-95.2	100	-3.0	-94.2	-94.2	-94.0	-94.2	-98.6	-72.0	-80.0	100	0	-25.0
2002	-99.8	-96.2	100	-6.8	-96.0	-96.0	-96.4	-96.0	-98.1	-68.3	-90.0	-85.0	-66.0	-86.4
2003	-99.8	-96.4	100	-8.1	-95.1	-95.1	-95.1	-95.1	-98.6	100	650.0	100	-30.0	-32.1
2004	-99.7	-93.0	100	10.2	-96.4	-96.4	-96.0	-96.4	-98.9	100	100	100	100	100
2005	-99.6	-97.5	100	-7.6	-97.1	-97.1	-97.6	-97.1	-98.6	100	-22.9	-90.0	-80.0	55.0
2006	100.0	-96.8	100	3.9	-67.4	-67.4	-68.0	-67.4	-97.2	0	36.8	-95.0	-70.0	-11.9
2007	-27.0	100.0	100	2.1	-55.1	-55.1	-52.9	-55.1	100.0	-39.0	66.0	-5.0	-4.0	100.0
2008	42.6	0.1	100	0.0	-11.2	-11.2	-16.7	-11.2	0.0	0.0	57.4	0	0	9 312.6
2009	242.0	-0.1	100	105 927	20.5	20.4	33.3	20.4	-1.4	0.0	54.0	0	0	9 416.0
2010	409.2	-15.0	100	51 612	6.9	6.9	25.0	6.8	162.0	18.6	0	1.2	-0.4	43.8
2011	-85.1	0.0	0	0	6.3	6.4	25.0	6.4	-8.0	99 900.0	0	0	0	43.5
2012	-96.1	0.0	0	0	-0.6	-0.6	0.0	-0.6	-8.1	0.0	0	0	0	13.2
2013	-99.8	-75.3	-2.0	0	-95.3	-95.3	-95.5	-95.2	-90.3	-78.9	0	0	0	44.8
2014	-99.8	-85.5	0	0	-95.4	-95.7	-94.6	-95.9	-94.9	-86.4	0	0	0	40.2
2015	-71.4	-84.3	0	0	-94.8	-94.5	-94.7	-94.9	-95.8	2.7	0	0	0	38.0
2016	464.7	0.0	0	0	27.5	27.6	50.0	27.6	0	0	0	0	0	40.8
2017	0	0	0	0	22.5	22.5	33.3	22.5	0	0	0	0	0	41.9

8.2.2. Solvent and Other Product Use

2D3a Domestic solvent use including fungicides

NMVOC emissions for the years 2004 to 2017 were recalculated using more detailed Tier 2 emission factors instead of the Tier 1 emission factor (see Table 8.23).

Mercury (Hg) emissions from fluorescence tubes were removed from the inventory due to the removal of the emission factor for that activity from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2019.

Table 8.23 The differences of NMVOC emissions in NFR 2D3a for the years 2004-2017 between 2019 and 2020 submissions

Year	2019	2020	Difference
	kt	kt	%
2004	2.022	2.142	5.9%
2005	1.631	2.168	33.0%
2006	1.621	2.261	39.5%
2007	1.612	2.364	46.7%
2008	1.606	2.371	47.6%
2009	1.603	2.112	31.8%

Year	2019	2020	Difference
	kt	kt	%
2010	1.600	2.034	27.1%
2011	1.596	2.153	35.0%
2012	1.590	2.617	64.6%
2013	1.584	2.375	49.9%
2014	1.579	2.699	70.9%
2015	1.576	2.711	72.0%
2016	1.579	2.812	78.1%
2017	1.579	3.210	103.4%

2D3d Coating applications

NMVOC emission for the year 2017 was recalculated due to the correction of statistical data for international trade and production of paints. Zn, Cu and Pb emissions from the OSIS point sources database were corrected due to the usage of the wrong measurement unit (see Table 8.24).

Table 8.24 The differences of pollutants emissions in NFR 2D3d for the years 2009-2017 between 2019 and 2020 submissions

Year	Pollutant	2019	2020	Difference
		kt	kt	%
2017	NMVOC	3.507493	3.507691	0.01
2009	Zn	0.000019	0.018801	-100.00
2012		0.000019	0.019397	101989.47
2013		0.000089	0.088803	99678.65
2014		0.000046	0.046000	99900.00
2015		0.000003	0.002994	99700.00
2016		0.000058	0.058326	100462.07
2017		0.000014	0.013900	99185.71
2013	Cu	0.000011	0.011100	100809.09
2014		0.000017	0.016800	98723.53
2015		0.000017	0.011708	68769.41
2013	Pb	0.000033	0.033000	99900.00
2014		0.000050	0.050000	99900.00
2015		0.000051	0.050978	99856.86

2D3h Printing

NMVOC emission for the year 2017 was recalculated due to the correction of statistical data for international trade of printing ink (see Table 8.25).

Table 8.25 The difference of NMVOC emission in NFR 2D3h for the year 2017 between 2019 and 2020 submissions

Year	2019	2020	Difference
	kt	kt	%
2017	0.662430	0.663480	0.16

2G Other product use

Pollutants emissions for 2017 were recalculated due to the correction of statistical data for international trade of fireworks (see Table 8.26).

Table 8.26 The differences (%) of pollutants emissions in NFR 2G for the year 2017 between 2019 and 2020 submissions

Year	NO_x	SO_2	$PM_{2.5}$	PM_{10}	TSP	CO	
2017	-0.3	-7.7	-2.5	-3.7	-3.9	-0.2	
Year	Pb	Cd	As	Cr	Cu	Ni	Zn
2017	-7.7	-0.5	-0.9	-7.7	-7.3	-7.7	-7.7

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 2020 and 2019 are made by using exact calculation numbers.

3B4d Manure management - goats

PM_{10} emissions from goats have been recalculated for the years 2000-2017 due to the correction of emission factor.

Table 8.27 The differences in goats manure management PM_{10} emissions (kt) for the years 2000–2017 between 2019 and 2020 submissions (%)

Year	PM_{10}		
	Old	Recalc.	Difference
2000	0.000080	0.000230	187.5
2001	0.000090	0.000260	188.9
2002	0.000100	0.000280	180.0
2003	0.000090	0.000250	177.8
2004	0.000080	0.000220	175.0
2005	0.000070	0.000190	171.4
2006	0.000080	0.000220	175.0
2007	0.000090	0.000270	200.0
2008	0.000090	0.000250	177.8
2009	0.000100	0.000280	180.0

Year	PM_{10}		
	Old	Recalc.	Difference
2010	0.000100	0.000300	200.0
2011	0.000100	0.000290	190.0
2012	0.000110	0.000330	200.0
2013	0.000110	0.000310	181.8
2014	0.000100	0.000280	180.0
2015	0.000100	0.000300	200.0
2016	0.000110	0.000330	200.0
2017	0.000110	0.000310	181.8

8.3.2. Agricultural Soils

3Da1 Inorganic N-fertilizers (includes also urea application)

NH_3 from inorganic N-fertilizer have been recalculated for the years 1990-2017. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2019. Also using corrected activity data for the years 2010-2017.

Table 8.28 The differences in fertilizer application emissions (kt) for the years 1990–2017 between 2019 and 2020 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	2.966	3.642	22.8
1991	2.422	2.971	22.7
1992	2.394	2.946	23.1
1993	1.225	1.509	23.1
1994	1.097	1.341	22.3
1995	0.806	0.982	21.9
1996	0.708	0.862	21.8
1997	0.859	1.051	22.3
1998	1.032	1.267	22.8
1999	0.835	1.021	22.4
2000	0.934	1.145	22.5
2001	0.822	1.006	22.4
2002	0.694	0.851	22.7
2003	0.966	1.185	22.7
2004	1.046	1.279	22.2
2005	0.901	1.085	20.4
2006	0.963	1.174	21.9
2007	1.109	1.338	20.7
2008	1.447	1.783	23.2
2009	1.121	1.379	23.1
2010	1.160	1.432	23.4
2011	1.278	1.491	16.7
2012	1.315	1.439	9.5
2013	1.209	1.486	22.9
2014	1.399	1.562	11.7
2015	1.442	1.583	9.8
2016	1.431	1.588	10.9
2017	1.464	2.588	76.7

3Da2b Sewage sludge applied to soils

NH_3 emissions from sewage sludge which was applied to soils have been recalculated for the years 1990-2017. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2019.

Table 8.29 The differences in sewage sludge applied to soils category emissions (kt) for the years 1990–2017 between 2019 and 2020 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	0.010	0.011	3.0
1991	0.010	0.011	3.0
1992	0.010	0.011	3.0
1993	0.010	0.010	3.0
1994	0.010	0.010	3.0
1995	0.010	0.010	3.0
1996	0.009	0.010	3.0
1997	0.009	0.010	3.0
1998	0.009	0.009	3.0
1999	0.009	0.009	3.0
2000	0.009	0.010	3.0
2001	0.009	0.009	3.0
2002	0.009	0.009	3.0
2003	0.009	0.009	3.0
2004	0.009	0.009	3.0
2005	0.009	0.009	3.0
2006	0.009	0.009	3.0
2007	0.009	0.009	3.0
2008	0.009	0.009	3.0
2009	0.009	0.009	3.0
2010	0.009	0.009	3.0
2011	0.009	0.009	3.0
2012	0.009	0.009	3.0
2013	0.009	0.009	3.0
2014	0.009	0.009	3.0
2015	0.009	0.009	3.0
2016	0.009	0.009	3.1
2017	0.009	0.009	3.0

3De Cultivated crops

NMVOC from cultivation of crops have been recalculated for the years 1990-2017. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2019 and the Tier 2 instead of Tier 1 for the first time.

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Table 8.30 The differences in cultivated crops emissions (kt) for the years 1990–2017 between 2018 and 2019 submissions (%)

Year	NMVOC		
	Old	Recalc.	Difference
1990	0.679	0.606	-10.8
1991	0.649	0.583	-10.2
1992	0.819	0.736	-10.1
1993	0.469	0.381	-18.9
1994	0.445	0.400	-10.1
1995	0.358	0.298	-16.6
1996	0.306	0.240	-21.7
1997	0.364	0.292	-19.7
1998	0.411	0.317	-22.9
1999	0.362	0.275	-24.0
2000	0.389	0.293	-24.7
2001	0.313	0.231	-26.1
2002	0.337	0.250	-25.8
2003	0.331	0.235	-29.2
2004	0.348	0.117	-66.2
2005	0.458	0.245	-46.5
2006	0.478	0.254	-46.9
2007	0.534	0.281	-47.4
2008	0.411	0.162	-60.5
2009	0.372	0.120	-67.8
2010	0.376	0.123	-67.3
2011	0.408	0.151	-62.9
2012	0.428	0.136	-68.2
2013	0.410	0.101	-75.4
2014	0.439	0.121	-72.4
2015	0.439	0.147	-66.4
2016	0.531	0.216	-59.4
2017	0.504	0.181	-64.1

8.4. Waste Sector (NFR 5)

5A Solid waste disposal on land

NMVOC emissions for the whole time series were recalculated by using the amounts of biodegradable solid waste deposited in landfills and the quantities of CH4 that is generated from the biodegrading process of that waste. Those amounts were obtained from the Estonian GHG inventory (see Table 8.31).

Table 8.31 The differences of NMVOC emissions in NFR 5A for the years 1990-2017 between 2019 and 2020 submissions

Year	2019	2020	Difference
	kt	kt	%
1990	1.213	0.135	-88.9
1991	1.201	0.144	-88.0
1992	1.189	0.152	-87.2
1993	1.214	0.167	-86.3
1994	0.980	0.168	-82.9
1995	1.107	0.162	-85.3
1996	1.138	0.189	-83.4
1997	1.285	0.226	-82.4
1998	1.032	0.247	-76.1
1999	1.004	0.252	-74.9
2000	0.810	0.278	-65.7
2001	0.913	0.285	-68.8
2002	0.944	0.280	-70.3
2003	1.084	0.268	-75.2
2004	0.896	0.269	-70.0
2005	0.789	0.249	-68.4
2006	0.766	0.239	-68.9
2007	0.817	0.225	-72.5
2008	0.699	0.220	-68.5
2009	0.545	0.231	-57.7
2010	0.508	0.230	-54.8
2011	0.493	0.216	-56.2
2012	0.318	0.202	-36.5
2013	0.168	0.179	6.8
2014	0.130	0.160	22.5
2015	0.122	0.153	26.1
2016	0.158	0.139	-12.1
2017	0.274	0.136	-50.5

5B2 Anaerobic digestion at biogas facilities

The NH_3 emission for 2017 was replaced with the notation key NE due to the correction of point sources data from the OSIS point sources information system.

5C1bi Industrial waste incineration

Pollutant emissions for the year 2017 were recalculated due to the correction of activity data from the OSIS point sources information system (see Table 8.32).

NMVOC (2004-2005), SO_2 (2003-2005), TSP (2003), CO (2003) and Pb (2004-2006) emissions were allocated under NFR source category 1A2gviii and were replaced with the notation key NA under this NFR source category.

Table 8.32 The differences (%) of pollutant emissions for NFR 5C1bi for the year 2017 between 2019 and 2020 submissions

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Cu
2017	21736.7	201.4	100.0	124.0	117.8	119.6	56.8	66.3	100.0

5E Other waste

Pollutant emissions for the years 2016 and 2017 were corrected due to the mistake done by the inventory expert (see Table 8.33).

Table 8.33 The differences (%) of pollutant emissions for NFR 5E for the years 2016-2017 between 2019 and 2020 submissions

Year	$PM_{2.5}$	PM_{10}	TSP	Pb	Cd	Hg	As	Cr	Cu
2016	-11.2	-11.2	-11.2	-11.8	-11.5	-11.5	-11.3	-11.3	-11.4
2017	0.4	0.4	0.4	0.0	0.3	0.3	0.4	0.4	0.4

Source: http://lofciam.pl

9. PROJECTIONS

Estonia's emission projections 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. In parallel with the projection compilation, working groups of relevant stakeholders representatives were assembled, to receive additional input in the energy (incl. transport), industrial processes and product use (incl. solvents) and agriculture sector. Waste sector projections are based on the national strategy documents and legislation.

More detailed information on the projections activity data, methodology and measures can be found in the Estonian National Air Pollution Control Programme pursuant to Article 6 of Directive 2016/2284, submitted to the Commission by 1 April 2019.

Projected emissions with measures and additional measures for 2020, 2025 and 2030 and reduction compared with a base 2005 year are presented in the following tables.

Table 9.1 National emission projection for 2020

Pollutant	2005	2017	WM	Reduction compared with 2005, %	WaM	Reduction compared with 2005, %
NO_x	41.862	33.200	30.395	-27.4	30.522	-27.1
NMVOC	32.313	22.245	19.813	-38.7	19.742	-38.9
SO_x	76.257	38.653	22.987	-69.9	22.500	-70.5
NH_3	10.256	10.255	10.955	6.8	10.513	2.5
$PM_{2.5}$	14.224	9.222	6.403	-55.0	6.376	-55.2

Table 9.2 National emission projection for 2025

Pollutant	2005	2017	WM	Reduction compared with 2005, %	WaM	Reduction compared with 2005, %
NO_x	41.862	33.200	30.014	-28.3	26.994	-35.5
NMVOC	32.313	22.245	19.973	-38.2	18.741	-42.0
SO_x	76.257	38.653	17.985	-76.4	16.181	-78.8
NH_3	10.256	10.255	11.386	11.0	10.395	1.4
$PM_{2.5}$	14.224	9.222	6.339	-55.4	5.838	-59.0

Table 9.3 National emission projection for 2030

Pollutant	2005	2017	WM	Reduction compared with 2005, %	WaM	Reduction compared with 2005, %
NO_x	41.862	33.200	27.889	-33.4	23.214	-44.5
NMVOC	32.313	22.245	19.998	-38.1	18.409	-43.0
SO_x	76.257	38.653	11.949	-84.3	10.829	-85.8
NH_3	10.256	10.255	12.025	17.2	10.506	2.4
$PM_{2.5}$	14.224	9.222	6.616	-53.5	5.451	-61.7

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

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
1A3c	Railways	–	–	EMEP/EEA Guidebook 2019
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

NFR	Source/sector name	PM emissions: the condensable component is		EF reference and comments
		included	excluded	
2H1	Pulp and paper industry			Facility specific EF. It is not known if the condensable part is included or not.
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 2018 for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$ that have not been implemented in the inventory submission 2019

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-2D3a-2017-0001	Yes	2D3a Domestic Solvent use including Fungicides, NMVOC, 1990-2015	No	RE	No

Recommendation made in previous review report

The TERT reiterates recommendation EE-2D3a-2017-0001 from the 2017 NECD Review. During the 2018 NECD Review, Estonia noted that it was unsure when it will acquire sufficient amount of data to move from Tier 1 to Tier 2 methodology, but efforts for that will be made depending on resources available. The TERT recommends that Estonia acquire detailed activity data so that it is possible to use a Tier 2 methodology for emission calculations.

Assessment of Implementation

For category 2D3a Domestic solvent use including fungicides and pollutant NMVOC in years 1990-2017, the TERT noted a potential over- or under-estimate exceeding the threshold of significance. This was raised during the 2017 and 2018 NECD review. In response to a question raised during the review, Estonia explained that activity data was difficult to obtain, and it will take some time before Estonia can move from a Tier 1 methodology. Nevertheless, Estonia provided a revised estimate for years 2005, 2010, 205, 2016 and 2017 as requested but identified issues with the activity data and stated that it should regarded as a first estimate. The TERT agreed with the revised estimate provided by Estonia.

The TERT recommends that Estonia investigates how it may develop the activity data and methodology and include intermediate years and, that the revised estimate is included in its 2020 NFR submission with a thorough documentation in the IIR.

Improvement made	IIR Chapter, page
NMVOC emissions have been recalculated for the period of 2004-2018 using product-based international trade and production statistics from the Statistics Estonia. Tier 2a (Table 3.4) and 2b (Table 3.5) emission factors are used from the Chapter 2.D.3.a of the EMEP/EEA Guidebook 2019. 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.	Chapter 4.2.5., pages 165-168

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-1A1c-2017-0002	No	1A1c Manufacture of Solid Fuels and Other Energy Industries, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005-2015	No	No	No

Recommendation made in previous review report

For category 1A1c Manufacture of Solid Fuels and Other Energy Industries, the TERT noted that there was a lack of transparency regarding the implementation of the previous 2017 NECD review recommendation EE-1A1c-2017-0002 concerning the reallocation of oil shale consumption for oil shale production. In response to a question raised during the review, Estonia explained that the oil shale used for shale oil production had been removed for 2016 but remains included in the activity data for previous years, and stated that NFR 1A1c activity data will be corrected in the next submission. The TERT recommends that Estonia corrects the activity data for the full time series and documents the changes transparently in the 2019 submission.

Assessment of Implementation

For category 1A1c Manufacture of Solid Fuels and Other Energy Industries, the TERT noted that there was a lack of transparency regarding the implementation of the previous 2017 NECD review recommendation EE-1A1c-2017-0002 and 2018 NECD review recommendation EE-1A1c-2018-0002 concerning the reallocation of oil shale consumption for oil shale production. In response to a question raised during the 2018 review, Estonia explained that the oil shale used for shale oil production had been removed for 2016 but remains included in the activity data for previous years, and stated that NFR 1A1c activity data will be corrected in the 2019 submission. In the 2019 IIR Estonia explained that the data has been corrected for the years 2010-2015 and the full time series will be corrected in the next submission.

The TERT recommends that Estonia corrects the activity data for the full time series and documents the changes transparently in the 2020 IIR and NFR submissions.

Improvement made	IIR Chapter, page
The oil shale used for shale oil production was removed from the solid fuel consumption data in the 2019 submission, with the exception for the years 1990-1993. There were difficulties with the activity data for this period, but we will try to add missing data and a table with a comparison next year submission.	NFR tables, Activity data, Solid fuels

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-1A4cii-2017-0001	No	1A4cii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery, NO_X, 2001,2002	No	No	No

Recommendation made in previous review report

For category 1A4cii Agriculture/Forestry/Fishing: Off-Road Vehicles and Other Machinery/liquid fuels/ all years the TERT notes that improvements to address the variability in activity data from years 2000-2015 and the separation of emissions from NFR 1A4ciii as a response to previous review observations (EE-1A4cii-2017-0001) are mentioned in the IIR and planned in coming years. In response to a question raised during the review, Estonia explained that it is working to improve the transparency of the inventory by double-checking fuel consumption data presented in the energy balance for category 1A4cii with Statistics Estonia and that they try to explain emission fluctuations for this period. Estonia also plans to calculate emissions from NFR 1A4ciii (1990-2012) and report them separately in the next submission. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that these improvements are carried out for the next 2019 submission.

Assessment of Implementation

For category 1A4cii Agriculture/Forestry/Fishing: Off-Road Vehicles and Other Machinery/liquid fuels/all years the TERT notes that improvements to address the variability in activity data from years 2000-2015 and the separation of emissions from NFR 1A4ciii as a response to previous review observations (EE-1A4cii-2017-0001) are mentioned in the IIR and planned in coming years. In response to a question raised during the review, Estonia explained that it is working to improve the transparency of the inventory by double-checking fuel consumption data presented in the energy balance for category 1A4cii with Statistics Estonia and that they try to explain emission fluctuations for this period. Estonia also plans to calculate emissions from NFR 1A4ciii (1990-2012) and report them separately in the next submission.

The TERT notes that this issue does not relate to an over- or under-estimate and recommends that these improvements are carried out for the next 2019 submission. The 2019 review has identified that in the IIR Annex III it is stated that these improvements are planned for the 2020 submission.

Improvement made	IIR Chapter, page
We 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. In addition, a separation of emissions has been made for the 1A4cii and 1A4ciii sectors for the period 1990–2002, which was recommended by the expert team following the 2017 review.	Chapter 3, Chapter 8

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-2C-2017-0002	No	2C Metal Industry, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2009-2015	No	No	No

Recommendation made in previous review report

The TERT reiterates recommendation EE-2C-2017-0002 from the 2017 NECD Review. The TERT recommends that Estonia reports emissions from this source consistently in NFR 2C under the correct NFR categories for the full time series before and after 2009. During the 2018 NECD Review, Estonia confirmed that the recommendation would be addressed by the 2020 submission.

Assessment of Implementation

For NFR categories 2C3 Aluminium Production, 2C5 Lead Production, 2C6 Zinc Production and 2C7a Copper Production, for $PM_{2.5}$ and years 2009 - 2015 and for 2C5 Lead Production also for SO_2, the TERT noted that emissions seem to be still reported inconsistently. This issue was raised during the 2017 and 2018 reviews. In response to a question raised during the review, Estonia responded that they would improve the inventory in the 2020 submission.

The TERT recommends that Estonia improves on the allocation of emissions and transparently describes in the IIR, how emissions from these sources have been estimated and reported in the 2020 submission.

Improvement made	IIR Chapter, page
This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out. The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the all reported substances emissions were distributed between the corresponding codes from 2C1 to 2C7c. In addition, particulate emissions were recalculated using the Guidebook 2019 EF (PM2.5 and PM10 % of the TSP, as TSP is calculated by the operator). The differences in the emissions of the metal industry between the submissions for 2019 and 2020 are presented in the Chapters 4 and 8.	Chapters 4 and 8, Tables 8.23–27

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-2C1-2017-0002	No	2C1 Iron and Steel Production, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2007-2015	No	No	No

Recommendation made in previous review report

The TERT reiterates recommendation EE-2C1-2018-0004 from the 2017 NECD Review. The TERT recommends that Estonia allocate data from 2000-2006 to NFR 2C1 instead of NFR 2C7c and to improve the data and descriptions of the iron and steel production source category. During the 2018 NECD Review, Estonia confirmed that the recommendation would be addressed by the 2020 submission.

Assessment of Implementation

For category 2C1 Iron and Steel Production, for NO_X, NMVOC and $PM_{2.5}$ emissions, the TERT notes a sharp increase in emissions in 2008 and at the same time a decrease in emissions of NFR 2C7c. The TERT also notes that Estonia does not provide an explanation on the follow up of recommendation EE-2C1-2018-0004 to allocate data from 2000-2006 to NFR 2C1 instead of NFR 2C7c and to improve the data and descriptions of the iron and steel production source category. In response to a question raised during the review, Estonia explained that no progress had been made on this issue.

The TERT recommends that Estonia implements the recommendation from the 2017 and 2018 reviews and reports accordingly in the 2020 submission.

Improvement made	IIR Chapter, page
This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out. The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the all reported substances emissions were distributed between the corresponding codes from 2C1 to 2C7c. In some cases emissions have been corrected (e.g. incorrect units) or extrapolated. In addition, particulate emissions were recalculated using the Guidebook 2019 EF (PM2.5 and PM10 % of the TSP, as TSP is calculated by the operator). Perhaps welding, cutting or some other metal processing is more correctly to include under the NFR 2C7c code. The differences in the emissions of the metal industry between the submissions for 2019 and 2020 are presented in the Chapters 4 and 8.	Chapter 8, tables 8.23 and 8.27

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE or TC in 2018	RE, TC or PTC in 2019	Tier 1 used for Key Category
2017 (3)	EE-5B2-2017-0001	No	5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities, NH_3, 2005;2010;2015	No	No	No

Recommendation made in previous review report

In the 2017 review report, the TERT recommended that Estonia increase the completeness of its inventory by considering all the biogas production facilities for the determination of national activity data and also recommended that Estonia includes this information in its IIR. The TERT noted that the recommendation was not implemented for the 2018 submission. In response to a question raised during the 2018 review, Estonia explained that the implementation of the 2017 recommendation is dependent on the current workload and prioritisation and that improvements were planned for no later than the 2020 submission. The TERT notes that this issue is expected to be below the threshold of significance for a technical correction. The TERT recommends that Estonia include all biogas facilities in its estimates to increase completeness and to avoid under-estimation and provide the resulting activity data in the IIR (to improve transparency). In addition, the TERT encourages Estonia to compare the Tier 1 approach with emission data reported by facilities, to check if the methodology used by facilities to report their emissions is relevant and to consider if a Tier 2 or 3 method can be developed.

Assessment of Implementation

In the 2017 review report, the TERT recommended that Estonia increase the completeness of its inventory by considering all the biogas production facilities for the determination of national activity data and also recommended that Estonia includes this information in its IIR. The TERT noted that the recommendation was not implemented for the 2018 and 2019 submissions. In response to a question raised during the 2019 review, Estonia explained that as using estimates reported by facilities, there is no need to use the 2016 EMEP/EEA Guidebook Tier 1 methodology because facility estimates can be considered as a Tier 3 methodology. Estonia also indicated that the only remaining source of under-estimate concerning NFR 5B2 is that some biogas production facilities may report under wrong SNAP codes and therefore they are under a wrong NFR code. The TERT notes that this issue is expected to be below the threshold of significance for a technical correction.

The TERT reiterates the recommendation that Estonia compare the Tier 1 approach with emission data reported by facilities, to check if the methodology used by facilities to report their emissions is relevant and also consider if a Tier 2 or 3 method can be developed. The objective is to check if facilities really do apply a methodology consistent with the 2016 EMEP/EEA Guidebook to estimate emissions from biogas production. Moreover, basing the inventory only on data reported by operators may be tricky : in addition to the exhaustivity of the plants reporting in the system, there is need to ensure that a possible threshold for reporting (e.g. a threshold applied for the E-PRTR reporting) does not prevent that all activities in the facilities are considered, including diffuse emissions, and that the methodologies applied by the operators are consistent with the one used in the inventory.

Improvement made	IIR Chapter, page
Unfortunately it wasn't possible to update data for this NFR source code in this (2020) submission due to the current workload. It is planned to work with the GHG inventory team this year to compare the data between two inventories and to make necessary updates and recalculations for the 2021 submission.	

Additional recommendations made during the NECD Review 2019 for NO_X, NMVOC, SO_2, NH_3, $PM_{2.5}$

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3Da1-2019-0002	Yes	3Da1 Inorganic N-Fertilizers (includes also urea application), NH_3, 2012-2016	PTC	Yes

Recommendation

The TERT notes with reference to category 3Da1 Inorganic N-fertilizers (includes also urea application), for NH_3 emissions in 2005, 2010, 2015, 2016 and 2017 that Estonia only differentiates urea and other fertilisers, therefore Estonia does not apply a Tier 2 approach for this key category. The TERT notes that using this method is not best practice and could result in an over- and/or under-estimate of emissions. This over-/under-estimate may have an impact on total emissions that is above the threshold of significance. Estonia has not provided a revised estimate. 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 in cooperation with the Statistics Estonia, Agricultural Board and the Environmental Research Centre, they have started analysing where the gaps and differences between IFASTAT data and their existing data come from and find the best solution for changing the methodology to Tier 2.

The TERT recommends that Estonia calculates NH3 emissions from category 3Da1 Inorganic N-fertilizers (includes also urea application) using a Tier 2 or a Tier 3 method, reports the emissions and documents the calculations in the next inventory submission.

Improvement made	IIR Chapter, page
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.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A3dii-2019-0001	No	1A3dii National Navigation (Shipping), $PM_{2.5}$, 2000-2017	No	No

Recommendation

For category 1A3dii National Navigation (Shipping) for all years, the TERT noted that in the NFR, $PM_{2.5}$ emission estimates are equal to PM_{10}, when in fact lower $PM_{2.5}$ emission estimates are expected. In response to a question raised during the review, Estonia explained that this is an item in their current improvement plan for this year. Estonia provided emissions data for years 1990 to 2017 and stated that it will be included in their next submission. The data showed that the impact of the revision is lower than the threshold of significance. The TERT agreed with the data provided by Estonia.

The TERT recommends that Estonia include the new data in its 2020 NFR and IIR submission.

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Improvement made			IIR Chapter, page	
According to an observation which was made by the expert team following the 2019 review, main pollutants as well as particulate matter emission factors and emission calculations were checked for the national navigation sector. There was an underestimation of NO_x emissions and an overestimation of NMVOC, PM, and CO emissions. In addition, NH_3 and PAHs emissions were removed from the NFR table and are reported as NE pursuant to the Tier 1 methodology described in the EMEP/EEA Guidebook. Therefore, emission factors and emission calculations have been corrected and recalculated.			Chapter 3, Chapter 8	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1B2ai-2019-0001	No	1B2ai Fugitive Emissions Oil: Exploration, Production, Transport, NMVOC, 2000-2007	No	No

Recommendation

For category 1B2ai Fugitive Emissions Oil: Exploration, Production, Transport and Pollutant NMVOC for all years the TERT noted that the notation key 'NA' is used. In response to a question raised during the review, Estonia agreed that for this NFR code the notation code ’NA’ is not correct. Estonia explained that the activity does not occur in Estonia for liquid fossil fuels so the notation key 'NO' should be used.

The TERT recommends that Estonia correct the notation key to 'NO' in the next submission and explain this in the IIR.

Improvement made	IIR Chapter, page
The notation key ’NA’ has been replaced with the correct key 'NO'.	NFR tables for 1990-2018, version v2.0, category 1B2ai.

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2B10a-2019-0002	No	2B10a Chemical Industry: Other, SO_2, 2017	No	No

Recommendation

For category 2B10a Chemical Industry: Other, for SO_2 emissions in 2017, the TERT noted that emissions of SO_2 had been reported as 'NA', while emissions were reported in previous years. In response to a question raised during the review Estonia explained that the emission stems from one plant, and that the plant in question had not reported emissions for 2017. Estonia further acknowledged that the correct notation key would have been 'NE'. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia tries to get an estimate from the plant, or alternatively calculates emissions using a proxy or extrapolation for the 2020 submission.

Improvement made				IIR Chapter, page
This year submission, in cases where emissions are not presented, the notation key 'NA' has been replaced with the correct key 'NE'. There are plans to check facility data and if possible alternatively calculate emissions in next year's submission.				NFR tables
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2C1-2019-0002	No	2C1 Iron and Steel Production, $PM_{2.5}$, 2000-2006	No	No
Recommendation For category 2C1 Iron and Steel Production, pollutant $PM_{2.5}$ and years 2000-2006, the TERT noted that emissions had not been reported. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Estonia estimates $PM_{2.5}$ emissions from iron and steel production for this part of the time series and reports the results in the 2020 submission together with a description of the methodology and the data sources used.**				
Improvement made				IIR Chapter, page
This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out. The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the all substances emissions were distributed between the corresponding codes from 2C1 to 2C7c. In addition, particulate emissions were recalculated using the Guidebook 2019 EF (PM2.5 and PM10 % of the TSP, as TSP is calculated by the operator).				Chapters 8 for industry
Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2D3d-2019-0001	No	2D3d Coating Applications, $PM_{2.5}$, 2001, 2002, 2005	No	No
Recommendation For category 2D3d Coating Applications, $PM_{2.5}$ for years 2001, 2002 and 2005, the TERT noted that there is a lack of transparency regarding particle size distribution as $PM_{2.5}$ is reported as equal to PM_{10}. In response to a question raised during the review, Estonia explained that the plants had only reported $PM_{2.5}$ and Estonia had used the same number for PM_{10}. This does not relate to an over- or under-estimate of emissions. **The TERT recommends that Estonia in the 2020 submission explains in the IIR in which cases assumptions have been made regarding particle size distribution.**				
Improvement made				IIR Chapter, page
The explanation on the assumptions made regarding particle size distribution is included in the IIR.				Chapter 4.2.6.2., page 174

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2D3g-2019-0001	No	2D3g Chemical Products, $PM_{2.5}$, 2003, 2005	No	No

Recommendation

For category 2D3g Chemical Products, $PM_{2.5}$ for years 2003 and 2005, the TERT noted that there is a lack of transparency regarding particle size distribution as $PM_{2.5}$ is reported as equal to PM_{10}. In response to a question raised during the review, Estonia explained that the plants had only reported $PM_{2.5}$ and Estonia had used the same number for PM_{10}. This does not relate to an over- or under-estimate of emissions.

The TERT recommends that Estonia in the 2020 submission explains in the IIR in which cases assumptions have been made regarding particle size distribution.

Improvement made	IIR Chapter, page
The explanation on the assumptions made regarding particle size distribution is included in the IIR.	Chapter 4.2.9.2, page 182

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3B4d-2019-0001	No	3B4d Manure Management - Goats, $PM_{2.5}$, 2000-2017	No	No

Recommendation

For category 3B4d Manure Management – Goats and $PM_{2.5}$ emissions for years 2015, 2020, 2015, 2016 and 2017 the TERT noted there is an under-estimate. In response to a question raised during the review Estonia indicated that they are aware of the small potential over-estimate of $PM_{2.5}$ emissions; however, the share of $PM_{2.5}$ from manure management (the sum of all animal categories) in national total emissions in 2017 was less than 1%. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia revise the estimates or provide an explanation of the impact of the potential over-estimate in submission 2020.

Improvement made	IIR Chapter, page
An explanation has been added in agriculture chapter. These issues will be discussed and investigated more deeply and all necessary improvements are carried out for the next 2021 submission.	Chapter 5.2.2

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Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3D-2019-0001	Yes	3D Crop Production and Agricultural Soils, NO_X, NH_3, 2005, 2010, 2015, 2016, 2017	No	No

Recommendation

For category 3D Crop Production and Agricultural Soils and NH_3 for NO_X and years 2005, 2020, 2015, 2016 and 2017 the TERT noted that there is a lack of transparency regarding the estimate and reporting of these emissions due to the application of the digestate from anaerobic digestion operators. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Estonia explained that the amount of digestate is insignificantly small compared to the total amount of manure generated, and therefore it is not presented separately, and that it is considered in the estimates from manure application.

The TERT recommends that Estonia provides the documentation for deriving these estimates and allocation in its next submission.

Improvement made	IIR Chapter, page
An explanation has been added in agriculture chapter.	Chapter 5.2.2

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3Da2a-2019-0001	Yes	3Da2a Animal Manure Applied to Soils, NH_3, 2000-2016	No	No

Recommendation

For category 3Da2a Animal Manure Applied to Soils, NH_3 emissions and years 2005, 2010, 2015, 2016 and 2017 the TERT noted that there is a lack of transparency regarding the recalculations performed. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Estonia provided data on the incorporation of ammonia abatement techniques in the estimates, the update of each technique by animal and year and the reduction factor used in the calculations.

The TERT recommends that the information provided is included in the next IIR submission to improve the description of the method, data and assumptions used in the estimates. The TERT also recommends that recalculations are further explained in the IIR by including the reasons behind and previous and current values used for the data or parameters changed. The TERT recommends that recalculations are explained considering the fact that emissions of N components in 3B and 3D are linked.

Improvement made	IIR Chapter, page
An explanation about used abatement techniques has been added in agriculture chapter.	Chapter 5.2.2 (Tables 5.14)

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3De-2019-0003	Yes	3De Cultivated Crops, NMVOC, 2005, 2010, 2015, 2016, 2017	No	Yes
Recommendation For category 3De Cultivated Crops and NMVOC emissions, for years 2005, 2010, 2015m 2016 and 2017 the TERT noted that these are calculated using a T1 method, while this is a key category in 2016 and 2017. In response to a question raised during the review, Estonia indicated that there is a plan to review activity data for the entire time series and to apply a Tier 2 method in the next submission. **The TERT recommends that Estonia estimates these emissions applying a Tier 2 approach in the 2020 submission. The TERT notes that for crops for which a Tier 2 EF is not presented in table 3.3 of chapter 3.D Crop production and agricultural soils of 2016 EMEP/EEA Guidebook, a Tier 1 default EF can be used.**				
Improvement made			IIR Chapter, page	
Tier 2 methodology was used for emission calculations.			NFR tables, IIR chapters 5.2.1 and 8	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-5A-2019-0001	Yes	5A Biological Treatment of Waste - Solid Waste Disposal on Land, NMVOC, 1990-2017	No	Yes
Recommendation For NMVOC emissions from category 5A Biological Treatment of Waste – Solid Waste Disposal on Land - waste disposal over the complete time series the TERT noted that Estonia is applying a Tier 1 EF proposed in the 2016 EMEP/EEA Guidebook although NFR 5A is a key category. The TERT notes that indeed the Guidebook doesn't propose a higher Tier methodology for NMVOC. In response to a question raised during the review Estonia confirmed that it will manage to recalculate those emissions as soon as possible depending on other priorities. The TERT noted that the issue is below the threshold of significance for a technical correction. **The TERT recommends that Estonia use a higher Tier methodology (which would result in lower emissions). For instance, CH_4 emission ratio per ton of disposed waste from the UNFCCC 2019 reporting can be used when converted into a volume of CH_4 per ton of disposed waste (using the molar volume of CH_4) and then into a volume of biogas per ton of disposed waste (applying the fraction of CH_4 in biogas F = 50%) and then apply the fraction of NMVOC in biogas (5.65 g/m3 of landfill gas) presented in the note at the bottom of table 3-1, chapter 5A of the 2016 EMEP/EEA Guidebook.**				
Improvement made			IIR Chapter, page	
NMVOC emissions were recalculated for the whole time series 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.			Chapter 6.3, page 213-215	

Recommendations from the NECD Review 2018 of POPs and heavy metals that have not been implemented in the inventory submission 2019

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-1A1a-2018-0002	Yes	1A1a Public Electricity and Heat Production, PAHs, PCBs, HCB, PCDD/F, 1990-2016	No	Yes

Recommendation made in previous review report

The TERT notes that category 1A1a Public Electricity and Heat Production is a key category for PCDD/F, PAH, PCB, HCB in 2016. Estonia currently uses a Tier 1 methodology when it is considered good practice to use Tier 2 for key categories. In response to a question raised during the review, Estonia explained that improvement to Tier 2 methodology is possible but that resource issues mean it will take at least two years to implement. The TERT recommends that Estonia pursues the implementation of a Tier 2 methodology as soon as resources allow.

Assessment of Implementation

The TERT notes that category 1A1a Public Electricity and Heat Production is a key category for PCDD/F, PAH, PCB, HCB in 2016. Estonia currently uses a Tier 1 methodology when it is considered good practice to use Tier 2 for key categories. This was raised during the 2018 NECD review. In response to a question raised during the 2019 review, Estonia explained that the national methodology for POPs for combustion plants was developed and entered into force in March 2019 and that they will strive to move to Tier 2 estimates for the next submission.

The TERT reiterates the recommendation that Estonia pursues the implementation of a Tier 2 methodology and includes a transparent description of the new method and associated recalculations in the next submission.

Improvement made	IIR Chapter, page
To apply the new methodology, it is necessary to carry out a detailed analysis of combustion plants (by fuel, capacity, abatement techniques, SNAP) for the whole period from 1990 to 2018. The analysis has now begun, but due to the current workload, this year it wasn't possible to complete the work. It is planned to make necessary recalculations for the 2021 submission, if it is possible.	

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-1A2f-2018-0001	No	1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals, Hg, 1990-2016	No	No

Recommendation made in previous review report

For category 1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals and pollutant Hg the TERT noted that there was a lack of transparency regarding the time series consistency, and a lack of transparency regarding the use of 'IE' for NFR 1A2f activity data. In response to a question raised during the review, Estonia explained that NFR 1A2f activity is included in NFR 1A2giii and plans to move this to NFR 1A2f no later than the 2020 submission. Estonia provided information on the method change across the time series and agreed the use of notation key 'NE' rather than 0 where no emissions were provided, and that Estonia would calculate these emissions for the 2019 submission. The TERT recommends that Estonia includes this transparency information concerning NFR1A2f activity data in the 2019 submission until the activity data are moved to NFR 1A2f in future submissions. The TERT recommends that Estonia includes the transparency information regarding the method change across the time series, and to develop a method to calculate emissions for years when operators do not provide emissions and include this in the next submission.

Assessment of Implementation

For category 1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-metallic Minerals and pollutant Hg the TERT noted that there was a lack of transparency regarding the time series consistency, and a lack of transparency regarding the use of 'IE' for NFR 1A2f activity data. This issue was raised in the 2018 review. In response to a question raised during the 2019 review, Estonia confirmed that the transparency would be improved in the next submission and that the '0's would be replaced with notation keys. The TERT reiterates the recommendation that Estonia includes this transparency information concerning 'IE' and NFR 1A2f activity data in the 2019 submission until the activity data are moved to NFR 1A2f in future submissions.

The TERT recommends that Estonia includes the transparency information regarding the method change across the time series, and develop a method to calculate emissions for years when operators do not provide emissions and include this in the next submission, and also use notation keys instead of zero values ('0's).

Improvement made	IIR Chapter, page
The value '0's for the Hg (2004-2005 years) has been replaced with the correct key 'NE'. It is planned to make necessary additional estimates for the 2021 submission, if it is possible.	NFR tables

<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 PTC in 2019</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2018 (2)</td><td>EE-1A3biv-2018-0001</td><td>No</td><td>1A3biv Road Transport: Mopeds & Motorcycles, PCBs, HCB, Cd, 2012-2016</td><td>No</td><td>No</td></tr>
<tr><td colspan="6">Recommendation made in previous review report
For category 1A3biv Road Transport: Mopeds & Motorcycles /liquid fuels the TERT noted a sudden increase by a factor of 9 in the emissions and IEFs for Cd in 2012. Emissions remain high to 2016. The TERT also noted an apparent very erratic trend in the IEFs and emissions for PCBs and HCBs from NFR 1A3biv across the time series 1990-2016 with emission factors falling to zero in 1994-2000 and again in 2005 and 2012-2014. In response to a question raised during the review, Estonia explained that for the period 1990-2011, emission calculations for NFR 1A3biv cover only emissions from motorcycles whereas from 2012 onwards, the calculations also include emissions from mopeds. This is the year from which all the mopeds have to be registered in the Estonian vehicle register. Estonia explained that they are aware that mopeds were also in use during the period 1990-2011 and that it needs to get activity information in order to account for their emissions. Estonia plan to include emissions from mopeds for the period 1990-2011 in the 2020 submission. Estonia also explained that the HCB and PCB emissions for this source are very small and are rounded to the sixth decimal place and that it is this rounding that causes these apparent erratic trends in the IEFs. Estonia demonstrated this with a spreadsheet of calculated emissions and activity data. The TERT recommends that mopeds are included in the 1A3biv calculations for the period 1990-2012 in order to report a consistent time series by getting the relevant activity data.</td></tr>
<tr><td colspan="6">Assessment of Implementation
For category 1A3biv Road Transport: Mopeds & Motorcycles /liquid fuels the TERT noted a sudden increase by a factor of 9 in the emissions and IEFs for Cd in 2012. Emissions remain high to 2016. The TERT also noted an apparent very erratic trend in the IEFs and emissions for PCBs and HCBs from 1A3biv across the time series 1990-2016 with emission factors falling to zero in 1994-2000 and again in 2005 and 2012-2014. In response to a question raised during the review, Estonia explained that for the period 1990-2011, emission calculations for 1A3biv cover only emissions from motorcycles whereas from 2012 onwards, the calculations also include emissions from mopeds. This is the year from which all the mopeds have to be registered in the Estonian vehicle register. Estonia explained that they are aware that mopeds were also in use during the period 1990-2011 and that it needs to get activity information in order to account for their emissions. Estonia plan to include emissions from mopeds for the period 1990-2011 in the 2020 submission. Estonia also explained that the HCB and PCB emissions for this source are very small and are rounded to the sixth decimal place and that it is this rounding that causes these apparent erratic trends in the IEFs. Estonia demonstrated this with a spreadsheet of calculated emissions and activity data.
The TERT agree with the explanation provided and recommend that mopeds are included in NFR 1A3biv calculations for the period 1990-2012 in order to report a consistent time series in the 2020 submission. If it is not possible to include the revised estimates in the 2020 submission, then a timeline for implementation should be provided in the 2020 IIR.</td></tr>
<tr><td colspan="5">Improvement made</td><td>IIR Chapter, page</td></tr>
<tr><td colspan="5">All mopeds are included in the calculations of NFR 1A3biv pursuant to the official activity data received from Estonian Road Administration. Emission calculations for NFR 1A3biv cover only emissions from mopeds from 2005 onwards. There are no official records for the number of mopeds for the period 1990–2004. We have made queries to Statistics Estonia, the Estonian Road Administration, the Police and Border Guard Board, etc.</td><td>Chapter 3</td></tr>
<tr><td colspan="6"></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 PTC in 2019</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2018 (2)</td><td>EE-2C1-2018-0005</td><td>Yes</td><td>2C1 Iron and Steel Production, Cd, PCDD/F, 1990, 2005, 2016</td><td>No</td><td>No</td></tr>
<tr><td colspan="6">Recommendation made in previous review report
For category 2C1 Iron and Steel Production for Cd, PCDD/F for the entire time series the TERT noted that there may be an under-estimate of emissions. Estonia reported ‘NA’ in its NFR tables but no justification for this was included in its IIR, 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. In response to a question raised during the review, Estonia explained that this sector is not a key category in Estonia and that the processes connected with contact are included under 1A2a and POPs and heavy metals are calculated under NFR 1A2giii. Estonia also noted that under NFR 2C1 the processes connected with welding and cutting of metals are mainly included. Estonia confirmed that it is planning to analyse facilities' data for the whole period, to review reported data or notation keys for NFR 2C1, to make corrections if necessary and to include its findings in the inventory, but not earlier than in submission 2020. The TERT notes that this issue may relate to an under-estimate and recommends that Estonia includes in its next submission a) how it is determined that this source is not key for Estonia; b) in anticipation of actions planned to be realised for submission 2020, an estimate for those processes for which there exists a Tier 1 method, AD and EF and that Estonia documents this in its IIR.</td></tr>
<tr><td colspan="6">Assessment of Implementation
For category 2C1 Iron and Steel Production, for pollutants Cd and PCDD/F and years 1990-2017, the TERT noted that emissions had not been reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that Estonia estimates Cd and PCDD/F emissions from iron and steel production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.</td></tr>
<tr><th colspan="5">Improvement made</th><th>IIR Chapter, page</th></tr>
<tr><td colspan="5">Unfortunately, due to the lack of activity data, it is not possible to estimate Cd and PCDD/F emissions from 2C1 category. Perhaps welding, cutting or some other metal processing is more correctly to include under the NFR 2C7c code. We are also try to develop a method to calculate emissions for which operators do not provide emissions data and include this in the next submission. We would be grateful if experts would give some recommendations on how to do this.</td><td></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 PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-2C1-2018-0006	No	2C1 Iron and Steel Production, Hg, HCB, PCBs, 1990, 2005, 2016	No	No

Recommendation made in previous review report

The TERT noted that for Hg, HCB, PCB for category 2C1 Iron and Steel Production for the entire time series Estonia reported 'NA' in its NFR tables and no reference to an estimate of Hg, HCB and PCB is included in its IIR. 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. In response to a question during the review Estonia agreed that the notation keys used ('NA') are incorrect. Estonia plans to analyse its facility data for improvement of inventory and to make corresponding changes to the report, but not earlier than in submission 2020. The TERT recommends Estonia to include an emission estimate for Hg, HCB and PCB for NFR 2C1 Iron and Steel Production as soon as possible and to include an explanation of the issue in its next IIR.

Assessment of Implementation

For category 2C1 Iron and Steel Production, Hg, HCB and PCBs in 1990-2017, the TERT noted that emissions had not been reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates Hg, HCB and PCBs from iron and steel production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.

Improvement made	IIR Chapter, page
Unfortunately, due to the lack of activity data, it is not possible to estimate Hg, HCB and PCB emissions from 2C1 category. We are also try to develop a method to calculate emissions for which operators do not provide emissions data and include this in the next submission. We would be grateful if experts would give some recommendations on how to do this.	

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-2C1-2018-0001	Yes	2C1 Iron and Steel Production, Pb, 1990, 2005	No	No

Recommendation made in previous review report

The TERT noted that for Pb from category 2C1 Iron and Steel Production Estonia reported 'NA' in its NFR tables while for 2010-2012 and for 2016 Pb emissions are reported. In the IIR no explanation for the use of 'NA' for 1990-2009 and for 2013-2015 is provided. In response to a question raised during the review Estonia agreed that reported notation keys are not correct and that the problem is not under-estimation, but in the distribution of emissions between NFR categories 2C1 and 2C7c. Estonia confirmed that they are planning to update the emission estimates but not earlier than in submission 2020. The TERT recommends Estonia to include an emission estimate for Pb for NFR 2C1 Iron and steel production as soon as possible and to include an explanation of the issue in its next IIR.

Assessment of Implementation

For category 2C1 Iron and Steel Production, for pollutant Pb and years 1990-2009 and 2013-2015, the TERT noted that emissions had not been reported, while for 2010-2012 and 2016-2017 emissions were reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates Pb emissions from iron and steel production for the whole time series and reports the results in the 2020 submission together with a description of the methodology and the data sources used.

Improvement made	IIR Chapter, page
This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out. The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the emissions were distributed between the corresponding codes from 2C1 to 2C7c, including lead emissions. In some cases (e.g. incorrect units), emissions have been corrected or extrapolated.	Chapter 8, table 8.23

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-2C3-2018-0001	No	2C3 Aluminium Production, PCDD/F, HCB, 1990, 2005, 2016	No	No

Recommendation made in previous review report

The TERT noted that for PCDD/F and HCB for category 2C3 Aluminium Production, for the entire time series, there may be an under-estimate of emissions. Estonia reported 'NA' in its NFR tables and no reference to an estimate of PCDD/F and HCB is included in its IIR. While there exist a Tier 2 method and EF in the 2016 EMEP/EEA Guidebook for secondary aluminium production, from the IIR it is not clear whether or not secondary production takes place in Estonia. In response to a question raised during the review Estonia confirmed that secondary aluminium production takes place in Estonia at one facility and indicated plans to include this emission source in the inventory. The TERT recommends Estonia to include an emission estimate for PCDD/F and HCB from NFR 2C3 Aluminium Production in its next submission.

Assessment of Implementation

For category 2C3 Aluminium Production, PCDD/F and HCB for 1990-2017, the TERT noted that emissions had not been reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates PCDD/F and HCB from aluminium production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.

Improvement made	IIR Chapter, page
Unfortunately, due to the lack of activity data, it is not possible to estimate PCDD/F and HCB emissions from 2C3 category. It is planned to make additional calculations for the 2021 submission, if it is possible. In addition, PCCD and PCB emissions from zinc production (NFR 2C6) were calculated by using the emission factors of Guidebook 2019.	Chapter 8, table 2.6

<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 PTC in 2019</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>2018 (2)</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></tr>
<tr><td colspan="6">Recommendation made in previous review report
The TERT noted that for PCB emissions from category 2C5 Lead Production for the entire time series that there may be an under-estimate of emissions. Estonia reported ‘NA’ in the NFR table and no reference to an estimate of PCB is included in the IIR, while there exists a Tier 1 method and EF in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review Estonia confirmed that secondary lead production takes place in Estonia at one facility and indicated plans to include this emission source in the inventory submission 2020.
The TERT recommends Estonia to include an emission estimate for PCB emissions from NFR 2C5 Lead Production in its next submission.</td></tr>
<tr><td colspan="6">Assessment of Implementation
For category 2C5 Lead Production, for PCBs and years 1990, 2005, 2016, the TERT noted that emissions had not been reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.
The TERT recommends that Estonia estimates PCBs from lead production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.</td></tr>
<tr><td colspan="5">Improvement made</td><td>IIR Chapter, page</td></tr>
<tr><td colspan="5">Unfortunately, due to the lack of activity data, it is not possible to estimate PCB emissions from 2C5 category. It is planned to make additional calculations for the 2021 submission, if it is possible.
In addition, PCCD and PCB emissions from zinc production (NFR 2C6) were calculated by using the emission factors of Guidebook 2019.</td><td>Chapter 8, table 2.6</td></tr>
<tr><td colspan="6"></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 PTC in 2019</td><td>Tier 1 used for Key Category</td></tr>
<tr><td>2018 (2)</td><td>EE-2C7a-2018-0001</td><td>No</td><td>2C7a Copper Production, Cd, Pb, 1990, 2005, 2016</td><td>No</td><td>No</td></tr>
<tr><td colspan="6">Recommendation made in previous review report
The TERT noted that, for Cd and Pb emissions from category 2C7a Copper Production for the entire time series, there may be an under-estimate of emissions. Estonia reported ‘NA’ in its NFR tables and no reference to an estimate of Cd and Pb is included in its IIR, while there exists a Tier 1 method and EF in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review Estonia confirmed that only one enterprise submits data under NFR 2C7a. The TERT recommends Estonia to include an emission estimate for Cd and Pb emissions from NFR 2C7a Copper Production in its next submission.</td></tr>
</table>

Assessment of Implementation

For category 2C7a Copper Production, Cd and Pb emissions for 1990-2017, the TERT noted that emissions had not been reported. This was raised during the 2018 NECD review. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates Cd and Pb from copper production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.

Improvement made	IIR Chapter, page
The process is not even related to primary or secondary copper production, but only to the mechanical treatement of copper pipes. In this case, the facility has a permit and calculates only the emissions of particulates. It may be more correct to include emissions data under NFR 2C7c code.	

Review year of initial recommendation (number of years it has been recommended)	Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
2018 (2)	EE-5C1biv-2018-0001	No	5C1biv Sewage Sludge Incineration, PCDD/F, HCB, 1990, 2005, 2016	No	No

Recommendation made in previous review report

For category 5C1biv Sewage Sludge Incineration, the TERT noted that the notation key 'NA' is reported for all pollutants and the complete time series, although default EFs are proposed in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review Estonia indicated that they are planning to conduct these investigations for all the pollutants that have EFs in the 2016 EMEP/EEA Guidebook and that these improvements will be included in the inventory no later than the 2020 submission. The TERT noted that these emissions are expected to be far below the threshold of significance for a technical correction and recommends that Estonia investigate further on activity data related to this activity and estimate emissions. Where emissions cannot be estimated Estonia should use the notation key 'NE' unless there is evidence that the activity does not occur, when 'NO' should be reported.

Assessment of Implementation

For category 5C1biv Sewage Sludge Incineration, the TERT noted during the 2018 review that the notation key 'NA' is reported for all pollutants and the complete time series, although default EFs are proposed in the 2016 EMEP/EEA Guidebook. In response to a question raised during the 2018 review Estonia explained that the necessary investigation has not been conducted on that matter as this is a minor source of pollution but did not provide a revised estimate. Estonia indicated that they are planning to conduct this investigation for all the pollutants that have EFs in the 2016 EMEP/EEA Guidebook and that these improvements will be included in the inventory no later than the 2020 submission. In response to a question raised during the 2019 review, Estonia confirmed that it will be done for the 2010 submission. The TERT noted that these emissions are expected to be far below the threshold of significance for a technical correction for the main pollutants and that it is unable to conclude concerning POPs and HM.

The TERT recommends that Estonia investigate further on activity data related to this activity and estimate and report the emissions in the 2020 submission. Where emissions cannot be estimated Estonia should use the notation key 'NE' unless there is evidence that the activity does not occur, in which case 'NO' should be reported.

Improvement made	IIR Chapter, page
Unfortunately it wasn't possible to update data for this NFR source code in this (2020) submission due to the current workload. It is planned to make necessary updates and recalculations for the 2021 submission, if it is possible.	

Additional recommendations made during the NECD Review 2019 for POPs and heavy metals

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A4bi-2019-0001	Yes	1A4bi Residential: Stationary, Cd, 2005, 2016, 2017	RE	No

Recommendation

For category 1A4bi Residential: Stationary, pollutants Cd, Hg, Pb and all years, the TERT noted that as Estonia does not estimate heavy metal emissions from waste combustion in domestic stoves this may result in an under-estimate of emissions. In response to a question raised during the review, Estonia agreed that uncalculated emissions of heavy metals from the waste incineration in stoves will impact on total heavy metal emissions. The TERT suggested that in the absence of country specific emission factors using the emission factors corresponding to uncontrolled incinerators presented in Table 3-2 of the chapter 5.C.1.a Municipal waste incineration of the Guidebook could be a suitable first estimate. Estonia provided revised estimates for all heavy metals for all years 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 estimates in its 2020 NFR and IIR submission. The TERT further recommends that Estonia investigate the share of domestic waste combusted as Estonia notes it may be a very conservative estimate.

Improvement made	IIR Chapter, page
In this year submission the emissions of heavy metals from waste incineration in stoves were additionally calculated, which caused a significant increase in emissions, especially lead.	Energy chapter, table 3.30 ; chapter 8, table 8.7

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-0A-2019-0001	No	Cd, PCDD/F, HCB, Hg, NH_3, NMVOC, NO_X, Pb, PCBs, $PM_{2.5}$, SO_2, 1992-2017	No	No

Recommendation

For several categories, pollutants and years the TERT noted that Estonia had reported zero values instead of notation keys. In response to a question raised during the review, Estonia explained that it will carry out the corresponding 'zero' values analysis and apply the appropriate notation keys in the 2020 submission.

The TERT recommends that Estonia carries out these corrections in its next submission.

Improvement made	IIR Chapter, page

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A1a-2019-0001	Yes	1A1a Public Electricity and Heat Production, BaP, PAHs, Pb, 2016, 2017	No	No

Recommendation

For category 1A1a Public Electricity and Heat Production and pollutants BaP, PAHs (2016, 2017), Pb (2017), the TERT noted that the IEF ratios of the pollutants when compared to PM_{10} were outliers (at a 95% confidence interval) when compared to other Member States. In response to a question raised during the review, Estonia explained that PM emissions were estimated through continuous measurements whilst heavy metals are calculated according to the old methodology, which does not take into account the combustion and abatement technologies. Estonia explained the trends in fuels which affect the time series of IEFs for PAHs and PM. Estonia explained that the new national methodology for HM and POPs for oil shale power plants was developed and entered into force in March 2019. In this case, the use of the new methodology for the whole time series requires an analysis, which Estonia plan to implement in 2019/2020. The TERT agreed with the explanation provided by Estonia.

The TERT recommends that Estonia include this transparency information in the next submission of the IIR and implements the improved methodology for heavy metals and POPs to reflect the changing technologies.

Improvement made	IIR Chapter, page
To apply the new methodology, it is necessary to carry out a detailed analysis of combustion plants (by fuel, capacity, abatement techniques, SNAP) for the whole period from 1990 to 2018. The analysis has now begun, but due to the current workload, this year it wasn't possible to complete the work. It is planned to make necessary recalculations for the 2021 submission, if it is possible.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A2a-2019-0001	No	1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel, Cd, Hg, 2016	No	No

Recommendation

For category 1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel for the year(s) and pollutant(s) Cd (2016) and Hg (2016), the TERT noted that there was a potential under-estimate of emissions as these were reported as 'NA' whilst a Tier 1 method is available in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia explained that emissions data are reported by operators, and it is possible that there is an error or emission was made too small.

The TERT recommends that Estonia develop a methodology to ensure time series consistency for years when emissions are likely to be occurring but may be below industry reporting thresholds.

Improvement made	IIR Chapter, page
It is planned to make analysis of industrial combustion sector and, if necessary, make additional calculations of emissions for the 2021-2022 submission.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A2b-2019-0001	No	1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals, HCB, 1990	No	No

Recommendation

For category 1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals, pollutant HCB and year 1990 (and other years e.g. 1991, 1993) the TERT noted that the notation key 'NA' (not applicable) is used whilst a Tier 1 method is available in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia explained that HCB emission for the whole time series for category 1A2b is reported under category 1A2giii and that for the same years the notation key 'NA' must be replaced with 'IE'.

The TERT recommends that Estonia align the notation key to 'IE' for the full time series and transparently document this in the IIR in the 2020 submission.

Improvement made	IIR Chapter, page
For the categories 1A2b-1A2f notation key 'NA' was replaced with 'IE'	NFR tables

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A2c-2019-0001	No	1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals, Cd, 2016-2017	No	No

Recommendation

For category 1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals for Cd in 2016-2017 the TERT noted that the notation key 'NA' (not applicable) is used whilst a Tier 1 method is available in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia explained that emissions of Cd take place from this activity but are very small (0.0002 kg in 2017).

As Estonia confirmed that emissions do occur, the TERT recommends that Estonia calculate the emissions and include the estimates and transparent methodology in the next submission.

Improvement made	IIR Chapter, page

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1A2c-2019-0002	No	1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals, Cd, Hg, 2012, 2014, 2015	No	No

Recommendation

For category 1A2a Stationary Combustion in Manufacturing Industries and Construction for Cd and Hg emissions in 2010, 2016 and for category 1A2b for Cd and Hg emissions in 2010-12 and in 2015-2017; and for category 1A2c for Cd and Hg emissions in 2012 and in 2014-2017 the TERT noted that notation key 'NA' is used whilst emission estimates are expected. In response to a question raised during the review, Estonia explained that some point source data had been allocated to the incorrect sectors for some years and stated that it will be corrected for the next submission. The TERT notes that this does not relate to an under- or over-estimation.

The TERT recommends that Estonia review the data and reallocate the emissions to the correct categories in the next submission, transparently documenting the recalculations.

Improvement made	IIR Chapter, page
Unfortunately, it wasn’t possible to review data in this year submission due to the current workload. It is planned to make analysis of industrial combustion sector and, if necessary, make additional calculations of emissions for the 2021-2022 submission.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-1B1-2019-0001	No	1B1b Fugitive Emission from Solid Fuels, BaP, PAHs, Cd, Hg, Pb, PCDD/F, 1990-2017	No	No

Recommendation

For category 1B1b Fugitive Emission from Solid Fuels: Solid fuel transformation for all years, heavy metals and POPs the TERT noted that the notation key 'NA' (not applicable) is used whilst emission estimates are expected as emission estimates are provided for particulate matter and NO_X The TERT also notes that Tier 1 emission factors are provided in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia explained that emissions in this sector are based only on data from enterprises which do not provide activity data for calculations.

The TERT acknowledges that NFR 1B1b is a small source for Estonia, and recommends that a methodology be developed to estimate heavy metals and POPs emissions from NFR 1B1b, or that the notation keys are changed to 'NE' (not estimated) until then and a timeline for the implementation of the improvement is included in the IIR.

Improvement made	IIR Chapter, page
In comparison with the previous submission, the emissions of NOx, particulates, and CO for 2017 from one enterprise were reallocated from NFR 1B1b to NFR 2C1 and replaced with the notation key ‘NA’. The reason was the wrong SNAP code. For the same reason, the part of particulate emissions for 2016 were changed.	Chapter 8, Table 8.9

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2C6-2019-0001	No	2C6 Zinc Production, Hg, Cd, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017	No	No

Recommendation

For category 2C6 Zinc Production, for Hg emissions in years 1992-2003, 2009-2017 and for Cd emissions in years 1993, 1994, 1995, 1997, 1999, 2001, 2002, 2014, 2015, the TERT noted that whilst emission estimates are expected, 'NA' was reported. In response to a question raised during the review, Estonia responded that improvements would be made in the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates emissions and reports them in the 2020 submission together with a methodological description and information on data sources and emission factors used.

Improvement made	IIR Chapter, page
This year, an analysis of pollutant emissions from a metal production industry (all 2C NFRs) for the period 2000–2017 was carried out. The metal industry emissions are based only on data from facilities. Therefore, SNAP codes were analysed at first and then, the emissions were distributed between the corresponding codes from 2C1 to 2C7c, including lead emissions. In some cases (e.g. incorrect units), emissions have been corrected or extrapolated.	Chapter 8

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-2C7a-2019-0002	No	2C7a Copper Production, Cd, Hg, 1990-2017	No	No

Recommendation

For category 2C7a Copper Production, for Hg emissions in 1990-2017, the TERT noted that emissions had not been reported. In response to a question raised during the review Estonia informed the TERT that work was ongoing and expected to be finalised for the 2020 submission. The TERT noted that the issue is below the threshold of significance for a technical correction.

The TERT recommends that Estonia estimates Hg emissions from copper production and reports the results in the 2020 submission together with a description of the methodology and the data sources used.

Improvement made	IIR Chapter, page
The process is not even related to primary or secondary copper production, but only to the mechanical treatement of copper pipes. In this case, the facility has a permit and calculates only the emissions of particulates. It may be more correct to include emissions data under NFR 2C7c code.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
EE-3Df-2019-0001	No	3Df Use of Pesticides, HCB, 1990, 2005, 2016, 2017	No	No

Recommendation

For category 3Df Use of Pesticides and pollutant HCB for years 1990, 2005, 2015, 2016 and 2017 the TERT noted that Estonia reports 'NO'. In response to a question raised during the review, Estonia explained that according to Estonian National Implementation Plan Under the Stockholm Convention (http://chm.pops.int/Implementation/NationalImplementationPlans/NIPTransmission/tabid/253/Default.aspx) most organochlorine pesticides either were not used at all (Aldrin, Chlordane, DDT, Dieldrin, Endrin, Hetachlor) or were discontinued before 1990 (Toxaphene, HCB); lindane was used only for seed treatment. The TERT notes that version 2018 of the 2016 EMEP/EEA Guidebook (available at https://www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/4-agriculture/3-d-f-3-i/view) includes an updated methodology, based on the HCB content in pesticides as an impurity.

The TERT recommends that Estonia investigate the list of active substances where HCB can be a contaminant and report emissions in its next submission.

Improvement made	IIR Chapter, page
The list of active substances will be reviewed after updating an Estonian National Implementation Plan Under the Stockholm Convention. The ERT recommendation would be addressed by the 2021 or 2022 submission.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	RE, TC or PTC in 2019	Tier 1 used for Key Category
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

Recommendation

For category 3F Field Burning of Agricultural Residues and pollutants SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F for years 2005-2017 the TERT noted the following paper on emissions from agricultural burning: http://ec.europa.eu/environment/air/pdf/clean_air_outlook_agriculture_report.pdf indicates emissions from field burning of agricultural residues contribute a large fraction of the reported national total emissions of several pollutants in Estonia. The TERT also noted that Estonia explained in chapter 5.4. Field Burning of Agricultural Residues (NFR 3F) of 2019 IIR that field burning of agricultural residues does not occur (based in regulation and in a survey performed by the Ministry of Environment). This potential under-estimate might have an impact on total emissions that is above the threshold of significance. In response to a question raised during the review, Estonia indicated that they will review the referred document and decide on the following actions.

The TERT recommends that Estonia review the emission estimates for category 3F for all pollutants in light of the data contained in the mentioned report and provides emission estimates in its next submission.

Improvement made	IIR Chapter, page
An analysis of possible historical data is ongoing. The results will be revealed for the next submission.	

<table>
<tr><th>Observation</th><th>Key Category</th><th>NFR, Pollutant(s), Year(s)</th><th>RE, TC or PTC in 2019</th><th>Tier 1 used for Key Category</th></tr>
<tr><td>EE-5C-2019-0001</td><td>Yes</td><td>5C1bi Industrial Waste Incineration, PCDD/F, 1990-2017</td><td>No</td><td>Yes</td></tr>
<tr><td colspan="5">Recommendation
For PCDD-F emissions from category 5C1bi Industrial Waste Incineration and from category 5C1biii Hospital Waste Incineration the TERT noted Estonia applies a "Tier 1 like" methodology to a KC (using a constant EFs from the UNEP toolkit). The TERT acknowledges that concerning category 5C1biii Hospital Waste Incineration the default EF proposed in the 2016 EMEP/EEA Guidebook is unlikely for modern incineration plants since it corresponds to uncontrolled incineration and using a value from the UNEP Toolkit is appropriate. In response to a question raised during the review Estonia indicated that it is planning to use direct facility estimates and to reallocate clinical and industrial waste incineration emissions under energy sector as the facility in question uses energy recovery system.
The TERT recommends that Estonia develops a country specific EF times series based on facilities measurements when available (recent years) and on the basis of information on the implementation of abatement technologies for prior years. In addition, the TERT recommends Estonia to allocate the emissions to the energy sector.</td></tr>
<tr><th colspan="3">Improvement made</th><th colspan="2">IIR Chapter, page</th></tr>
<tr><td colspan="3">Unfortunately it wasn’t possible to update data for this NFR source code in this (2020) submission due to the current workload. It is planned to make necessary updates and recalculations for the 2021 submission, if it is possible.</td><td colspan="2"></td></tr>
</table>

ANNEX III – The Results of the Uncertainty Calculations by Air Pollutants and NFR Codes

	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	NOx	25.6900	9.0574	2%	20%	20.10%	0.003209	-0.01596	0.11339	-0.32%	0.32%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	NOx	0.0000	0.3871	2%	20%	20.10%	0.000006	0.00485	0.00485	0.10%	0.01%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	NOx	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NOx	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	NOx	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NOx	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	NOx	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NOx	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2gvii	Mobile Combustion in manufacturing industries and construction	NOx	5.3286	1.8118	2%	100%	100.02%	0.003179	-0.00416	0.02268	-0.42%	0.06%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NOx	5.6000	2.2055	2%	20%	20.10%	0.000190	-0.00060	0.02761	-0.01%	0.08%	0.00%
1A3ai(i)	International aviation LTO (civil)	NOx	0.0507	0.0914	2%	30%	30.07%	0.000001	0.00089	0.00114	0.03%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	NOx	0.0016	0.0018	2%	30%	30.07%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	NOx	12.9909	3.1520	2%	20%	20.10%	0.000389	-0.02594	0.03946	-0.52%	0.11%	0.00%
1A3bii	Road transport: Light duty vehicles	NOx	1.5730	1.1798	2%	20%	20.10%	0.000054	0.00685	0.01477	0.14%	0.04%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	NOx	10.4211	2.8678	2%	20%	20.10%	0.000322	-0.01657	0.03590	-0.33%	0.10%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	NOx	0.1173	0.0152	2%	20%	20.10%	0.000000	-0.00040	0.00019	-0.01%	0.00%	0.00%
1A3c	Railways	NOx	2.4310	0.4192	2%	100%	100.02%	0.000170	-0.00700	0.00525	-0.70%	0.01%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A3dii	National navigation (shipping)	NOx	0.5495	0.3925	2%	100%	100.02%	0.000149	0.00215	0.00491	0.21%	0.01%	0.00%
1A4ai	Commercial/institutional: Stationary	NOx	0.3000	0.2366	2%	50%	50.04%	0.000014	0.00145	0.00296	0.07%	0.01%	0.00%
1A4aii	Commercial/institutional: Mobile	NOx	0.3971	0.4365	2%	50%	50.04%	0.000046	0.00346	0.00546	0.17%	0.02%	0.00%
1A4bi	Residential: Stationary, liquid fuels	NOx	0.2276	0.0164	3%	50%	50.09%	0.000000	-0.00094	0.00021	-0.05%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	NOx	0.3496	0.0072	2%	50%	50.04%	0.000000	-0.00167	0.00009	-0.08%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	NOx	0.1181	0.1257	2%	50%	50.04%	0.000004	0.00098	0.00157	0.05%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	NOx	3.4491	4.5773	5%	50%	50.25%	0.005122	0.03991	0.05731	2.00%	0.41%	0.04%
1A4bi	Residential: Stationary, waste	NOx	0.0722	0.0911	50%	50%	70.71%	0.000004	0.00078	0.00114	0.04%	0.08%	0.00%
1A4bii	Residential: Household and gardening (mobile)	NOx	0.0058	0.0677	2%	50%	50.04%	0.000001	0.00082	0.00085	0.04%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	NOx	0.3300	0.1503	2%	50%	50.04%	0.000005	0.00022	0.00188	0.01%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NOx	4.0306	2.2705	2%	50%	50.04%	0.001250	0.00812	0.02843	0.41%	0.08%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NOx	0.8571	0.0493	2%	50%	50.04%	0.000001	-0.00370	0.00062	-0.18%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	NOx	0.0000	0.0242	2%	50%	50.04%	0.000000	0.00030	0.00030	0.02%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NOx	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	NOx	0.0000	0.0054	2%	50%	50.04%	0.000000	0.00007	0.00007	0.00%	0.00%	0.00%
2A6	Other mineral products	NOx	0.0000	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2B1	Ammonia production	NOx	0.1900	0.0000	2%	50%	50.04%	0.000000	-0.00096	0.00000	-0.05%	0.00%	0.00%
2B10a	Chemical industry: Other	NOx	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	NOx	0.0000	0.0458	2%	50%	50.04%	0.000001	0.00057	0.00057	0.03%	0.00%	0.00%
2C7c	Other metal production	NOx	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3d	Coating applications	NOx	0.0000	0.0000	5%	50%	50.25%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	NOx	0.0075	0.0031	5%	50%	50.25%	0.000000	0.00000	0.00004	0.00%	0.00%	0.00%
2H1	Pulp and paper industry	NOx	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2H2	Food and beverages industry	NOx	0.0000	0.0024	2%	50%	50.04%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
2I	Wood processing	NOx	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	NOx	0.0703	0.0067	2%	100%	100.02%	0.000000	-0.00027	0.00008	-0.03%	0.00%	0.00%
3B1b	Manure management - Non-dairy cattle	NOx	0.0343	0.0103	2%	100%	100.02%	0.000000	-0.00004	0.00013	0.00%	0.00%	0.00%
3B2	Manure management - Sheep	NOx	0.0013	0.0006	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00%	0.00%	0.00%
3B3	Manure management - Swine	NOx	0.0059	0.0011	2%	100%	100.02%	0.000000	-0.00002	0.00001	0.00%	0.00%	0.00%
3B4d	Manure management - Goats	NOx	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
3B4e	Manure management - Horses	NOx	0.0017	0.0012	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	NOx	0.0109	0.0030	2%	100%	100.02%	0.000000	-0.00002	0.00004	0.00%	0.00%	0.00%
3B4gii	Manure management - Broilers	NOx	0.0061	0.0045	2%	100%	100.02%	0.000000	0.00003	0.00006	0.00%	0.00%	0.00%
3B4giv	Manure management - Other poultry	NOx	0.0036	0.0012	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00%	0.00%	0.00%
3B4h	Manure management - Other animals	NOx	0.0001	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
3Da1	Inorganic N-fertilizers (includes also urea application)	NOx	2.8680	1.5547	2%	100%	100.02%	0.002341	0.00501	0.01946	0.50%	0.06%	0.00%
3Da2a	Animal manure applied to soils	NOx	1.3366	0.5693	2%	100%	100.02%	0.000314	0.00039	0.00713	0.04%	0.02%	0.00%
3Da2b	Sewage sludge applied to soils	NOx	0.0031	0.0026	2%	100%	100.02%	0.000000	0.00002	0.00003	0.00%	0.00%	0.00%

	A	B	C	D	E	F	G	H	I	J	K	L	M
3Da2c	Other organic fertilisers applied to soils (including compost)	NOx	0.0050	0.1584	2%	100%	100.02%	0.000024	0.00196	0.00198	0.20%	0.01%	0.00%
3Da3	Urine and dung deposited by grazing animals	NOx	0.4260	0.1101	2%	100%	100.02%	0.000012	-0.00077	0.00138	-0.08%	0.00%	0.00%
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NOx	0.0000	0.0010	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	NOx	0.0000	0.0086	2%	100%	100.02%	0.000000	0.00011	0.00011	0.01%	0.00%	0.00%
5C1bv	Cremation	NOx	0.0000	0.0067	2%	100%	100.02%	0.000000	0.00008	0.00008	0.01%	0.00%	0.00%
5C2	Open burning of waste	NOx	0.0138	0.0062	10%	100%	100.50%	0.000000	0.00001	0.00008	0.00%	0.00%	0.00%
5D2	Industrial wastewater handling	NOx	0.0000	0.0009	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
TOTAL			79.8752	32.1384				0.016807					0.0006
					% uncertainty in total inventory			12.96%			Trend uncertainty:		2.46%

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
	A	B	C	D	E	F	G	H	I	J	K	L	M
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	NMVOC	0.9000	0.3480	2%	50%	50.04%	0.000061	0.00050	0.00546	0.00025	0.00015	0.00000
1A1c	Manufacture of solid fuels and other energy industries	NMVOC	0.8627	0.4241	2%	50%	50.04%	0.000090	0.00190	0.00665	0.00095	0.00019	0.00000
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	0.6604	0.1875	2%	50%	50.04%	0.000018	-0.00070	0.00294	-0.00035	0.00008	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NMVOC	0.6200	0.5666	2%	50%	50.04%	0.000160	0.00547	0.00889	0.00274	0.00025	0.00001
1A3ai(i)	International aviation LTO (civil)	NMVOC	0.0096	0.0132	2%	30%	30.07%	0.000000	0.00015	0.00021	0.00005	0.00001	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	NMVOC	0.0025	0.0031	2%	30%	30.07%	0.000000	0.00003	0.00005	0.00001	0.00000	0.00000
1A3bi	Road transport: Passenger cars	NMVOC	10.3305	0.8976	2%	20%	20.10%	0.000065	-0.04277	0.01408	-0.00855	0.00040	0.00007
1A3bii	Road transport: Light duty vehicles	NMVOC	0.7871	0.0593	2%	20%	20.10%	0.000000	-0.00341	0.00093	-0.00068	0.00003	0.00000
1A3biii	Road transport: Heavy duty vehicles and buses	NMVOC	2.4887	0.0903	2%	20%	20.10%	0.000001	-0.01229	0.00142	-0.00246	0.00004	0.00001
1A3biv	Road transport: Mopeds & motorcycles	NMVOC	0.4668	0.0643	2%	20%	20.10%	0.000000	-0.00156	0.00101	-0.00031	0.00003	0.00000
1A3bv	Road transport: Gasoline evaporation	NMVOC	3.4198	0.2698	2%	20%	20.10%	0.000006	-0.01460	0.00423	-0.00292	0.00012	0.00001
1A3c	Railways	NMVOC	0.2245	0.0372	2%	100%	100.02%	0.000003	-0.00065	0.00058	-0.00065	0.00002	0.00000
1A3dii	National navigation (shipping)	NMVOC	0.0196	0.0140	2%	100%	100.02%	0.000000	0.00011	0.00022	0.00011	0.00001	0.00000
1A4ai	Commercial/institutional: Stationary	NMVOC	0.0600	0.0289	2%	50%	50.04%	0.000000	0.00012	0.00045	0.00006	0.00001	0.00000
1A4aii	Commercial/institutional: Mobile	NMVOC	0.4951	0.0974	2%	50%	50.04%	0.000005	-0.00120	0.00153	-0.00060	0.00004	0.00000
1A4bi	Residential: Stationary, liquid fuels	NMVOC	0.0029	0.0005	3%	50%	50.09%	0.000000	-0.00001	0.00001	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	NMVOC	1.7563	0.0187	2%	50%	50.04%	0.000000	-0.00938	0.00029	-0.00469	0.00001	0.00002

	A	B	C	D	E	F	G	H	I	J	K	L	M
1A4bi	Residential: Stationary, gaseous fuels	NMVOC	0.0041	0.0044	2%	50%	50.04%	0.000000	0.00005	0.00007	0.00002	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	NMVOC	2.5062	3.1553	5%	50%	50.25%	0.005017	0.03568	0.04950	0.01784	0.00350	0.00033
1A4bi	Residential: Stationary, waste	NMVOC	0.0612	0.0773	50%	50%	70.71%	0.000006	0.00087	0.00121	0.00044	0.00086	0.00000
1A4bii	Residential: Household and gardening (mobile)	NMVOC	0.1036	0.4728	2%	100%	100.02%	0.000446	0.00685	0.00742	0.00685	0.00021	0.00005
1A4ci	Agriculture/Forestry/Fishing: Stationary	NMVOC	0.0400	0.0108	2%	50%	50.04%	0.000000	-0.00005	0.00017	-0.00003	0.00000	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NMVOC	0.8368	0.2343	2%	50%	50.04%	0.000027	-0.00094	0.00368	-0.00047	0.00010	0.00000
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NMVOC	0.1639	0.0018	2%	50%	50.04%	0.000000	-0.00088	0.00003	-0.00044	0.00000	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	NMVOC	0.0000	0.1778	2%	50%	50.04%	0.000016	0.00279	0.00279	0.00140	0.00008	0.00000
1B2av	Distribution of oil products	NMVOC	2.3780	0.9011	2%	50%	50.04%	0.000406	0.00103	0.01414	0.00052	0.00040	0.00000
1B2b	Fugitive emissions from natural gas	NMVOC	0.0960	0.0139	2%	50%	50.04%	0.000000	-0.00031	0.00022	-0.00016	0.00001	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NMVOC	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2A6	Other mineral products	NMVOC	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2B1	Ammonia production	NMVOC	0.0052	0.0000	2%	50%	50.04%	0.000000	-0.00003	0.00000	-0.00001	0.00000	0.00000
2B10a	Chemical industry: Other	NMVOC	13.3000	0.0264	2%	50%	50.04%	0.000000	-0.07272	0.00041	-0.03636	0.00001	0.00132
2B10b	Storage, handling and transport of chemical products	NMVOC	0.0000	0.0104	2%	50%	50.04%	0.000000	0.00016	0.00016	0.00008	0.00000	0.00000
2C1	Iron and steel production	NMVOC	0.0000	0.0067	2%	50%	50.04%	0.000000	0.00010	0.00010	0.00005	0.00000	0.00000
2C3	Aluminium production	NMVOC	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C7c	Other metal production	NMVOC	0.0000	0.0004	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00000	0.00000	0.00000
2D3a	Domestic solvent use including fungicides	NMVOC	4.0679	2.8887	2%	50%	50.04%	0.004170	0.02289	0.04532	0.01145	0.00128	0.00013
2D3b	Road paving with asphalt	NMVOC	0.0270	0.0253	2%	100%	100.02%	0.000001	0.00025	0.00040	0.00025	0.00001	0.00000
2D3d	Coating applications	NMVOC	2.2421	3.8152	2%	50%	50.04%	0.007274	0.04749	0.05986	0.02374	0.00169	0.00057
2D3e	Degreasing	NMVOC	0.1795	0.0877	10%	30%	31.62%	0.000002	0.00039	0.00138	0.00012	0.00019	0.00000
2D3f	Dry cleaning	NMVOC	0.0146	0.0068	10%	50%	50.99%	0.000000	0.00003	0.00011	0.00001	0.00001	0.00000
2D3g	Chemical products	NMVOC	0.4959	0.1081	2%	20%	20.10%	0.000001	-0.00104	0.00170	-0.00021	0.00005	0.00000
2D3h	Printing	NMVOC	0.0798	0.5794	2%	100%	100.02%	0.000670	0.00865	0.00909	0.00865	0.00026	0.00007
2D3i	Other solvent use	NMVOC	1.2644	0.8570	5%	50%	50.25%	0.000370	0.00648	0.01345	0.00324	0.00095	0.00001
2G	Other product use	NMVOC	0.0202	0.0080	5%	50%	50.25%	0.000000	0.00001	0.00013	0.00001	0.00001	0.00000
2H1	Pulp and paper industry	NMVOC	0.2200	0.0206	2%	50%	50.04%	0.000000	-0.00089	0.00032	-0.00044	0.00001	0.00000
2H2	Food and beverages industry	NMVOC	1.7884	0.7092	2%	50%	50.04%	0.000251	0.00127	0.01113	0.00064	0.00031	0.00000
2I	Wood processing	NMVOC	0.0000	0.0043	2%	50%	50.04%	0.000000	0.00007	0.00007	0.00003	0.00000	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	NMVOC	0.0000	0.0018	2%	50%	50.04%	0.000000	0.00003	0.00003	0.00001	0.00000	0.00000
3B1a	Manure management - Dairy cattle	NMVOC	3.1439	2.2991	2%	100%	100.02%	0.010554	0.01874	0.03607	0.01874	0.00102	0.00035
3B1b	Manure management - Non-dairy cattle	NMVOC	4.2472	1.4840	2%	100%	100.02%	0.004397	-0.00012	0.02328	-0.00012	0.00066	0.00000
3B2	Manure management - Sheep	NMVOC	0.0442	0.0204	2%	100%	100.02%	0.000001	0.00008	0.00032	0.00008	0.00001	0.00000
3B3	Manure management - Swine	NMVOC	0.8506	0.3198	2%	100%	100.02%	0.000204	0.00033	0.00502	0.00033	0.00014	0.00000
3B4d	Manure management - Goats	NMVOC	0.0013	0.0033	2%	100%	100.02%	0.000000	0.00004	0.00005	0.00004	0.00000	0.00000
3B4e	Manure management - Horses	NMVOC	0.0669	0.0444	2%	100%	100.02%	0.000004	0.00033	0.00070	0.00033	0.00002	0.00000
3B4gi	Manure management - Laying hens	NMVOC	0.3670	0.1004	2%	100%	100.02%	0.000020	-0.00045	0.00157	-0.00045	0.00004	0.00000

	A	B	C	D	E	F	G	H	I	J	K	L	M
3B4gii	Manure management - Broilers	NMVOC	0.2108	0.1568	2%	100%	100.02%	0.000049	0.00130	0.00246	0.00130	0.00007	0.00000
3B4giv	Manure management - Other poultry	NMVOC	0.6159	0.2003	2%	100%	100.02%	0.000080	-0.00025	0.00314	-0.00025	0.00009	0.00000
3B4h	Manure management - Other animals	NMVOC	0.4480	0.0804	2%	100%	100.02%	0.000013	-0.00121	0.00126	-0.00121	0.00004	0.00000
3De	Cultivated crops	NMVOC	0.6055	0.1844	2%	100%	100.02%	0.000068	-0.00044	0.00289	-0.00044	0.00008	0.00000
5A	Biological treatment of waste - Solid waste disposal on land	NMVOC	0.1347	0.1285	2%	100%	100.02%	0.000033	0.00127	0.00202	0.00127	0.00006	0.00000
5B1	Biological treatment of waste - Composting	NMVOC	0.0000	0.0035	2%	100%	100.02%	0.000000	0.00005	0.00005	0.00005	0.00000	0.00000
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NMVOC	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C1bi	Industrial waste incineration	NMVOC	0.0000	0.0009	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00001	0.00000	0.00000
5C1bv	Cremation	NMVOC	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C2	Open burning of waste	NMVOC	0.0002	0.0001	10%	100%	100.50%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5D1	Domestic wastewater handling	NMVOC	0.0000	0.0249	2%	100%	100.02%	0.000001	0.00039	0.00039	0.00039	0.00001	0.00000
5D2	Industrial wastewater handling	NMVOC	0.0000	0.0014	2%	100%	100.02%	0.000000	0.00002	0.00002	0.00002	0.00000	0.00000
5E	Other waste	NMVOC	0.0000	0.0064	2%	100%	100.02%	0.000000	0.00010	0.00010	0.00010	0.00000	0.00000
TOTAL			63.7371	22.3846				0.034491					0.0030
					% uncertainty in total inventory			18.57%			Trend uncertainty:		5.45%

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
	A	B	C	D	E	F	G	H	I	J	K	L	M
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	SOx (SO2)	220.4000	23.5818	2%	10%	10.20%	0.006072	-0.00506	0.08658	-0.05%	0.24%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	SOx (SO2)	0.4800	1.7608	2%	10%	10.20%	0.000034	0.00626	0.00646	0.06%	0.02%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	SOx (SO2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	SOx (SO2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	SOx (SO2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	SOx (SO2)	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	SOx (SO2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	SOx (SO2)	IE	IE	2%	10%	10.20%	IE	IE	IE	IE	IE	IE
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	SOx (SO2)	38.5100	4.7943	2%	10%	10.20%	0.000251	0.00158	0.01760	0.02%	0.05%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	SOx (SO2)	1.6320	0.0000	2%	50%	50.04%	0.000000	-0.00068	0.00000	-0.03%	0.00%	0.00%
1A3ai(i)	International aviation LTO (civil)	SOx (SO2)	0.0053	0.0090	2%	30%	30.07%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	SOx (SO2)	0.0003	0.0003	2%	30%	30.07%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A3bi	Road transport: Passenger cars	SOx (SO2)	0.9012	0.0063	2%	20%	20.10%	0.000000	-0.00035	0.00002	-0.01%	0.00%	0.00%
1A3bii	Road transport: Light duty vehicles	SOx (SO2)	0.3209	0.0012	2%	20%	20.10%	0.000000	-0.00013	0.00000	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	SOx (SO2)	1.9670	0.0023	2%	20%	20.10%	0.000000	-0.00081	0.00001	-0.02%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	SOx (SO2)	0.0235	0.0000	2%	20%	20.10%	0.000000	-0.00001	0.00000	0.00%	0.00%	0.00%
1A3c	Railways	SOx (SO2)	0.5671	0.0002	2%	50%	50.04%	0.000000	-0.00024	0.00000	-0.01%	0.00%	0.00%
1A3dii	National navigation (shipping)	SOx (SO2)	0.0700	0.0100	2%	50%	50.04%	0.000000	0.00001	0.00004	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	SOx (SO2)	1.3000	0.0932	2%	20%	20.10%	0.000000	-0.00020	0.00034	0.00%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	SOx (SO2)	0.1240	0.0002	2%	20%	20.10%	0.000000	-0.00005	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	SOx (SO2)	0.3055	0.0001	3%	20%	20.22%	0.000000	-0.00013	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	SOx (SO2)	2.6205	0.0333	2%	20%	20.10%	0.000000	-0.00097	0.00012	-0.02%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	SOx (SO2)	0.0006	0.0007	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%

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1A4bi	Residential: Stationary, biomass	SOx (SO2)	0.0776	0.1980	5%	20%	20.62%	0.000002	0.00069	0.00073	0.01%	0.01%	0.00%
1A4bi	Residential: Stationary, waste	SOx (SO2)	0.0063	0.0080	50%	50%	70.71%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
1A4bii	Residential: Household and gardening (mobile)	SOx (SO2)	0.0022	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	SOx (SO2)	1.7800	0.2505	2%	20%	20.10%	0.000003	0.00018	0.00092	0.00%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	SOx (SO2)	1.1682	0.0013	2%	20%	20.10%	0.000000	-0.00048	0.00000	-0.01%	0.00%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	SOx (SO2)	0.1098	0.0013	2%	20%	20.10%	0.000000	-0.00004	0.00000	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	SOx (SO2)	0.0000	0.0289	2%	20%	20.10%	0.000000	0.00011	0.00011	0.00%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	SOx (SO2)	0.0000	0.0005	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	SOx (SO2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	SOx (SO2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A6	Other mineral products	SOx (SO2)	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		0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C5	Lead production	SOx (SO2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7c	Other metal production	SOx (SO2)	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3d	Coating applications	SOx (SO2)	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2D3e	Degreasing	SOx (SO2)	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	SOx (SO2)	0.0000	0.0016	5%	50%	50.25%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2H2	Food and beverages industry	SOx (SO2)	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2I	Wood processing	SOx (SO2)	0.0000	0.0000	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	SOx (SO2)	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	SOx (SO2)	0.0000	0.0701									
5C1bv	Cremation	SOx (SO2)	0.0000	0.0009	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C2	Open burning of waste	SOx (SO2)	0.0130	0.0059	10%	50%	50.99%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
5D2	Industrial wastewater handling	SOx (SO2)	0.0000	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
TOTAL			272.3850	30.8612				0.006362					0.00001
					% uncertainty in total inventory			7.98%			Trend uncertainty:		0.27%

	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	NH_3	0.0806	0.1962	2%	50%	50.04%	0.000091	0.00715	0.00884	0.36%	0.03%	0.00%
1A1c	Manufacture of solid fuels and other energy industries	NH_3	0.0000	0.2237	2%	50%	50.04%	0.000118	0.01008	0.01008	0.50%	0.03%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	NH_3	0.0013	0.0004	2%	50%	50.04%	0.000000	-0.00001	0.00002	0.00%	0.00%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NH3	0.0095	0.2284	2%	50%	50.04%	0.000123	0.01009	0.01029	0.50%	0.03%	0.00%
1A3bi	Road transport: Passenger cars	NH_3	0.0102	0.1254	2%	20%	20.10%	0.000006	0.00544	0.00565	0.11%	0.02%	0.00%
1A3bii	Road transport: Light duty vehicles	NH_3	0.0007	0.0055	2%	20%	20.10%	0.000000	0.00023	0.00025	0.00%	0.00%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	NH_3	0.0039	0.0053	2%	20%	20.10%	0.000000	0.00016	0.00024	0.00%	0.00%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	NH_3	0.0006	0.0001	2%	20%	20.10%	0.000000	-0.00001	0.00001	0.00%	0.00%	0.00%
1A3c	Railways	NH_3	0.0003	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	NH_3	0.0144	0.0356	2%	50%	50.04%	0.000003	0.00130	0.00161	0.07%	0.00%	0.00%
1A4aii	Commercial/institutional: Mobile	NH_3	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, liquid fuels	NH_3	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	NH_3	0.0011	0.0000	2%	100%	100.02%	0.000000	-0.00002	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	NH_3	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	NH_3	0.0227	0.0452	5%	100%	100.12%	0.000019	0.00156	0.00204	0.16%	0.01%	0.00%
1A4bi	Residential: Stationary, waste	NH_3	0.0010	0.0012	50%	50%	70.71%	0.000000	0.00004	0.00006	0.00%	0.00%	0.00%
1A4bii	Residential: Household and gardening (mobile)	NH3	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	NH3	0.0073	0.0040	2%	50%	50.04%	0.000000	0.00003	0.00018	0.00%	0.00%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NH_3	0.0010	0.0005	2%	50%	50.04%	0.000000	0.00000	0.00002	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	NH_3	0.0000	0.1567	2%	50%	50.04%	0.000058	0.00706	0.00706	0.35%	0.02%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2B1	Ammonia production	NH3	0.0218	0.0000	2%	20%	20.10%	0.000000	-0.00046	0.00000	-0.01%	0.00%	0.00%
2B10a	Chemical industry: Other	NH_3	0.3482	0.0000	2%	20%	20.10%	0.000000	-0.00729	0.00000	-0.15%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	NH_3	0.0000	0.0135	2%	20%	20.10%	0.000000	0.00061	0.00061	0.01%	0.00%	0.00%
2C1	Iron and steel production	NH_3	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7c	Other metal production	NH_3	0.1600	0.0744	2%	200%	200.01%	0.000208	0.00000	0.00335	0.00%	0.01%	0.00%
2D3g	Chemical products	NH_3	0.0000	0.0020	2%	100%	100.02%	0.000000	0.00009	0.00009	0.01%	0.00%	0.00%
2D3i	Other solvent use	NH_3	0.0000	0.0000	5%	100%	100.12%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2G	Other product use	NH_3	0.0173	0.0069	5%	50%	50.25%	0.000000	-0.00005	0.00031	0.00%	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	NH_3	0.0000	0.0085	2%	200%	200.01%	0.000003	0.00038	0.00038	0.08%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	NH_3	2.2906	2.3004	2%	100%	100.02%	0.049797	0.05565	0.10368	5.56%	0.29%	0.31%
3B1b	Manure management - Non-dairy cattle	NH_3	2.1243	0.8745	2%	100%	100.02%	0.007197	-0.00507	0.03941	-0.51%	0.11%	0.00%
3B2	Manure management - Sheep	NH_3	0.2219	0.1023	2%	100%	100.02%	0.000099	-0.00003	0.00461	0.00%	0.01%	0.00%
3B3	Manure management - Swine	NH_3	2.3080	0.6602	2%	100%	100.02%	0.004102	-0.01856	0.02976	-1.86%	0.08%	0.03%
3B4d	Manure management - Goats	NH_3	0.0029	0.0073	2%	100%	100.02%	0.000000	0.00027	0.00033	0.03%	0.00%	0.00%
3B4e	Manure management - Horses	NH_3	0.1273	0.0844	2%	100%	100.02%	0.000067	0.00114	0.00380	0.11%	0.01%	0.00%
3B4gi	Manure management - Laying hens	NH_3	0.6425	0.1757	2%	100%	100.02%	0.000291	-0.00554	0.00792	-0.55%	0.02%	0.00%
3B4gii	Manure management - Broilers	NH_3	0.2403	0.1788	2%	100%	100.02%	0.000301	0.00302	0.00806	0.30%	0.02%	0.00%
3B4giv	Manure management - Other poultry	NH_3	0.3761	0.1223	2%	100%	100.02%	0.000141	-0.00236	0.00551	-0.24%	0.02%	0.00%
3B4h	Manure management - Other animals	NH_3	0.0046	0.0008	2%	100%	100.02%	0.000000	-0.00006	0.00004	-0.01%	0.00%	0.00%
3Da1	Inorganic N-fertilizers (includes also urea application)	NH_3	3.6421	1.7012	2%	100%	100.02%	0.027236	0.00039	0.07668	0.04%	0.22%	0.00%
3Da2a	Animal manure applied to soils	NH_3	8.8971	2.4675	2%	100%	100.02%	0.057298	-0.07483	0.11121	-7.48%	0.31%	0.56%
3Da2b	Sewage sludge applied to soils	NH_3	0.0107	0.0090	2%	100%	100.02%	0.000001	0.00018	0.00040	0.02%	0.00%	0.00%
3Da2c	Other organic fertilisers applied to soils (including compost)	NH_3	0.0099	0.3167	2%	100%	100.02%	0.000944	0.01407	0.01427	1.41%	0.04%	0.02%
3Da3	Urine and dung deposited by grazing animals	NH_3	0.5853	0.1333	2%	100%	100.02%	0.000167	-0.00625	0.00601	-0.63%	0.02%	0.00%
5A	Biological treatment of waste - Solid waste disposal on land	NH_3	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5B1	Biological treatment of waste - Composting	NH_3	0.0016	0.0407	2%	50%	50.04%	0.000004	0.00180	0.00183	0.09%	0.01%	0.00%
5C1bi	Industrial waste incineration	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
5C1bv	Cremation	NH_3	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5D2	Other wastewater handling	NH_3	0.0000	0.0013	2%	50%	50.04%	0.000000	0.00006	0.00006	0.00%	0.00%	0.00%
TOTAL			22.1873	10.3105				0.148272					0.0095
					% uncertainty in total inventory			38.51%			Trend uncertainty:		9.73%

	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	PM2.5	7.3066	1.8243	2%	20%	20.10%	0.002902	-0.09233	0.11905	-1.85%	0.34%	0.04%
1A1c	Manufacture of solid fuels and other energy industries	PM2.5	0.3600	0.1073	2%	20%	20.10%	0.000010	-0.00343	0.00700	-0.07%	0.02%	0.00%
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	PM2.5	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	PM2.5	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	PM2.5	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	PM2.5	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	PM2.5	IE	IE	2%	20%	20.10%	IE	IE	IE	IE	IE	IE
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	PM2.5	0.5946	0.0388	2%	20%	20.10%	0.000001	-0.01470	0.00253	-0.29%	0.01%	0.00%
1A2gvii	Mobile Combustion in manufacturing industries and construction	PM2.5	0.0317	0.1168	2%	50%	50.04%	0.000074	0.00671	0.00762	0.34%	0.02%	0.00%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PM2.5	1.0676	1.1378	2%	20%	20.10%	0.001129	0.04327	0.07425	0.87%	0.21%	0.01%
1A3ai(i)	International aviation LTO (civil)	PM2.5	0.0003	0.0005	2%	30%	30.07%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
1A3aii(i)	Domestic aviation LTO (civil)	PM2.5	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	PM2.5	0.1105	0.1387	2%	20%	20.10%	0.000017	0.00585	0.00905	0.12%	0.03%	0.00%
1A3bii	Road transport: Light duty vehicles	PM2.5	0.2041	0.0329	2%	20%	20.10%	0.000001	-0.00377	0.00215	-0.08%	0.01%	0.00%
1A3biii	Road transport: Heavy duty vehicles and buses	PM2.5	0.2952	0.0479	2%	20%	20.10%	0.000002	-0.00543	0.00313	-0.11%	0.01%	0.00%
1A3biv	Road transport: Mopeds & motorcycles	PM2.5	0.0003	0.0010	2%	20%	20.10%	0.000000	0.00006	0.00007	0.00%	0.00%	0.00%
1A3bvi	Road transport: Automobile tyre and brake wear	PM2.5	0.0621	0.1065	2%	20%	20.10%	0.000010	0.00515	0.00695	0.10%	0.02%	0.00%
1A3bvii	Road transport: Automobile road abrasion	PM2.5	0.0368	0.0552	2%	20%	20.10%	0.000003	0.00253	0.00360	0.05%	0.01%	0.00%
1A3c	Railways	PM2.5	0.0596	0.0110	2%	20%	20.10%	0.000000	-0.00101	0.00072	-0.02%	0.00%	0.00%
1A3dii	National navigation (shipping)	PM2.5	0.0098	0.0070	2%	20%	20.10%	0.000000	0.00017	0.00046	0.00%	0.00%	0.00%
1A4ai	Commercial/institutional: Stationary	PM2.5	0.3302	0.1178	2%	20%	20.10%	0.000012	-0.00189	0.00769	-0.04%	0.02%	0.00%
1A4aii	Commercial/institutional: Mobile	PM2.5	0.0136	0.0290	2%	50%	50.04%	0.000005	0.00150	0.00189	0.07%	0.01%	0.00%

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1A4bi	Residential: Stationary, liquid fuels	PM2.5	0.0014	0.0006	3%	20%	20.22%	0.000000	0.00000	0.00004	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, solid fuels	PM2.5	0.3917	0.0140	2%	20%	20.10%	0.000000	-0.01044	0.00091	-0.21%	0.00%	0.00%
1A4bi	Residential: Stationary, gaseous fuels	PM2.5	0.0031	0.0039	2%	20%	20.10%	0.000000	0.00017	0.00026	0.00%	0.00%	0.00%
1A4bi	Residential: Stationary, biomass	PM2.5	2.9495	1.8136	5%	20%	20.62%	0.003017	0.03278	0.11835	0.66%	0.84%	0.01%
1A4bi	Residential: Stationary, waste	PM2.5	0.4833	0.4088	50%	50%	70.71%	0.001803	0.01266	0.02668	0.63%	1.89%	0.04%
1A4bii	Residential: Household and gardening (mobile)	PM2.5	0.0092	0.0106	2%	50%	50.04%	0.000001	0.00043	0.00069	0.02%	0.00%	0.00%
1A4ci	Agriculture/Forestry/Fishing: Stationary	PM2.5	0.1501	0.0792	2%	20%	20.10%	0.000005	0.00082	0.00517	0.02%	0.01%	0.00%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	PM2.5	0.0461	0.1260	2%	50%	50.04%	0.000086	0.00689	0.00823	0.34%	0.02%	0.00%
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PM2.5	0.0030	0.0009	2%	50%	50.04%	0.000000	-0.00003	0.00006	0.00%	0.00%	0.00%
1B1c	Other fugitive emissions from solid fuels	PM2.5	0.0100	0.0055	2%	100%	100.02%	0.000001	0.00007	0.00036	0.01%	0.00%	0.00%
1B2aiv	Fugitive emissions oil: Refining / storage	PM2.5	0.0000	0.0072	2%	100%	100.02%	0.000001	0.00047	0.00047	0.05%	0.00%	0.00%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	PM2.5	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2A1	Cement production	PM2.5	0.0075	0.0051	2%	100%	100.02%	0.000001	0.00012	0.00034	0.01%	0.00%	0.00%
2A2	Lime production	PM2.5	0.0000	0.0002	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
2A3	Glass production	PM2.5	0.0000	0.0004	2%	100%	100.02%	0.000000	0.00003	0.00003	0.00%	0.00%	0.00%
2A5a	Quarrying and mining of minerals other than coal	PM2.5	0.0000	0.0058	2%	100%	100.02%	0.000001	0.00038	0.00038	0.04%	0.00%	0.00%
2A5b	Construction and demolition	PM2.5	0.0496	0.1398	5%	100%	100.12%	0.000423	0.00769	0.00912	0.77%	0.06%	0.01%
2A6	Other mineral products	PM2.5	0.0710	0.0035	2%	100%	100.02%	0.000000	-0.00183	0.00023	-0.18%	0.00%	0.00%
2B10a	Chemical industry: Other	PM2.5	0.0892	0.0007	2%	20%	20.10%	0.000000	-0.00254	0.00005	-0.05%	0.00%	0.00%
2B10b	Storage, handling and transport of chemical products	PM2.5	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	PM2.5	0.0186	0.0270	2%	20%	20.10%	0.000001	0.00122	0.00176	0.02%	0.00%	0.00%
2C3	Aluminium production	PM2.5	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C5	Lead production	PM2.5	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C6	Zinc production	PM2.5	0.0000	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7a	Copper production	PM2.5	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
2C7c	Other metal production	PM2.5	0.0002	0.0008	2%	20%	20.10%	0.000000	0.00005	0.00006	0.00%	0.00%	0.00%
2D3b	Road paving with asphalt	PM2.5	0.0007	0.0016	2%	100%	100.02%	0.000000	0.00008	0.00010	0.01%	0.00%	0.00%
2G	Other product use	PM2.5	0.0562	0.0721	5%	50%	50.25%	0.000028	0.00307	0.00470	0.15%	0.03%	0.00%
2H1	Pulp and paper industry	PM2.5	0.0840	0.0349	2%	100%	100.02%	0.000026	-0.00016	0.00228	-0.02%	0.01%	0.00%
2H2	Food and beverages industry	PM2.5	0.0011	0.0051	2%	100%	100.02%	0.000001	0.00030	0.00033	0.03%	0.00%	0.00%
2I	Wood processing	PM2.5	0.0000	0.0564	2%	100%	100.02%	0.000069	0.00368	0.00368	0.37%	0.01%	0.00%
2L	Other production, consumption, storage, transportation or handling of bulk products	PM2.5	0.0000	0.0077	2%	100%	100.02%	0.000001	0.00050	0.00050	0.05%	0.00%	0.00%
3B1a	Manure management - Dairy cattle	PM2.5	0.0537	0.0349	2%	100%	100.02%	0.000026	0.00072	0.00228	0.07%	0.01%	0.00%
3B1b	Manure management - Non-dairy cattle	PM2.5	0.0170	0.0244	2%	100%	100.02%	0.000013	0.00110	0.00159	0.11%	0.00%	0.00%
3B2	Manure management - Sheep	PM2.5	0.0007	0.0015	2%	100%	100.02%	0.000000	0.00008	0.00010	0.01%	0.00%	0.00%
3B3	Manure management - Swine	PM2.5	0.0016	0.0014	2%	100%	100.02%	0.000000	0.00005	0.00009	0.00%	0.00%	0.00%
3B4d	Manure management - Goats	PM2.5	0.0001	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00%	0.00%	0.00%

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3B4e	Manure management - Horses	PM2.5	0.0006	0.0008	2%	100%	100.02%	0.000000	0.00004	0.00005	0.00%	0.00%	0.00%
3B4gi	Manure management - Laying hens	PM2.5	0.0022	0.0018	2%	100%	100.02%	0.000000	0.00006	0.00012	0.01%	0.00%	0.00%
3B4gii	Manure management - Broilers	PM2.5	0.0012	0.0029	2%	100%	100.02%	0.000000	0.00015	0.00019	0.02%	0.00%	0.00%
3B4giv	Manure management - Other poultry	PM2.5	0.0063	0.0082	2%	100%	100.02%	0.000001	0.00035	0.00053	0.04%	0.00%	0.00%
3B4h	Manure management - Other animals	PM2.5	0.0002	0.0002	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	PM2.5	0.0272	0.0354	2%	100%	100.02%	0.000027	0.00152	0.00231	0.15%	0.01%	0.00%
5A	Biological treatment of waste - Solid waste disposal on land	PM2.5	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00%	0.00%	0.00%
5C1bi	Industrial waste incineration	PM2.5	0.0000	0.0001	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00%	0.00%	0.00%
5C1bv	Cremation	PM2.5	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00002	0.00002	0.00%	0.00%	0.00%
5C2	Open burning of waste	PM2.5	0.1050	0.0317	10%	100%	100.50%	0.000022	-0.00098	0.00207	-0.10%	0.03%	0.00%
5E	Other waste	PM2.5	0.1995	0.0594	2%	100%	100.02%	0.000076	-0.00191	0.00388	-0.19%	0.01%	0.00%
TOTAL			15.3239	6.8074				0.009794					0.00107
					% uncertainty in total inventory			9.90%			Trend uncertainty:		3.27%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sector	NFR name	Pollutant	2000 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	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%

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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%

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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%

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
	A	B	C	D	E	F	G	H	I	J	K	L	M
			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%

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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%

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	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%

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	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%

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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%

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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(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	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(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%