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ESTONIA

Estonian Informative Inventory Report 1990-2016

Submitted under the Convention on Long-Range Transboundary Air Pollution

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Data sheet

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Cover photo by Jaak Sarv (2016) *"Winter Magic"*

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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	Road transport database
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 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 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309, 27 November 2001
NFR	Nomenclature for Reporting
OSIS	Web-interfaced air emissions data system for point sources at the Estonian Environment Agency (ESTEA)

PP	Power Plant
RAINS	The Regional Air Pollution 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
HM	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
POP	Persistent organic pollutants, (lindane, dichloro-diphenyl-trichloroethane (DDT), polychlorinated biphenyl (PCBs), pentabromodiphenyl ether (PeBDE), perfluorooctane sulfonate (PFOS), hexachlorobutadeine (HCBD), octabromodiphenyl ether (OctaBDE), polychlorinated naphthalenes (PCNs), pentachlorobenzene (PeCB) and short-chained chlorinated paraffins (SCCP)
Se	Selenium
SCCP	Short-chained chlorinated paraffins
SO_2	Sulphur dioxide
SO_x	Sulphur oxides, all sulphur compounds expressed as sulphur dioxide
TSP	Total suspended particulates. The mass of particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions
Zn	Zinc

Units

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

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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 1990-2016 was submitted on 13th February 2018. 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 2015. The reasons for the recalculations are specified in Table 0.1 below:

Table 0.1 The status of recalculations in the 2018 submission

NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1a	Public electricity and heat production	Additionally calculated NH_3 emissions from biomass combustion	NH_3	1990-2015
		Additionally calculated pollutants emissions from natural gas combustion	TSP, HMs and PAHs	
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A1c	Manufacture of solid fuels and other energy industries	Additionally calculated NH_3 emissions from biomass combustion	NH_3	2000-2015
		Additionally calculated pollutants emissions from natural gas combustion	TSP, $PM_{2.5}$, PM_{10}, BC, HMs and PAHs	
		Correction of emission factors	NMVOC	1990-2015
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Correction of pollutants emission	NO_x, NMVOC, SO_x, TSP, CO, HMs	2008
1A2gvii	Mobile Combustion in manufacturing industries and construction	Correction of calculation and emission factors	NO_x, NMVOC, TSP, CO	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
		Correction of calculation	Cd, Cr, Cu, Ni, Se, Zn, PAHs	1990-2000, 2002-2015
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Additionally calculated NH_3 emissions from biomass combustion	NH_3	1990-2015
		Additionally calculated pollutants emissions from natural gas combustion	TSP, HMs and PAHs	
			$PM_{2.5}$, PM_{10}, BC	2000-2015
		Reallocation of emissions from sector 1B2aiv	NO_x, NMVOC, SO_x, TSP, CO, HMs	2012
1A3bi	Road transport: Passenger cars	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A3bii	Road transport: Light duty vehicles	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015

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NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A3biii	Road transport: Heavy duty vehicles and buses	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A3biv	Road transport: Mopeds & motorcycles	Correction of activity data and emission factors	NO_x, NMVOC, SO_x, NH_3, TSP, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PCDD/PCDF, PAHs, HCB, PCBs	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A3bv	Road transport: Gasoline evaporation	Correction of activity data and emission factors	NMVOC	1990-2015
1A3bvi	Road transport: Automobile tyre and brake wear	Correction of activity data and emission factors	TSP, Pb, Cd, Cr, Cu, Ni, Se, Zn	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A3bvii	Road transport: Automobile road abrasion	Correction of activity data and emission factors	TSP	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A3c	Railways	Correction of emission factors	SO_x	2011-2015
			BC	2000-2002
1A3dii	National navigation (shipping)	Correction of calculation and emission factors	SO_x	2015
1A4ai	Commercial/institutional: Stationary	Additionally calculated NH_3 emissions from biomass combustion	NH_3	1990-2015
		Additionally calculated pollutants emissions from natural gas combustion	TSP, HMs and PAHs	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A4aii	Commercial/institutional: Mobile	Correction of emission factors	SO_x	2014-2015
			NOx, NMVOC, TSP, CO	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A4bi	Residential: Stationary	Correction of emission factors	SO_2, Cd, Hg, Se	1990-2015
			BC	2000-2015
		Correction of activity data	B(k)f, I(1,2,3-cd)p, BC	2015
1A4bii	Residential: Household and gardening (mobile)	Correction of emission factors	SO_x	2010, 2012-2015
			NO_x, CO	1990, 1992-2015
			NH_3	2010
			NMVOC, TSP	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
		Correction of calculation	Cd, Hg, As, Cr, Cu, Ni, Zn, PAHs	2009-2015
1A4ci	Agriculture/Forestry/Fishing: Stationary	Additionally calculated NH_3 emissions from biomass combustion	NH_3	1990-2015
		Additionally calculated pollutants emissions from natural gas combustion	TSP, HMs and PAHs	1992-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Correction of calculation and emission factors	NO_x, NMVOC, TSP, CO	1990-2015
			$PM_{2.5}$, PM_{10}, BC	2000-2015
			NH_3	1990-2004, 2006-2011, 2013-2015
		Correction of calculation	Cd, Hg, As, Cr, Cu, Ni, Zn, PAHs	1990-2004, 2006-2015
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Correction of emission factors	BC, PCBs	2003-2015

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NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
2A2	Lime production	Correction of pollutants emissions (reallocation to NFR 1A2f, PCCD to NFR 1A2giii)	NO_x, NMVOC, SO_x, TSP, CO, HMs	2008
2B1	Ammonia production	Additionally calculated NMVOC emissions	NMVOC	1990-2004
		Correction of emissions data	NH_3	2000-2007
2B10a	Chemical industry: Other	Correction of emissions data	NH_3	2000-2007
2D3a	Domestic solvent use including fungicides	Correction of the number of population	NMVOC	2015
2D3d	Coating application	New methodology	NMVOC	1990-2015
		Corrected emissions data form the OSIS point sources database	SO_x	2006-2009, 2012-2014
			TSP	2009-2014
			Pb, Cu	2013
			Zn	2013, 2015
2D3e	Degreasing	Miscalculation of emissions	NMVOC	2000-2015
2D3i	Other solvent use	Corrected emissions data form the OSIS point sources database	NMVOC	2013-2015
2G	Other product use	Corrections of statistical data from Statistics Estonia	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/PCDF, PAHs Total	2015
2K	Consumption of POPs and heavy metals	Correction of emissions data (reallocation of emissions to sector 2L)	NH_3	2006-2011, 2014-2015
2L	Other production, consumption, storage, transportation or handling of bulk products	Correction of emissions data (reallocation of emissions from sector 2K)	NH_3	2006-2011, 2014-2015
3B1a	Cattle dairy	Correction of emission factor	NMVOC	1990-2015
3B1b	Non-dairy cattle	Correction of calculation	NH_3	1990-2015
3B3	Swine	Correction of activity data	NMVOC	1990-2015
3B4gi	Laying hens	More detailed calculation method were used	NO_x, NH_3	1990-2015
3B4gii	Broilers	More detailed calculation method were used	NO_x, NH_3	1990-2015
3Da1	Synthetic N-fertilizers	More detailed allocation between fertilizers	NH_3	1990-2015
3Da2a	Animal manure applied to soils	More detailed allocation between 3B4gi, 3B4gii and 3D sector. Additional calculation for NO_x	NO_x, NH_3	1990-2015
3Da3	Urine and dung deposited by grazing animals	Additionally calculated NO_x	NO_x, NH_3	1990-2015
5B1	Biological treatment of waste – composting	Change of the used emission factor	NH_3	1990-2015
5D2	Industrial wastewater handling	Correction of statistical data from Statistics Estonia	NMVOC	2014-2015

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

The differences in total emissions between the 2017 and 2018 submissions are presented in Table 0.2.

Table 0.2 Difference between the 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
1990	2.26	0.72	-0.00	9.75	NR	NR	0.01	NR	9.98	-0.27	-0.05
1991	2.36	0.41	-0.00	12.83	NR	NR	0.02	NR	6.42	-0.30	-0.04
1992	2.95	1.08	-0.00	11.64	NR	NR	0.01	NR	11.83	-0.37	-0.03
1993	2.46	0.80	-0.00	11.08	NR	NR	0.00	NR	5.40	-0.41	-0.04
1994	1.67	0.91	-0.00	10.36	NR	NR	0.01	NR	3.13	-0.41	0.96
1995	1.59	-0.40	-0.01	10.01	NR	NR	0.00	NR	-0.09	-0.43	-0.05
1996	0.63	0.45	-0.00	11.19	NR	NR	0.02	NR	3.86	-0.40	-0.09
1997	1.13	-1.31	-0.00	10.30	NR	NR	0.00	NR	-0.15	-0.23	-0.10
1998	6.84	4.81	0.13	9.28	NR	NR	0.04	NR	11.79	3.78	-0.04
1999	1.16	-2.25	-0.00	9.59	NR	NR	-0.00	NR	-0.42	-0.17	-0.11
2000	1.07	0.72	0.00	8.81	0.07	0.03	0.01	0.97	1.91	-0.11	0.57
2001	1.07	-0.51	0.01	9.76	0.06	0.03	0.01	1.07	1.69	-0.08	1.34
2002	1.06	-0.09	0.01	11.69	0.11	0.06	0.03	1.18	1.88	-0.07	0.79
2003	1.19	-0.03	-0.02	10.41	0.13	0.07	0.04	1.11	3.53	-0.03	0.70
2004	1.27	1.40	-0.01	8.45	0.11	0.07	0.04	1.16	2.54	-0.01	-0.06
2005	1.49	1.48	-0.01	11.52	0.22	0.13	0.10	1.57	1.31	-0.01	-0.28
2006	1.70	2.12	0.00	9.05	0.30	0.18	0.13	2.29	2.08	-0.01	1.51
2007	1.46	1.10	0.01	8.64	0.23	0.12	0.11	1.95	1.87	-0.02	0.87
2008	0.43	2.48	-0.00	5.79	0.02	-0.01	-0.01	1.31	1.00	-0.21	-0.14
2009	1.67	2.41	-0.01	6.31	0.22	0.13	0.11	1.87	1.30	-0.03	-0.10
2010	1.40	1.84	0.02	6.47	0.26	0.15	0.11	1.93	1.29	0.24	-0.10
2011	2.44	2.61	-0.07	6.81	0.31	0.17	0.15	2.18	1.19	0.30	-0.08
2012	1.82	2.97	-0.10	7.46	0.45	0.27	0.11	3.05	1.12	0.31	-0.10
2013	2.15	2.72	-0.09	7.23	0.19	0.11	0.09	2.15	0.53	0.29	-0.08
2014	2.19	2.53	-0.05	8.29	0.32	0.18	0.13	2.96	0.55	-0.10	-0.08
2015	2.70	-0.58	-0.07	8.23	1.50	0.16	0.13	2.76	0.74	-0.12	-0.04

Table 0.2 continues

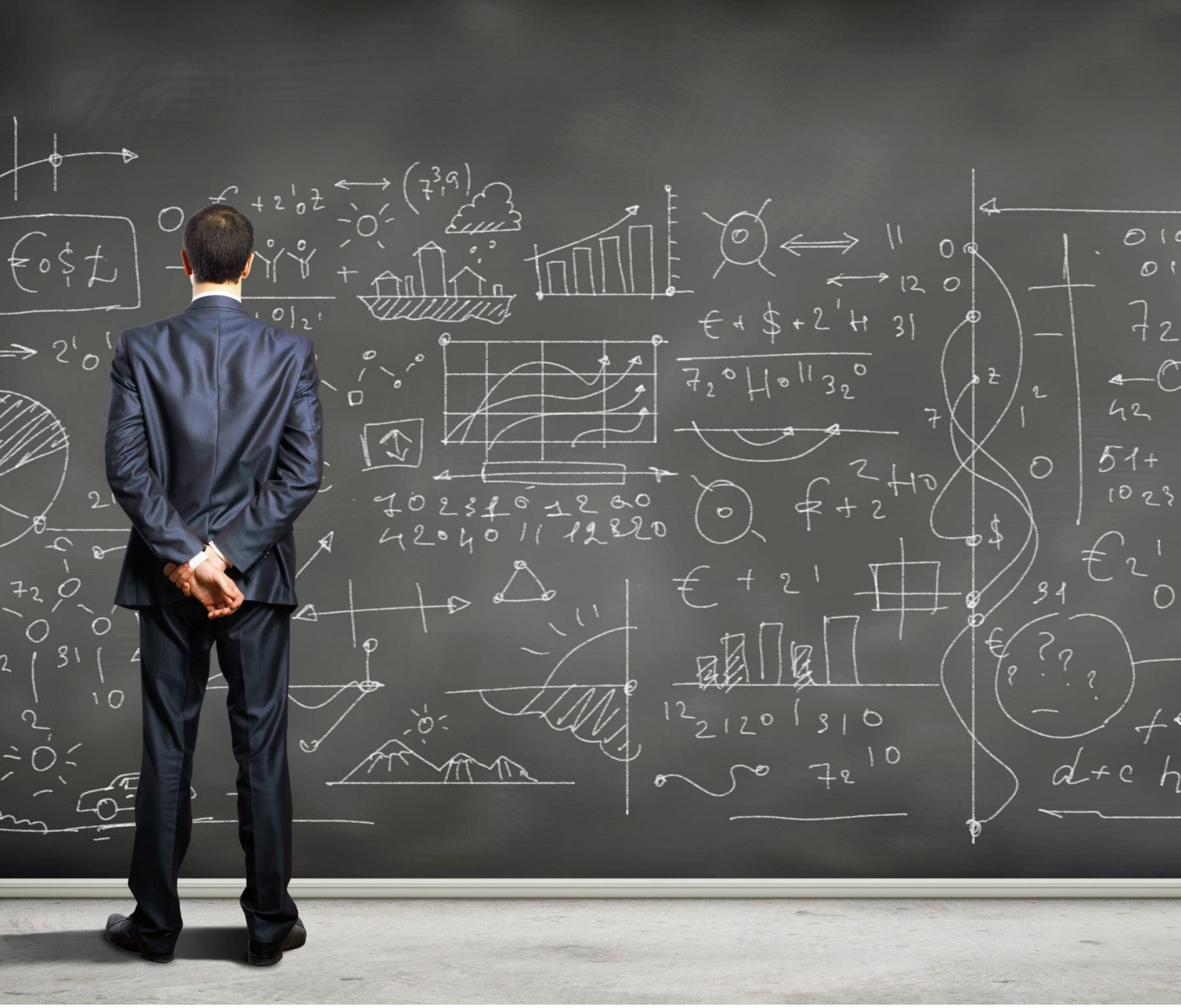
Year	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
1990	0.57	0.03	0.08	9.28	0.12	30.38	-0.82	-0.02	0.03	-0.00	-0.00
1991	0.58	0.03	0.09	9.43	0.12	27.36	-0.79	-0.00	0.02	-0.00	-0.00
1992	0.42	0.02	0.04	6.18	0.09	28.24	-0.50	-0.03	0.03	-0.00	-0.00
1993	0.46	0.10	0.34	8.18	0.11	35.94	-0.72	1.78	0.32	-0.00	-0.00
1994	0.85	0.11	0.07	9.82	0.16	77.50	-0.85	-0.11	-0.00	-0.00	-0.00
1995	0.67	0.22	0.07	11.21	0.19	30.39	-0.85	-0.05	0.10	-0.00	-0.00
1996	0.70	0.12	0.06	11.97	0.19	24.27	-0.94	-0.14	0.08	-0.00	-0.00
1997	0.73	0.12	0.08	13.74	0.23	25.85	-0.99	-0.06	0.09	-0.00	-0.00
1998	0.83	0.13	0.19	19.01	0.27	34.20	-0.76	0.41	0.14	0.01	-0.00
1999	1.66	0.25	0.08	14.53	0.27	26.65	-1.10	-0.05	-0.00	-0.00	-0.00
2000	1.05	-0.01	0.13	16.01	0.36	29.22	-1.17	-0.05	-0.08	-0.00	-0.00
2001	1.60	0.09	0.10	18.74	0.44	39.51	-1.38	-0.05	0.00	-0.00	-0.00
2002	1.49	0.11	0.03	18.39	0.40	36.52	-1.43	-0.05	-0.10	-0.00	-0.00
2003	2.94	0.09	0.04	16.94	0.33	36.25	-1.18	-0.05	0.08	-0.00	-0.00
2004	2.24	-0.94	0.25	15.71	0.62	36.33	-3.88	-0.05	0.04	-0.00	-0.04
2005	2.45	0.06	0.03	17.95	0.25	42.03	-1.34	-0.05	-0.30	-0.00	-0.04
2006	2.32	0.15	0.14	20.74	0.56	48.76	-1.53	-0.03	-4.75	-0.00	-0.03
2007	1.90	0.03	0.18	18.87	0.60	47.09	-1.27	-0.04	-0.01	-0.00	-0.04
2008	1.20	0.03	0.10	18.60	0.55	40.99	-1.46	-0.21	-0.03	-0.00	-0.05
2009	1.30	0.03	0.16	22.03	0.65	41.77	-1.48	-0.04	-0.00	-0.00	-0.06
2010	0.98	0.02	0.10	17.60	0.47	39.01	-1.16	-0.08	-0.00	-0.00	-0.03
2011	0.93	0.02	0.13	19.60	0.51	45.74	-1.12	0.12	0.02	-0.00	-0.02
2012	1.08	0.03	0.12	19.60	0.59	45.00	-1.35	-0.11	-0.01	-0.00	-0.02
2013	0.86	0.02	0.10	18.50	0.51	47.21	-1.16	-0.11	-0.00	-0.00	-0.00
2014	0.87	0.02	0.11	18.83	0.57	46.47	-1.28	-0.10	-0.00	-0.00	-0.00
2015	1.08	0.02	0.16	22.63	0.78	20.97	-1.54	-0.04	-0.01	0.00	-0.01

In comparison to last year's submission, recalculations were made for all pollutants (different pollutants for different sectors, Tables 0.1 and 0.2). The detailed descriptions for recalculations are presented in the following chapters.

The main changes occurred in the emissions of ammonia and selenium. The main reason for the ammonia emissions change is an extensive ammonia emissions recalculation in the agriculture sector and for the first time ammonia emissions from biomass burning was calculated. The main reason for the selenium emissions change is mainly due to the pollutants emissions calculation from lubricant use in road transport sector.

Priorities for future inventory improvement:

- Check the POPs emissions from energy sector and waste incineration;
- Check the activities 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 2018. The report contains information on Estonian emission inventory from 1990 to 2016. 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 1950 reports for the year 2016) 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 2016.

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.

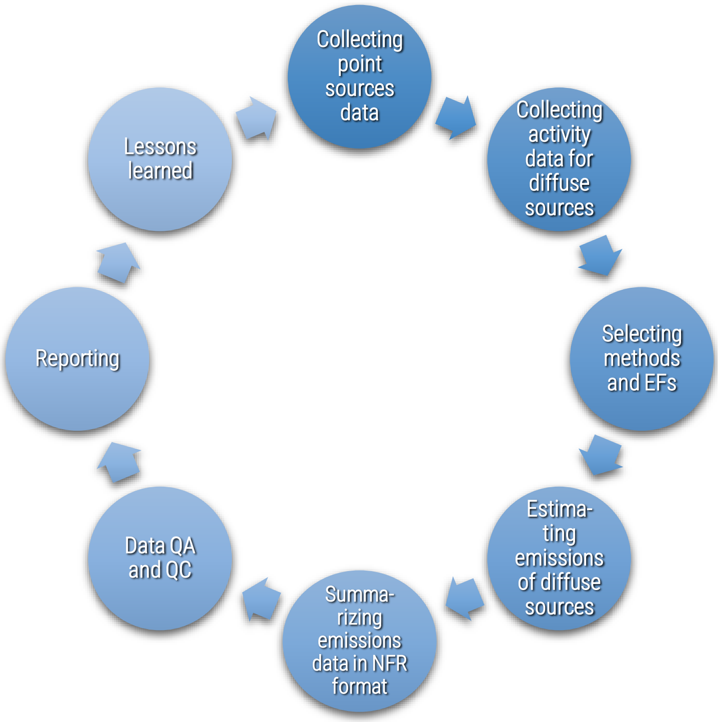

Figure 1.1 The main activities of inventory preparation

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 2016 the number had increased to 1,950.

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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 (Figure 1.2).

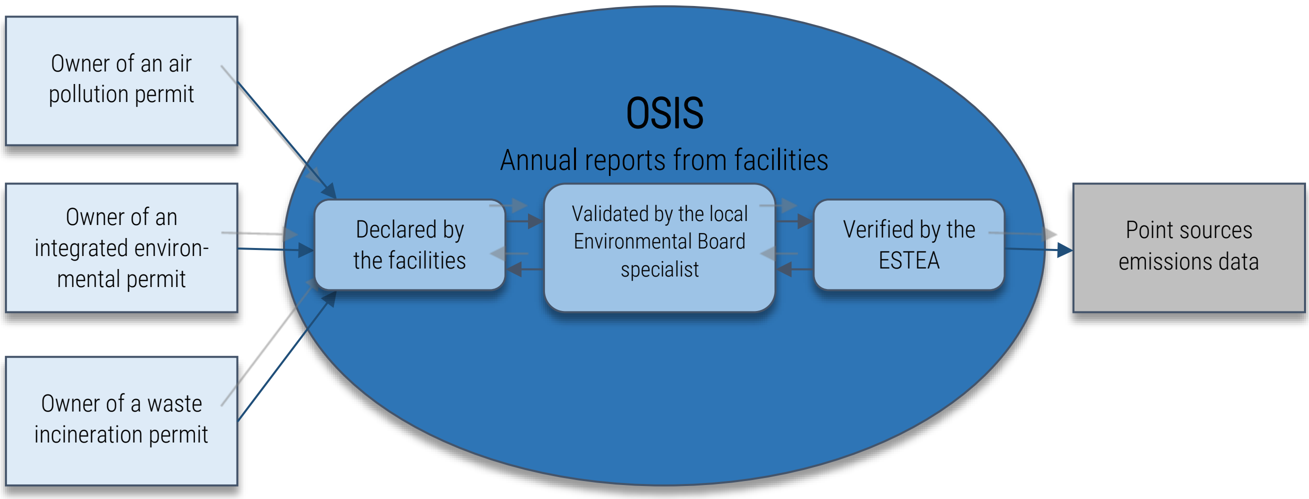

Figure 1.2 Validation of Estonian point sources data

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.

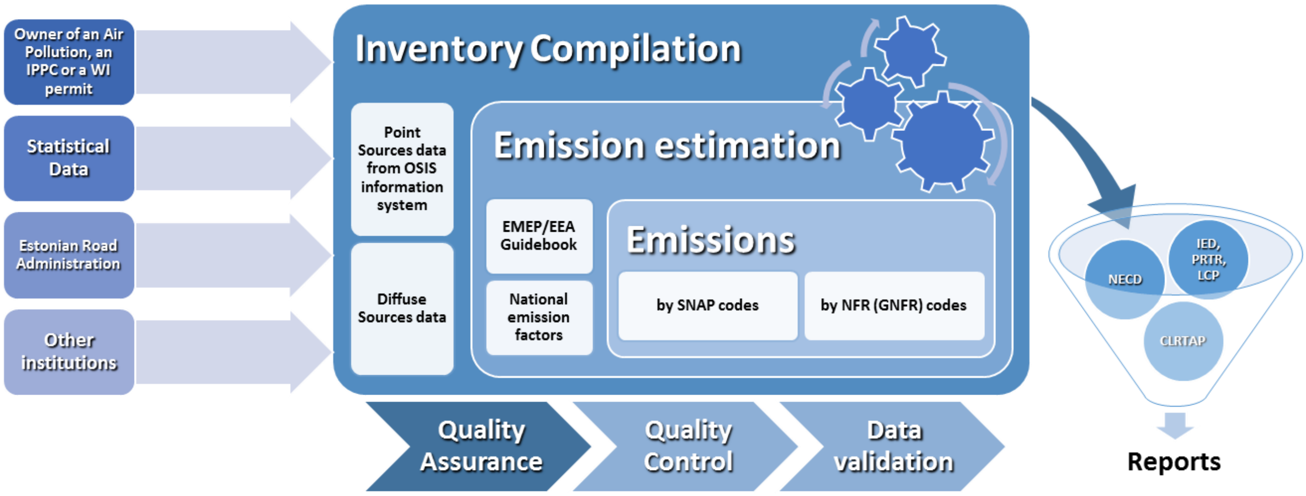

Figure 1.3 Air pollution inventory structure

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 methodology 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 Air Pollutant Emission Inventory Guidebook 2016.

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 2016, only the level assessment was chosen.

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

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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 (15.3%). 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 for 2016 from the energy sector are responsible for 76.4% of SO_2 emissions in 2016. 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 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, 49.4% 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 PAH 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													92.4
	-76.4%	-16.0%													
NO_x	1A1a	1A4bi	1A3biii	1A3bi	1A4cii	3Da1	1A2gvii								80.9
	-26.6%	-16.0%	-11.4%	-10.4%	-8.5%	-4.6%	-3.4%								
NH_3	3Da2a	3B1a	3Da1	3Da3	3B3	3B1b	3B4giv								81.5
	-27.3%	-14.2%	-13.6%	-11.3%	-6.6%	-4.9%	-3.8%								
NMVOC	2D3d	1A4bi	3B1a	2D3a	3B1b	2D3e	1A3bi	1B2av	2D3i	2H2	1A1c	1A2gviii	1A1a	2D3h	82.0
	-15.3%	-15.2%	-9.0%	-7.0%	-5.3%	-4.9%	-4.8%	-4.7%	-3.1%	-3.0%	-3.0%	-2.5%	-2.2%	-2.1%	
CO	1A4bi	1A1c	1A3bi												82.2
	-49.4%	-25.4%	-7.4%												
TSP	2A5b	1A1a	1A4bi	1A2gviii	3Dc	1A4ai	1A1c	1A4ci							80.3
	-22.0%	-20.4%	-15.6%	-9.5%	-4.8%	-3.0%	-2.6%	-2.3%							
PM_{10}	1A1a	1A4bi	1A2gviii	2A5b	3Dc	1A4ai									80.6
	-26.3%	-21.2%	-12.6%	-9.8%	-7.1%	-3.7%									
$PM_{2.5}$	1A4bi	1A1a	1A2gviii	1A4ai	1A2d										80.8
	-30.5%	-26.4%	-16.2%	-5.0%	-2.6%										
Pb	1A1a														93.4
	-93.4%														
Hg	1A1a														91.3
	-91.3%														
Cd	1A1a	1A4bi													93.6
	-67.8%	-25.8%													
DIOX	1A1a	1A4bi	5E	5C1bi	1A2gviii										85.9
	-25.4%	-21.3%	-17.0%	-15.9%	-6.2%										
PAH	1A4bi	1A1a													82.4
	-42.5%	-39.9%													
HCB	1A4bi	1A1a													85.6
	-58.1%	-27.5%													

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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 the Estonian inventory was 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 was carried out for the first time for 2016 submission under LRTAP convention as part of the Estonian IIR 2016.

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

1.7.1. Overview of the Method

Evaluating the uncertainties was based on Tier 1 methodology as described in the EMEP/EEA Air Pollutant Emission Inventory Guidebook. Tier 1 methodology calculations are based on the emissions of the base year and the so-called reference year, and on activity rate uncertainties and emission factors of every NFR sector. Firstly, the uncertainty was calculated pollutant by pollutant for every subcategory, then, the uncertainties of all subcategories were added together, thus finding the overall uncertainty of the inventory data. Uncertainty was evaluated also for aggregated sectors such as stationary combustion, aviation, road transport, other mobile, industrial processes, solvent use, agriculture and waste management; the results are presented under each IIR chapter. The base year for all pollutants was 1990, except for the

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PM_{10} and $PM_{2.5}$, in which case the appointed base year was 2000. The reference year is 2015.

The uncertainty values of emission factors were mainly based on the EMEP/EEA Guidebook. If the default values of uncertainty values of specific emissions of pollutants were not set out in the guidance document, expert evaluations were also used. Recommended range of error listed in the EMEP/EEA Guidebook for source data and emission factors are given in Table 1.3. The margins of error for source data and emission factors of this document are shown by sectors respectively in Tables 1.2 and 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	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	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	Dioxin	PAHs	HCB	PCB
1A1a	B	C	A	C	B	B	B	B	D	D	D	D	D
1A1c	B	C	A		B	B	B	B					
1A2a					B	B	B						
1A2gvii	C	C	C	C	C	C	C	C	D		C		
1A2gviii	B	C	A		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					
1A3bi	B	B	B	B	B	B	B	B	B	D	C	C	C
1A3bii	B	B	B	B	B	B	B	B	B	D	C	C	C
1A3biii	B	B	B	B	B	B	B	B	B	D	C	C	C
1A3biv	B	B	B	B	B	B	B	B	B	D	C	C	C
1A3bv		B											
1A3bvi					B	B	B		B				
1A3bvii					B	B	B						
1A3c	D	D	C	C	B	B	B	D	B	D	D	D	D
1A4ai	C	C	B		B	B	B	B	D	D	D	D	D
1A4aii	C	C	B	C	C	C	C	C	D		D	D	D
1A4bi (liquid fuels)	D	D	C	C	B	B	B	B	D		D		
1A4bi (solid fuels)	D	D	C	C	B	B	B	B	D		D		
1A4bi (gaseous fuels)	D	D	C	C	B	B	B	B	D		D		
1A4bi (biomass)	D	D	C	C	B	B	B	B	D		D		
1A4bii	C	C	B	C	C	C	C	C	C		D	D	D
1A4ci	C	C	B	C	C	C	C	C	C	D	D		D
1A4cii	C	C	B	C	C	C	C	C	C		D		D
1B1a	C				D	D	D	D					
1B2av		C											
1B2b		C											
2A5b					D	D	D						
2A5c													
2A6					D	D	D						
2B1	C												
2B10a		C		B	B	B	B	C					
2C7c	C			E	B	B	B						
2D3a		B							B (Hg)				
2D3b		D			D	D	D						
2D3d		C											
2D3e		D											

NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxin	PAHs	HCB	PCB
2D3f		B											
2D3g		B		D									
2D3h		C											
2D3i		C											
2G	C	C	C	C	C	C	C	C	C	D	D		
2H1	C	C			D	D	D	C					
2H2		C			D	D	D						
2L				E									
3B1a	D	D		D	D	D	D						
3B1b	D	D		D	D	D	D						
3B2	D	D		D	D	D	D						
3B3	D	D		D	D	D	D						
3B4e	D	D		D	D	D	D						
3B4gi	D	D		D	D	D	D						
3B4gii	D	D		D	D	D	D						
3B4giv	D	D		D	D	D	D						
3B4h	D	D		D	D	D	D						
3Da1	D	D		D	D	D	D						
5B1				C									
5C1biii										D			
5C2	C	C	C		D	D	D	C	D	D	D	D	D
5E					D	D	D						

1.7.2. Results of Uncertainty Evaluation

Table 1.5 shows the results of uncertainty evaluation, which include the estimated emissions by pollutants of both 1990 and 2015, uncertainties of trends of 1990–2015, and the whole uncertainty of 2015 national emissions. Special attention should be given to the fact that the uncertainty calculations have not been updated with the latest recalculated data.

Table 1.5 Uncertainty evaluation

Pollutant	Total emission, 1990	Total emission, 2015	Unit	Trend in 1990-2015, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	77.270	30.737	kt	-60.22	13.150	2.98
NMVOC	65.404	22.917	kt	-64.96	16.460	5.02
SO_x	272.392	31.807	kt	-88.32	8.110	0.27
NH_3	21.744	11.645	kt	-46.45	36.790	4.98
$PM_{2.5}$[1]	15.325	9.151	kt	-40.29	9.620	4.32
PM_{10}[1]	32.069	14.006	kt	-56.33	16.450	6.37
TSP	279.070	21.054	kt	-92.46	28.490	2.08
CO	215.002	128.086	kt	-40.43	11.680	6.89
Pb	206.003	28.433	t	-86.20	183.890	17.32
Cd	4.505	0.747	t	-83.42	134.430	18.16
Hg	1.154	0.542	t	-53.06	182.250	4.71
PCDD/F	8.069	4.133	g I-TEQ	-48.78	89.030	38.21
B(a)p	2.367	2.029	t	-14.28	92.370	52.96
B(b)f	2.749	2.327	t	-15.34	101.640	65.61
B(k)f	1.510	1.177	t	-22.05	86.760	44.02
I(1,2,3-cd)p	1.567	1.491	t	-4.84	81.460	44.71
HCB	0.193	0.279	kg	44.94	89.430	97.27
PCB	8.375	4.232	kg	-49.47	103.490	6.1

[1] For $PM_{2.5}$ and PM_{10} base year is 2000 and trend in 2000-2015.

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

The uncertainty was highest for the all POPs and heavy metals. The main reason is high emission factors uncertainty for energy activities. Ammonia also showed a bit higher uncertainty than others did, with uncertainties about 100%. Uncertainties of the pollutant trend were highest for the PAHs.

1.8. General Assessment of Completeness

Next two tables present, which sources of pollution in emission inventory are not estimated or are included elsewhere.

Table 1.6 Sources not estimated (NE)

NFR14 code	Substance(s)	Reason for not estimated
1A2a	NH_3, Se	Will be calculated in the next year submission.
1A2b	NH_3, Se	Will be calculated in the next year submission.
1A2c	NH_3, Se	Will be calculated in the next year submission.
1A2d	NH_3, Se	Will be calculated in the next year submission.
1A2e	NH_3, Se	Will be calculated in the next year submission.
1A2f	NH_3, Se	Will be calculated in the next year submission.
1A2giii	NH_3	Will be calculated in the next year submission.
1A3bi	Hg, As	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3bii	Hg, As	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3biii	Hg, As	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3biv	Hg, As	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3bv	PCDD/PCDF, PAHs, HCB, PCBs	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3bvi	Hg, As, PAHs, HCB, PCBs	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A3bvii	Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PAHs, HCB, PCBs	Emissions occur, but have not been estimated due to lack of emission factors in methodology (Copert 4 version 11.3 generates and fills NFR table (including notation keys NE).
1A4ai	NH_3	Will be calculated in the next year submission.
1A4ci	NH_3	Will be calculated in the next year submission.
1A4ciii	NH_3, PAHs	Emission have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
1A3di(i)	NH_3	Emission have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
1B2av	SO_2, PCDD/PCDF	Emission have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
2A3	NH_3, HCB, PCBs	Emission have not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
2D3a	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016

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NFR14 code	Substance(s)	Reason for not estimated
2D3e	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
2D3f	$PM_{2.5}$	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
2D3g	SO_x, $PM_{2.5}$, PM_{10}, BC; Pb, Cd, Hg, As, Cu, Ni, Se, PCDD/PCDF, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
2D3h	$PM_{2.5}$, PM_{10}, BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
2D3i	NO_x, SO_x, CO, Cd, Hg, As, Cr, Ni, Se, Zn, PCDD/PCDF, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
2G	Se, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5A	CO, Hg	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5B1	NO_x, $PM_{2.5}$, PM_{10}, TSP, BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5B2	$PM_{2.5}$, PM_{10}, BC	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5C1	Zn, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5C1bi	Cr, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016
5C1bv	BC	Emission has not been estimated due to lack of emission factor in EMEP/EEA Guidebook 2016
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 2016
5E	SO_x, BC, CO, Ni, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs	Emissions have not been estimated due to lack of emission factors in EMEP/EEA Guidebook 2016

Table 1.7 Sources included elsewhere (IE)

NFR14 code	Substance(s)	Included in NFR code
1A2a	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A2b	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A2c	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A2d	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A2e	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A2f	PCDD/PCDF, PAHs, HCB, PCBs	1A2gviii
1A3bii	HCB, PCBs	1A3bi
1A3biii	HCB, PCBs	1A3bi
1A3biv	HCB, PCBs	1A3bi
1A3bvi	BC	1A3bi-1A3biv
1A5a	All	1A4ai
1A5b	All	1A4aii
2A1	All, partially TSP, PM_{10}, $PM_{2.5}$	1A2f
2A2	All, partially TSP, PM_{10}, $PM_{2.5}$	1A2f
2A3	All	1A2f
3B4giii	NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TPS	3B4giv
5C1a	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, PCDD/PCDF, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB	1A1a
5C1biii	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs	5C1bi

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Source: http://coachespanel.com.au/

2. POLLUTANTS 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: 1990–2016;
- PM_{10} and $PM_{2.5}$: 2000–2016;
- BC: 2000–2016;
- All heavy metals: 1990–2016;
- POPs: 1999–2016.

Table 2.1 Main pollutant emissions in the period of 1990-2016 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	CO	$PM_{2.5}$	PM_{10}	BC	TSP
1990	79.018	65.873	272.384	23.863	236.464	NR	NR	NR	279.099
1991	72.889	62.972	250.090	21.761	228.953	NR	NR	NR	277.781
1992	47.630	43.336	190.990	18.211	134.979	NR	NR	NR	249.331
1993	41.736	35.105	155.218	13.305	128.400	NR	NR	NR	195.388
1994	46.956	37.644	150.042	12.721	162.581	NR	NR	NR	169.968
1995	47.946	42.052	115.730	11.852	212.208	NR	NR	NR	127.411
1996	51.936	43.058	124.702	10.655	244.910	NR	NR	NR	115.318
1997	51.246	44.685	115.930	10.776	247.938	NR	NR	NR	92.260
1998	48.682	41.124	104.295	10.558	218.819	NR	NR	NR	84.187
1999	44.032	38.107	97.779	9.678	203.049	NR	NR	NR	82.536
2000	44.877	38.246	97.110	9.329	198.618	15.336	32.079	3.451	70.148
2001	46.827	37.195	90.712	9.697	200.464	16.257	31.987	3.742	68.349
2002	47.495	36.609	87.037	9.842	190.003	16.653	28.070	3.936	48.495
2003	48.414	35.239	100.304	10.761	182.812	14.303	24.346	3.701	44.485
2004	45.435	35.458	88.168	10.692	173.806	15.445	24.906	3.824	43.142
2005	41.869	33.424	76.241	10.732	155.441	14.224	22.498	3.495	35.740
2006	40.535	31.984	69.903	10.649	141.658	9.791	16.332	2.543	27.245
2007	44.872	29.396	88.042	11.036	157.585	12.712	22.804	3.046	32.869
2008	41.666	27.543	69.475	11.509	156.553	11.931	19.030	3.112	28.437
2009	36.533	24.864	54.872	11.020	155.918	9.641	15.517	2.590	22.626
2010	42.888	24.396	83.286	11.299	156.760	13.930	23.393	3.208	30.176
2011	41.411	24.190	72.716	11.424	131.827	18.227	34.441	3.544	42.712
2012	37.819	24.017	40.584	11.861	141.979	8.201	13.048	2.201	19.603
2013	35.201	23.428	36.496	11.888	134.326	10.807	17.516	2.554	23.430
2014	34.834	23.145	40.816	12.067	128.931	7.929	13.228	2.028	19.626
2015	31.566	22.783	31.786	12.603	129.034	9.288	14.027	2.551	21.080
2016	31.293	22.461	29.840	11.923	139.895	7.484	11.186	2.179	16.473
Trend 1990-2016, %	-60.4	-65.9	-89.0	-50.0	-40.8	-51.2	-65.1	-36.9	-94.1
Trend 2005-2016, %	-25.3	-32.8	-60.9	11.1	-10.0	-47.4	-50.3	-37.6	-53.9

2.1. Sulphur Dioxide

During the period of 1990–2016, 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 167.3 PJ in 2016) (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.

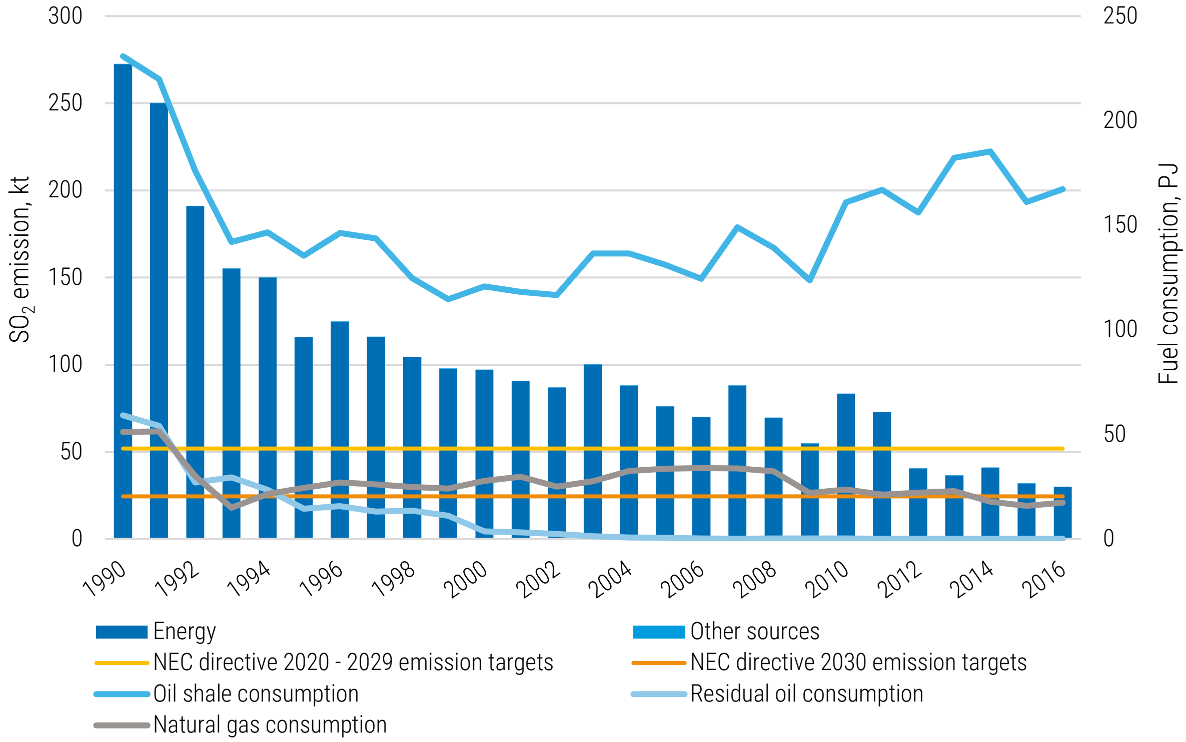

Figure 2.1 SO_2 emissions in the period of 1990–2016 and NEC Directive 2016/2284 targets

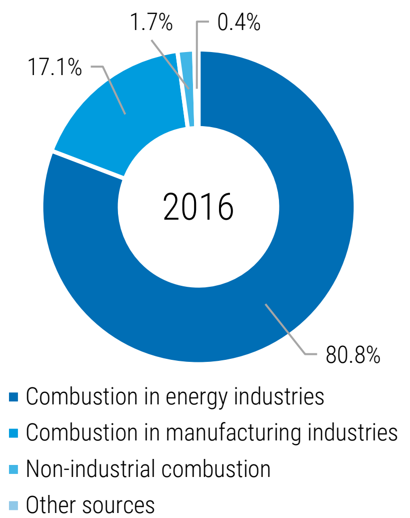

Figure 2.2 SO_2 emissions by sources of pollution in 2016

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 reduced SO_2 emissions to virtually zero. Emissions have also been considerably reduced by shutting down the old blocks.

When Estonia became a member of the EU in 2004, Estonia took the responsibility with the Accession Treaty to the EU to make all efforts to ensure that in 2012 SO_2 emissions from oil shale fired combustion plants do not exceed 25,000 tonnes and progressively decrease thereafter. Unique sulphur scrubbers designed in the course of five years of research and development were installed in the Narva PP on four energy production units of the Eesti 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 that will come into effect from 2016. Measures are also being taken to reduce nitrogen emissions, which will enable units to work at full capacity after 2016, without limits. These scrubbers will also reduce the solid particle content of flue gases.

In 2012, SO_2 emissions from the oil shale power plants did not exceed 25 thousand tonnes.

In 2014, SO_2 emissions had increased about 12% compared to 2013. Increase in emissions has occurred due to the fact that in 2014, pulverised limestone was not added to upper parts of furnaces of units 1, 2 and 7 of Eesti PP (adding limestone would reduce SO_2 emissions in PC boilers without NID systems).

In 2016, SO_2 emissions had decreased by about 6% when compared to 2015's figures. The main reason for the reduction of emissions is the conservation of one of the power plants in Ida-Virumaa, which used as its main source of fuel generator and coke oven gas (the facility worked for only half a month at a time and the reduction in emissions amounted to about four thousand tons).

The share of energy sector, including mobile sources, in total SO_2 emission is 99.8%; the combustion in energy industry (NFR 1.A.1.a-c) is responsible for about 80.8% of total emissions in 2016 (Figure 2.2). The share of SO_2 emissions from the two large oil shale plants – Narva PP (Eesti and Balti) – accounts for approximately 68.5% of total 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 2015. SO_2 emissions decreased by 60.9% in 2016 compared to 2005.

2.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 60.4% compared to 1990 (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 – 27.5% and 25% respectively, the share of other mobile sources was 17.4% and non-industrial combustion – 17.3% in 2016 (Figure 2.4).

In 2016, NO_x emissions decreased by 0.8% in comparison to 2015's figures, mainly by the stricter emission standards for new vehicles categories. This means that new technologies have been introduced gradually and the average age of vehicles has decreased over the years. The introduction of clearing devices at oil shale power plants played a role. One of Eesti Energia's major achievements over the past five 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*).

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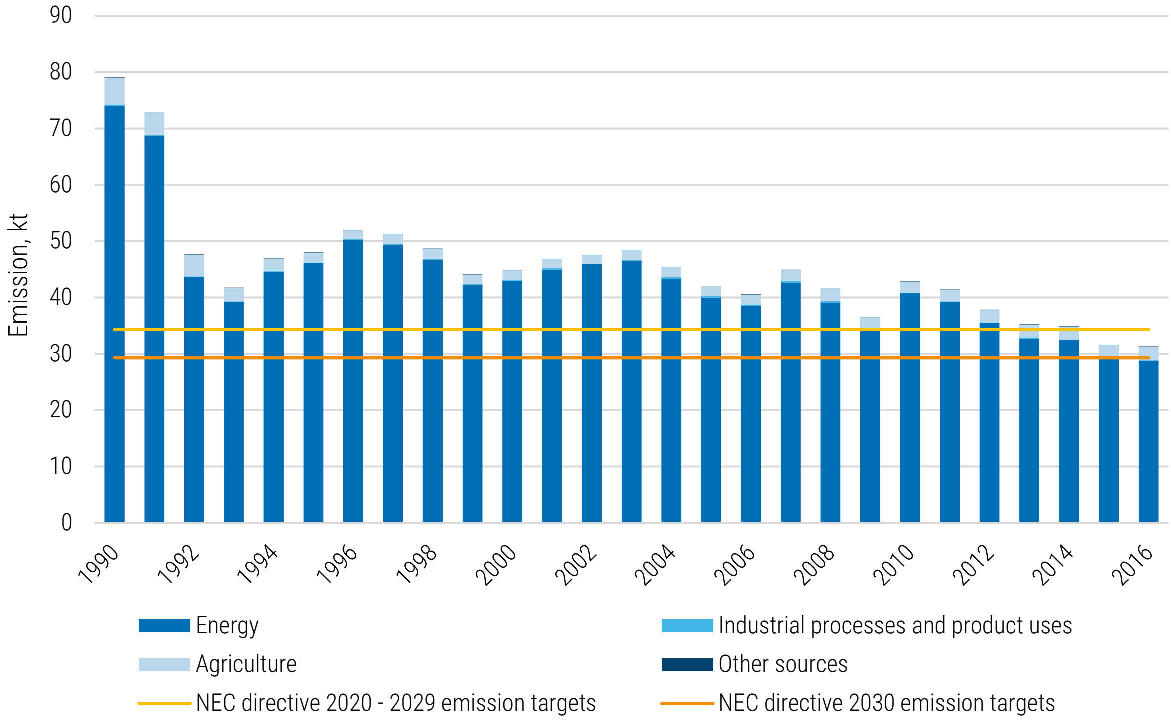

Figure 2.3 NO_x emissions in the period of 1990-2016 and NEC Directive 2016/2284 targets

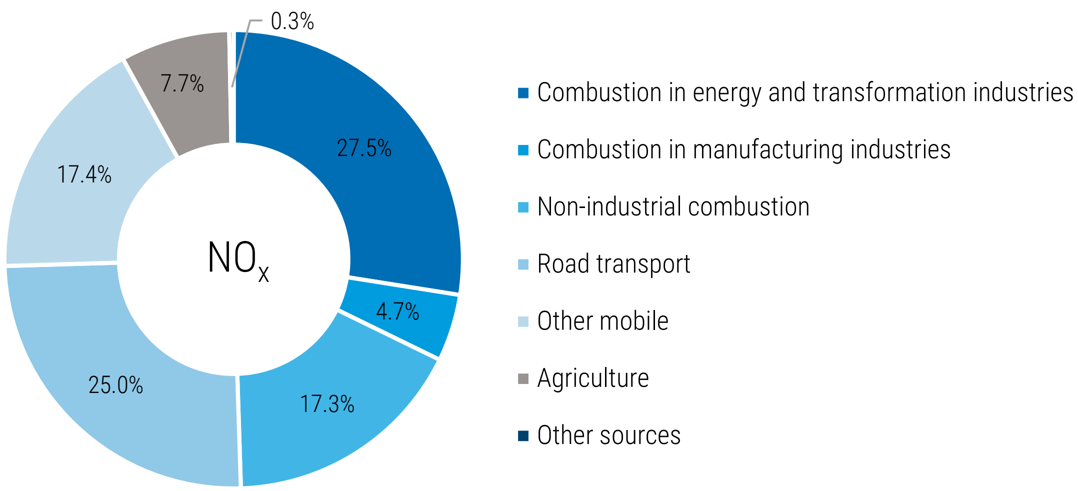

Figure 2.4 NO_x emissions by sources of pollution in 2016

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 25.3% in 2016 compared to 2005.

2.3. Non-Methane Volatile Compounds

Emissions of NMVOC in 2016 remained practically the same as the 2015 level (showing a decrease of 1.4%). During this period an insignificant increase or decrease in emissions in all sectors was observed (Figure 2.6).

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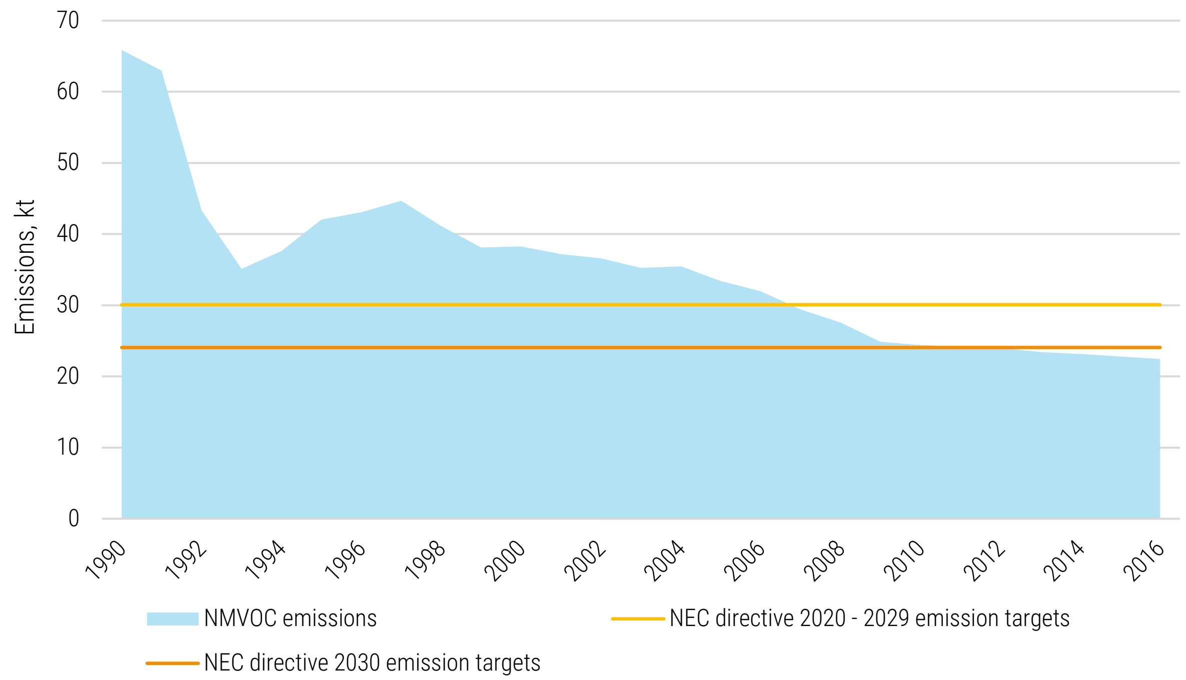

Figure 2.5 Emissions of non-methane volatile organic compounds in the period of 1990-2016 and NEC Directive 2016/2284 targets

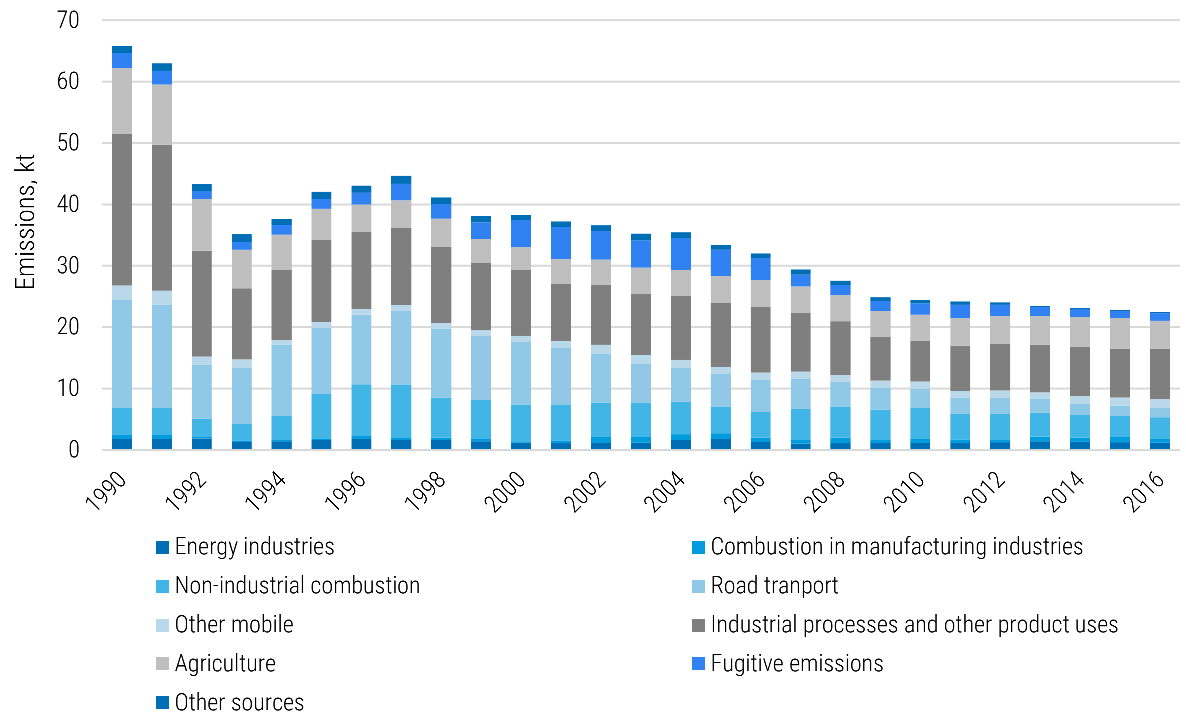

Figure 2.6 Emissions of non-methane volatile organic compounds in the period of 1990-2016

The total emissions of non-methane volatile organic compounds decreased by 65.9% between 1990 and 2016 (Table 2.1, Figure 2.5). In 1990, the main polluters of NMVOC were industrial processes and product uses (37.5%) and road transport (26.7%). In 2016, the dominant source was the same – industrial processes and product uses sector (36.5%), but share of non-industrial combustion has increased from 6.7% to 15.7% and share of road transport has decreased from 26.7% to 7.3% (Figure 2.7). The primary reason for this change was a decline in the use of motor fuel in the transport sector and an increase in the consumption of diesel compared to petrol.

Secondly, during the period of 1990–2016, 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).

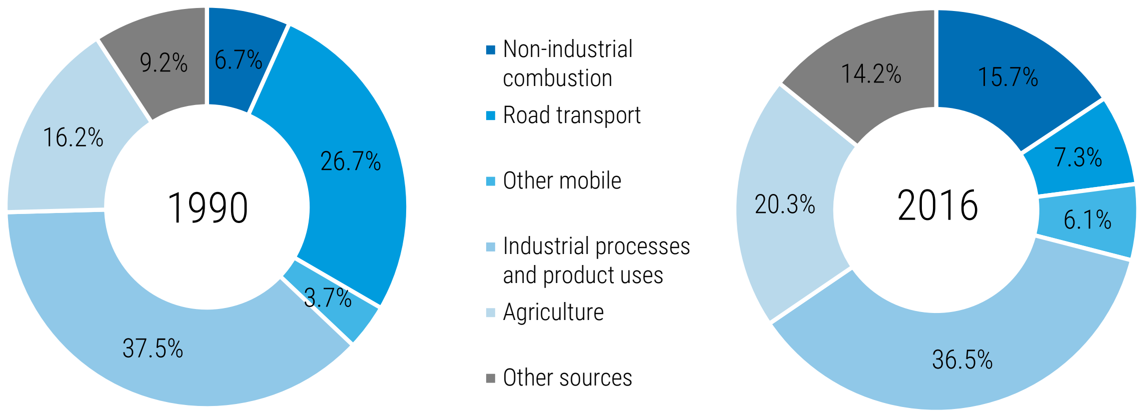

Figure 2.7 NMVOC emissions by sources of pollution in 1990 and 2016

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 10% relative to 2005 baseline emissions by 2020, already in 2015. NMVOC emissions decreased by 32.8% in 2016 compared to 2005.

2.4. Ammonia

Total NH_3 emissions decreased by 50% between the years 1990 to 2016 due to a reduction in the number of animals and the use of fertilisers (Figure 2.8). Livestock manure management and use of mineral fertiliser are the main sources of pollution regarding ammonia (about 88.6%). The process of combustion in energy and transformation industries and non-industrial combustion sectors is responsible for 3.3% and 3.1% of total emissions respectively. Fugitive emissions from solid fuels (oil shale open cast mining, mainly explosive works) account for approximately 1.2% of emissions, and road transport makes up 1.2%. Ammonia emissions from road transport activities have increased in recent years due to a growth in the share of petrol-driven vehicles (by 11% between 2010-2016). All other sectors (manufacturing industry, waste, and other mobiles) account for approximately 2.5% of total ammonia emissions (Figure 2.9).

In 2016, NH_3 emissions decreased by 5.4% when compared to 2015's figures, due mainly to a decrease in livestock figures.

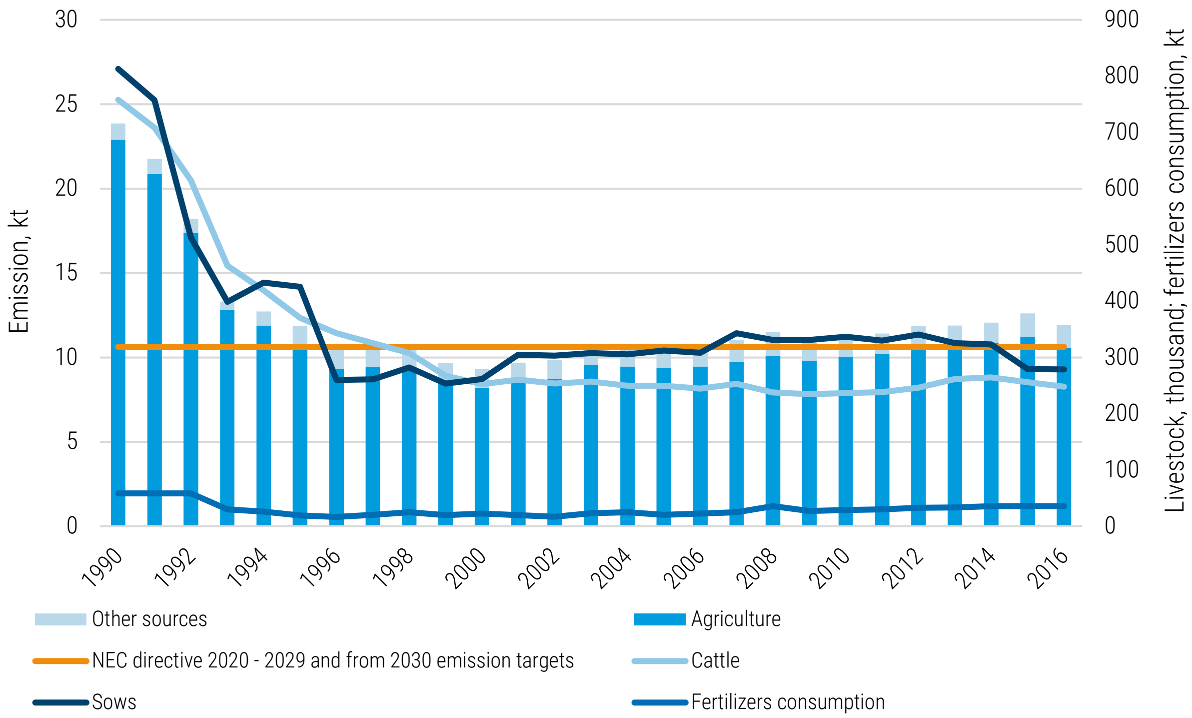

Figure 2.8 Emissions of ammonia in the period of 1990-2016 and NEC Directive 2016/2284 targets

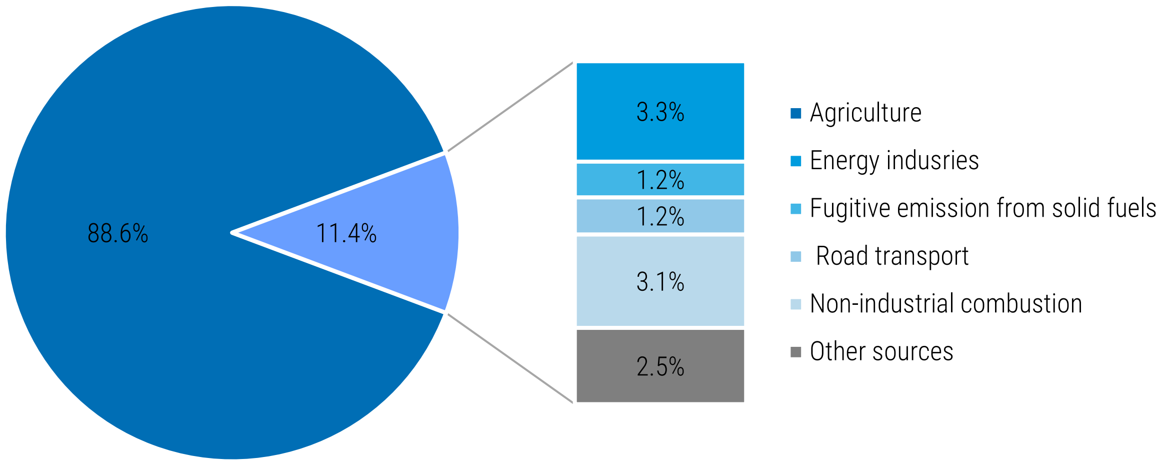

Figure 2.9 Ammonia emissions by sources of pollution in 2016

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 2016 there was an increase in emissions of 11.1% when compared to the figures for 2005, due mainly to an increase in the use of fertilisers and through improved animal productivity in the cattle category. Dairy cattle annual nitrogen production figures and milk production figures have increased by 15% and 17% respectively in comparison to the figures for 2005.

2.5. Carbon Monoxide

In the period of 1990–2016, the emissions of carbon monoxide decreased by 40.8%. 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 (Figure 2.10).

In 1990, the main polluters of carbon monoxide were road transport (50.9%), while in 2016, the dominant source was non-industrial combustion (50.4%) (Figure 2.11). The primary reason for this change was a decrease in the use of motor fuel in the transport sector and an increase in the consumption of diesel compared to petrol. 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 30%, mainly due to an increase in shale oil production in Eesti Energia Õlitööstus AS (Eesti Energia Oil Industry) plant.

In 2016, CO emissions increased by 8.4% in comparison to 2015. The main reasons were an increase in shale oil production in KKT Oil OÜ and in the growth of petrol consumption in industrial equipment.

In 2016, the biggest polluters of CO were combustion in the non-industrial sector (about 50%, from which a large part is wood combustion in the domestic sector), combustion in the energy industry (30%, mainly from shale oil production industry) and road transport – 9% (Figure 2.11).

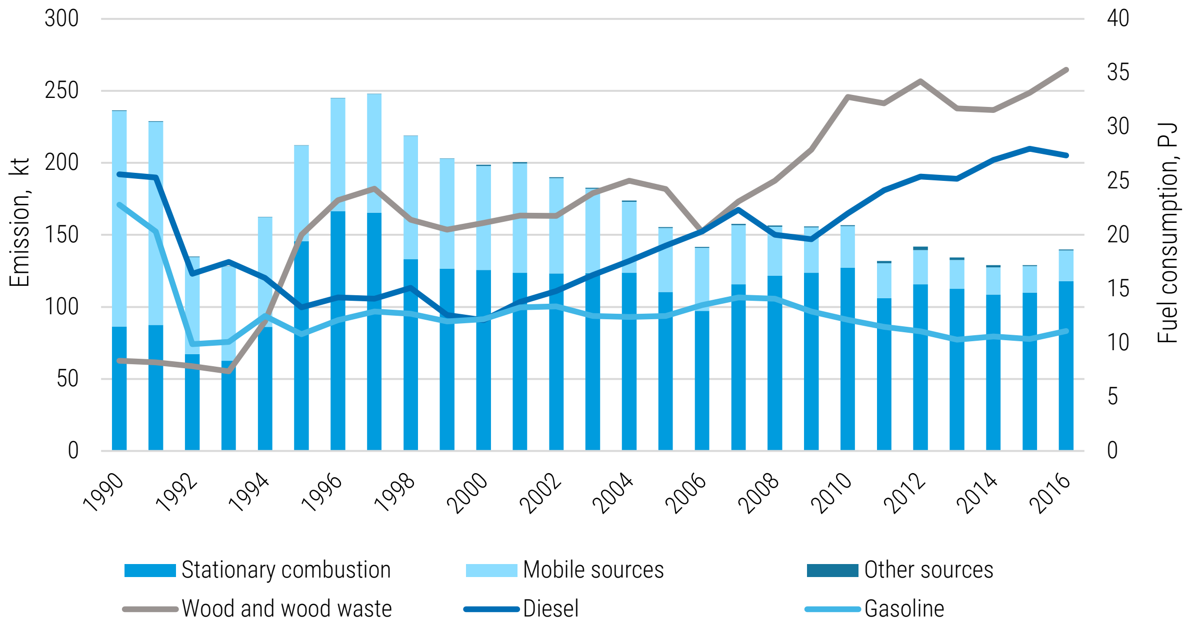

Figure 2.10 Emissions of carbon monoxide in the period of 1990-2016

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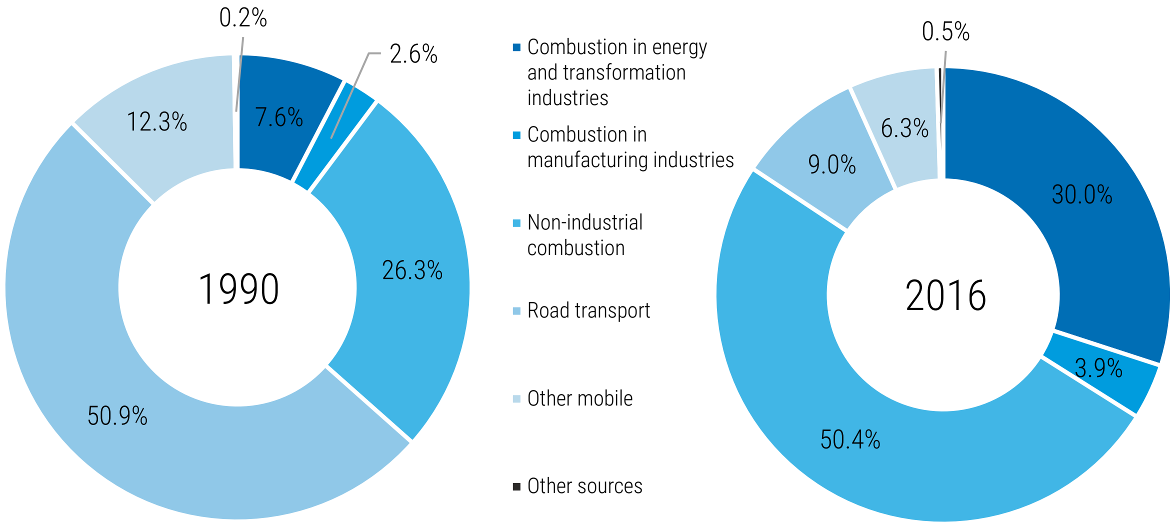

Figure 2.11 CO emissions by sources of pollution in 1990 and 2016

2.6. Particulates

The main source of particulates is the energy sector (including mobile sources), which accounts for 61.6% of the total figure. The emissions of TSP by sectors of pollution are shown in Figure 2.13.

In 1990–2016, TSP emissions dropped significantly – by 94.1% (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 2016, particulate emissions decreased by 21.9% in comparison to 2015, due mainly to a decrease in emissions from energy-related industries (mainly due to the installation of additional filters on the one energy unit in oil shale Eesti PP and also at the Balti PP the old block No. 9 wasn't used) and the construction/demolition sectors.

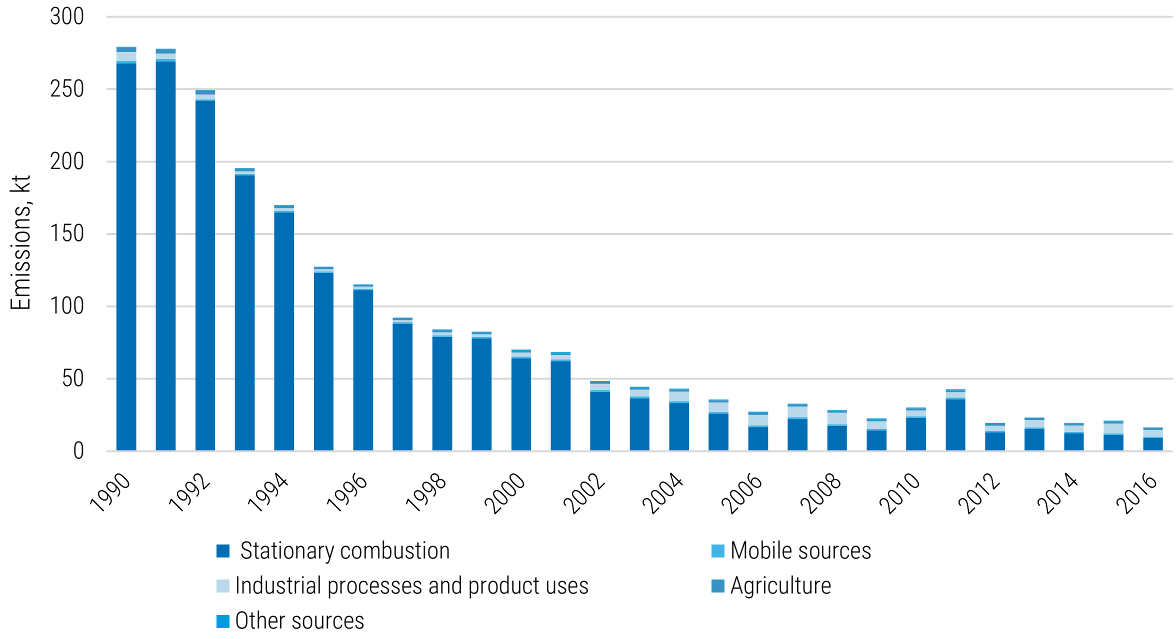

Figure 2.12 TSP emission in the period of 1990-2016

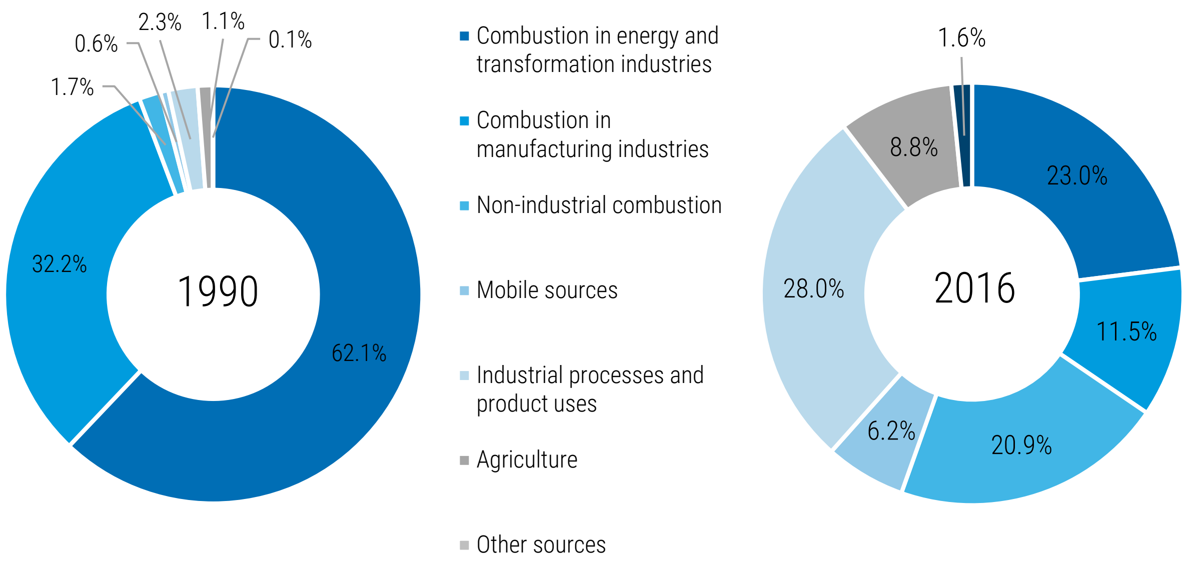

Figure 2.13 TSP emissions by sources of pollution in 1990 and 2016

In 1990, the main polluters of TSP were the energy industry (62.1%) and combustion in manufacturing industries (32.2%). In 2016, the share of combustion in energy industries dropped to 23% and dominant source was industrial processes and product uses (more precisely, construction and demolition) (28%). The share of industrial combustion has decreased by 20.7%, while the share of non-industrial combustion, agriculture, and mobile sources had increased by 19.2%, 7.7% and 5.5% respectively compared to 1990 (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 a decrease in electricity production in the oil shale power plants. Other sources contribute to 1.6% of the total emissions.

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

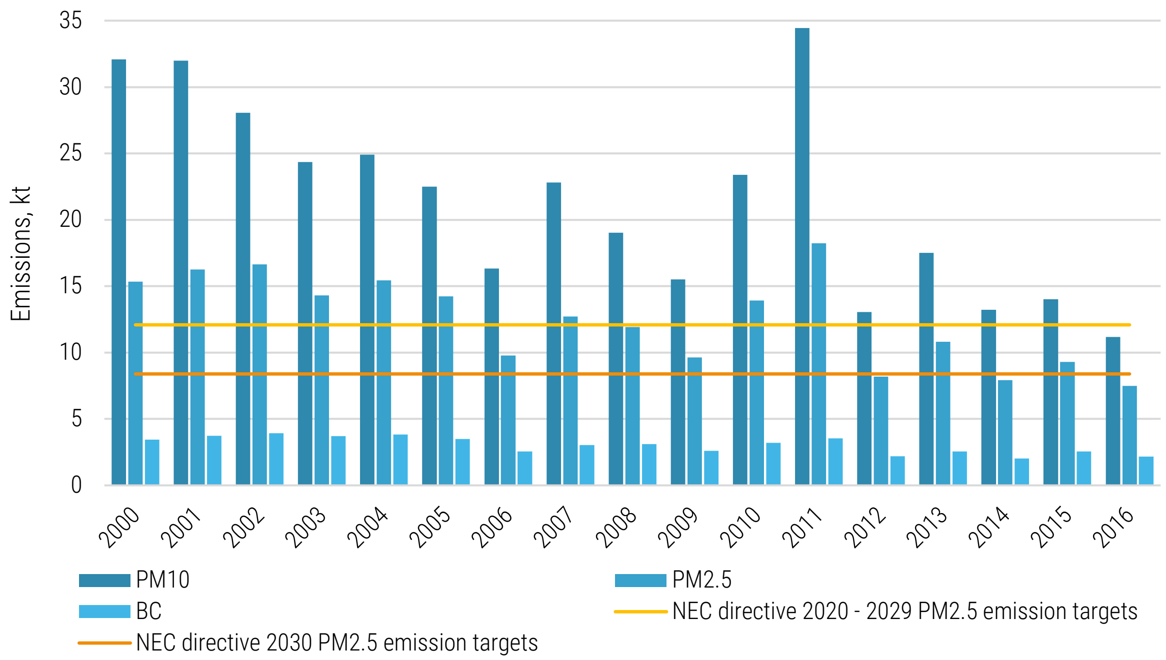

Figure 2.14 PM_{10}, $PM_{2.5}$ and BC emissions in the period of 2000–2016 and NEC directive 2016/2284 $PM_{2.5}$ targets

Emission of black carbon for all activities was calculated in this submission for 2000–2016. In the process of making the calculations, the new EMEP/EEA Guidebook 2016 methodology was applied.

In the period between 2000-2016, emissions of PM_{10}, $PM_{2.5}$, and BC increased by 65.1%, 51.2%, and 36.9% respectively, despite an increase in electricity production in the same period (by 19%). The main reason is an increase in the efficiency of combustion devices and cleaning installations in oil shale power plants.

The increase in the PM_{10}, $PM_{2.5}$ and BC emissions in 2016 compared to 2015 (6.1%, 15.8% and 26% respectively) was the result of increasing the amount of wood burned in industrial boiler.

The reasons of decrease in emissions in 2016 in comparison with 2015 same as well as for TSP.

The primary sources of fine particulates (PM_{10}) emission in 2016 were combustion in energy and transformation industries (26%, mainly oil shale combustion), non-industrial combustion (26%, mainly wood combustion) and combustion in manufacturing industries (15%) (Figure 2.15). The distribution of $PM_{2.5}$ and BC emissions by sources of pollution is also visible in Figures 2.15 and 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 20.9% of the total emissions, then share in emissions of BC is significantly higher and makes up 44%.

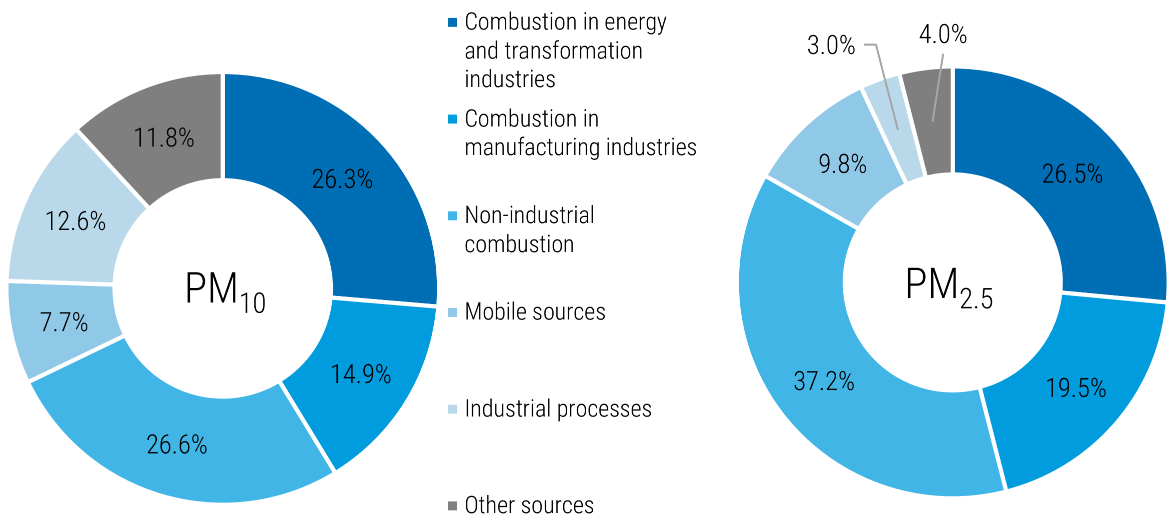

Figure 2.15 PM_{10} and $PM_{2.5}$ emissions by activities in 2016

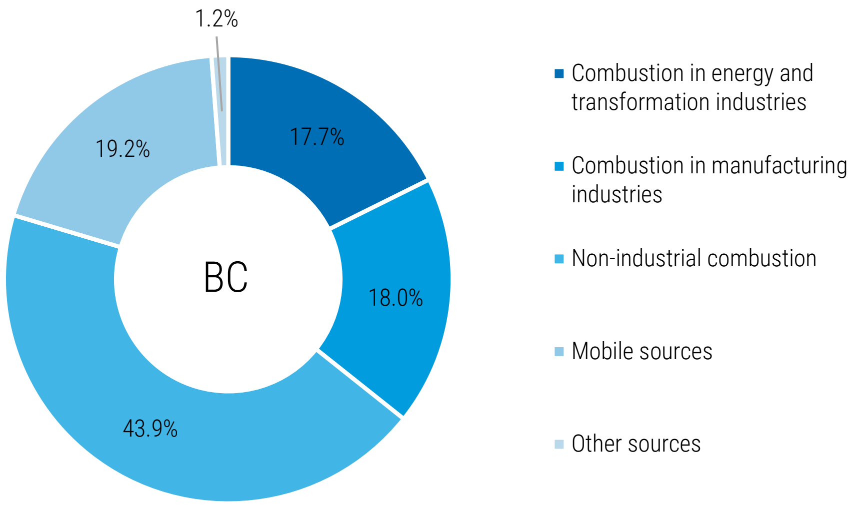

Figure 2.16 Black Carbon emission by activities in 2016

The primary sources of black carbon emission in 2016 were non-industrial combustion (44%), mobile sources (19%), combustion in manufacturing industry (18%), combustion in energy and transformation industries (18%, mainly oil shale combustion) (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 2015. $PM_{2.5}$ emissions decreased by 47.4% in 2016 compared to 2005.

2.7. Heavy Metals

In 1990–2016, 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 86.2% due to the modernisation of cleaning equipment at both the Narva PP and Kunda Nordic Cement and due to the decrease in energy production. A further reason is the discontinued use of leaded petrol in Estonia since 2000 (Figure 2.19).

Table 2.2 Heavy metal emissions in the period of 1990-2016 (t)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
1990	205.447	4.503	1.161	18.872	18.409	10.993	27.357	105.968
1991	188.118	4.295	1.050	16.471	16.039	10.206	25.573	97.090
1992	124.223	3.088	0.861	14.050	13.804	7.069	16.967	79.395
1993	102.675	2.310	0.677	10.867	10.505	5.821	14.326	61.931
1994	122.832	3.004	0.682	10.710	10.331	6.516	12.856	65.023
1995	85.892	2.179	0.641	10.105	9.963	5.607	10.480	63.445
1996	66.477	1.305	0.638	10.389	10.231	5.143	10.844	61.914
1997	47.331	1.343	0.644	10.233	9.976	5.219	9.740	61.882
1998	41.632	1.222	0.577	9.178	8.922	4.979	8.788	55.296
1999	40.064	1.157	0.556	8.750	8.510	4.649	7.502	52.963
2000	36.904	0.779	0.556	8.607	8.365	4.325	6.471	49.318
2001	36.992	0.755	0.543	8.407	8.239	4.762	6.425	49.042
2002	36.324	0.777	0.547	8.381	8.353	4.939	6.188	48.421
2003	38.438	0.847	0.638	10.007	9.824	5.266	6.790	56.866
2004	36.767	0.786	0.582	9.701	9.409	5.264	6.692	55.524
2005	35.620	0.760	0.561	9.240	9.096	5.433	6.446	52.779
2006	32.123	0.740	0.563	8.616	8.476	5.454	5.781	48.307
2007	40.479	0.909	0.692	11.088	10.810	6.219	6.764	61.367
2008	35.290	0.828	0.605	9.419	9.338	5.623	5.935	54.575
2009	28.440	0.709	0.474	7.613	7.555	4.911	4.861	45.835
2010	39.125	0.896	0.659	10.973	10.604	5.840	6.618	62.008
2011	38.599	0.859	0.663	10.891	10.431	5.853	6.448	60.034
2012	34.084	0.792	0.585	9.607	9.189	5.650	5.671	54.304
2013	39.568	0.965	0.695	11.246	10.594	5.943	6.529	61.836
2014	36.494	0.897	0.686	10.255	9.861	5.998	6.057	56.747
2015	28.398	0.747	0.548	7.754	7.611	5.462	4.684	46.199
2016	32.418	0.809	0.615	8.990	8.692	5.791	5.352	51.837
Trend 1990-2016, %	-84.2	-82.0	-47.0	-52.4	-52.8	-47.3	-80.4	-51.1

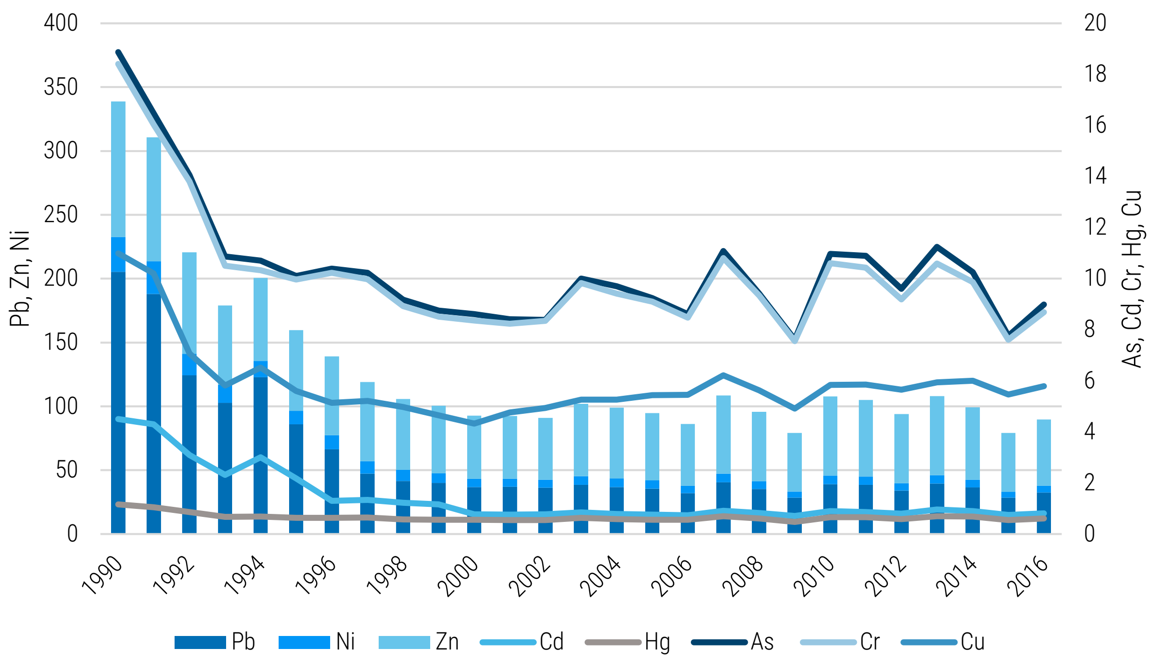

Figure 2.17 Heavy metals emissions in the period of 1990-2016 (t)

The emissions of lead by sources of pollution in 1990 and 2016 are shown in Figure 2.18. The distribution of emissions by sector has considerably changed over the last 25 years. While in 1990 the main sources of lead pollution were almost equally road transport, energy industries and industrial combustion (mainly cement manufacturing), in 2016 the main source of pollution by all heavy metals was the energy industry (mainly oil shale power plants).

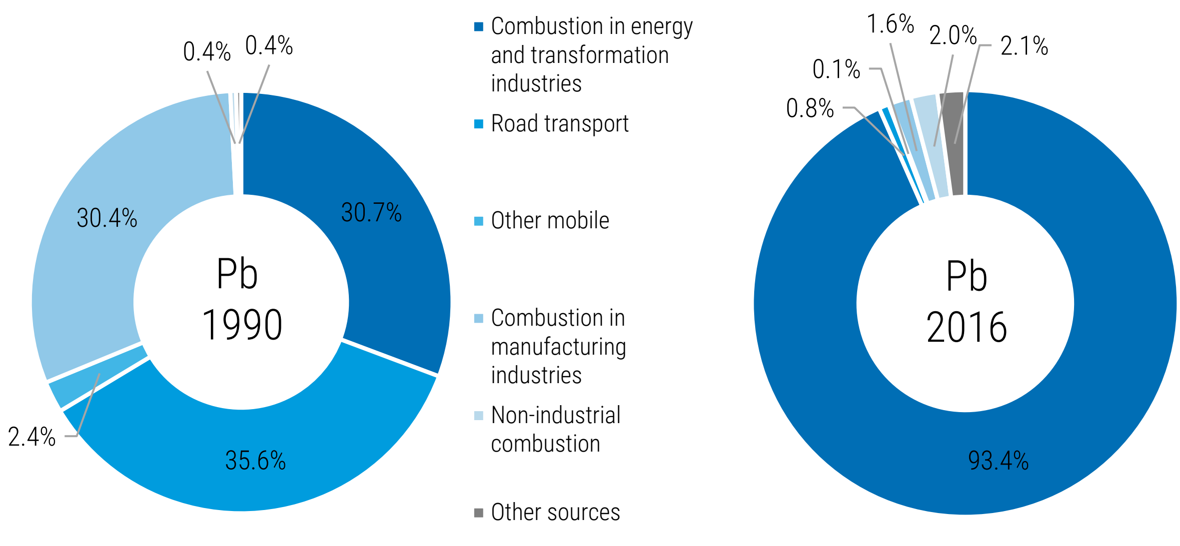

Figure 2.18 Lead emission by sources of pollution in 1990 and 2016

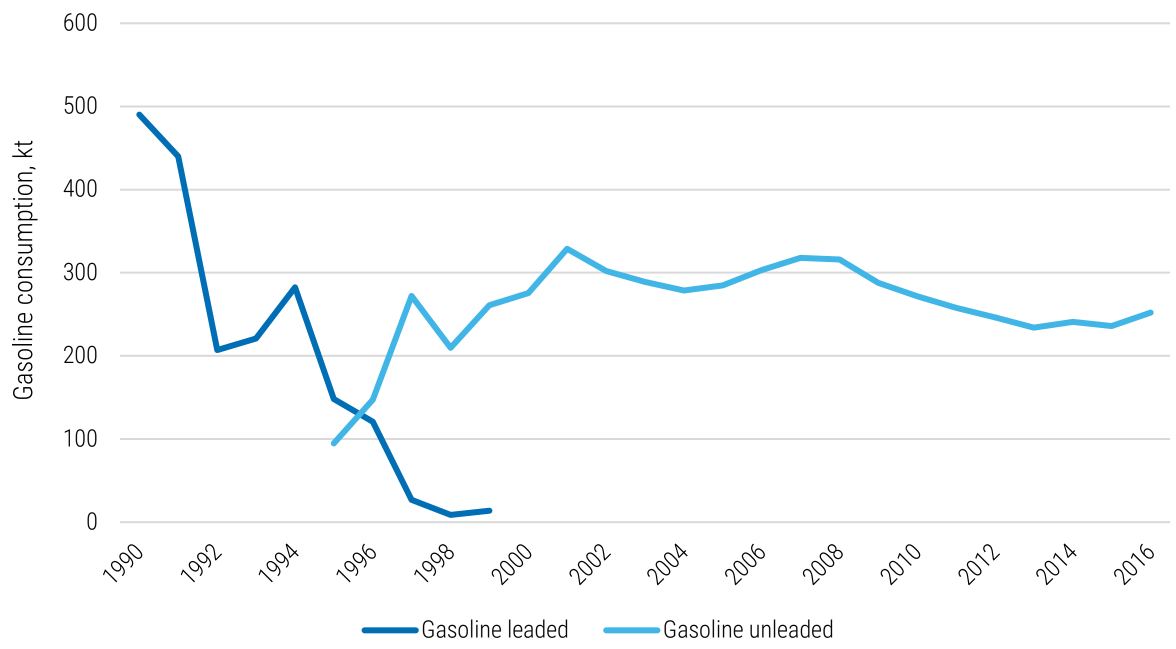

Figure 2.19 Gasoline consumption in 1990-2016

2.8. Persistent Organic Pollutants

In the period of 1990–2016, dioxin, PAHs total and PCB emissions decreased by approximately 50%, 15% and 50% respectively. Only HCB emissions increased for the same period by 47%, but decreased from 1995 to 2016 by 15%.

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

Table 2.3 POPs emissions in the period of 1990-2016

Year	PCDD/ F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs Total	HCB	PCB
	g I-Teq	t					kg	
1990	8.067	2.369	2.750	1.510	1.567	8.196	0.193	8.375
1991	7.958	2.349	2.773	1.498	1.540	8.160	0.187	8.539
1992	5.332	1.629	1.797	1.020	1.160	5.606	0.164	5.609
1993	4.311	1.385	1.484	0.897	1.065	4.831	0.143	5.048
1994	4.194	1.744	1.776	1.124	1.501	6.145	0.214	5.149
1995	5.590	2.821	2.756	1.826	2.621	10.023	0.333	4.122
1996	6.295	3.226	3.200	2.106	3.006	11.537	0.370	4.725
1997	6.285	3.224	3.189	2.105	3.024	11.543	0.382	4.317
1998	7.111	2.620	2.650	1.689	2.375	9.333	0.330	4.350
1999	7.092	2.549	2.629	1.638	2.259	9.075	0.315	3.773
2000	6.734	2.398	2.455	1.527	2.153	8.532	0.317	2.620
2001	6.553	2.337	2.436	1.484	2.059	8.316	0.322	4.197
2002	6.881	2.301	2.409	1.456	2.004	8.171	0.305	4.002
2003	6.872	2.307	2.435	1.448	1.999	8.189	0.312	4.753
2004	6.174	2.416	2.595	1.486	1.994	8.491	0.341	3.710
2005	5.728	2.207	2.421	1.331	1.736	7.694	0.289	3.724
2006	5.039	1.895	2.049	1.165	1.428	6.537	0.257	3.045
2007	6.667	1.898	1.972	1.223	1.712	6.805	0.316	1.806
2008	6.690	2.014	2.099	1.254	1.752	7.120	0.333	2.801
2009	6.091	2.136	2.250	1.314	1.821	7.520	0.307	3.057

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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	PCB
	g I-Teq	t					kg	
2010	6.405	2.386	2.600	1.431	1.928	8.346	0.347	4.175
2011	6.310	2.022	2.231	1.210	1.600	7.064	0.314	3.618
2012	4.728	2.039	2.247	1.229	1.620	7.135	0.329	3.480
2013	3.662	2.090	2.210	1.274	1.566	7.140	0.335	3.939
2014	4.038	2.049	2.326	1.198	1.530	7.103	0.280	4.222
2015	4.131	2.029	2.327	1.177	1.491	7.025	0.279	4.232
2016	4.017	2.008	2.295	1.166	1.486	6.955	0.283	4.193
Trend 1990-2016, %	-50.2	-15.2	-16.5	-22.8	-5.2	-15.1	47.0	-49.9

The main sources of dioxin emission are the waste sector (38.3%, mainly industrial and clinical waste incineration), combustion in energy industries (25.7%, includes also waste combustion as fuel), non-industrial combustion sector (22.5%), combustion in the manufacturing industry (6.2%), includes also waste combustion as fuel, mainly in the cement manufacturing industry) and road transport (7.2%) (Figure 2.22).

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

The main contributor to the total PAHs and HCB emissions is the non-industrial combustion (45.8% and 59.7% respectively, mainly wood combustion in residential sector) (Figures 2.21, 2.23 and 2.24), which is followed by the energy sector. Currently, national POPs emission factors are being developed for the energy sector.

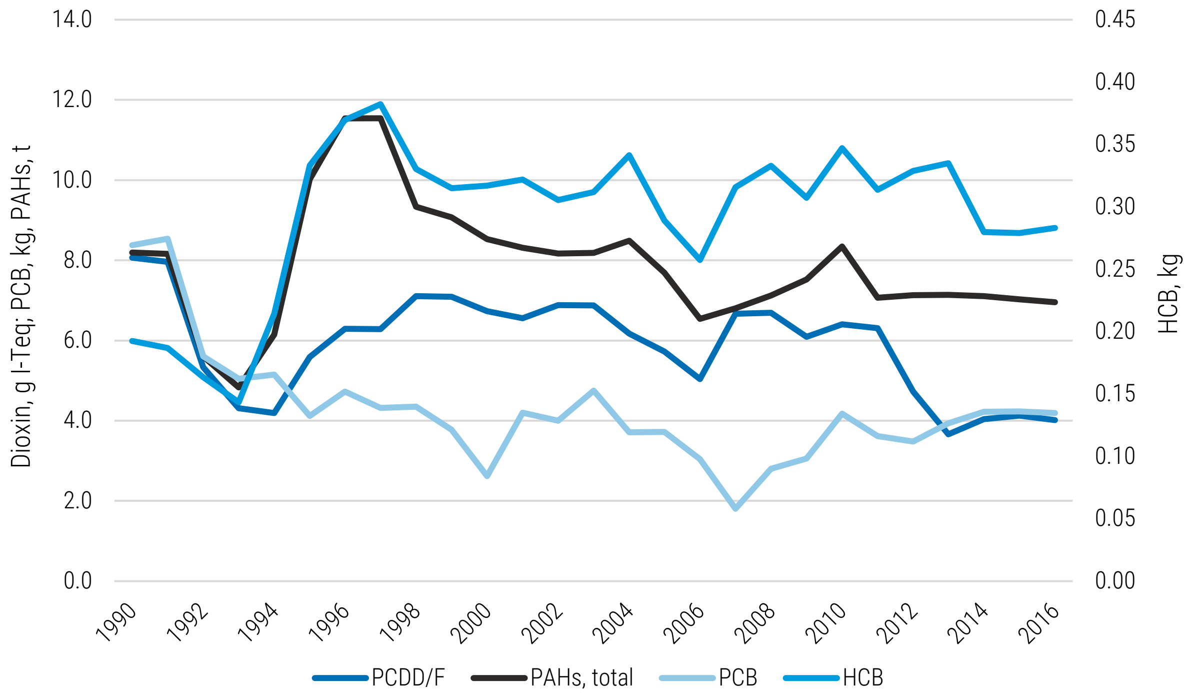


Figure 2.20 POPs emissions in the period of 1990-2016

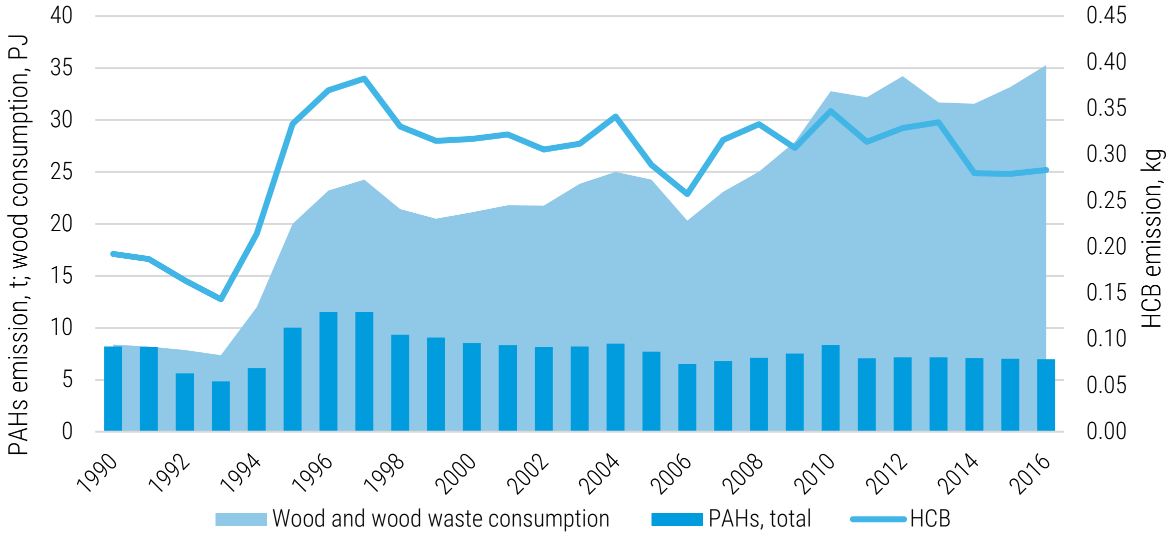


Figure 2.21 PAHs and HCB emissions and wood consumption in 1990-2016

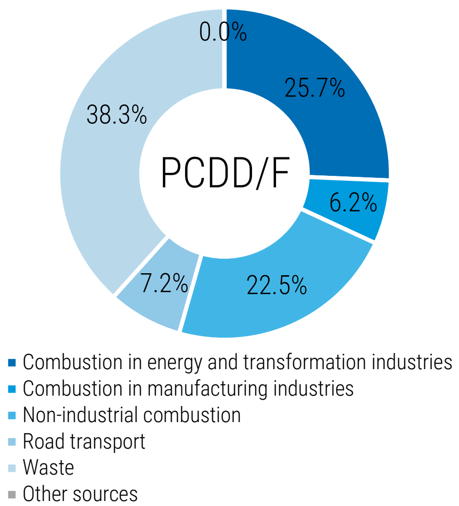


Figure 2.22 Dioxin (PCDD/P) emissions by activities in 2016

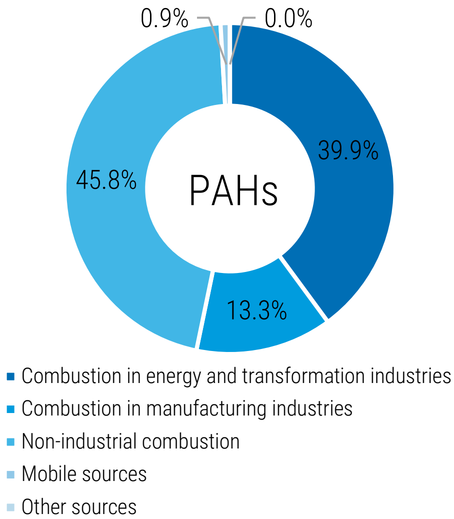


Figure 2.23 PAHs emissions by activities in 2016

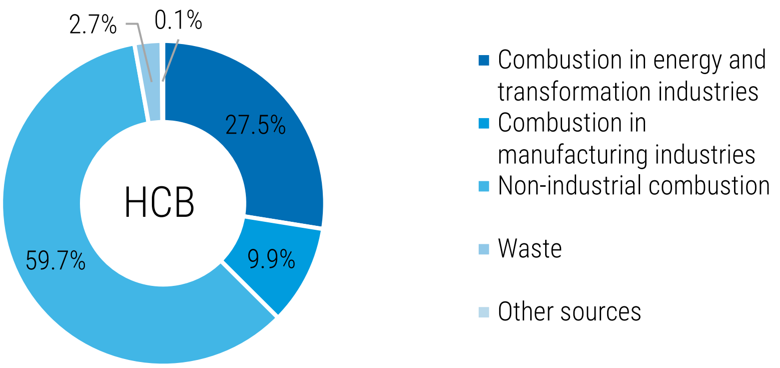
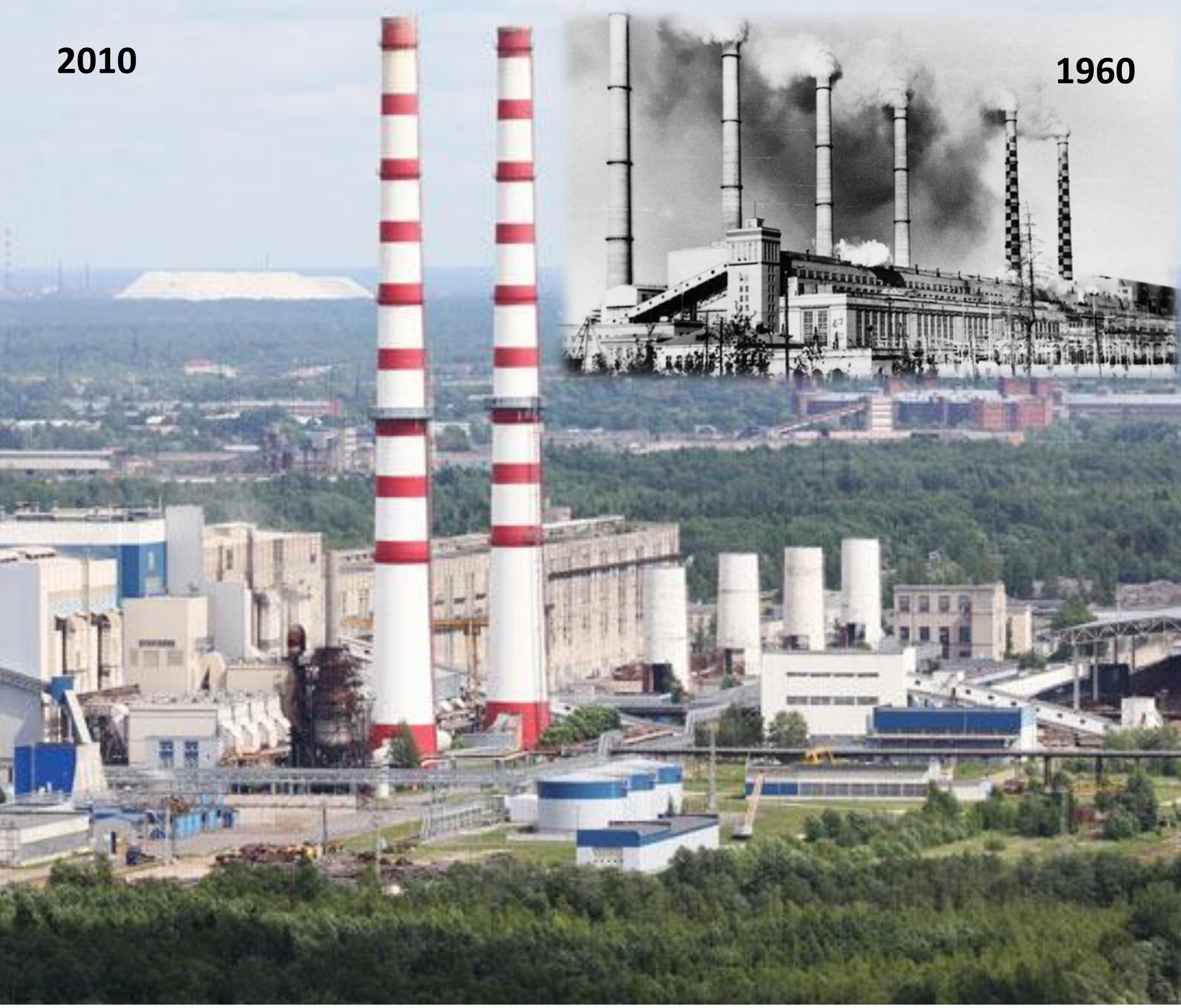


Figure 2.24 HCB emission by activities in 2016



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 (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 2016, the share of domestic fuels – oil shale, wood and peat – accounted for approximately 85.8% (from which oil shale is about 68.6%) of the primary energy supply. Coal, natural gas and liquid fuels were imported to Estonia in 2016. Imports of natural gas increased by about 10% compared to 2015. The imports of motor gasoline increased by about 20%, while imports of diesel increased by about 4% compared to the previous year. The imports of coal increased by about 206% compared to 2015. Imported fuels (natural gas, fuel oils, coal, and motor fuels) made up 11.5% (Figure 3.3).

According to the Estonian government, gas consumption fell from 1,003 mcm in 2007 to 632 mcm in 2012, a decrease of approximately 37%. This was partly due to the general economic downfall, but the greatest impact came from the economic failure of the fertiliser producer Nitrofert AS in February 2009. In 2008, the share of industrial consumption was 39.7% of the total, while in 2009, it fell to 21.3%. The share of gas consumed by Nitrofert was close to 20% of the national consumption of gas. Nitrofert resumed operations in December 2012, although it remains to be seen whether it will scale up its ammonia and urea production to pre-2009 levels ("Estonia 2013. Energy Policies Beyond IEA Countries. OECD/IEA 2013"). The main reason for the reduction of gas consumption by 22% in 2014 in comparison with 2013 was the termination of production of fertilizer.

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- and wind 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. In 2015, the production of wind and hydro energy increased by 17.6% in comparison with 2014. However, production figures in 2016 decreased by around 18% in comparison with 2015. The generation of hydro energy has been stable over the past four years (2016 saw an increase from 27 GWh to 35 GWh). In 2005, electricity generated from renewable energy sources was only 1.1%, but in 2016, it accounted for 12.2%. The growth was due to the enlargement of the existing wind parks and the commissioning of new combined heat and power plants working on wood fuel.

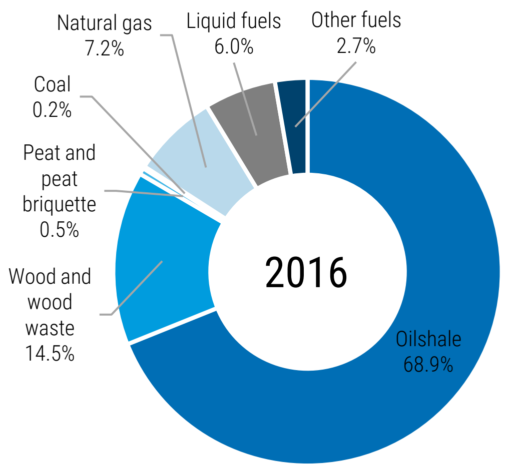


Figure 3.1 Structure of primary energy supply in Estonia in 2016

Domestic fuels (oil shale, peat, biomass) have a large share in Estonia's total energy resources, and in the balance of primary energy, they are mainly based on oil shale. The oil shale is primary resource of electricity generation in Estonia (Figure 3.1).

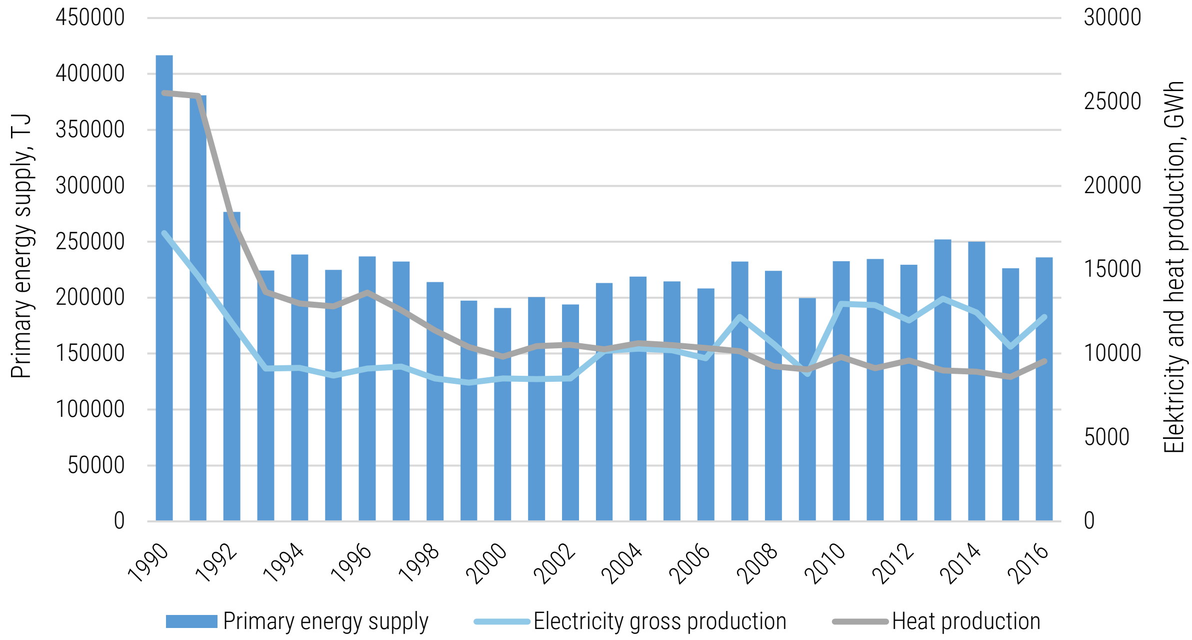


Figure 3.2 Total energy supply, electricity and heat production in the period of 1990–2016
(Source: Statistics Estonia)

The energy sector is the main source of SO_2, NO_x, CO, particulates, HMs and POPs in Estonia. In 2016, the energy sector contributed 99.8% of total SO_2 emissions, 92% of total NO_x emissions, 76.2% of PM_{10} emissions, 42.3% of total NMVOC emissions, 99.6% of total CO emissions, and 97.9% of Pb emissions (Figures 3.4-3.6 and Table 3.1).

Table 3.1 Pollutant emissions from the energy sector in the period of 1990–2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	74.054	29.277	272.371	0.427	NR	NR	NR	269.465	235.889	204.651
1995	46.093	22.444	115.712	1.017	NR	NR	NR	124.147	212.079	84.789
2000	43.003	22.939	97.050	0.990	14.553	29.701	3.419	65.521	197.972	35.652
2005	40.030	17.756	76.081	1.112	13.218	18.814	3.453	27.352	154.940	34.605
2006	38.497	16.088	69.772	0.996	8.756	12.397	2.503	18.103	141.156	31.117
2007	42.689	14.660	88.002	1.121	11.744	18.926	2.995	23.774	156.925	39.680
2008	39.053	13.827	69.442	1.177	10.897	14.999	3.081	18.886	155.978	34.661
2009	34.468	12.995	54.822	1.078	8.945	12.559	2.555	15.772	155.344	28.010
2010	40.791	12.966	83.239	1.126	13.315	20.870	3.187	24.581	156.208	38.592
2011	39.279	11.792	72.677	1.052	17.700	32.019	3.517	37.385	131.278	38.053
2012	35.537	11.474	40.526	1.075	7.708	10.653	2.177	14.321	141.526	33.475
2013	32.687	10.808	36.448	1.064	10.162	14.605	2.525	16.772	133.826	38.904
2014	32.463	10.079	40.799	1.078	7.392	10.594	2.004	13.640	128.398	35.753
2015	29.113	9.714	31.753	1.270	8.694	10.648	2.524	12.566	128.508	27.770
2016	28.799	9.505	29.789	1.219	6.974	8.520	2.153	10.280	139.395	31.735
Trend 1990-2016, %	-61.11	-67.54	-89.06	185.60	-52.08	-71.31	-37.02	-96.19	-40.91	-84.49

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Table 3.1 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F	HCB	PCB
	t								g I-TEQ	kg	
1990	4.455	1.119	18.845	18.408	10.968	27.356	105.961	8.195	7.291	0.177	8.335
1995	2.131	0.596	10.077	9.961	5.585	10.478	63.430	10.022	4.743	0.312	4.067
2000	0.728	0.505	8.575	8.350	4.268	6.468	49.269	8.532	3.865	0.294	2.559
2005	0.728	0.526	9.221	9.018	5.248	6.405	52.668	7.693	3.190	0.279	3.697
2006	0.709	0.526	8.597	8.408	5.244	5.749	48.190	6.536	3.061	0.247	3.018
2007	0.874	0.654	11.068	10.735	5.965	6.732	61.225	6.805	4.663	0.307	1.783
2008	0.806	0.574	9.406	9.255	5.466	5.885	54.487	7.119	4.692	0.325	2.779
2009	0.684	0.442	7.598	7.508	4.812	4.848	45.797	7.520	4.084	0.300	3.038
2010	0.878	0.630	10.962	10.517	5.689	6.597	61.932	8.346	4.969	0.340	4.157
2011	0.838	0.631	10.879	10.335	5.691	6.421	59.954	7.063	4.910	0.307	3.600
2012	0.772	0.554	9.595	9.170	5.447	5.652	54.198	7.135	3.489	0.322	3.462
2013	0.944	0.663	11.234	10.575	5.722	6.510	61.717	7.139	2.549	0.328	3.921
2014	0.875	0.653	10.242	9.845	5.747	6.037	56.593	7.103	2.749	0.273	4.203
2015	0.725	0.514	7.741	7.604	5.282	4.662	46.083	7.024	2.619	0.272	4.212
2016	0.787	0.582	8.977	8.682	5.588	5.337	51.703	6.955	2.477	0.276	4.173
Trend 1990-2016, %	-83.7	-54.1	-58.9	-58.7	-51.8	-83.0	-56.5	-14.3	-64.1	53.2	-49.5

During the period of 1990–2016, the emissions of sulphur dioxide from the energy sector decreased by 89% and the emissions of nitrogen oxides by about 61% resulting from a decline in energy production (oil shale consumption as a main fuel in Estonia fell from 231 PJ in 1990 to 167,3 PJ in 2016) (Figures 3.4 and Table 3.1). The other reason for the drop in emissions in last years was installation of the semi-dry NID (Novel Integrated Desulphuri-sation) 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 2014, SO_2 emissions from energy sector had increased by about 12% compared to 2013. Increase in emissions has occurred due to the fact that in 2014, pulverised limestone was not added to upper parts of furnaces of Units 1, 2 and 7 of Eesti PP (adding limestone would reduce SO_2 emissions in PC boilers without NID systems).

In 2015, SO_2 emissions from energy sector had decreased by about 22% compared to 2014, mainly resulting from a decline in energy production. The electricity gross production in 2015 was reduced by 16.3% in comparison with 2014, but import of electricity (mainly from Finland) has increased by 56% for the same period. Export has slightly decreased, only by 1.7% (Figures 3.1 and 3.2).

In 2016, SO_2 emissions had decreased by about 6.2% when compared to 2015's figures. The main reason for the reduction of emissions is the conservation of one of the power plants in Ida-Virumaa, which used as its main source of fuel generator and coke oven gas (the facility worked for only half a month at a time and the reduction in emissions amounted to about four thousand tons).

Electricity production volume increased in 2016 by about 18% compared to 2015. A significant factor that supported production growth was a decrease in production costs.[2]

[2] Eesti Energia „Annual Report 2016“ https://www.energia.ee/-/doc/8457332/ettevottest/investorile/pdf/annual_report_2016_eng.pdf

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In 2015, NO_x emissions decreased by 10.4% compared to 2014, mainly due to the reduction in energy production for the same period. In addition, the introduction of clearing devices at oil shale power plants played a role. By the end of 2014, the pilot project on reduction of nitrogen emissions, first in the history of oil shale industry, had run little over 12 months. In 2013, one boiler of the Eesti PP was supplied with NO_x capture system, which has allowed reducing its NO_x emissions approximately two times. Last year, the pilot project was followed by a three-year project to equip another seven boilers with similar emission capture systems (*Eesti Energia "Environmental Report 2014"*).

In 2016, NO_x emissions from energy sector decreased by 1.1% in comparison to 2015's figures, despite an increase in electricity production.

The TSP emissions decreased in 2016 by 18.2% compared to 2015. The PM_{10} and $PM_{2.5}$ emissions decreased in the same period by 20% and 19.8% respectively, which was mainly the result of decreasing the amount of wood and solid fuels burned in industrial boiler. At the same time, emissions of particulates from NFR 1A1 were reduced as a result of modernisation of electric precipitators at oil shale power plants.

Decrease in electricity production also was the cause of decrease in emissions of heavy metals and POPs (Figure 3.3, Table 3.1). During the same period, insignificant decrease in emissions in residential sector took place.

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.

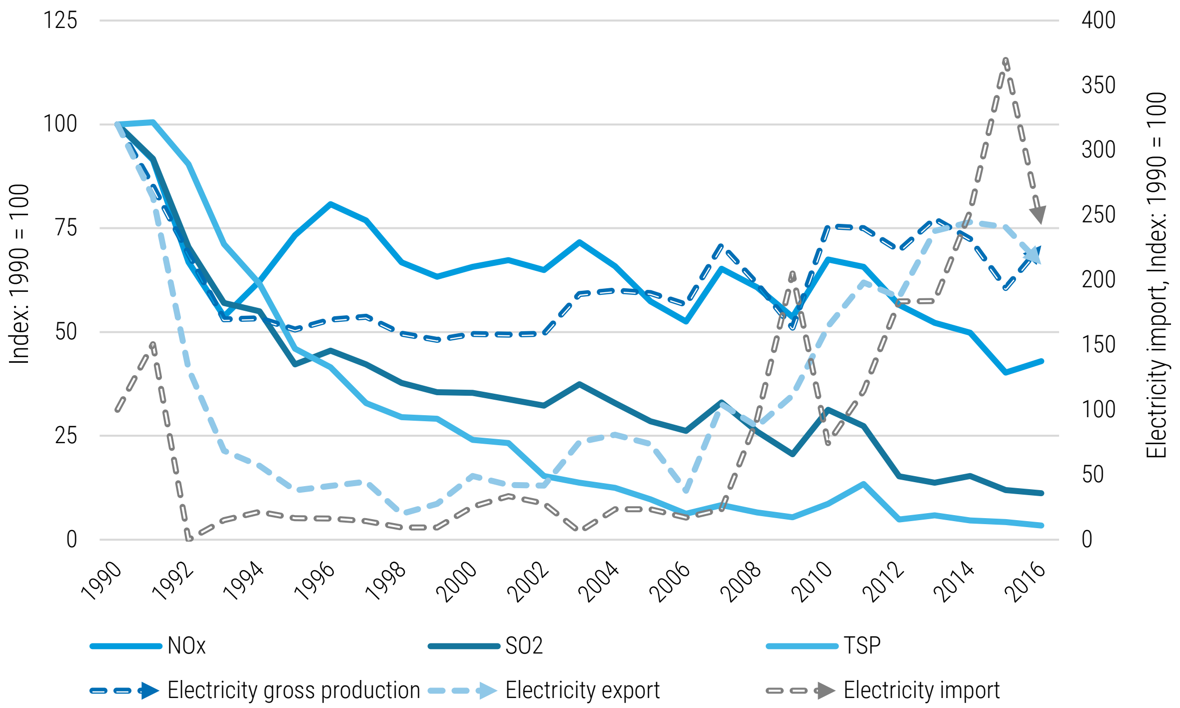

Figure 3.3 Pollutant emissions from stationary combustion, electricity production, and export in the period of 1990–2016

In terms of the efficiency of electricity generation, the renovation of two units in the Narva PP of Eesti Energia AS was essential. These resulted in introducing a new technology – the combustion of oil shale in a low-temperature circulating fluidised bed (CFB). Renovation of the 8th unit in the Eesti PP was completed in November 2003. Since the beginning of 2004, the new and more efficient unit has been in constant commercial use. In 2005, the specific fuel consumption for electricity generation in Narva Elektrijaamad AS decreased as a result of shutting down the older

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boilers: in May 2005, Narva Elektrijaamad AS terminated the use of the old low-efficiency and high-polluting equipment of the first three stages in the Balti PP. On 1 June 2005, the renovated unit No. 11 in the Balti PP was launched. The two boilers of the new unit fire oil shale in a circulating fluidised bed. The new units save more than 20% in fuel. The pollution level is several times lower than that stipulated in EU environmental regulations.

Upon joining the European Union, Estonia assumed the obligation to decrease annual SO_2 emissions to 25,000 tonnes in 2012. In order to meet the target, 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. The accepted obligations were fulfilled and the emission of sulphur dioxide from Narva PP did not exceed 25 thousand tonnes in 2012.

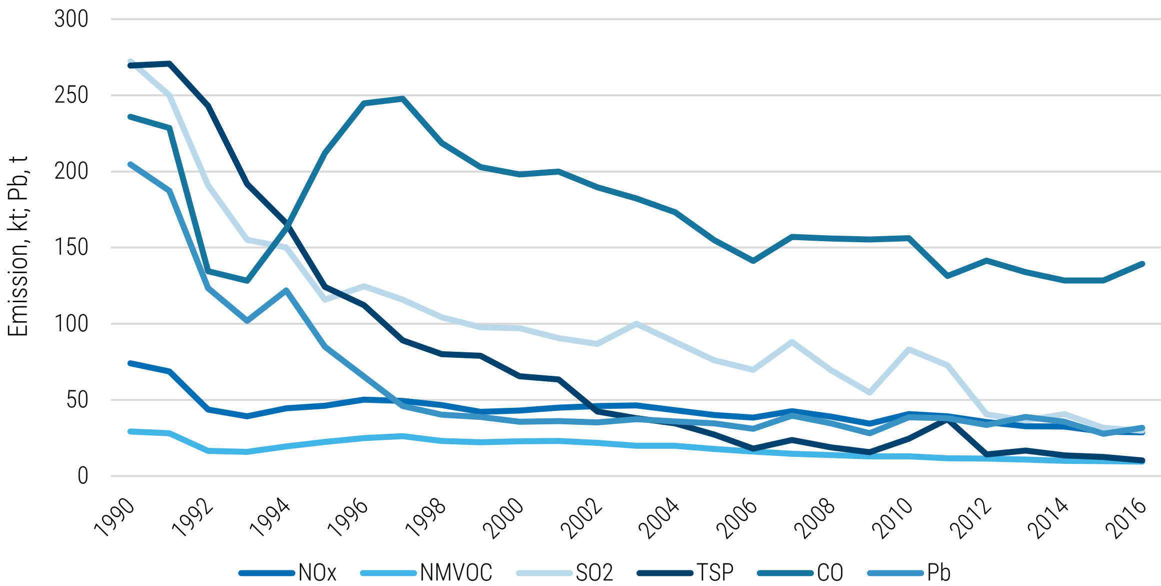

Figure 3.4 Pollutant emissions from the energy industry in the period of 1990-2016

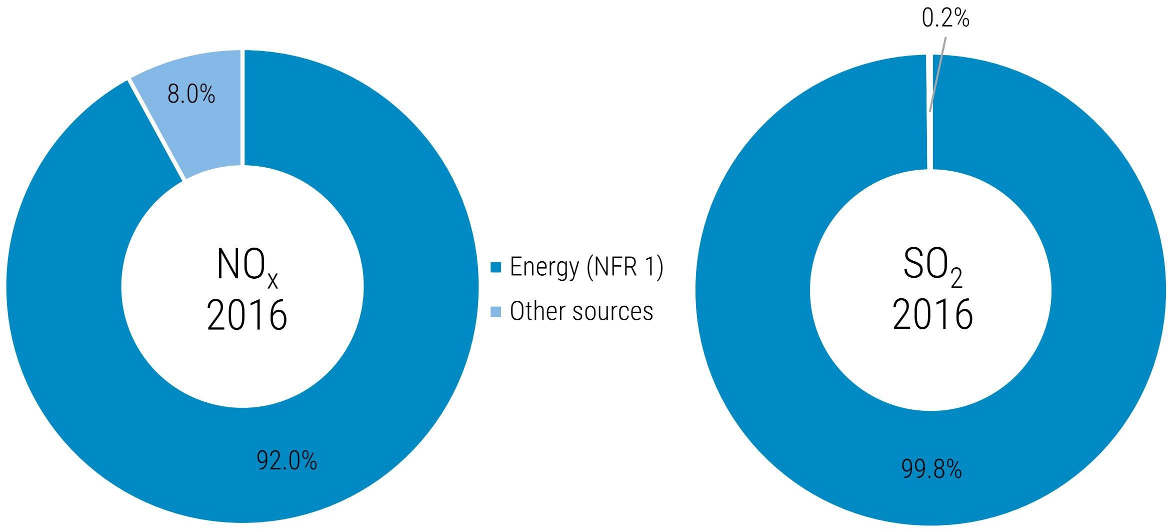

Figure 3.5 Share of SO_2 and NO_x emissions from the energy sector in total emissions in 2016

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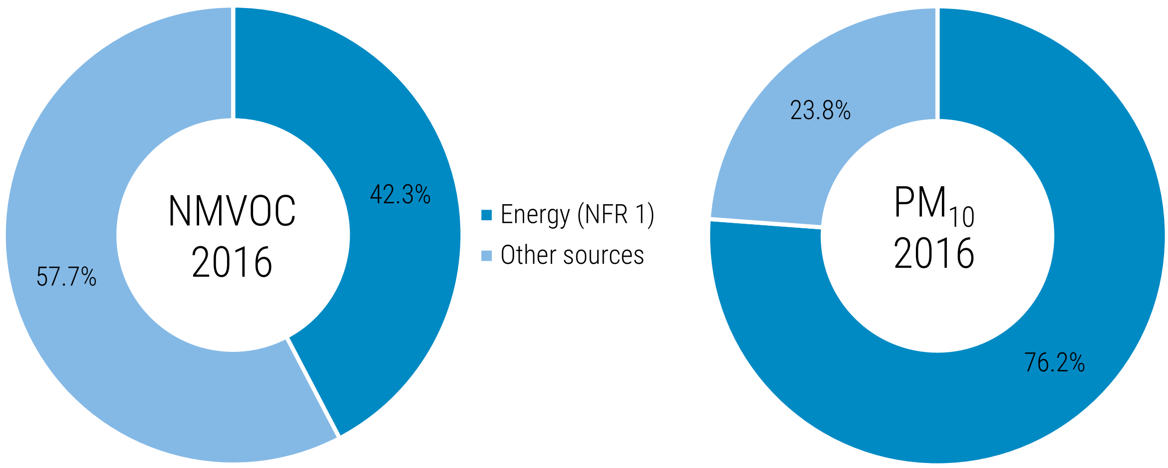

Figure 3.6 Share of NMVOC and PM_{10} emissions from the energy sector in total emissions in 2016

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 SO2 emissions – 99.6% in 2016. The share of mobile sources of the total emissions is very small – 0.2% (Figure 3.8 and 3.9, includes in other sources).

The stationary fuel combustion sector is a key source for all pollutants except ammonia. Pollutant emissions in the 1990-2016 period and the distribution of emissions between stationary combustion and other sectors are presented in the Table 3.3 and Figures 3.7 – 3.9.

3.2.1.1. Source Category Description

Sources category description are presented in the Table 3.2.

Table 3.2 Stationary fuel combustion activities

NFR	Source	Description	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, HM, PCDD/F, PAHs, HCB, PCB
	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, HM, PCDD/F, PAHs, HCB, PCB
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

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NFR	Source	Description	Emissions reported
	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, 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, HM
	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, HM
	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, HM, PCDD/F, PAHs, HCB, PCB
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, HM, PCDD/F, PAHs, HCB, PCB
	bi Residential: Stationary	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, HM, PCDD/F, PAHs, HCB, PCB
	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, HM, PCDD/F, PAHs, HCB, PCB
1A5a	Other stationary (including military)		IE, reported under 1A4ai

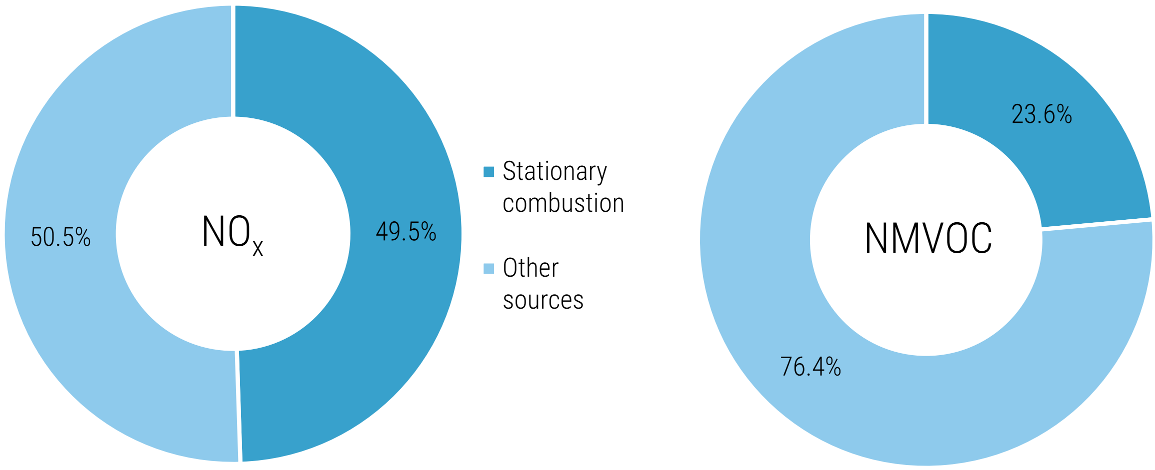

Figure 3.7 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2016

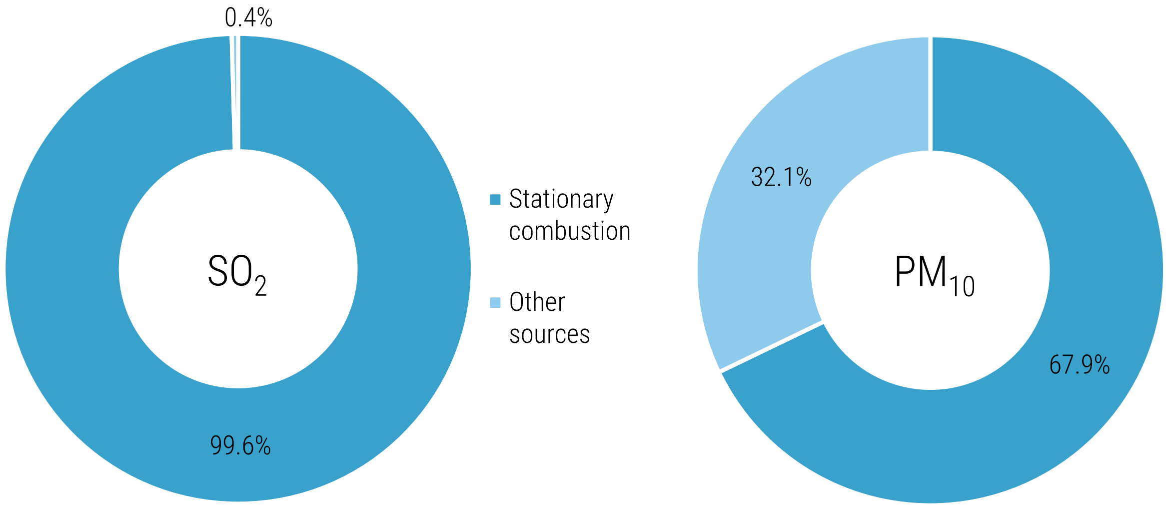

Figure 3.8 SO_2 and PM_{10} emissions from stationary fuel combustion and other sources in 2016

Table 3.3 Pollutant emissions from stationary fuel combustion in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	36.062	6.811	265.480	0.408	NR	NR	NR	267.731	86.444	126.479
1995	26.435	9.087	112.073	0.989	NR	NR	NR	123.138	145.675	60.376
2000	23.680	7.372	93.898	0.881	13.637	28.657	2.944	64.309	125.786	30.670
2005	20.682	7.061	75.716	0.852	12.254	17.656	2.921	25.966	110.369	32.476
2006	18.942	6.181	69.445	0.694	7.790	11.207	1.963	16.655	97.363	29.651
2007	23.539	6.681	87.691	0.775	10.765	17.737	2.444	22.339	115.783	38.140
2008	21.904	7.072	69.184	0.821	10.009	13.899	2.588	17.536	121.604	33.142
2009	19.324	6.555	54.679	0.759	8.169	11.557	2.128	14.507	123.709	26.616
2010	24.323	6.839	83.100	0.799	12.482	19.780	2.720	23.207	127.343	37.981
2011	23.691	5.888	72.538	0.673	16.899	30.949	3.075	36.002	106.270	37.456
2012	20.381	5.834	40.438	0.673	6.898	9.586	1.731	12.956	115.794	32.884

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
2013	18.819	6.081	36.370	0.708	9.445	13.683	2.114	15.614	112.701	38.344
2014	17.959	5.679	40.720	0.732	6.611	9.613	1.561	12.418	108.585	35.490
2015	14.509	5.539	31.666	0.919	7.894	9.649	2.072	11.322	109.845	27.502
2016	15.489	5.292	29.707	0.928	6.229	7.591	1.735	9.131	117.959	31.442
Trend 1990-2016, %	-57.0	-22.3	-88.8	127.4	-54.3	-73.5	-41.1	-96.6	36.5	-75.1

Table 3.3 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	4.444	1.113	18.844	18.263	7.281	27.274	104.245	8.102	6.938	0.177	8.314
1995	2.126	0.593	10.076	9.881	3.586	10.437	62.506	9.980	4.522	0.312	4.060
2000	0.723	0.502	8.575	8.266	2.146	6.425	48.300	8.495	3.643	0.293	2.558
2005	0.721	0.521	9.220	8.906	2.406	6.342	51.332	7.643	2.879	0.278	3.697
2006	0.700	0.522	8.597	8.286	2.163	5.683	46.740	6.481	2.718	0.247	3.018
2007	0.866	0.649	11.067	10.607	2.713	6.662	59.694	6.747	4.299	0.307	1.782
2008	0.797	0.569	9.405	9.132	2.339	5.816	53.027	7.066	4.359	0.324	2.779
2009	0.676	0.437	7.598	7.394	1.923	4.783	44.440	7.470	3.768	0.299	3.037
2010	0.870	0.626	10.962	10.398	2.672	6.530	60.523	8.290	4.647	0.340	4.157
2011	0.829	0.627	10.879	10.214	2.606	6.356	58.522	7.006	4.580	0.306	3.600
2012	0.764	0.549	9.595	9.046	2.306	5.585	52.737	7.076	3.162	0.322	3.462
2013	0.936	0.658	11.234	10.453	2.653	6.446	60.290	7.082	2.238	0.328	3.921
2014	0.867	0.649	10.242	9.715	2.553	5.970	55.096	7.042	2.452	0.272	4.202
2015	0.716	0.510	7.741	7.472	1.981	4.592	44.531	6.960	2.310	0.271	4.212
2016	0.778	0.577	8.977	8.549	2.255	5.265	50.134	6.892	2.185	0.275	4.168
Trend 1990-2016, %	-82.5	-48.2	-52.4	-53.2	-69.0	-80.7	-51.9	-14.9	-68.5	55.4	-49.9

The energy industry sector is responsible for the about 81% of total SO_2 emissions, 27% of NO_x, 26% of PM_{10}, and 93% 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 5.4% of the fuel used 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.

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

The oil shale power plants contribute about 68.5% 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.

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

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

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

2016 was the fourth year when we used waste as fuel for heat and power cogeneration. We can save approximately 70 million m^3 of natural gas by producing 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 2016, 247.9 tonnes of mixed municipal waste was used to produce heat and electricity. The mixed municipal waste used in Iru plant is mostly local, but the power plant is also providing environment friendly waste management services to Irish and Finnish cooperation partners. Heat generated by Iru power plant is provided to the inhabitants of Maardu and Tallinn at prices that are up to 25% lower than before. Iru waste-to-energy unit impacts every single inhabitant in Estonia since the waste management in Iru is approximately twice cheaper than landfilling. The launching of waste-to-energy unit can be seen as a nation-wide environmental project: the Estonian waste management became environmentally friendlier and the large-scale landfilling in the country has ended.[3]

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

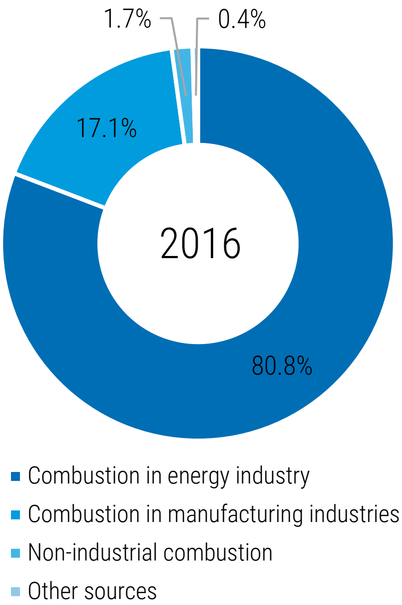

Figure 3.9 SO_2 emissions by sources of pollution in 2016

Non-industrial combustion is responsible for about 66% of the total NMVOC and 60% of CO emissions in stationary combustion, for approximately 1.7% of SO_2 and 38% of TSP emissions (Figures 3.10–3.14). Combustion in energy and transformation industries accounts for 81% of SO_2, for 41.5% of TSP and for the 35.6% of CO emissions in stationary combustion (the main part of carbon monoxide is emitted from shale oil production plant) (Figures 3.10, 3.12, 3.13, 3.14).

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

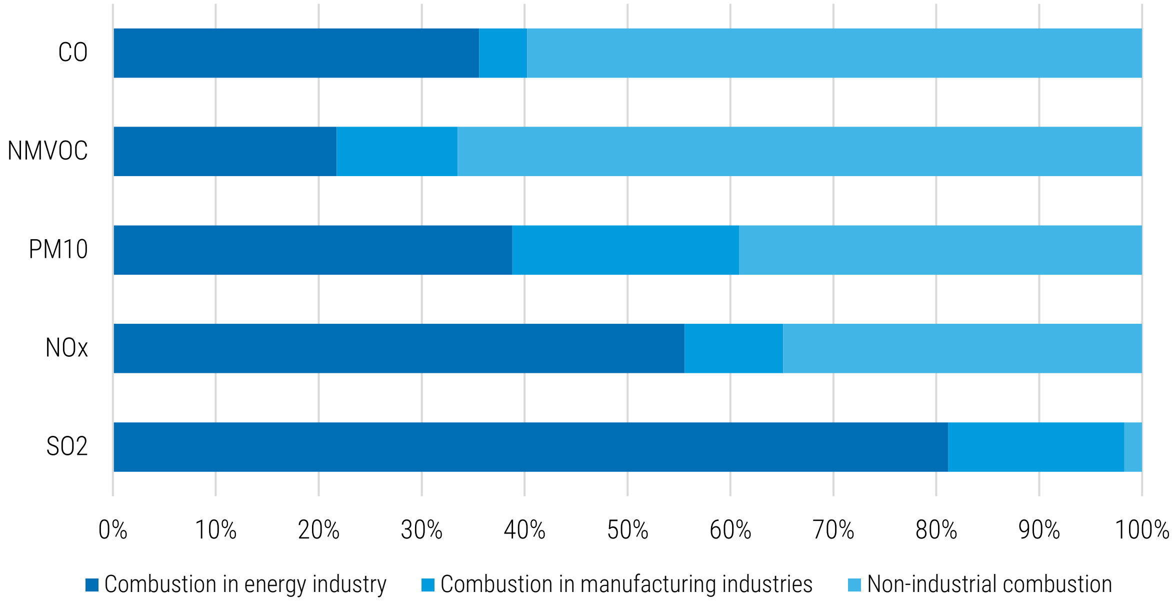

Figure 3.10 Distribution of pollutant emissions by sector in stationary combustion in 2016

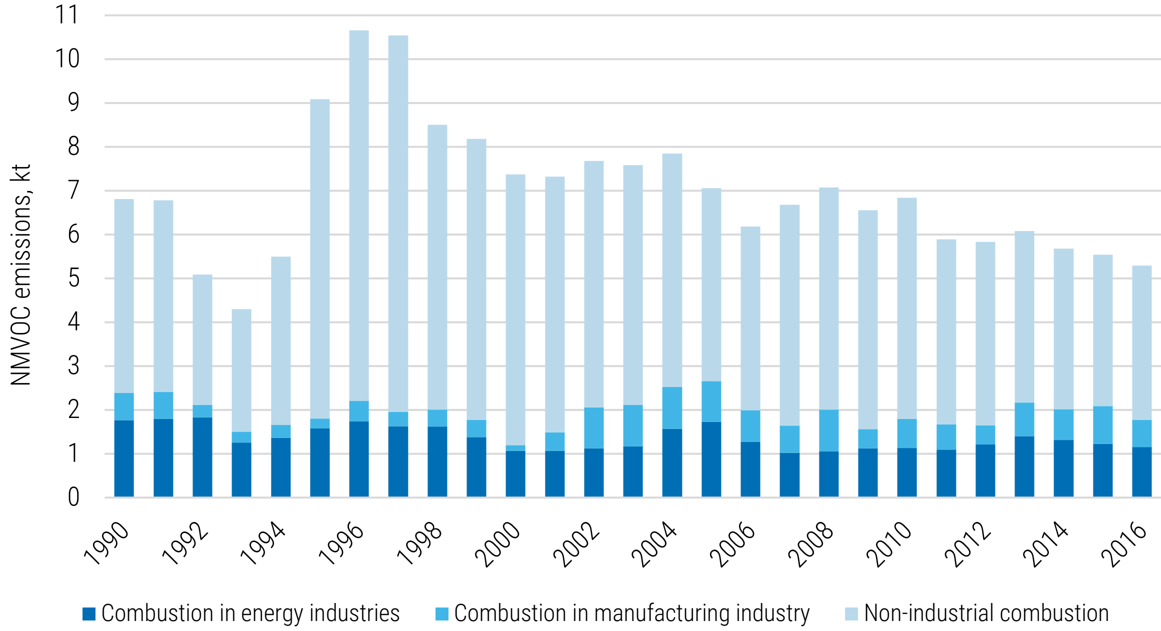

Figure 3.11 Distribution of NMVOC emissions by sector in stationary combustion in the period of 1990–2016

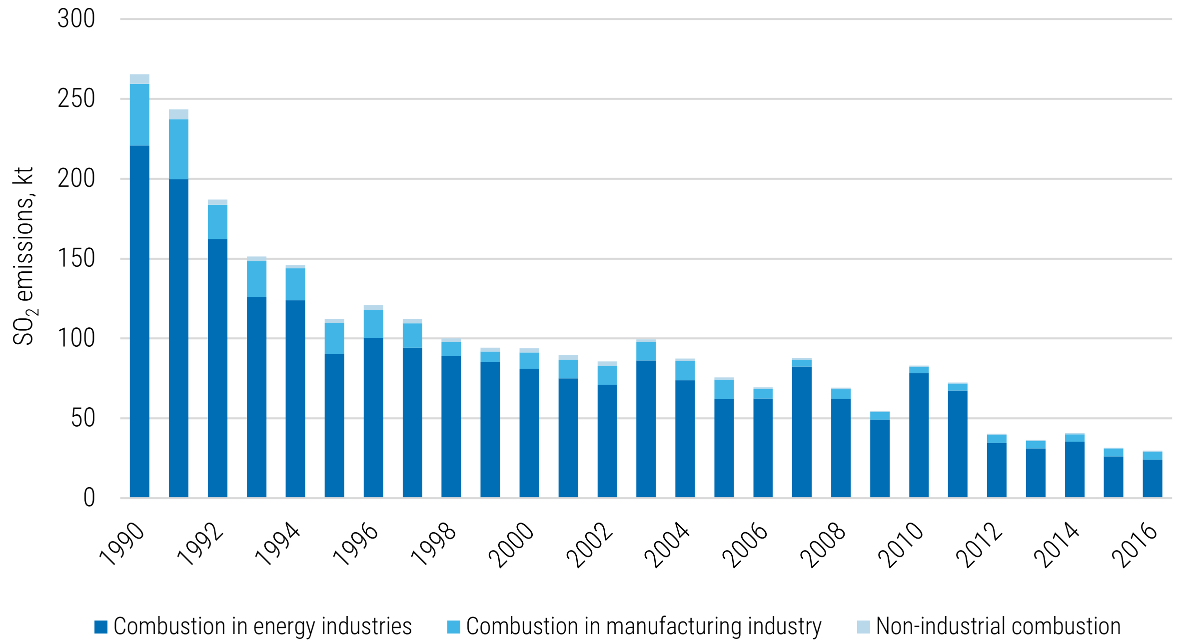

Figure 3.12 Distribution of SO_2 emissions by sector in stationary combustion in the period of 1990–2016

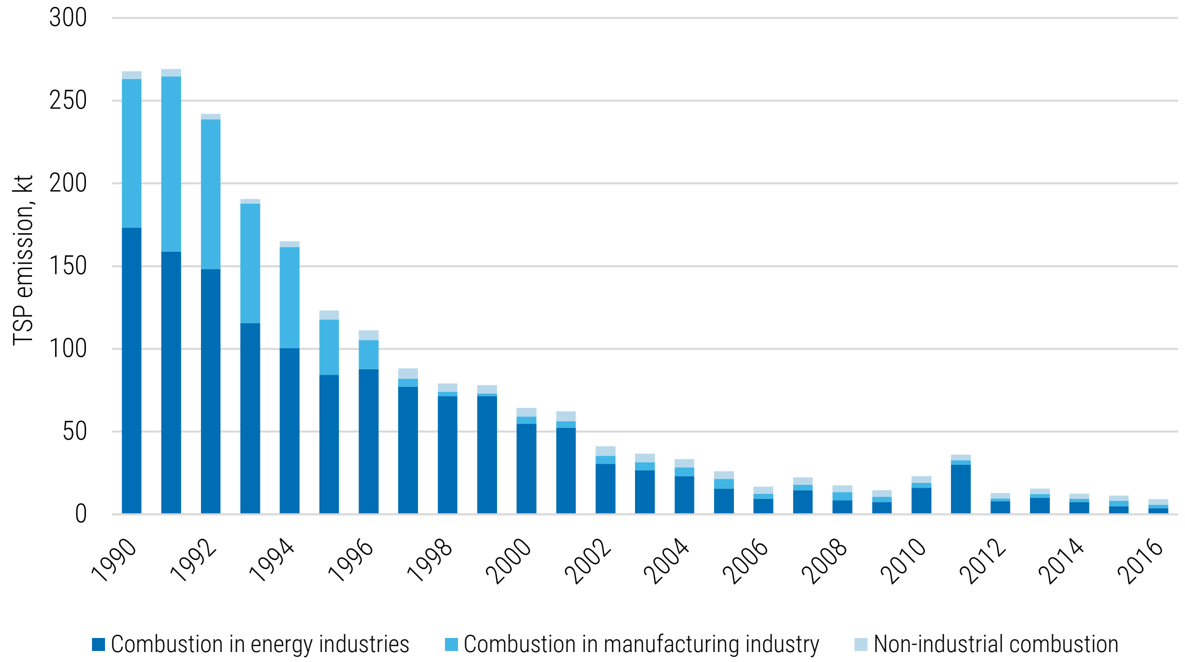

Figure 3.13 Distribution of TSP emissions by sector in stationary combustion in the period of 1990–2016

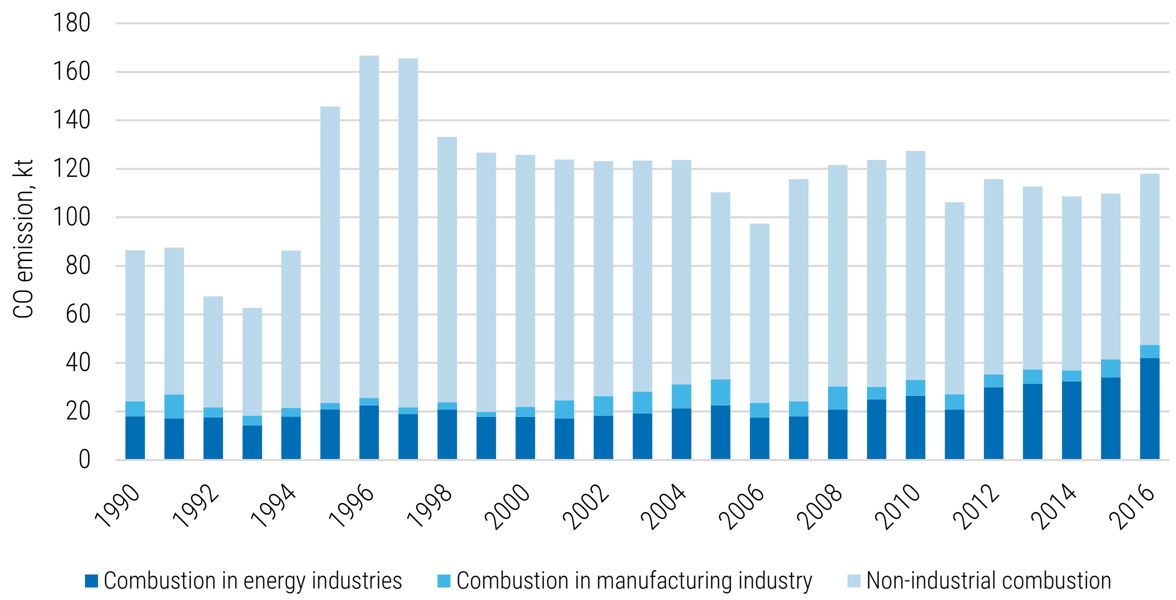

Figure 3.14 Distribution of CO emissions by sector in stationary combustion in the period of 1990–2016

3.2.1.2. Uncertainty

An uncertainty analysis was carried out to the year 2015 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, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	14.509	kt	47.20	9.09%	2.32%
NMVOC	5.539	kt	24.17	7.51%	1.96%
SO_x	31.644	kt	99.49	8.11%	0.27%
NH_3	0.537	kt	4.61	2.95%	0.79%
$PM_{2.5}$	7.775	kt	84.96	9.27%	4.15%
PM_{10}	9.643	kt	68.85	8.86%	3.88%
TSP	11.317	kt	53.75	5.80%	0.69%
CO	109.845	kt	85.76	11.51%	4.97%
Pb	27.502	t	96.73	183.89%	17.30%
Cd	0.716	t	95.82	134.42%	18.16%
Hg	0.509	t	93.87	182.24%	4.71%
PCDD/F	2.310	g I-TEQ	55.89	67.27%	37.65%
B(a)p	2.014	t	99.23	92.37%	52.96%
B(b)f	2.303	t	98.96	101.64%	65.61%
B(k)f	1.162	t	98.77	86.74%	44.02%
I(1,2,3-cd)p	1.481	t	99.29	81.46%	44.71%
HCB	0.271	kg	97.18	89.25%	95.09%
PCB	2.915	kg	68.86	103.49%	6.10%

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

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.

The energy and transformation industries sector is responsible for about 81% of total SO_2 emissions, 27% of NO_x, 26% of PM_{10}, 30% of CO, and 93% 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 1990-2016 period, emissions of SO_2 decreased by 89% and NO_x emissions by 66.6%, 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.

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 2016, SO_2 emissions had decreased by about 8.2% compared to 2015's figures. The main reason for the reduction of emissions is the conservation of one of the power plants in Ida-Virumaa, which used as its main source of fuel generator and coke oven gas (the facility worked for only half a month at a time and the reduction in emissions amounted to about four thousand tons). Emissions of NO_x had increased by about 10% due to a growth in electricity production. Emissions of heavy metals have increased (Pb by 15%) for the same reason.

Table 3.6 Pollutant emissions from energy in the period of 1990-2016

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	63.120
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	12.400	1.726	62.090	0.180	4.486	8.956	0.515	15.516	22.460	30.740
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	12.210	1.208	34.663	0.119	2.860	5.308	0.325	7.864	30.005	31.826
2013	10.648	1.398	31.131	0.156	4.787	8.695	0.576	10.007	31.490	37.211
2014	10.453	1.314	35.491	0.213	2.893	5.615	0.327	7.476	32.402	34.333
2015	7.831	1.229	26.270	0.348	2.579	4.020	0.382	4.887	34.127	26.141
2016	8.604	1.150	24.112	0.398	1.982	2.947	0.385	3.788	41.976	30.274
Trend 1990-2016, %	-66.5	-34.8	-89.1	394.3	-74.1	-86.2	-57.0	-97.8	132.9	-52.0

Table 3.6 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	1.130	1.014	18.304	17.450	4.650	20.300	84.890	2.000	2.330	0.020	5.244
1995	0.620	0.551	9.972	9.460	2.500	7.550	48.000	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	0.530	0.506	9.152	8.180	2.225	5.630	42.340	1.630	0.560	0.030	1.811
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
Trend 1990-2016, %	-51.5	-44.6	-51.4	-54.4	-54.7	-75.2	-52.0	38.8	-55.8	289.8	-43.5

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%, Ar = 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) (Table 3.7).

Table 3.7 Block No. 8 of the Eesti PP and old PF Blocks. CFBC unit parameters (Hotta *et. al*[4])

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 3.15). 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.

[4] Hotta, A.; Parkkonen, R.; Hiltunen, M.; Arro, H.; Loosaar, J.; Parve, T.; Pihu, T.; Prikk, A.; Tiikma, T (2005). Experience of Estonian oil shale combustion based on CFB technology at Narva Power Plants. Oil Shale, 22 (4), 381–397.

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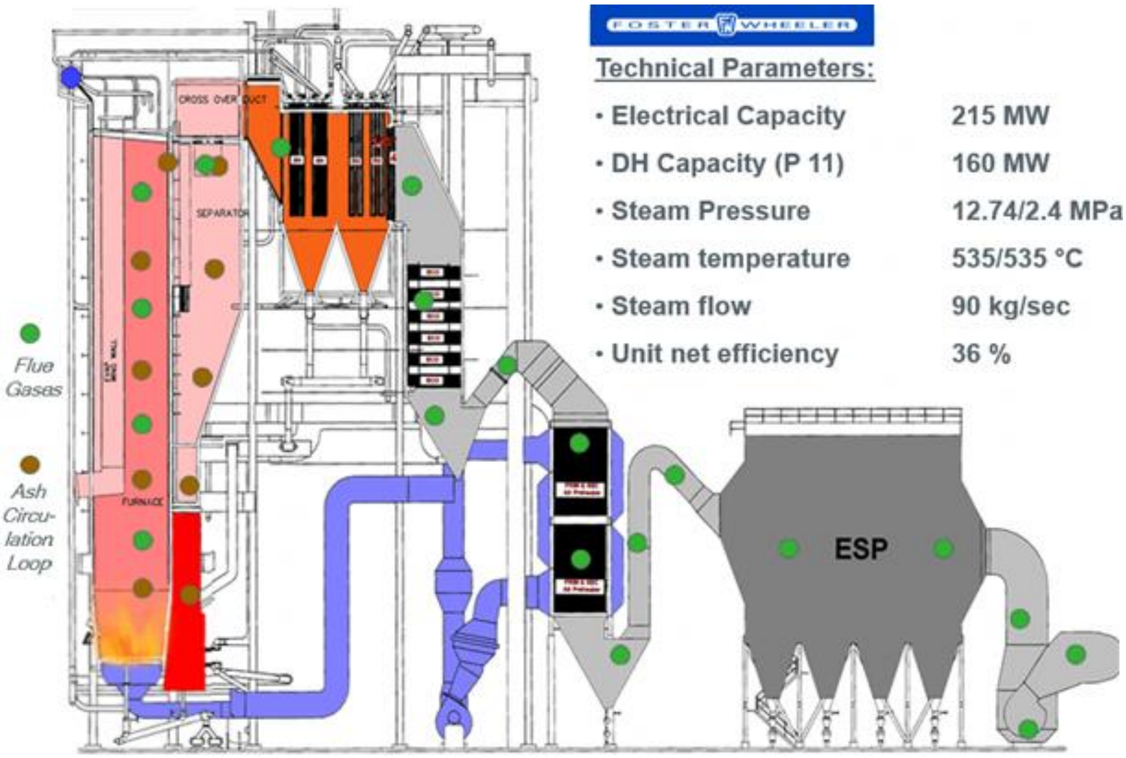

Figure 3.15 Existing EOS CFBC boiler drawing

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*[5], Plamus *et. al*[6]) 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.

[5] Konist, A; Pihu, T; Neshumayev, D; Külaots, I (2013). Low-grade fuel–oil shale and biomass co-combustion in CFB boiler. Oil Shale, 30, 294–304, 10.3176/oil.2013.2S.09.

[6] Plamus, K.; Soosaar, S.; Ots, A.; Neshumayev, D. (2011). Firing Estonian oil shale of higher quality in CFB boilers – environmental and economic impact. Oil Shale, 28, 113–126, 10.3176/oil.2011.1S.04.

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

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

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

The second technology of processing is fine-grained oil shale with solid heat carrier (SHC). The Solid Heat Carrier Plant (SHCP) is designed for the thermal decomposition (pyrolysis) of fine-grained technological oil shale, with the objective of producing shale oils, gas with high calorific value, and high-pressure steam. The oil shale pyrolysis process is effected in a drum rotating reactor in the absence of air, at a temperature of 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 (in the right on the photo) 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 a factor of three. In 2016 production figures remained approximately at the level of 2015 (Figure 3.16, 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 71% in 2016 in comparison with 2010). In 2016, a total of 63% of shale oil was produced with the use of new SHC technologies.

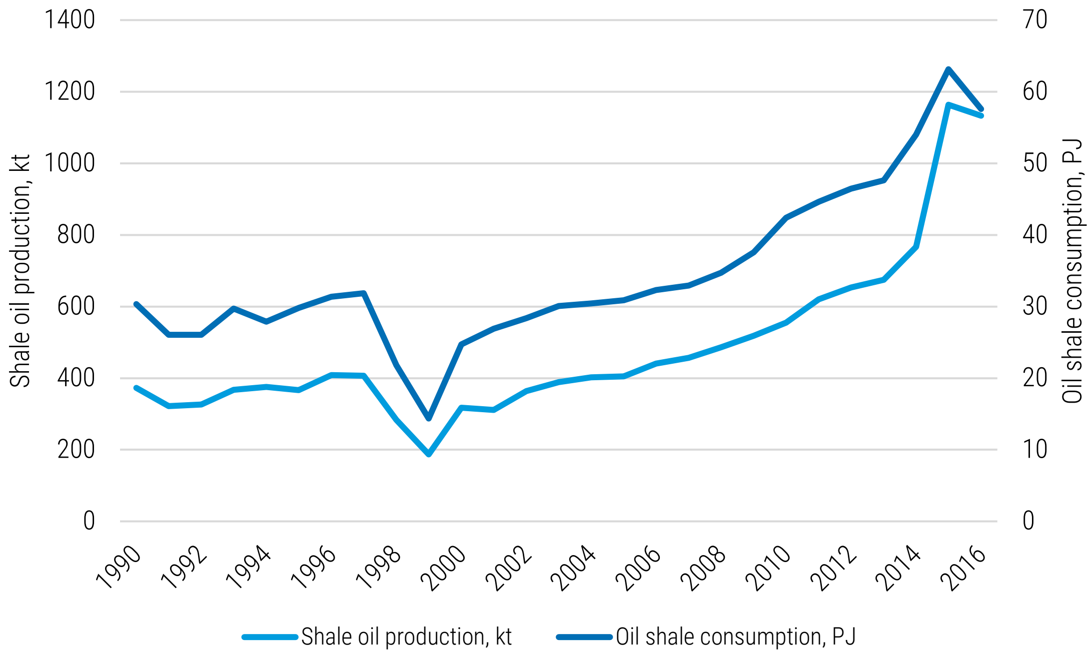

Figure 3.16 Shale oil production and oil shale consumption in the period 1990-2016

3.2.2.2. Methodological Issues

According to national legislation, all operators with boiler capacity from 0.3 MW 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 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".

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 are obliged to carry out continuous monitoring.

Within the framework of the 2017 Comprehensive Technical Review of National Emission Inventories under the NEC Directive, the TERT noted that in case when continuously measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED and have used validated average values (after having subtracted the value of the confidence interval) although this subtraction must not be applied in the context of reporting annual emissions. In the opinion of the TERT, bottom-up data based on the "validated average values" defined in the IED cannot be used by the inventory team without an adjustment in the framework of a national inventory. The TERT notes that this issue relates to an underestimate, which could correspond to 20% of SO_2, 20% of NO_x, 30% of dust of the sector (depending on the fraction of the operators subtracting confidence interval). The TERT recommends that Estonia organise a survey among operators to identify whether any are reporting emissions on the basis of the validated average values and try to derive a methodology to adjust the national emissions over the time series in order to compensate for any under reporting.

Estonia has organised a survey amongst its operators in order to be able to understand whether any operator is reporting emissions on the basis of the validated average values. Our investigation shows that in Estonia there is one operator (covering three facilities) who is using validated average values for reporting emissions. We have contacted the operator in question and are in the process of carrying out negotiations. Unfortunately, at this stage we don't have enough information to identify the real value of any underestimation of emissions. We will make correction to the inventory as soon as we have received the necessary information from the operator.

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 2004 (Tables 3.9–3.13).

The SO_2 emissions are calculated by the formula:

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

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

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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
Heavy fuel oil	100				100		
Oil shale oil	100				100		
Light fuel oil	100				100		

Table 3.10 NO_x emission factors for boilers (g/GJ)

Fuel	P < 10 MW_{th}				50 MW_{th} > P > 10 MW_{th}	
	Burner	Extended furnace	Grate-fired furnace	Fluidized	Burner	Fluidized
Coal		200	200			
Oil shale					150	
Peat		300	300	300		300
Wood		100	100	100	100	100
Heavy fuel oil	200				250	
Oil shale oil	150				200	
Light fuel oil	100					
Gas	60				100	

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

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

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

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

Table 3.13 Heavy metal 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

Fuel /purification equipment	Heavy metals EFs							
	Hg	Cd	Pb	Cu	Zn	As	Cr	Ni
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 factors 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

Table 3.15 POPs emission factors

Fuel	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PCB	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

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 new EMEP/EEA Guidebook 2016 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.

In this year's submission, ammonia emissions were calculated from biomass combustion for the whole period between 1990-2016 by using the default EMEP/EEA 2016 Guidebook emissions factor. It should be noted that emissions are calculated for boilers with a capacity less than 50 MW. In addition, calculated particulates, heavy metals, and PAHs from natural gas consumption were included.

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

Table 3.16 NFR 1A1a pollutants IEF, g/total fuels GJ

Year	SO_2	NO_x	TSP	$PM_{2.5}$
1990	753.5	87.8	590.8	
1995	640.9	99.9	595.4	
2000	666.8	104.4	445.2	61.6
2005	474.7	94.6	113.4	32.8
2006	503.8	87.0	70.3	20.9
2007	551.4	92.6	92.2	36.5
2008	477.9	92.5	61.5	24.8
2009	432.9	92.0	58.4	25.8
2010	506.7	96.6	96.2	41.4
2011	428.5	95.4	189.2	75.8
2012	205.1	73.2	44.4	16.2
2013	171.3	59.0	54.6	26.4
2014	234.3	69.4	47.4	18.5
2015	208.1	63.4	38.0	20.6
2016	168.6	61.6	24.8	14.6

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 (Figure 3.17).

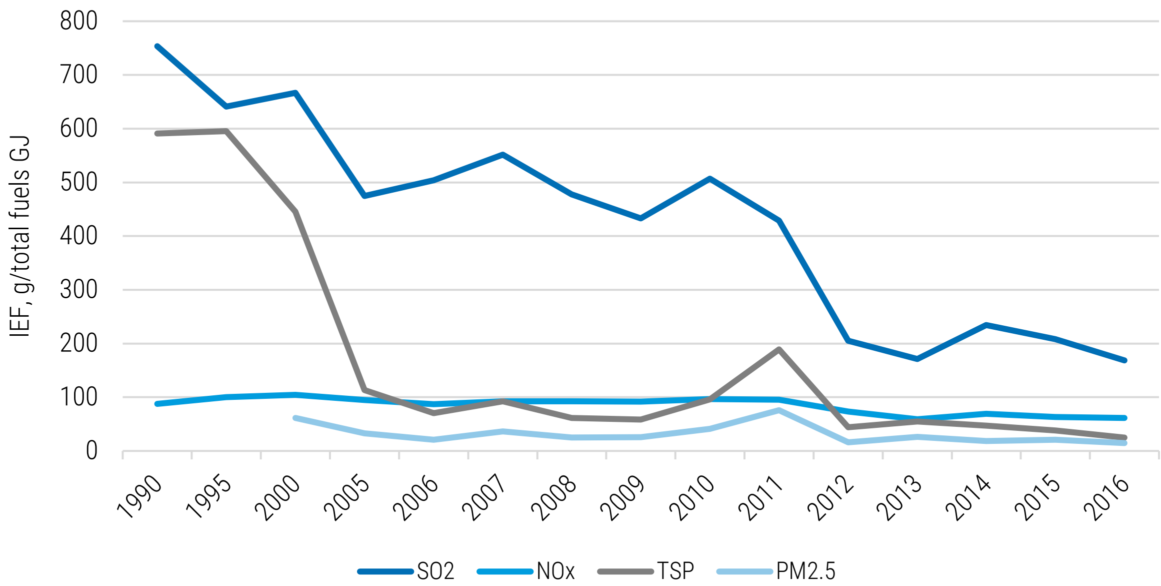

Figure 3.17 Implied emission factors for NFR 1A1a

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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 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".

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 3.17 and Figure 3.18. The consumption of all fuels by this sector with the exception of biomass (mainly wood and wood waste) has decreased across 1990-2016. 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) (Figure 3.19). 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 3.17 Fuel consumption in energy industries in the period of 1990–2016 (PJ)

Year	Liquid fuels	Solid fuels	Bio-mass	Gaseous fuels	Other fuels
1990	44.09	229.09	2.18	35.81	NA
1995	12.37	136.79	4.63	14.30	NA
2000	5.74	118.47	4.77	14.73	NA
2005	4.86	134.15	5.30	14.25	2.09
2006	2.31	130.08	3.64	15.25	4.80
2007	2.12	157.65	3.53	14.74	4.94
2008	2.29	134.31	3.49	13.69	5.45
2009	2.41	126.15	7.51	10.96	7.35
2010	3.25	163.89	10.79	12.41	6.65
2011	3.15	170.35	12.46	10.25	7.10
2012	3.17	147.64	14.04	10.28	29.08
2013	3.43	173.30	11.02	8.49	27.22
2014	2.31	169.70	12.29	7.84	8.83
2015	3.01	148.72	11.51	6.29	10.57
2016	2.63	110.72	13.74	7.43	2.32
Trend 1990-2016, %	-94.0	-51.7	530.4	-79.3	

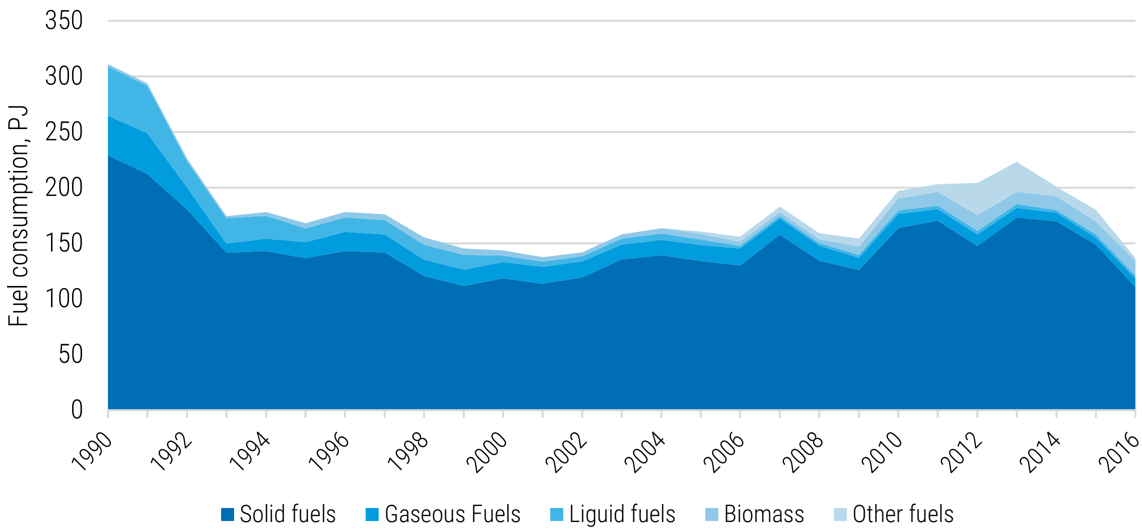

Figure 3.18 Fuel consumption by energy industries sector in the period 1990-2106

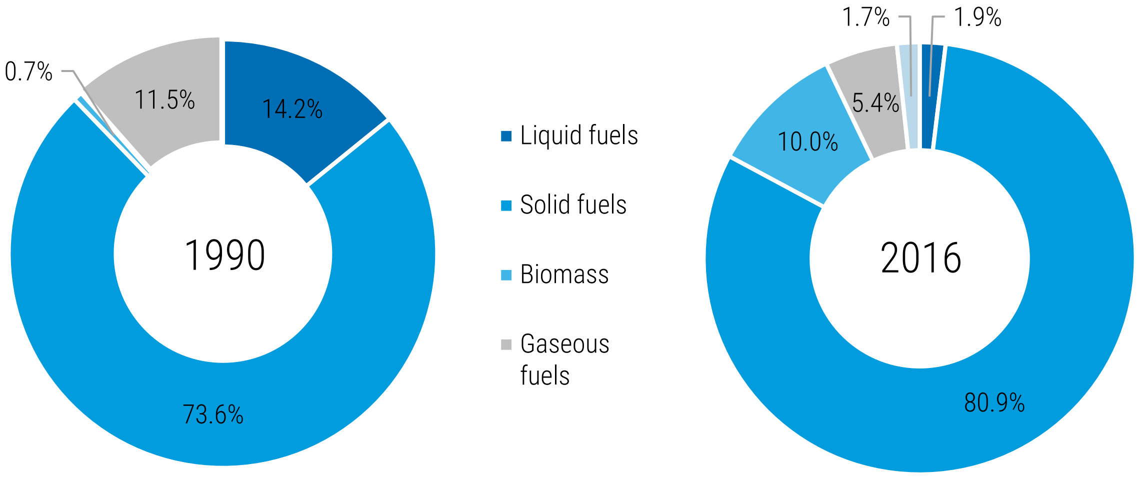

Figure 3.19 Distribution of fuel consumption in energy industries in 1990 and 2016

Table 3.18 Shale oil production in the period of 1990-2016, 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	
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	

Table 3.19 Oil shale consumption for oil shale production by different technologies, PJ[7]

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
1991	1.77	NO	NO	1.77	19.05	5.24	24.29	26.06
1992	2.57	NO	NO	2.57	18.22	5.26	23.48	26.05
1993	4.20	NO	NO	4.20	20.09	5.44	25.53	29.73
1994	4.75	NO	NO	4.75	18.14	5.00	23.14	27.89
1995	4.31	NO	NO	4.31	20.14	5.35	25.49	29.80
1996	4.58	NO	NO	4.58	21.42	5.37	26.79	31.37
1997	5.15	NO	NO	5.15	21.22	5.47	26.69	31.84
1998	4.35	NO	NO	4.35	13.14	4.34	17.48	21.83
1999	4.14	NO	NO	4.14	9.75	0.47	10.22	14.36
2000	5.86	NO	NO	5.86	13.57	5.30	18.87	24.73
2001	6.24	NO	NO	6.24	15.38	5.29	20.67	26.91
2002	6.74	NO	NO	6.74	16.13	5.52	21.65	28.39
2003	7.66	NO	NO	7.66	16.93	5.49	22.42	30.08
2004	8.13	NO	NO	8.13	17.63	4.69	22.32	30.45
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

[7] Greenhouse Gas Emissions in Estonia 1990-2016, National Inventory Report Submissions to the European Commission, Tallinn 2018

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Year	Solid Heat Carrier (SHC)			Total	Gas generators (GGS)		Total	Total
	Narva	VKG Oil	Kiviõli	SHC	VKG	Kiviõli	GGS	Oil shale
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

3.2.2.3. Uncertainty

An uncertainty analysis for the stationary combustion sector alone (NFR 1A1, 1A2, and 1A4) was carried out upon the 2015 inventory (Chapter 3.2.1.2). The uncertainty analysis for each NFR sector will be provided for the following year's submission.

3.2.2.4. Source-Specific QA/QC and Verification

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

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

The data on fuel consumption are then summarised by SNAP codes and compared to the statistical energy balance data. There are difficulties in comparing the consumption of fuel in activities. The principle of a database is that, for example, the industrial boiler is designated SNAP 03, irrespective of whether the heat is sold or is used for its own needs.

3.2.2.5. Recalculations

In the 2018 submission the following recalculations were carried out:

- Calculated ammonia emissions from biomass combustion for 1990-2015;
- Calculated emissions of TSP, PM_{10}, $PM_{2.5}$, HMs and PAHs from natural gas combustion for 1990-2016;
- Recalculated NMVOC emission for NFR 1A1c.

3.2.2.6. Source-Specific Planned Improvements

- Correction of activity data for the period 1990-2015 (fuel groups);
- Recalculation of POPs emissions.

3.2.3. Manufacturing industries and construction (NFR 1A2)

This sector is a key source of SO_2 (16%), NMVOC (2.5%), TSP (9.5%), PM_{10} (12.6%), $PM_{2.5}$ (16.2%) and dioxins (6.2%).

Emissions of all pollutants from the NFR 1A2 sector have decreased across 1990-2016, with the exception of NMVOC, ammonia, and PAHs, which can mainly be explained by the increase in biomass combustion (Table 3.21). 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 of NMVOC, CO, particulates, heavy metals, and POPs in 2016 in comparison with 2015 is explained by a decrease in the consumption of wood and an increase in the share of natural gas.

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 3.20.

Table 3.20 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 EFs
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 EFs

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 7 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 7 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 14 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 53 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. 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 NFR 1A2a-e, 1A2f), other processes with contact: other productions (SNAP 0301, 030326). Data are from point and diffuse sources. Emissions from the point sources are calculated on the basis of measurements, national emission factors, or the combined method (measurements plus calculations) is used. Emissions of the main pollutants and heavy metals from diffuse sources are calculated on the basis of national emission factors and POPs on the basis of the EMEP/EEA Guidebook.

Table 3.21 Pollutant emissions from combustion in manufacturing industries in the period of 1990-2016

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	10.100	0.055	1.662	2.679	0.426	4.506	4.050	0.780
2005	2.140	0.930	12.170	0.226	4.312	4.892	1.167	5.842	10.720	0.950
2006	2.130	0.720	6.020	0.133	1.591	2.091	0.427	3.001	6.070	0.570
2007	2.060	0.620	4.390	0.102	1.432	1.902	0.385	3.132	6.220	0.690
2008	2.330	0.943	6.029	0.174	3.213	3.778	0.872	4.947	9.419	1.454
2009	1.337	0.435	4.840	0.096	1.587	2.176	0.432	3.077	5.241	0.849
2010	1.621	0.659	4.136	0.133	2.140	2.506	0.584	3.157	6.573	0.852
2011	2.397	0.576	4.445	0.138	1.995	2.290	0.531	2.686	6.293	0.699
2012	1.871	0.437	5.097	0.129	1.226	1.327	0.323	1.767	5.334	0.467
2013	2.357	0.769	4.569	0.154	1.787	1.978	0.473	2.279	5.776	0.525
2014	1.973	0.700	4.608	0.132	1.134	1.282	0.303	1.900	4.427	0.603
2015	1.405	0.856	4.915	0.209	2.723	2.906	0.773	3.401	7.417	0.809
2016	1.481	0.623	5.088	0.160	1.461	1.670	0.393	1.898	5.507	0.515
Trend 1990-2016, %	**-73.5**	**0.5**	**-86.8**	**1 577.6**	**-12.1**	**-37.7**	**-7.6**	**-97.9**	**-10.9**	**-99.2**

Table 3.21 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	3.230	0.080	0.500	0.530	2.470	6.070	15.390	0.741	1.440	0.064	2.000
1995	1.310	0.030	0.080	0.049	0.962	2.429	6.514	0.213	0.920	0.046	1.030
2000	0.030	0.010	0.021	0.069	0.040	0.289	0.578	0.386	0.530	0.060	0.380
2005	0.020	0.002	0.031	0.289	0.062	0.379	2.080	1.356	0.670	0.091	1.460
2006	0.010	0.004	0.030	0.309	0.070	0.219	1.170	0.867	0.790	0.074	0.990

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Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
2007	0.030	0.021	0.061	0.360	0.120	0.239	0.788	0.683	0.930	0.094	0.440
2008	0.057	0.034	0.104	0.442	0.127	0.389	1.734	1.051	0.600	0.107	1.040
2009	0.021	0.006	0.085	0.271	0.100	0.285	0.847	0.658	0.171	0.049	0.670
2010	0.020	0.005	0.072	0.249	0.090	0.219	1.125	0.822	0.246	0.068	0.940
2011	0.014	0.004	0.054	0.169	0.062	0.164	0.869	0.847	0.222	0.077	0.835
2012	0.015	0.004	0.063	0.162	0.053	0.141	0.513	0.793	0.216	0.080	0.753
2013	0.018	0.003	0.055	0.169	0.048	0.120	0.814	0.904	0.259	0.078	0.886
2014	0.018	0.004	0.080	0.274	0.061	0.182	0.604	0.780	0.222	0.023	0.779
2015	0.022	0.004	0.059	0.236	0.037	0.163	1.415	1.168	0.314	0.035	1.145
2016	0.013	0.004	0.054	0.139	0.028	0.104	0.918	0.928	0.250	0.028	0.949
Trend 1990-2016, %	-99.6	-95.3	-89.2	-73.8	-98.9	-98.3	-94.0	25.2	-82.6	-55.8	-52.6

3.2.3.2. Methodological Issues

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

Diffuse sources Fuel = EB fuel – PS fuel

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

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

Implied emission factors (IEF) for some pollutants for sector 1A2 are presented in the Table 3.22.

The main impact on the IEF decrease in the period between 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 (Figure 3.20 and Table 3.23).

Table 3.22 NFR 1A2 pollutants IEF, g/total fuels GJ

	SO_2	NO_x	TSP	$PM_{2.5}$
1990	1359.6	197.7	3170.1	
1995	1463.3	175.5	2520.8	
2000	841.8	205.9	375.6	138.5
2005	632.9	111.3	303.8	224.3
2006	428.0	151.4	213.4	113.1
2007	246.1	115.5	175.6	80.3
2008	287.1	111.0	235.6	153.0
2009	305.9	84.5	194.4	100.3
2010	271.1	106.2	206.9	140.3
2011	300.8	162.3	181.8	135.0
2012	367.2	134.8	127.3	88.3
2013	315.4	162.7	157.3	123.4
2014	319.3	136.8	131.7	78.6
2015	368.3	105.2	254.9	204.0
2016	379.6	110.5	141.6	109.0

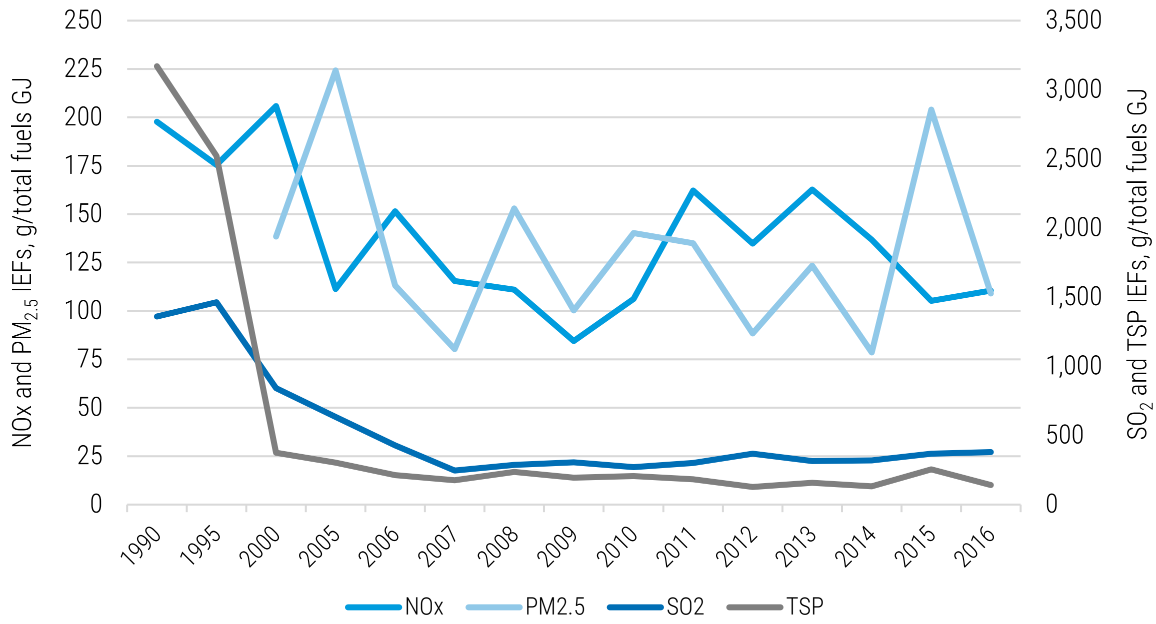

Figure 3.20 Implied emission factors for NFR 1A2

Details on fuel consumption by manufacturing industries are presented in the Table 3.23 and Figures 3.21 - 3.22.

Table 3.23 Fuel consumption by manufacturing industries in the period of 1990-2016

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	1.57	3.21	3.60	4.47	2.41
2011	2.04	3.85	3.74	4.39	0.75
2012	1.85	3.29	3.49	4.60	0.64
2013	1.06	4.26	4.15	4.33	0.69
2014	1.04	4.69	3.58	4.23	0.89
2015	0.95	2.31	5.64	3.54	0.91
2016	1.25	1.90	4.47	4.80	0.99
Trend 1990-2016, %	-93.5	-70.6	1 637.8	104.0	

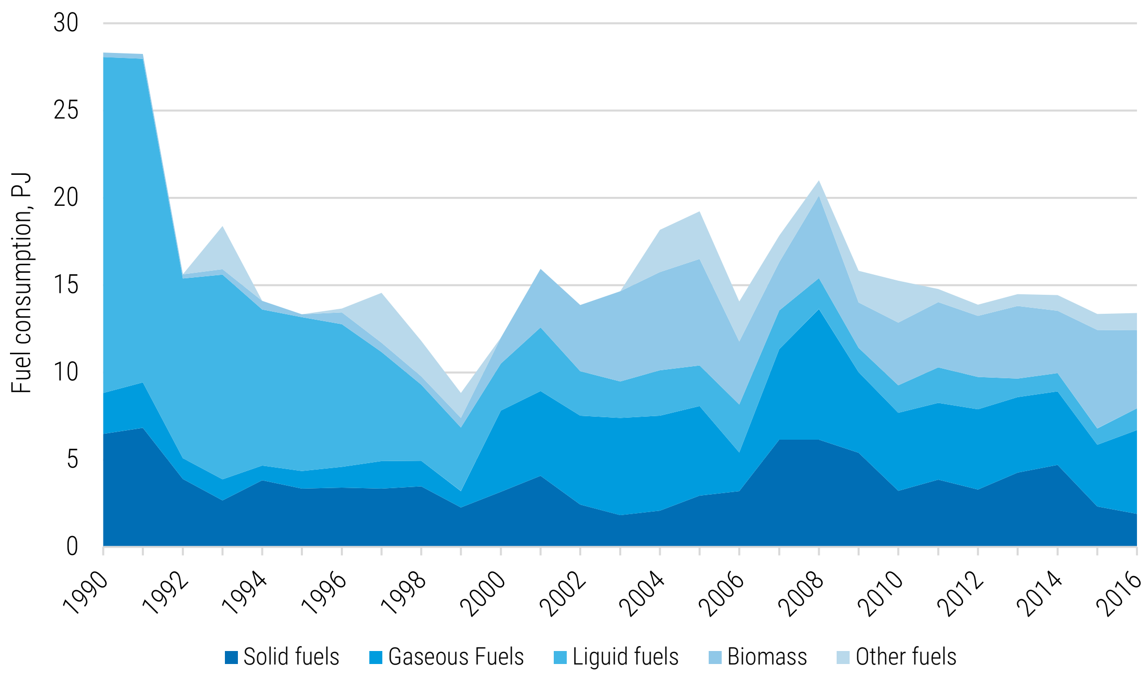

Figure 3.21 Fuel consumption by manufacturing industries in the period of 1990-2016

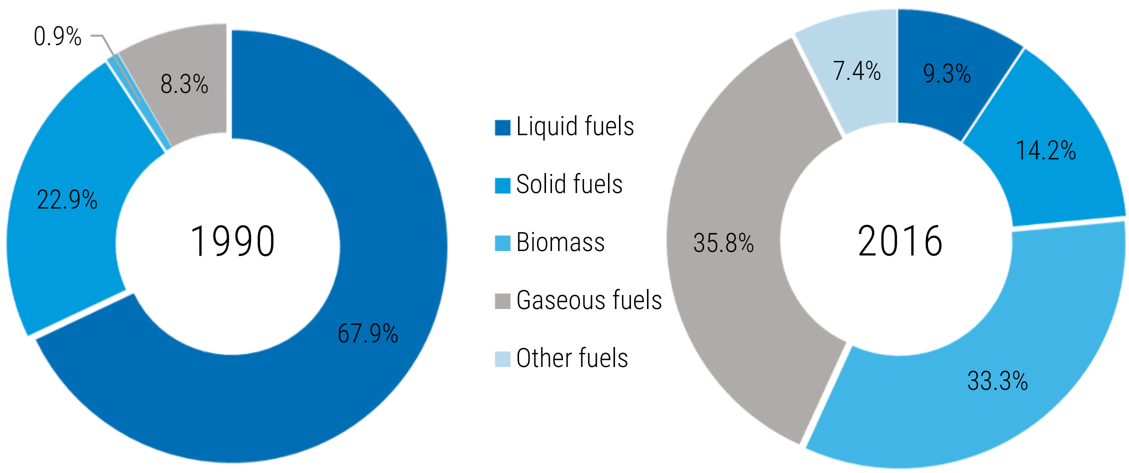

Figure 3.22 Distribution of fuel consumption in manufacturing industries in 1990 and 2016

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 2018 submission the following recalculations were carried out:

- Calculated ammonia emission from biomass combustion for 1990-2015;
- Calculated emissions of TSP, PM_{10}, $PM_{2.5}$, HMs and PAHs from natural gas combustion for 1990-2015.

3.2.3.5. Source-Specific Planned Improvements

- 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 NO_x, MNVOC, CO, particulates, HM 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 1990-2016 period, the emission of some pollutants from this sector have decreased, and some pollutants such as NO_x, CO, NH_3, Cd, Cr, Zn, and HCB, have increased due to an increase in wood combustion and higher wood emissions factors for these substance (Table 3.25).

Table 3.24 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 Estonian Statistics	National EF; Measurements; Default EMEP/EEA Guidebook EFs
1A4bi	Residential: Stationary	Tier 2	Energy balance of Estonian Statistics	National EF; Default EMEP/EEA Guidebook EFs
1A4ci	Agriculture/Forestry/Fishing: Stationary	Tier 1 / Tier 3	Fuel consumption reported by operators; Energy balance of Estonian Statistics	National EF; Measurements; Default EMEP/EEA Guidebook EFs

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 include pollutant emissions data from diffuse sources.

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Table 3.25 Pollutant emissions from combustion in non-industrial sector in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	4.772	4.428	6.090	0.318	NR	NR	NR	4.654	62.244	0.899
1995	10.015	7.282	2.293	0.811	NR	NR	NR	5.321	122.085	0.562
2000	8.430	6.178	2.688	0.649	4.309	4.581	1.623	5.106	103.946	0.700
2005	6.142	4.405	1.456	0.446	3.455	3.808	1.239	4.608	77.189	0.786
2006	5.922	4.190	1.085	0.433	3.432	3.690	1.224	4.247	73.843	0.681
2007	7.379	5.040	0.941	0.542	3.626	3.888	1.396	4.520	91.563	0.750
2008	7.276	5.068	0.869	0.522	3.398	3.606	1.324	4.111	91.368	0.673
2009	7.351	4.995	0.702	0.529	3.380	3.573	1.338	4.036	93.513	0.652
2010	7.420	5.048	0.750	0.523	3.491	3.676	1.359	4.141	94.296	0.713
2011	6.183	4.215	0.700	0.420	2.964	3.127	1.113	3.486	79.205	0.613
2012	6.301	4.189	0.679	0.425	2.812	2.951	1.083	3.326	80.455	0.590
2013	5.814	3.913	0.670	0.398	2.870	3.009	1.066	3.328	75.434	0.608
2014	5.532	3.666	0.622	0.387	2.585	2.716	0.932	3.042	71.756	0.554
2015	5.273	3.454	0.481	0.362	2.592	2.722	0.916	3.034	68.300	0.553
2016	5.404	3.519	0.507	0.370	2.785	2.974	0.957	3.446	70.476	0.652
Trend 1990-2016, %	13.3	-20.5	-91.7	16.4	-35.4	-35.1	-41.0	-26.0	13.2	-27.5

Table 3.25 continues

Year	Cd	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCCD/F	HCB	PCB
	t								g I-Teq	kg	
1990	0.084	0.019	0.039	0.283	0.161	0.904	3.964	5.361	3.168	0.093	1.071
1995	0.196	0.011	0.025	0.372	0.124	0.458	7.992	7.897	2.302	0.236	0.306
2000	0.188	0.015	0.023	0.387	0.136	0.496	7.632	6.739	2.303	0.204	0.479
2005	0.171	0.013	0.038	0.437	0.119	0.333	6.912	4.657	1.649	0.157	0.426
2006	0.170	0.012	0.035	0.367	0.129	0.154	6.810	4.334	1.478	0.152	0.481
2007	0.216	0.013	0.035	0.467	0.139	0.173	8.576	5.044	1.499	0.193	0.246
2008	0.217	0.014	0.027	0.435	0.130	0.128	8.717	4.949	1.495	0.196	0.325
2009	0.229	0.013	0.023	0.444	0.129	0.121	9.123	4.891	1.413	0.203	0.267
2010	0.236	0.013	0.026	0.469	0.137	0.131	9.476	4.833	1.424	0.204	0.349
2011	0.204	0.012	0.020	0.399	0.116	0.090	8.220	3.975	1.238	0.173	0.293
2012	0.215	0.012	0.021	0.410	0.122	0.082	8.614	3.980	1.239	0.182	0.208
2013	0.209	0.012	0.014	0.397	0.113	0.070	8.456	3.678	1.168	0.173	0.340
2014	0.217	0.015	0.019	0.389	0.110	0.066	8.157	3.505	1.103	0.171	0.299
2015	0.201	0.011	0.014	0.382	0.105	0.070	7.991	3.209	0.973	0.163	0.251
2016	0.216	0.011	0.023	0.447	0.119	0.118	8.510	3.187	0.905	0.169	0.254
Trend 1990-2016, %	157.3	-41.7	-41.3	58.1	-26.0	-86.9	114.7	-40.5	-71.4	80.9	-76.3

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 3.28. 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 2016 and these are presented in the Tables 3.26 and 3.27.

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*" (Table 3.29). Data on the amount of the burned waste were obtained on the basis of the Statistics Estonia questionnaire. Emissions are included in sector 1A4bi.

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 (Table 3.32). It might be considered that growing awareness and continuous notification concerning the quantities of waste incinerated will assist in its downward trend.

Table 3.26 Main pollutants emission factors for NFR 1A4bi (Tier 2 EMEP/EEA Guidebook 2016)

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
PCB	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

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})
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 3.27 HMs and PCB emission factors for wood combustion for NFR 1A4bi (EMEP/EEA Guidebook 2016)

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
PCB	µg/GJ	0.06	0.06	0.007	0.01

Table 3.28 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	70	2.629	9.869	0.308	2.497	0.933
NMVOC	g/GJ	66.763	60.625	1,851.82	57.883	204.556	2.28
CO	g/GJ	3,295.845	2,574.958	24,264.87	758.454	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

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Table 3.29 National pollutants emission factors 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 3.30.

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 (Table 3.31, Figure 3.24 and 3.25). 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) (Figure 3.23).

Table 3.30 NFR 1A4 pollutants IEF, g/total fuels GJ

	SO_2	NO_x	TSP	$PM_{2.5}$
1990	297.9	233.4	227.7	
1995	108.3	472.9	251.2	
2000	131.7	413.1	250.3	211.2
2005	74.6	314.7	236.1	177.1
2006	51.8	282.6	202.7	163.8
2007	38.1	299.0	183.1	146.9
2008	34.2	286.3	161.8	133.7
2009	29.4	307.8	169.0	141.6
2010	28.0	277.3	154.8	130.5
2011	30.5	269.6	152.0	129.3
2012	27.6	256.0	135.1	114.3
2013	28.6	248.5	142.2	122.7
2014	26.6	236.4	130.0	110.5
2015	21.5	236.4	136.0	116.2
2016	22.1	235.3	150.0	121.3

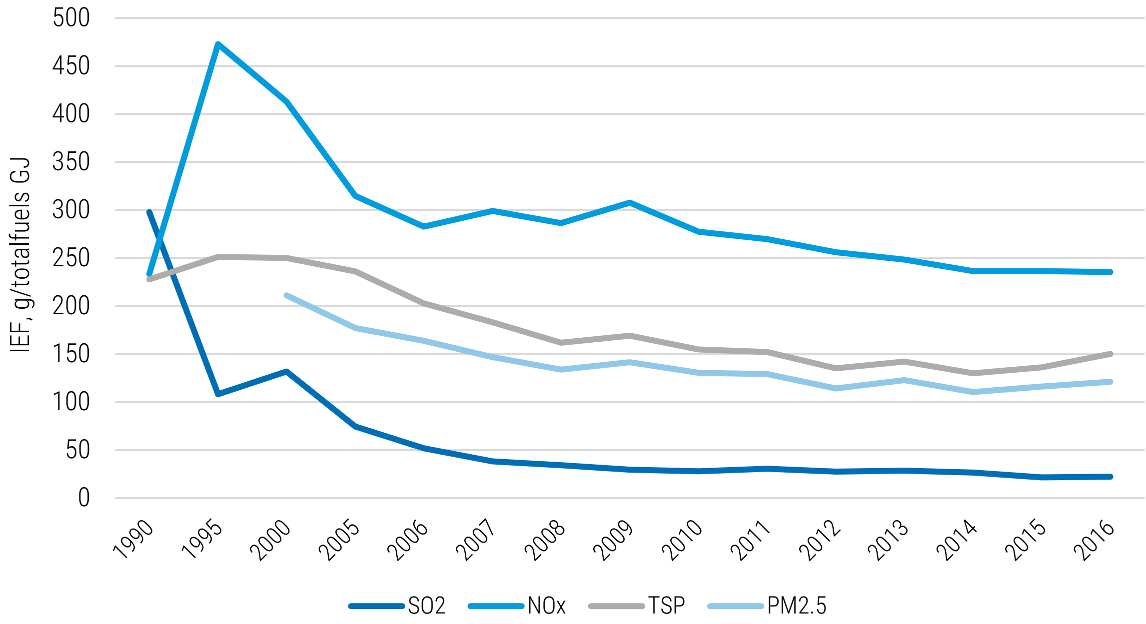

Figure 3.23 Implied emission factors for NFR 1A4

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Activity Data

Table 3.31 Fuel consumption in non-industrial combustion plants in the period of 1990–2016 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gaseous fuels	Other fuels
1990	4.80	7.26	5.93	2.45	NA
1995	1.44	2.53	15.20	2.01	NA
2000	2.25	1.38	14.36	2.41	NA
2005	1.08	1.40	12.81	4.16	0.07
2006	1.25	1.03	12.80	5.87	0.02
2007	1.13	0.72	16.55	6.20	0.08
2008	1.15	0.62	16.82	6.24	0.57
2009	0.95	0.44	17.31	5.11	0.07
2010	1.11	0.47	18.41	6.59	0.17
2011	0.82	0.54	15.04	6.52	NA
2012	0.86	0.50	16.68	6.49	0.07
2013	0.58	0.52	16.47	5.76	0.07
2014	0.52	0.48	16.57	5.73	0.09
2015	0.50	0.34	16.03	5.31	0.13
2016	0.51	0.26	17.02	5.17	0.00
Trend 1990-2016, %	-89.4	-96.4	187.1	110.9	

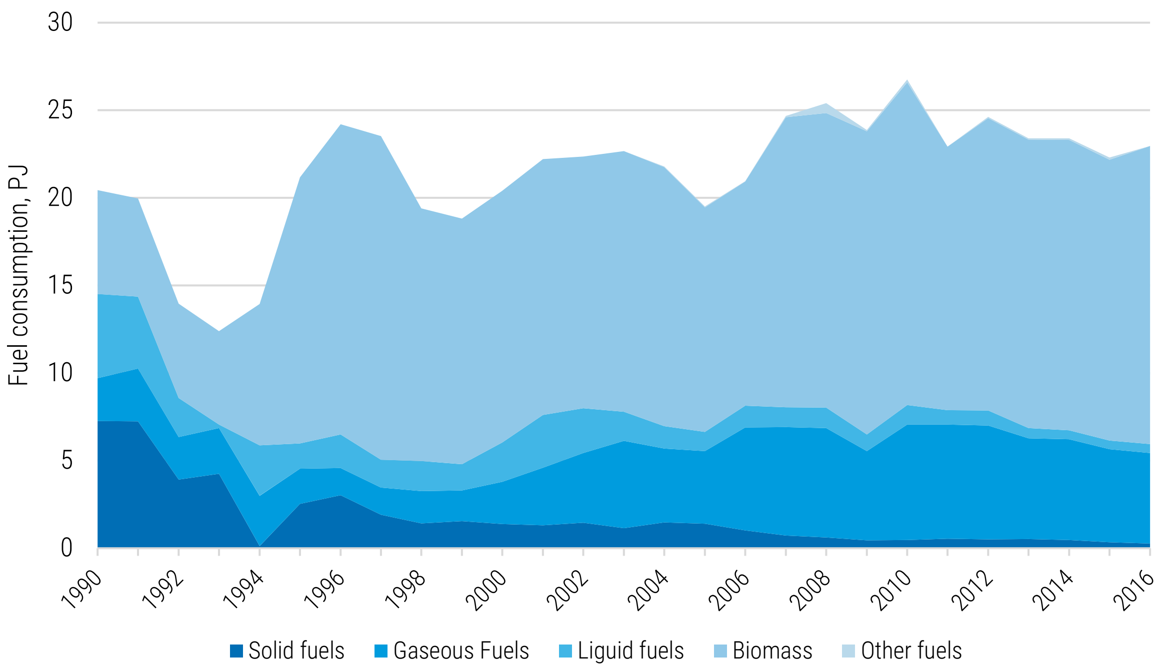

Figure 3.24 Fuel consumption by non-industrial combustion plants in the period of 1990–2016

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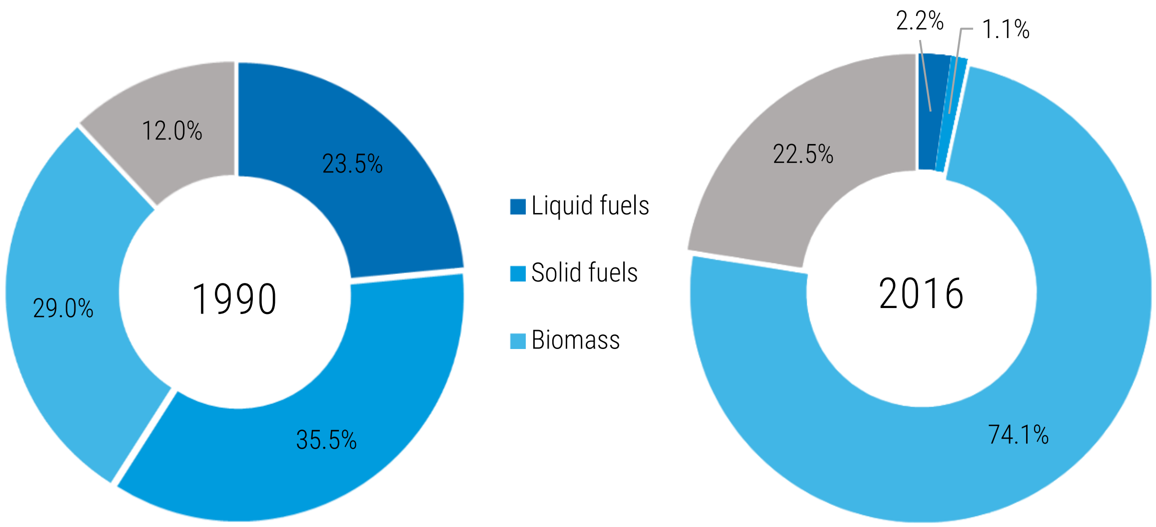

Figure 3.25 Distribution of fuel consumption in non-industrial combustion sector in 1990 and 2016

Table 3.32 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

3.2.4.3. Uncertainty

An uncertainty analysis for the stationary combustion sector alone (NFR 1A1, 1A2, and 1A4) was carried out for the 2015 inventory (Chapter 3.2.1.2). The uncertainty analysis for each NFR sector will be provided at the following year's submission.

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.

- SO_2 emission for the period 1990-2015 from residual boilers (wood EF correction for advance boilers);
- B(k)f and I(1,2,3-cd)p emissions for 2015 (activity data correction);
- BC (2000-2015) and Cd, Hg, Se (1990-2015) emissions due to EFs correction;
- Calculated ammonia emission from biomass combustion for 1990-2015 (NFR 1A4ai, 1A4ci);
- Calculated emissions of TSP, PM_{10}, $PM_{2.5}$, HMs and PAHs from natural gas combustion for 1990-2016 (NFR 1A4ai, 1A4ci).

3.2.4.6. Source-Specific Planned Improvements

- Recalculation of POPs emissions for NFRs 1A4ai and 1A4ci.

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

Table 3.33 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/PCDF, 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

NFR	Source	Description	Method	Emissions
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, Cd, Cr, Cu, Ni, Se, Zn, B(a)p, B(b)f, PAHs total
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/PCDF, 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/PCDF, HCB, PCBs

The transport sector is a major contributor to national emissions. The transport sector includes road transport which is the largest and most important emission source (Figure 3.26). The share of mobile sources in total national emissions in 2016 was the following: NO_x – 42.5%, BC – 19.2%, CO – 15.2% and NMVOC – 13.3%. 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, non-methane volatile compounds and carbon monoxide have decreased compared to 1990 by 65.0%, 85.0% and 85.8% respectively. The trend of the emissions of these categories is given in Figure 3.27 and Table 3.34.

Recalculations have been made for the following sectors: industrial machinery (NFR 1A2gvii), road transport (1A3bi-vii), railways (1A3c), national navigation (1A3dii), commercial machinery (NFR 1A4aii), household and gardening machinery (NFR 1A4bii), 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 emission factors in the new, revised EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, and for some corrections in calculation formulas, which all led to a change in total emissions. A detailed overview is given in each transport subsector and in Chapter 8.

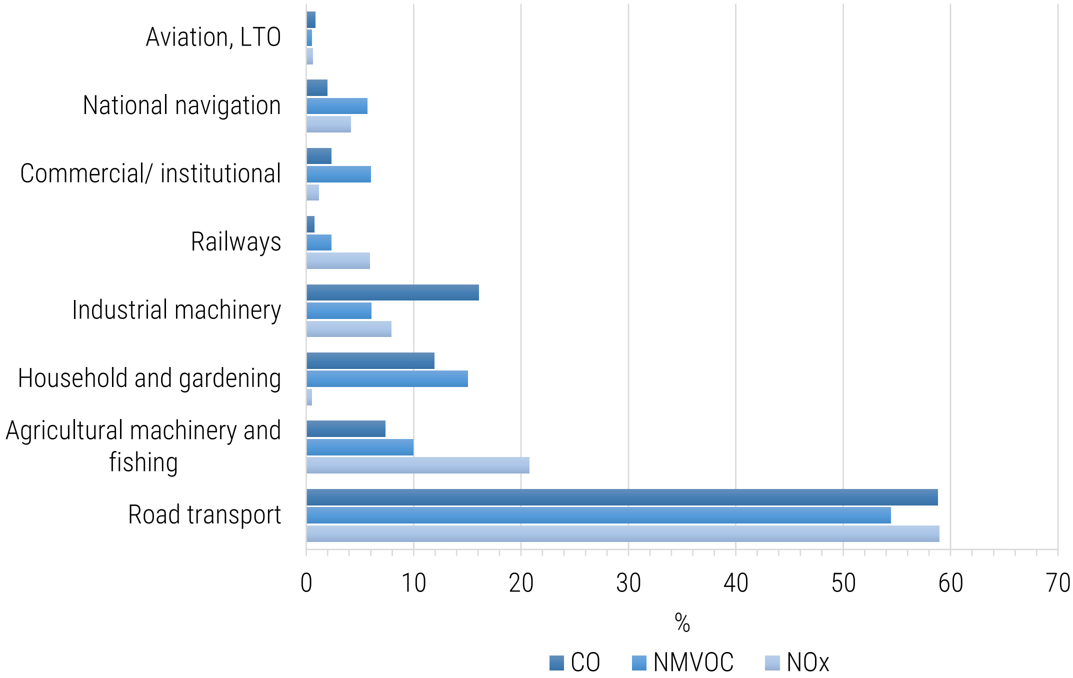

Figure 3.26 NO_x, NMVOC and CO emission shares in the transport sectors in 2016

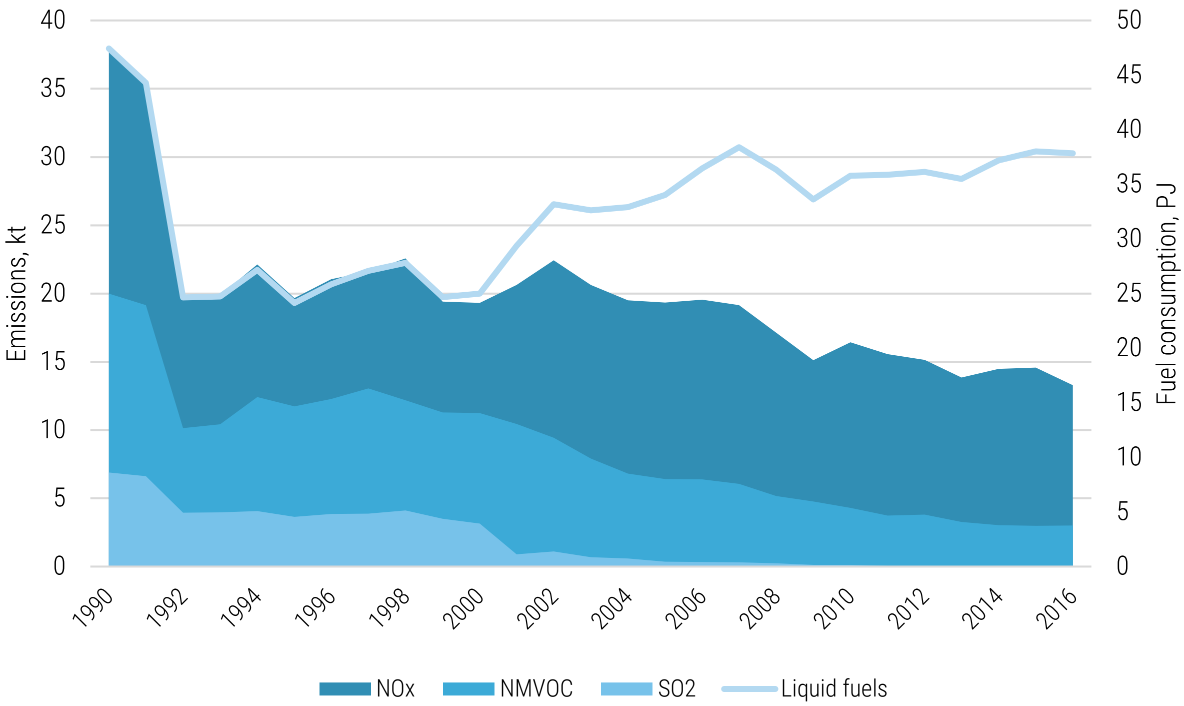

Figure 3.27 NO_x, NMVOC and CO emissions from the transport sector in the period of 1990-2016

Table 3.34 Total emissions from the transport sector in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	37.992	19.992	6.891	0.018	NR	NR	1.733	NR	149.445
1995	19.658	11.725	3.639	0.029	NR	NR	1.010	NR	66.403
2000	19.313	11.241	3.152	0.109	0.906	0.994	1.102	0.475	71.986
2005	19.338	6.412	0.365	0.210	0.953	1.068	1.205	0.532	44.401
2006	19.545	6.391	0.327	0.241	0.956	1.079	1.228	0.540	43.543
2007	19.140	6.057	0.301	0.257	0.969	1.099	1.255	0.551	40.922
2008	17.132	5.162	0.245	0.254	0.874	0.998	1.147	0.493	34.098
2009	15.108	4.757	0.117	0.229	0.746	0.860	0.998	0.427	31.467
2010	16.433	4.309	0.121	0.212	0.799	0.919	1.065	0.467	28.677
2011	15.556	3.726	0.063	0.203	0.759	0.883	1.033	0.442	24.195
2012	15.137	3.816	0.050	0.190	0.759	0.884	1.036	0.445	23.722
2013	13.844	3.256	0.027	0.164	0.696	0.819	0.967	0.410	19.773
2014	14.479	3.034	0.040	0.155	0.761	0.885	1.035	0.442	18.785
2015	14.580	2.990	0.055	0.155	0.782	0.909	1.063	0.453	18.480
2016	13.290	2.997	0.057	0.148	0.732	0.861	1.016	0.418	21.294
Trend 1990-2016, %	-65.0	-85.0	-99.1	704.7	-19.2	-13.5	-41.4	-12.1	-85.8

Table 3.34 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t			kg	t				
1990	78.172	0.011	0.006	0.644	0.145	3.687	0.082	0.011	1.716
1995	24.414	0.005	0.004	0.249	0.080	1.999	0.041	0.006	0.924
2000	4.981	0.005	0.003	0.126	0.084	2.123	0.043	0.006	0.969
2005	2.129	0.008	0.004	0.288	0.112	2.841	0.063	0.009	1.335
2006	1.466	0.008	0.005	0.214	0.122	3.082	0.066	0.009	1.450
2007	1.540	0.009	0.005	0.220	0.128	3.253	0.070	0.010	1.531
2008	1.518	0.008	0.005	0.307	0.124	3.127	0.069	0.010	1.460
2009	1.394	0.008	0.005	0.348	0.114	2.889	0.066	0.009	1.357
2010	0.611	0.008	0.005	0.257	0.119	3.017	0.066	0.009	1.409
2011	0.596	0.008	0.004	0.188	0.122	3.085	0.065	0.009	1.431
2012	0.591	0.008	0.005	0.193	0.124	3.141	0.066	0.009	1.460
2013	0.560	0.008	0.004	0.157	0.121	3.069	0.064	0.009	1.427
2014	0.263	0.009	0.004	0.138	0.126	3.194	0.068	0.009	1.496
2015	0.267	0.009	0.005	0.145	0.129	3.302	0.070	0.010	1.551
2016	0.293	0.009	0.005	0.178	0.131	3.333	0.071	0.010	1.568
Trend 1990-2016, %	-99.6	-15.4	-26.9	-72.4	-9.6	-9.6	-13.3	-12.5	-8.6

Table 3.34 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	0.353	0.023	0.041	0.017	0.012	0.093	0.275	20.305
1995	0.220	0.009	0.017	0.009	0.007	0.042	0.147	6.667
2000	0.222	0.007	0.014	0.009	0.006	0.037	0.163	1.061
2005	0.311	0.011	0.019	0.012	0.008	0.050	0.587	0.217
2006	0.343	0.012	0.021	0.013	0.009	0.055	0.465	0.144
2007	0.364	0.013	0.022	0.013	0.009	0.057	0.491	0.148
2008	0.332	0.012	0.020	0.012	0.009	0.053	0.650	0.231
2009	0.316	0.011	0.019	0.012	0.008	0.050	0.747	0.276
2010	0.321	0.013	0.021	0.013	0.009	0.056	0.577	0.191
2011	0.330	0.013	0.021	0.014	0.009	0.056	0.456	0.130
2012	0.327	0.013	0.022	0.014	0.009	0.058	0.465	0.134

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	
2013	0.311	0.013	0.021	0.014	0.010	0.057	0.386	0.100
2014	0.297	0.014	0.023	0.014	0.010	0.061	0.329	0.081
2015	0.309	0.015	0.024	0.014	0.010	0.064	0.353	0.088
2016	0.291	0.015	0.023	0.014	0.011	0.063	0.397	0.118
Trend 1990-2016, %	-17.5	-33.5	-43.7	-16.7	-10.2	-32.0	44.6	-99.4

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

3.3.2.1. Source Category Description

Estonia's 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 nitrogen oxides, non-methane volatile compounds, and carbon monoxide in the transport sector in 2016 was 0.6%, 0.5%, and 0.8% respectively. 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 1990–2016, the emission of NO_x, NMVOC, and CO from the LTO phase increased by 56.4%, 22.1%, and 48.6% respectively (Figure 3.28, Table 3.35), mainly due to changes in fuel consumption, which increased by 43.7% (Table 3.39) and the number of landing and take-off operations (Figure 3.30). This is roughly in line with the trends in the number of air passengers and passenger traffic volume over the same period. Figure 3.29 illustrate the importance of the international aviation sector, which contributes the majority of the emissions from the aviation sector.

In 2016, the emissions of NO_x, NMVOC and CO increased by 3.3%, 0.2% and 2.7% respectively compared to 2015. An increase in emissions took place within the context of passenger traffic volumes, with the number of passengers and landing and take-off operations declining by 35.4%, 14.9%, and 3.5% respectively. However, the amount of fuel consumed increased by 4.1%. This increase in emissions has mainly been caused by the fact that the share of different aircraft types varies and, therefore, the average emissions factor (Table 3.37) changes from year to year in the LTO phase in the aviation sector. In 2016, the share of jet aircraft was higher than the year before. It was due to this change in aircraft fleet types that the growth in emissions occurred.

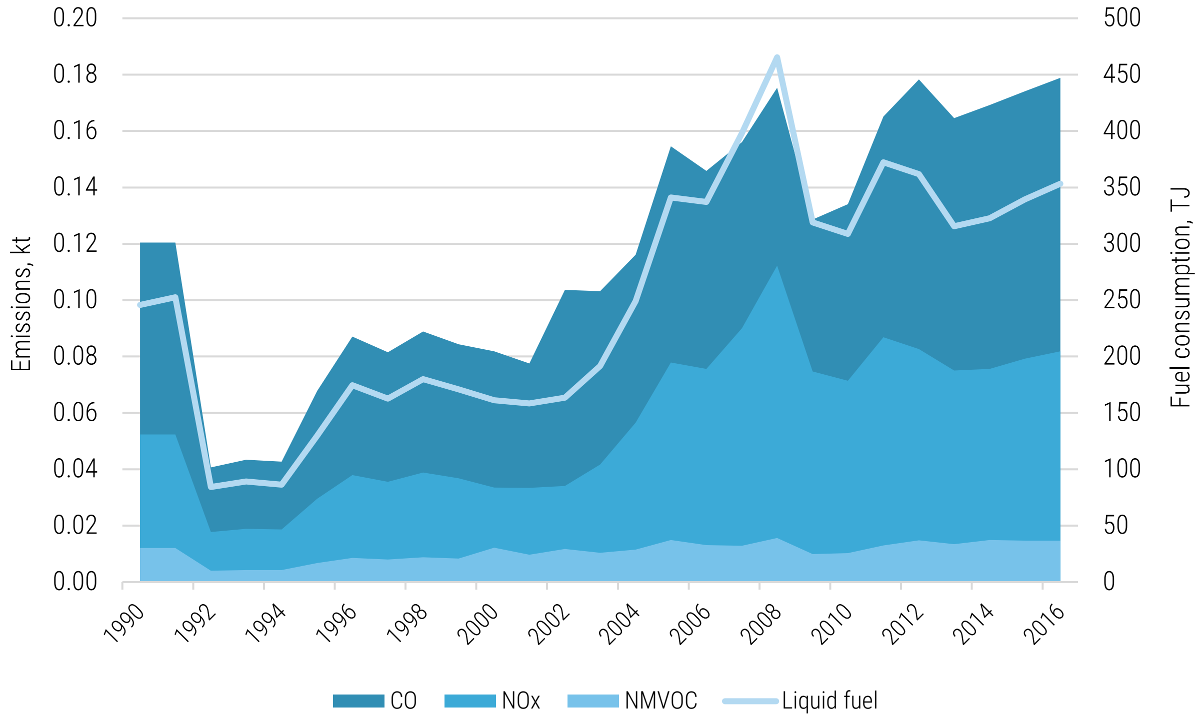

Figure 3.28 NO_x, NMVOC and CO emissions from the LTO cycle in aviation sector in the period of 1990-2016

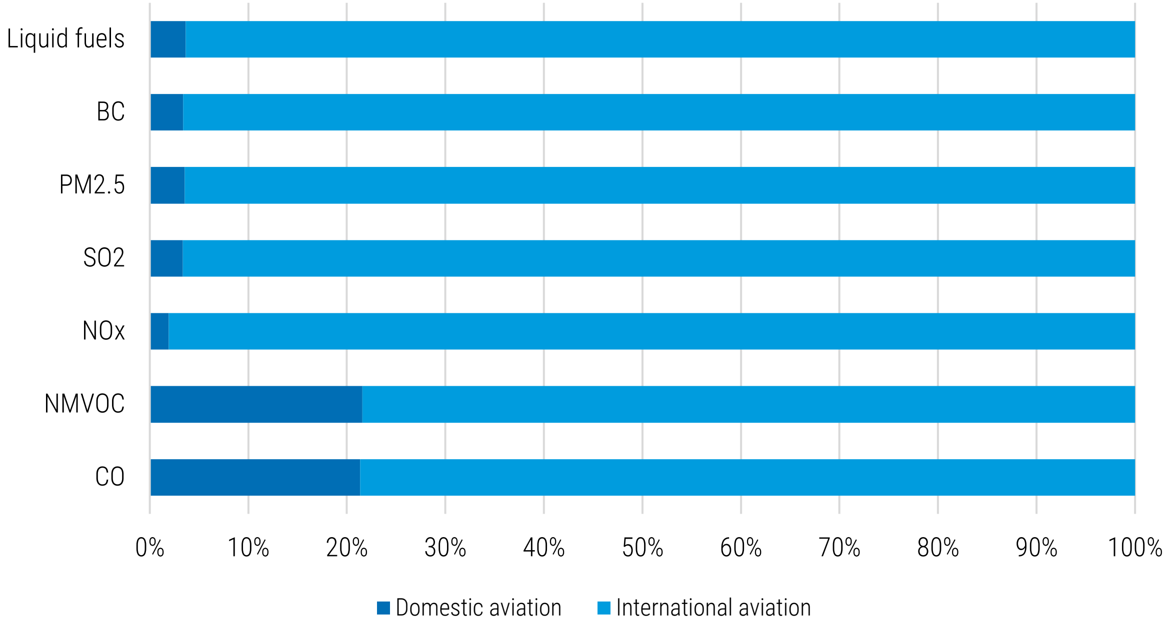

Figure 3.29 The share of pollutant emissions from the LTO cycle in aviation sector in 2016

Table 3.35 Emissions from the LTO cycle in the aviation sector in the period of 1990–2016

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
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
Trend 1990-2016, %	56.4	22.1	41.7	65.0	65.0	32.1	65.0	48.6

Table 3.36 Emissions from the cruise phase in the aviation sector in the period of 1990–2016 (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	0.501	0.020	0.039	0.008	0.008	0.008	0.004	0.043
2006	0.301	0.012	0.024	0.005	0.005	0.005	0.002	0.026
2007	0.511	0.020	0.040	0.008	0.008	0.008	0.004	0.044
2008	0.216	0.008	0.017	0.003	0.003	0.003	0.002	0.019
2009	0.321	0.012	0.025	0.005	0.005	0.005	0.002	0.028
2010	0.376	0.015	0.029	0.006	0.006	0.006	0.003	0.033
2011	0.320	0.012	0.025	0.005	0.005	0.005	0.002	0.028
2012	0.369	0.014	0.029	0.006	0.006	0.006	0.003	0.032
2013	0.269	0.010	0.021	0.004	0.004	0.004	0.002	0.023
2014	0.415	0.016	0.032	0.006	0.006	0.006	0.003	0.036
2015	0.208	0.008	0.016	0.003	0.003	0.003	0.002	0.018
2016	0.167	0.006	0.013	0.003	0.003	0.003	0.000	0.014
Trend 1990-2016, %	-56.7	-55.6	-57.0	-25.9	--25.9	-57.0	-76.9	-58.3

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 (Table 3.37) 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 (Table 3.39). Fuel-based cruise emission factors are taken from the EMEP/EEA Guidebook 2013 as a single set for an average aircraft (Table 3.38). 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 (Table 3.37). 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 2016. Extrapolation has been done for 1990 and 1991.

Table 3.37 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

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
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
AL03	0.11	0.28	0.01	0.00	0.40	21.4
AS32	0.65	0.49	0.04	0.02	0.68	77.4
AS35	0.18	0.22	0.01	0.01	0.32	27.5
AS55	0.15	0.82	0.02	0.01	1.20	34.8
H269	0.01	0.09	0.00	0.00	6.59	6.6
B412	0.64	0.49	0.04	0.02	0.69	77.0
B06	0.08	0.35	0.01	0.00	0.50	18.2
EC35	0.21	0.71	0.02	0.01	1.03	41.1
EN48	0.08	0.34	0.01	0.00	0.48	18.6
MI8	0.53	0.55	0.04	0.02	0.78	70.0
R22	0.01	0.09	0.00	0.00	6.21	6.2
R44	0.02	0.11	0.00	0.00	8.79	8.8
S76	0.29	0.59	0.02	0.01	0.85	48.2

Table 3.38 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	0.48	2.0
International aviation	12.8	0.5	1.0	0.2	0.48	1.1

Table 3.39 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	13.334	10.346	327.611	1,687.709	2,039.0
2006	13.508	3.872	323.582	1,008.038	1,349.0
2007	12.512	5.418	385.633	1,711.437	2,115.0
2008	13.721	17.183	451.679	707.417	1,190.0
2009	12.210	11.480	306.719	1,070.591	1,401.0
2010	12.344	11.914	296.477	1,253.265	1,574.0
2011	14.573	22.871	357.664	1,054.892	1,450.0
2012	15.507	31.437	346.148	1,213.908	1,607.0
2013	13.410	3.068	302.160	897.362	1,216.0
2014	13.763	3.223	308.801	1,391.213	1,717.0
2015	13.834	3.235	325.464	696.466	1,039.0
2016	12.861	6.534	340.335	557.271	917.0

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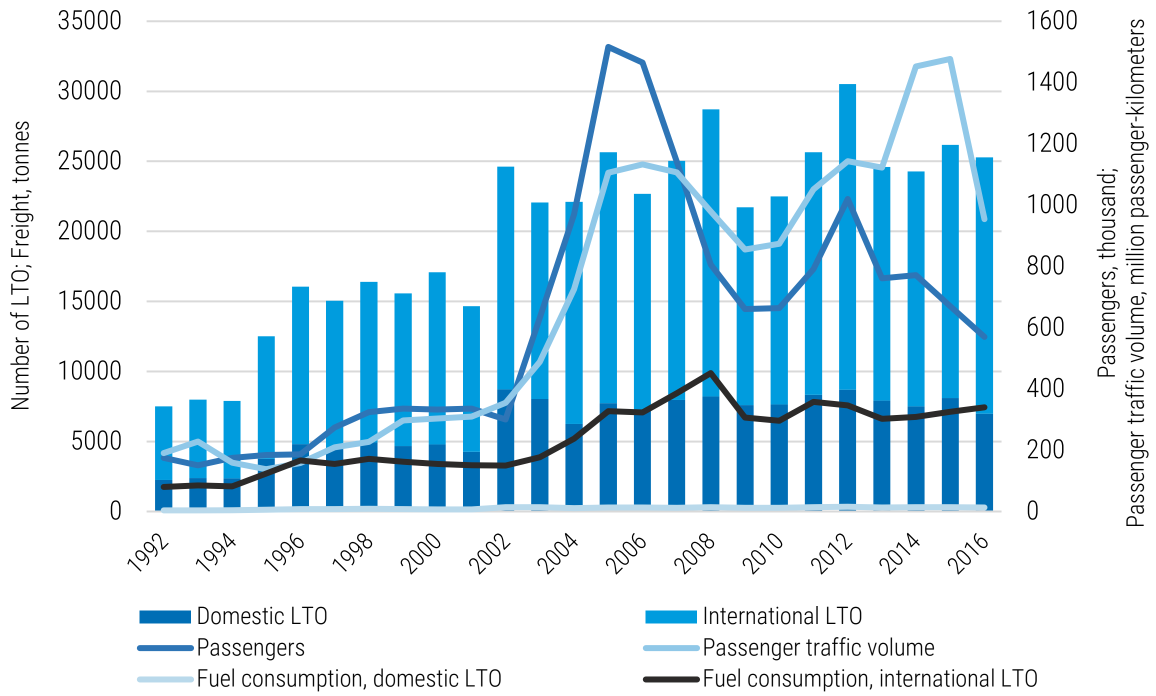

Figure 3.30 The number of LTO cycles, passengers carried and freight transported

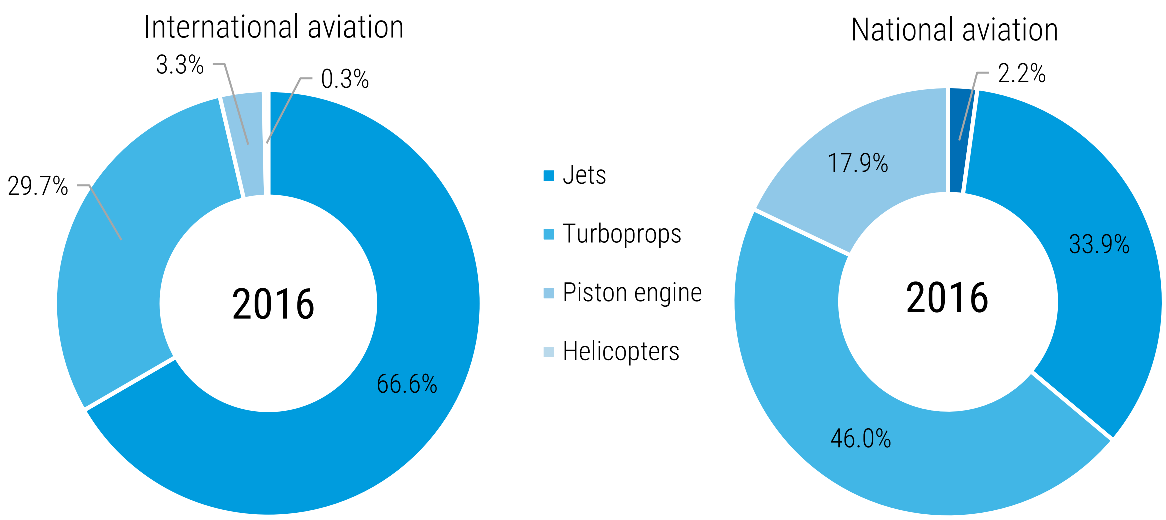

Figure 3.31 The share of different aircraft types in domestic and international civil aviation

3.3.2.3. Uncertainty

In the 2017 submission, an uncertainty analysis was carried out for the 2015 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 3.40. No uncertainty estimation for cruise phase has been carried out.

Table 3.40 Uncertainties in the aviation (LTO) sector

Pollutant	Emission, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	0.079221	kt	0.260	0.080	0.020
NMVOC	0.014657	kt	0.060	0.020	0.004
SO_x	0.007289	kt	0.020	0.010	0.001
$PM_{2.5}$	0.000501	kt	0.010	0.002	0.001
PM_{10}	0.000501	kt	0.000	0.001	0.0003
TSP	0.000501	kt	0.000	0.001	0.00005
CO	0.174126	kt	0.140	0.030	0.010

3.3.2.4. Source-Specific QA/QC and Verification

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

3.3.2.5. Source-Specific Planned Improvements

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

3.3.3. Road transport (1A3bi-vii)

3.3.3.1. Source Category Description

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

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

In 2016, road transport contributed to the total national emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide by 25.0%, 7.3%, and 9.0% respectively, and in the transport sector, 58.9%, 54.4%, and 58.8% respectively (Figure 3.26). 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 (Figure 3.32) has mainly been caused by the stricter emission standards for road vehicles. In addition, Figure 3.33 illustrates the importance of different vehicle types in pollutant emissions in the road transport sector.

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

The lead emissions from road transport have decreased by about 99.7% since 1990 (Figure 3.32). 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 2016.

The reduction of sulphur content in fuels has led to a substantial decrease in SO_2 emissions in the road transport sector (Figure 3.32). 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 (Table 3.42). Currently, all road transport fuels are sulphur free (sulphur content less than 10 ppm). Therefore, SO_2 emissions have decreased by 99.8% between 1990 and 2016.

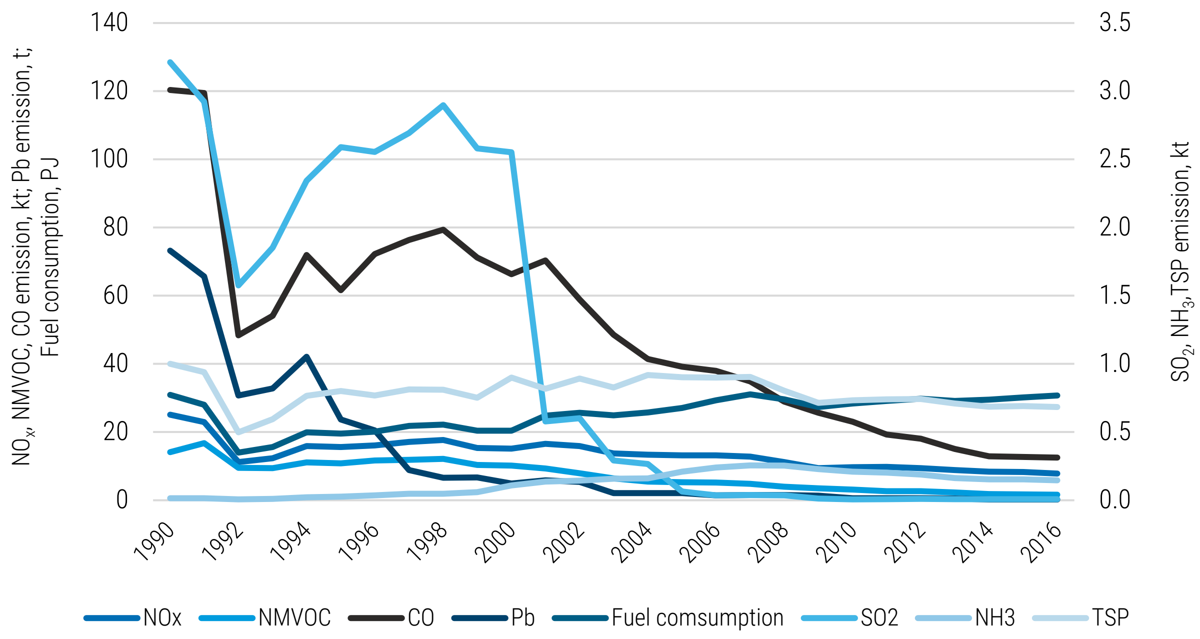

Figure 3.32 Fuel consumption and pollutant emissions from road transport in the period 1990-2016

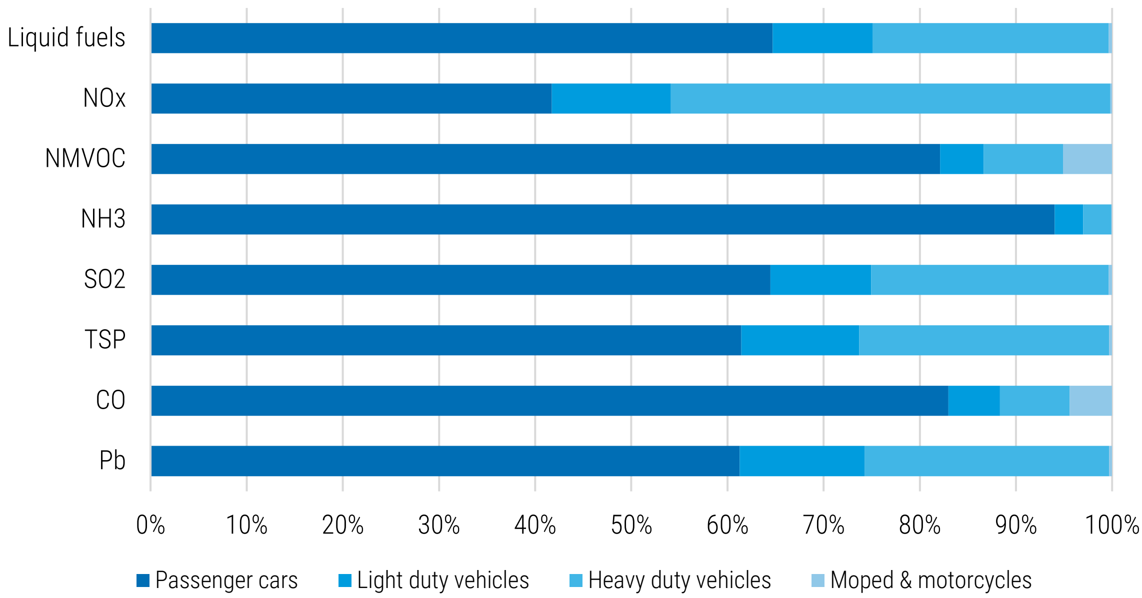

Figure 3.33 The share of pollutant emissions in the road transport sector in 2016

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 (Figure 3.34, Table 3.47). 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 94% and 91% respectively between 1990 and 2016. 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, NH_3 emissions have fallen since 2008 as the second generation of catalytic converters - which emit lower levels of NH_3 than the first generation of catalytic converters - become more widely used in the vehicle fleet. NH_3 emissions have decreased by 42.4% in 2016 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 1.2% of the national total NH_3 emissions in 2016.

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 51.8% decrease in petrol consumption during the period of 1990–2016 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 0.3% in 2016 (Table 3.47).

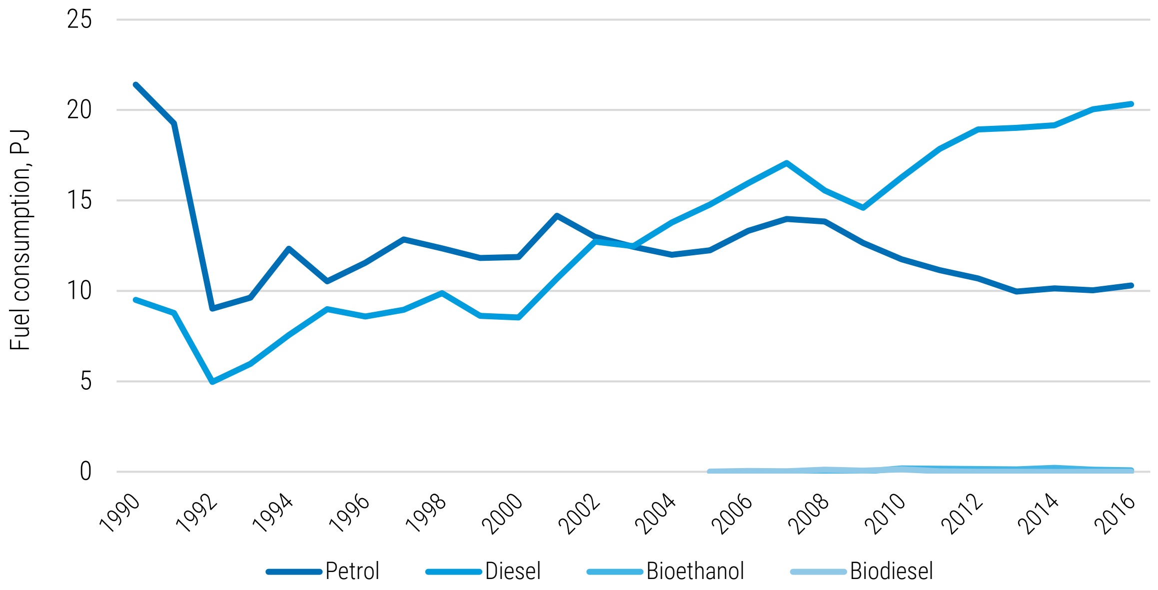

Figure 3.34 Fuel consumption in the road transport sector

TSP exhaust emissions from road transport vehicles have decreased by 54.2% during the 1990-2016 period. In 2016, petrol and diesel vehicles contributed 17.0% and 83.0% respectively of the total TSP exhaust emissions in the road transport sector. PM exhaust emissions are declining in new model vehicles due to tightening regulations, and new engine and after-treatment technologies. However, a significant part of the total PM emissions also originate from

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non-exhaust sources (road abrasion, and tyre and brake wear). Figure 3.35 illustrates the importance of different sources in pollutant emissions in the road transport sector.

As shown in Figure 3.35, 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 17.1% between 1990 and 2016 (1.2 thousand tonnes to 1.4 thousand tonnes) which is directly linked with the change in annual mileage driven by the vehicles (an increase of 15.6%) over the same period of time. As shown in Figure 3.35, the share of lubricant combustion in heavy metals emissions are relatively high, except for Pb. The combustion of lubricants contributed around 83.7% of Cd, 21.5% of Cr, 34.9% of Cu, 74.4% of Ni, 75.3% of Se, 43.9% of Zn, and only 0.02% of Pb across the entire total road transport sector in 2016.

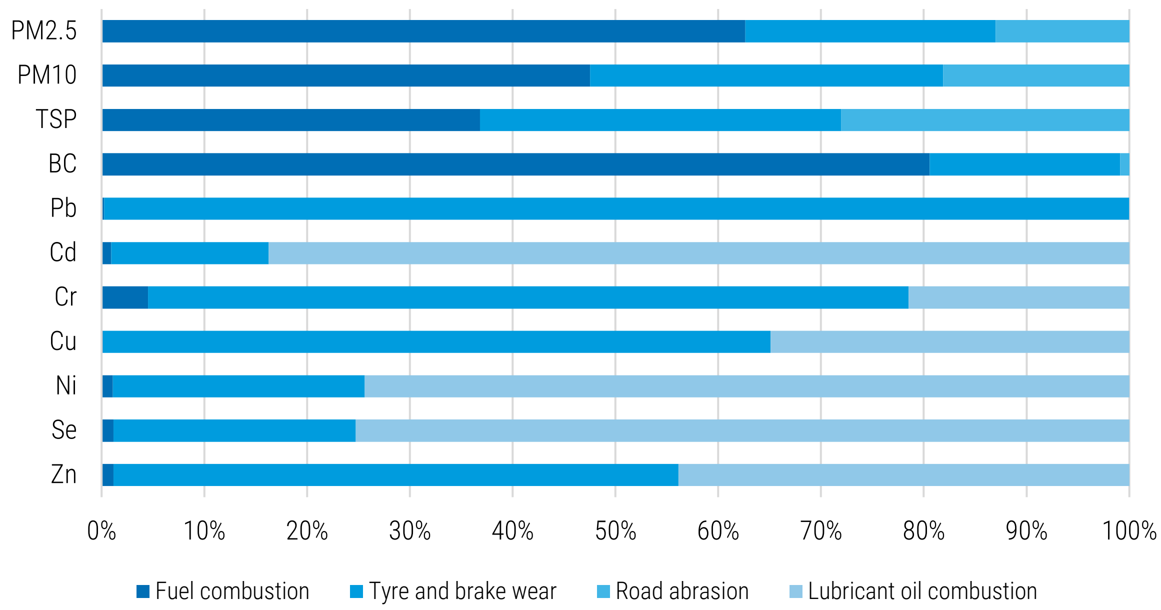

Figure 3.35 The share of different sources in pollutant emissions in 2016

The emission trend in recent years has been impacted by the improved fuel efficiency and minimised emissions of new vehicles. In 2016, statistics showed that the number of vehicles continued to increase (8.1%) compared to 2015. Therefore, the total mileage driven by vehicles and the amount of fuel consumed also increased by 3.3% and 1.8% respectively. Although there has been an increase in activity data, the main pollutant emissions from road transport decreased compared to 2015: nitrogen oxides emissions by 5.0%, non-methane volatile organic compounds by 3.4%, sulphur dioxide by 16.5%, and carbon monoxide by 1.7%.

In the Figures 3.32-33, 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 3.41.

Passenger Cars (1A3bi)

Passenger cars contributed the majority of emissions within the road transport sector: 41.7% of NO_x, 82.1% of NMVOC, 64.5% of SO_2, 94.0% of NH_3, 61.4% of $PM_{2.5}$, 61.4% of PM_{10}, 61.4% of TSP, 63.1% of BC, 83.0% of CO in 2016.

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 564 thousand between 1990 and 2016. Cars with petrol engines make up a majority of registered passenger cars – 88% in 1990 and 59% in 2016

(Figure 3.36). This trend reflects that the number of diesel cars has grown fast during the same period (Figure 3.37). Significant changes have also taken place in annual mileage – annual mileage driven by diesel cars increased nine times (442 to 3,987 million km) and annual mileage per petrol cars decreased by 32% (5,121 to 3,503 million km). Overall fuel consumption in this subsector increased by 28% between 1990 and 2016. In detail, fuel consumed by diesel cars increased approximately ten times and petrol fuel amount decreased by 32% during the same period.

During the period of 1990–2016, the pollutant emissions decreased significantly: 74.8% of NO_x, 89.8% of NMVOC, 99.5% of SO_2 and 89.7% 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 average age of passenger-carrying cars has decreased over the years. 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 2016.

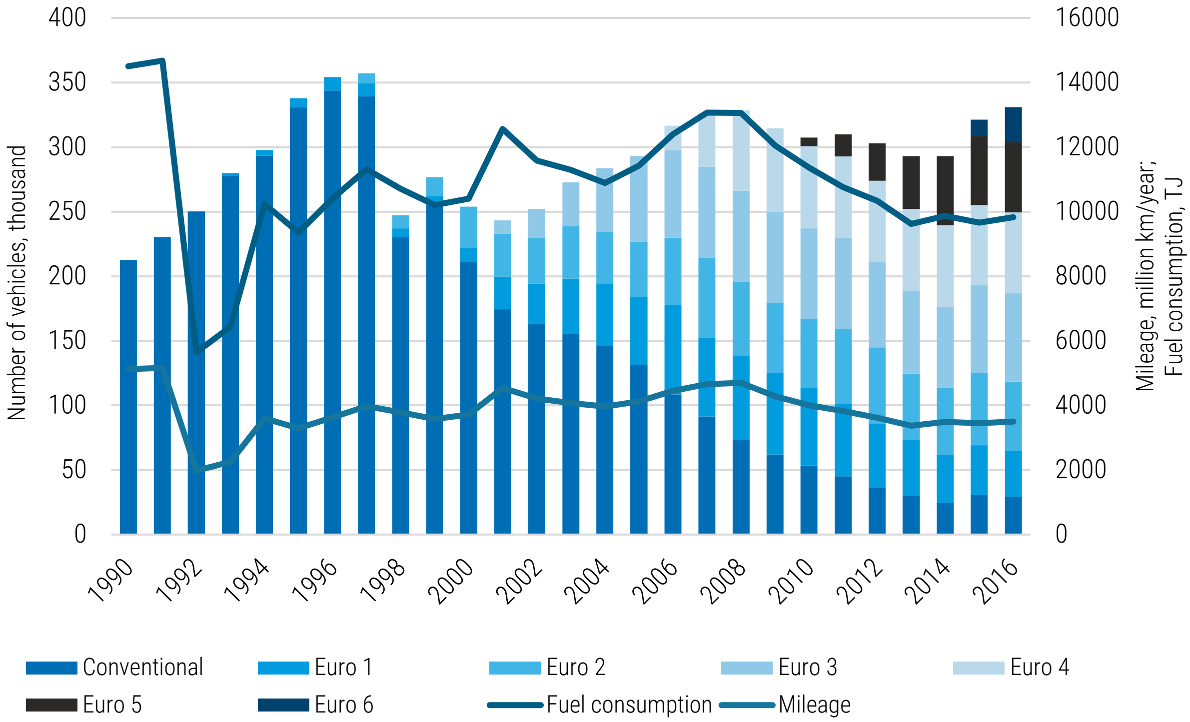

Figure 3.36 Petrol passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

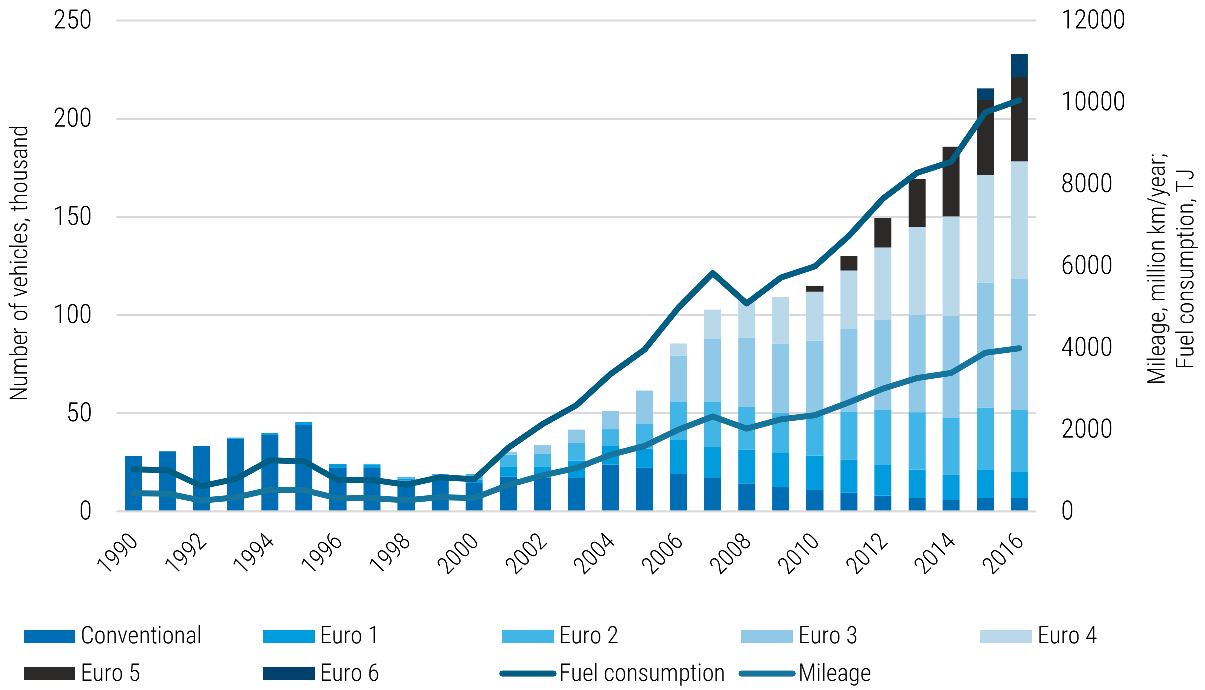

Figure 3.37 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

Light Duty Vehicles (1A3bii)

Light commercial vehicles contributed about 12.4% of NO_x, 4.5% of NMVOC, 10.5% of SO_2, 2.9% of NH_3, 13.3% of $PM_{2.5}$, 12.8% of PM_{10}, 12.3% of TSP, 14.5% of BC and 5.4% of CO in the total road transport sector in 2016.

The light commercial vehicle fleet has grown over the last decades from 31 thousand vehicles to 59 thousand between 1990 and 2016. 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 50 thousand vehicles in 2016 (Figure 3.39). The petrol light duty vehicle fleet decreased by 34% over the same period from 13 thousand to 9 thousand vehicles (Figure 3.38). A similar trend can be seen in the annual mileage and fuel consumption – mileage and fuel consumption increased by 47% and 33% respectively in this subsector. As expected, annual mileage driven by petrol vehicles declined by 68% and the total annual kilometres driven by diesel vehicles increased almost three times. In addition, petrol fuel consumption decreased by 70% and diesel fuel consumption increased more than twice in this subsector during the same period.

The pollutant emissions decreased significantly: 38.3 of NO_x, 92.4% of NMVOC, 99.8% of SO_2, 51.7% of TSP and 92.5% of CO, although all the activity data increased in the period of 1990–2016. 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.

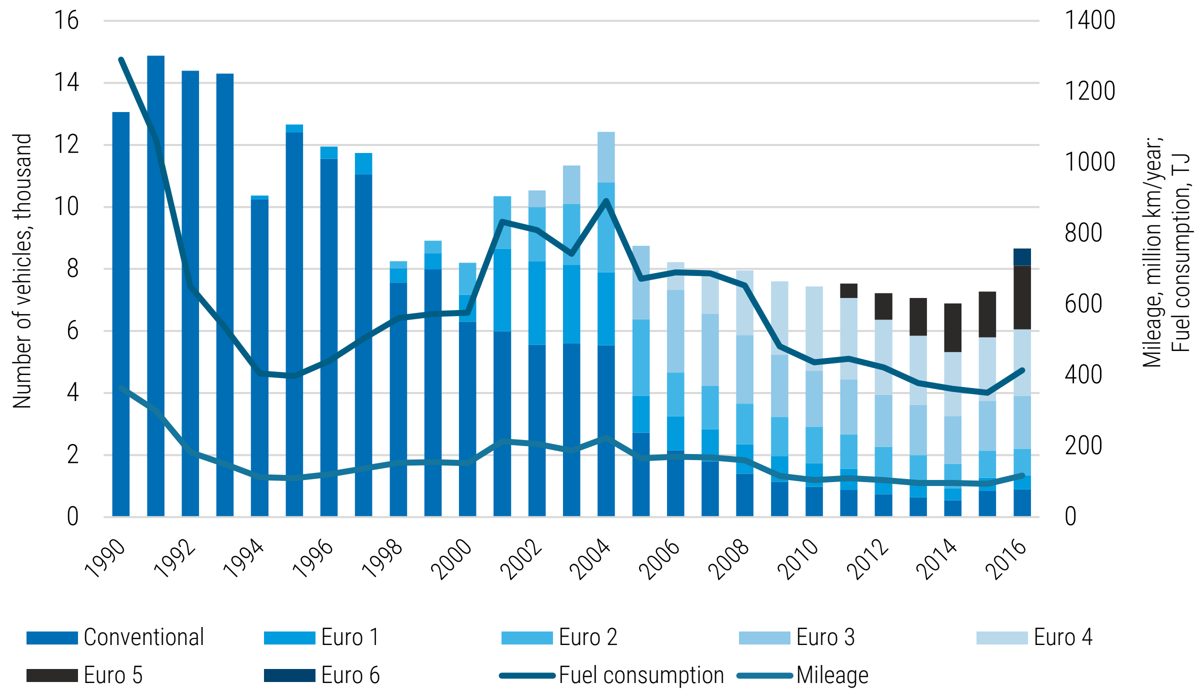

Figure 3.38 Petrol light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

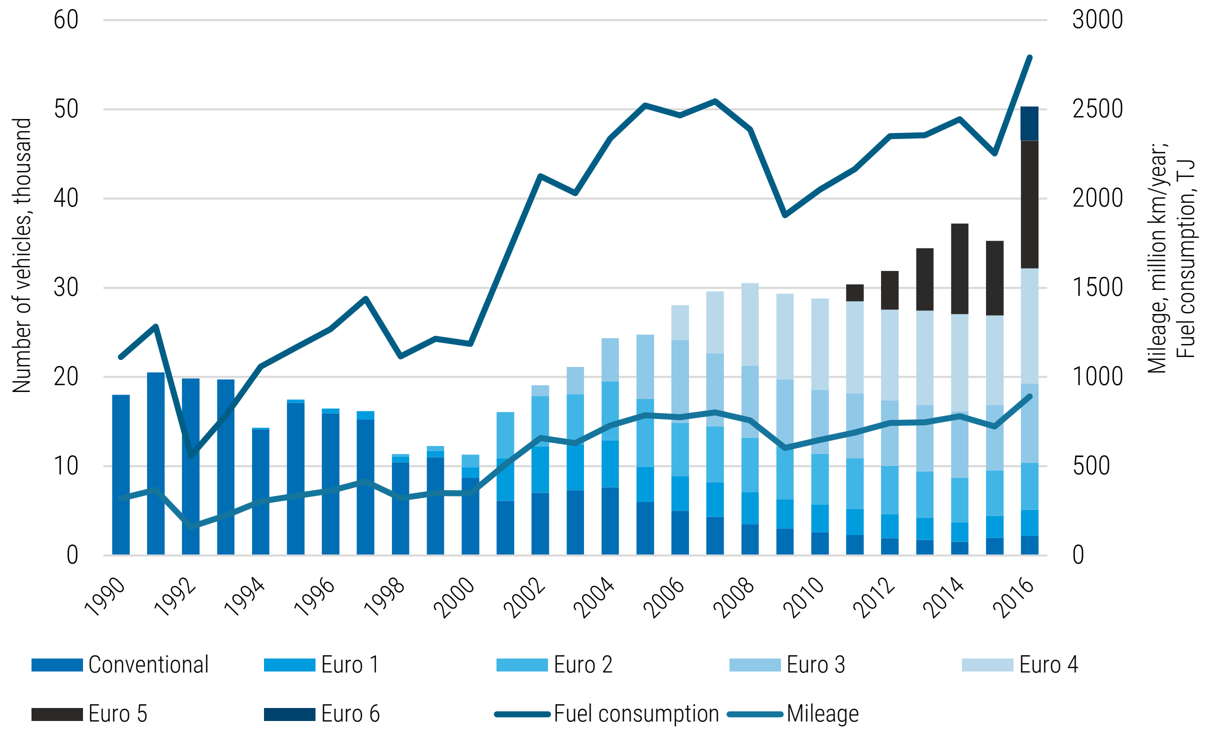

Figure 3.39 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

Heavy Duty Vehicles and Buses (1A3biii)

Heavy duty vehicles contributed about 45.7% of NO_x, 8.3% of NMVOC, 24.7% of SO_2, 2.9% of NH_3, 25.0% $PM_{2.5}$, 25.5% of PM_{10}, 26.0% of TSP, 22.3% of BC and 7.3% of CO in the total road transport sector in 2016.

The heavy duty vehicle fleet has declined over the last decades from 45 thousand vehicles to 31 thousand between 1990 and 2016. Heavy duty vehicles with diesel engines make up the majority of registered vehicles – 60% in 1990 and 94% in 2016. The number of petrol vehicles has declined by 89% and the number of diesel vehicles increased slightly by 1%. Total annual mileage and fuel consumption decreased by 46% and 39% respectively during this period. In detail, mileage driven and fuel consumed by petrol vehicles decreased by 99% (Figure 3.40). However, the same indicators for diesel powered heavy duty vehicles increased by 1% (Figure 3.41).

During the period of 1990–2016, the pollutant emissions decreased significantly: 65.6% of NO_x, 95.3% of NMVOC, 99.9% of SO_2, 63.5% of TSP and 77.8% 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.

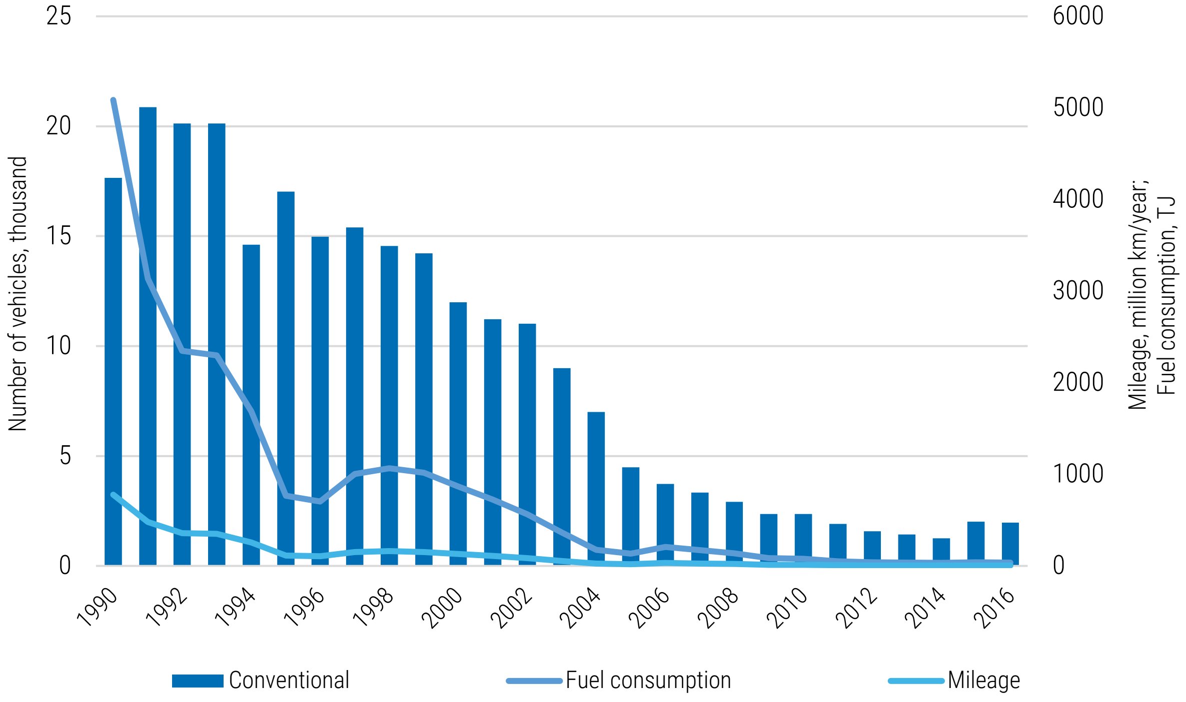

Figure 3.40 Petrol heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

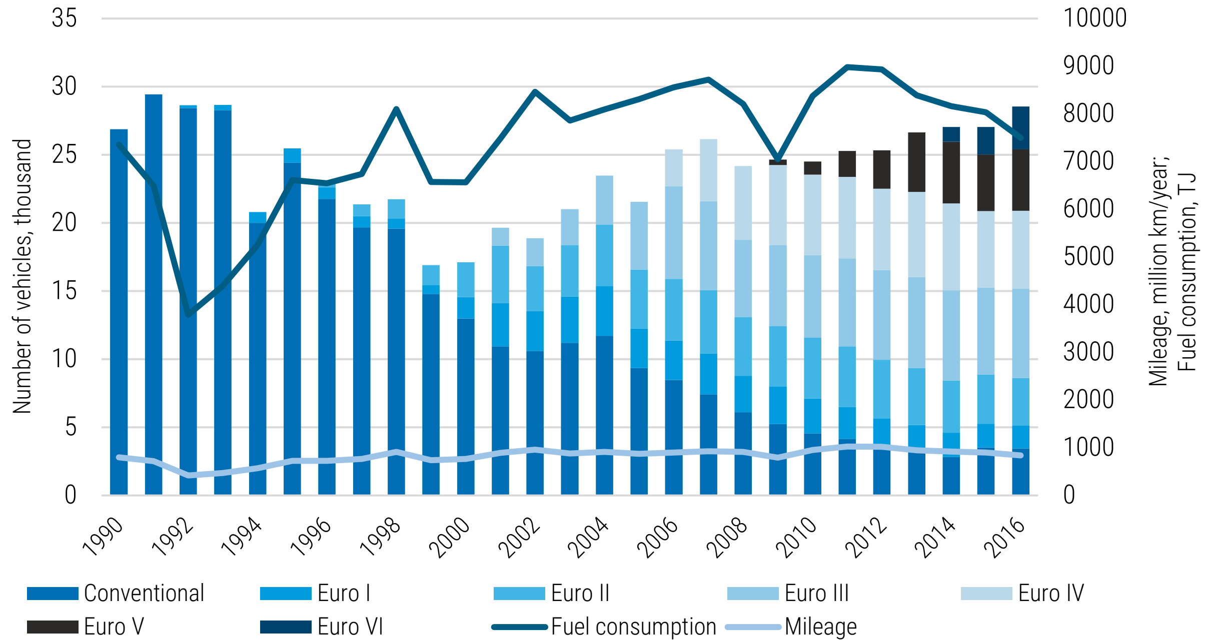

Figure 3.41 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

Motorcycles and Mopeds (1A3biv)

This subsector contributes only a marginal share of the total road transport sector emissions: 0.2% of NO_x, 5.1% of NMVOC, 0.3% of SO_2, 0.1% of NH_3, 0.3% $PM_{2.5}$, 0.3% of PM_{10}, 0.3% of TSP, 0.1% of BC and 4.4% of CO in 2016.

The number of motorcycles, annual mileage, and fuel consumption decreased by 64.8%, 77.0%, and 79.1% respectively between 1990 and 2016 (Figure 3.42). During this period, NO_x emissions decreased by 88.4%, NMVOC emissions by 86.8%, SO_2 emissions by 99.9%, and CO emissions by 91.4%. In addition, there was a very high statistical number of motorcycles in use during the period between 1980-1994. After 1994, the statistical data no longer reflects vehicles which have not been technically inspected for years.

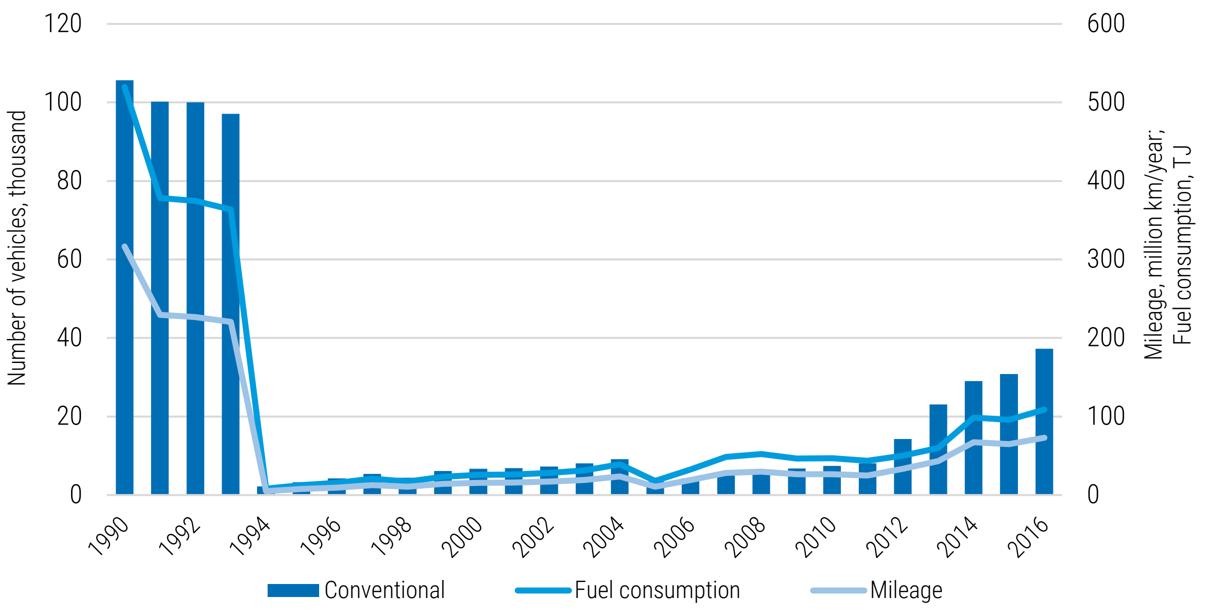

Figure 3.42 Motorcycles and mopeds: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2016

Recalculations

All the emissions from road transport have been recalculated for the period 1990-2015. Recalculations entail using corrected activity data, updated emission factors in the new, revised EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, and the taking into use of an improved new edition of the COPERT 5 program (version 5.1.1) for emission calculations. An overview of the updated data is given in Chapter 8.

Table 3.41 Emissions from road transport in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	25.100	17.556	3.212	0.016	NR	NR	1.001	NR	120.360
1995	15.594	10.797	2.591	0.028	NR	NR	0.802	NR	61.584
2000	15.131	10.187	2.553	0.108	0.709	0.795	0.899	0.362	66.284
2005	13.199	5.317	0.063	0.209	0.657	0.768	0.902	0.360	39.213
2006	13.185	5.234	0.036	0.240	0.635	0.754	0.900	0.352	37.920
2007	12.798	4.857	0.037	0.256	0.623	0.750	0.904	0.351	34.891
2008	11.182	4.008	0.036	0.253	0.534	0.656	0.803	0.299	28.976
2009	9.467	3.511	0.012	0.228	0.467	0.579	0.714	0.269	25.675
2010	9.657	3.141	0.006	0.211	0.474	0.591	0.732	0.276	23.058
2011	9.776	2.639	0.008	0.202	0.472	0.594	0.741	0.276	19.246
2012	9.452	2.627	0.009	0.189	0.470	0.593	0.743	0.279	18.043
2013	8.888	2.275	0.008	0.163	0.442	0.563	0.709	0.263	15.101
2014	8.367	1.777	0.008	0.154	0.415	0.537	0.686	0.243	12.907
2015	8.250	1.690	0.009	0.154	0.412	0.538	0.691	0.241	12.733
2016	7.834	1.632	0.007	0.147	0.402	0.530	0.685	0.233	12.521
Trend 1990-2016, %	-68.8	-90.7	-99.8	846.1	-43.3	-33.3	-31.6	-35.8	-89.6

Table 3.41 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t			kg	t				
1990	73.230	0.007	0.005	0.168	0.124	3.034	0.054	0.007	1.310
1995	23.652	0.004	0.003	0.093	0.074	1.819	0.034	0.005	0.811
2000	4.899	0.004	0.003	0.102	0.079	1.946	0.036	0.005	0.864
2005	2.105	0.006	0.004	0.120	0.105	2.584	0.048	0.007	1.181
2006	1.440	0.007	0.005	0.129	0.113	2.808	0.053	0.007	1.288
2007	1.511	0.007	0.005	0.136	0.120	2.975	0.056	0.008	1.366
2008	1.495	0.007	0.005	0.133	0.116	2.869	0.054	0.008	1.305
2009	1.364	0.006	0.004	0.121	0.107	2.653	0.051	0.007	1.214
2010	0.585	0.006	0.004	0.120	0.110	2.731	0.051	0.007	1.239
2011	0.574	0.007	0.004	0.117	0.114	2.832	0.053	0.007	1.281
2012	0.564	0.007	0.005	0.117	0.117	2.887	0.054	0.008	1.310
2013	0.538	0.007	0.004	0.113	0.115	2.846	0.054	0.008	1.296
2014	0.236	0.007	0.004	0.116	0.117	2.906	0.055	0.008	1.327
2015	0.242	0.007	0.005	0.117	0.121	3.004	0.057	0.008	1.376
2016	0.247	0.008	0.005	0.119	0.123	3.072	0.059	0.008	1.414
Trend 1990-2016, %	-99.7	12.8	-15.1	-29.4	-0.7	1.2	9.8	12.8	8.0

Table 3.41 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	0.212	0.004	0.009	0.007	0.006	0.026	0.123	0.037
2000	0.221	0.004	0.009	0.008	0.006	0.026	0.159	0.041
2005	0.310	0.007	0.012	0.010	0.008	0.037	0.250	0.058
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	0.068
2008	0.332	0.007	0.013	0.011	0.008	0.040	0.302	0.065
2009	0.315	0.007	0.012	0.010	0.008	0.038	0.294	0.061
2010	0.321	0.008	0.013	0.012	0.008	0.040	0.303	0.061
2011	0.330	0.008	0.014	0.012	0.009	0.043	0.313	0.062
2012	0.326	0.009	0.014	0.013	0.009	0.045	0.312	0.061
2013	0.311	0.009	0.014	0.013	0.009	0.046	0.298	0.058
2014	0.297	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	0.291	0.010	0.016	0.014	0.011	0.050	0.279	0.062
Trend 1990-2016, %	-11.5	89.0	2.3	8.4	13.0	17.7	39.0	-17.7

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 5.1.1), 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 (Table 3.45) and the number of vehicles (Table 3.46), 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 (Table 3.47) by emission factors (Table 3.42–3.44). 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 (Table 3.42) 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 3.42 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

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 3.43 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 3.44 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 3.45 Annual mileage driven in the road transport sector (million km per year)

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	5,563.9	684.5	1,577.9	316.6	8,142.9
1995	3,811.1	443.9	838.8	7.6	5,101.4
2000	4,044.1	501.1	894.7	15.6	5,455.5
2005	5,722.3	952.4	894.1	10.6	7,579.4
2006	6,448.3	944.6	932.3	19.3	8,344.5
2007	6,979.3	970.0	950.6	28.2	8,928.1
2008	6,718.5	917.2	936.5	30.0	8,602.2
2009	6,533.0	719.6	807.7	26.7	8,087.0
2010	6,356.2	751.5	965.9	26.6	8,100.2
2011	6,483.9	799.2	1,033.0	24.7	8,340.8
2012	6,618.0	846.4	1,025.9	33.4	8,523.7
2013	6,627.7	842.6	952.4	43.0	8,465.7
2014	6,872.7	876.3	923.7	67.3	8,740.0
2015	7,323.2	816.1	908.4	64.8	9,112.5
2016	7,491.1	1,008.4	844.7	72.9	9,417.1

Table 3.46 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	6.0	507.9
2009	424.0	36.9	27.0	6.7	494.7
2010	422.1	36.3	26.9	7.4	492.7
2011	440.2	37.9	27.2	8.1	513.4
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

Table 3.47 Fuel consumption in the road transport sector (TJ)

Year	Petrol	Diesel	Bioethanol	Biodiesel	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	10,308.2	20,337.4	84.7	0.0	30,730.3

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 2016). Nevertheless, BC emissions from automobile tyre and brake wear and $PM_{2.5}$, PM_{10}, TSP and BC emissions from the road abrasion 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 2016 (Table 3.48).

Table 3.48 Emission factors for road abrasion, tyre and brake wear (g/km)

Transport Category	Road abrasion, g/km			f-BC		
	$PM_{2.5}$	PM_{10}	TSP	Road abrasion	Road tyre wear	Road brake wear
Passenger cars	0.0041	0.0075	0.0150	0.0106	0.153	0.0261
Light duty vehicles	0.0041	0.0075	0.0150	0.0106	0.153	0.0261
Heavy duty vehicles	0.0205	0.0380	0.0760	0.0106	0.153	0.0261
Motorcycles	0.0016	0.0030	0.0060	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 2016).

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 (Table 3.49). Necessary lubricant metal content factors for heavy metal emissions calculations are provided in Table 3.44. The full total of heavy metals in fuel is presumed to be emitted into the atmosphere.

Table 3.49 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

In the 2017 submission, an uncertainty analysis was carried out for the 2015 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 3.50.

Table 3.50 Uncertainties in the road transport sector

Pollutant	Emissions, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	8.160	kt	26.55	3.52	0.53
NMVOC	1.712	kt	7.47	1.01	0.85
SO_x	0.009	kt	0.03	0.004	0.02
NH_3	0.154	kt	1.33	0.25	0.13
$PM_{2.5}$	0.413	kt	4.52	0.45	0.23
PM_{10}	0.541	kt	3.86	0.39	0.12
TSP	0.688	kt	3.27	0.33	0.02
CO	12.417	kt	9.69	1.62	4.74
Pb	0.277	t	0.97	0.26	0.71
Cd	0.008	t	1.04	0.14	0.02
PCDD/PCDF	0.311	g I-TEQ	7.51	14.50	4.25
B(a)p	0.010	t	0.50	0.80	0.44
B(b)f	0.015	t	0.66	0.89	0.36
B(k)f	0.014	t	1.16	1.53	0.73
I(1,2,3-cd)p	0.010	t	0.69	1.08	0.29
HCB	0.0003	kg	0.11	0.27	0.01
PCB	0.0001	kg	0.002	0.002	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.

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.

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

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 5.9%, 2.3% and 0.8% respectively, in the transport sector in 2016. The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 67.7%, 68.9% and 73.4% respectively. The trend of all the emissions is given in Table 3.51. During the same period, fuel consumption decreased 68.8%.

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 2016, volume figures for the Estonian transport companies fell for the fifth year in a row. Although the passenger traffic volume grew, the carriage of goods decreased by 9.5%, amounting to

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25.4 million tonnes. A total of 15.7 million tonnes of goods were transported by domestic rail traffic and 9.6 million tonnes by international traffic, which was 4.9% more and 26.1% less, respectively, in comparison to 2015's figures. The rail freight transport volume has decreased notably from 2011. When compared to 2015's figures, the rail freight volume has fallen by approximately 24.9% in total, and even more (32.3%) at the international level. The major change in the rail sector is influenced by the bilateral sanctions of the European Union and Russia which were established in the second half of 2014 and which will continue to affect development in rail transport services.

Despite the increasing trend in passenger transport figures, the emissions decline in the railway sector was in line with the freight transport performance which influenced the overall railway sector significantly. Therefore, fuel consumption decreased by 20.8% in 2016 when compared to 2015, and a significant decrease in emissions for this period can be observed. Emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have decreased by 21.1% during that period. As shown in Figure 3.43, freight turnover shows similar changes in this trend and, therefore, all of the emissions are directly influenced by freight rail activity.

Recalculations

SO_x emissions have been recalculated for the period 2011-2015 and BC emissions for the period 2000-2002. An overview of the updated data is given in Chapter 8.

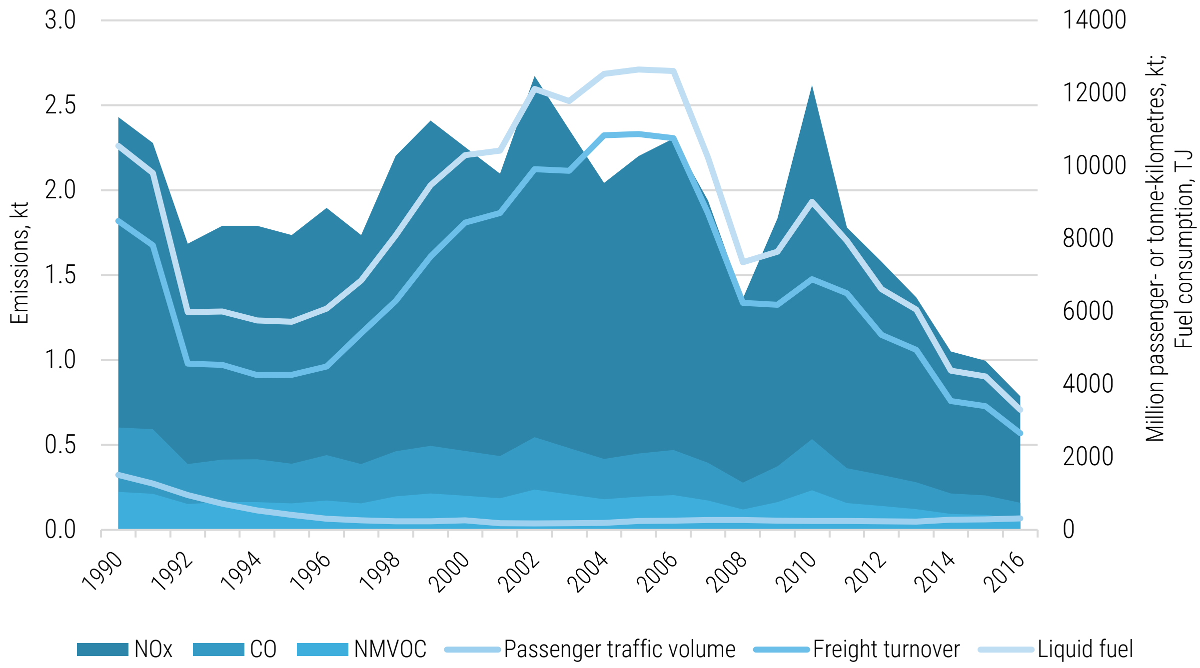

Figure 3.43 NO_x, NMVOC and CO emissions from the railway sector

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Table 3.51 Emissions from railway transport in the period of 1990-2016

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
Trend 1990-2016, %	-67.7	-68.9	-99.9	-67.4	-65.5	-65.5	-73.1	-65.2	-73.4

Table 3.51 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
Trend 1990-2016, %	-100.0	-77.8	-100.0	-100.0	-80.8	-68.2	-78.0	-77.8	-78.5

Table 3.51 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

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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	kg
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
Trend 1990-2016, %	-100.0	-93.4	-91.9	-88.3	-95.4	-92.0	-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 (Table 3.54) 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 3.52.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.54) by emission factors (Table 3.53). 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 3.52 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
PCB	mg/t	NA	μg/GJ	170

Table 3.53 Sulphur content of fuel (by weight)

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

Table 3.54 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

3.3.4.3. Uncertainty

In the 2017 submission, an uncertainty analysis was carried out to the year 2015 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 3.64.

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 2016 was: NO_x – 4.2%, NMVOC – 5.7%, CO – 2.0%. Detailed emission data are provided in Table 3.55.

Deviations of time series can be explained by changing statistical fuel consumption in the national navigation sector (Figure 3.44). Fuel consumption increased 12.3% in 2016 compared to 2015, therefore all the emissions increased also in same extent.

Recalculations

The emissions of SO_x were recalculated for the year 2015. The reason for the recalculation was correction of emission factor used for petrol fuel. An overview of the updated data is given in Chapter 8.

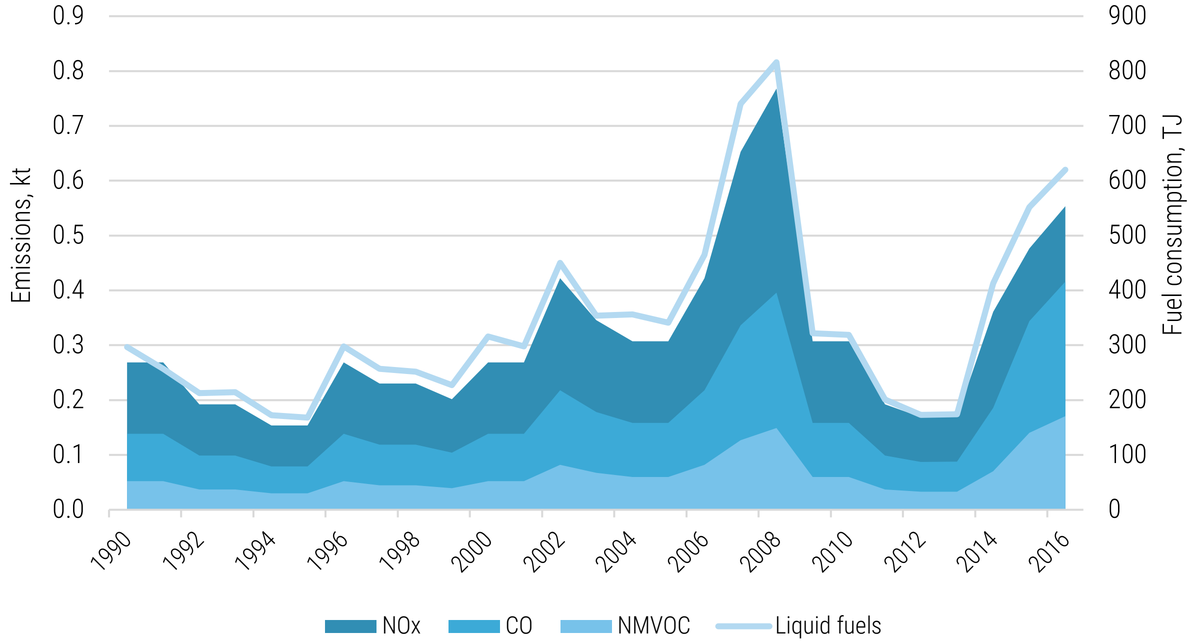

Figure 3.44 NO_x, NMVOC and CO emissions from the national navigation sector

Table 3.55 Emissions from national navigation in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt			t	kt				
1990	0.269	0.052	0.070	0.049	NR	NR	0.032	NR	0.139
1995	0.154	0.030	0.040	0.028	NR	NR	0.018	NR	0.079
2000	0.269	0.052	0.028	0.049	0.032	0.032	0.032	0.018	0.139
2005	0.307	0.060	0.032	0.056	0.037	0.037	0.037	0.020	0.158
2006	0.422	0.082	0.044	0.077	0.051	0.051	0.051	0.028	0.218
2007	0.653	0.127	0.068	0.119	0.078	0.078	0.078	0.043	0.337
2008	0.768	0.149	0.080	0.140	0.092	0.092	0.092	0.051	0.396
2009	0.307	0.060	0.032	0.056	0.037	0.037	0.037	0.020	0.158
2010	0.307	0.060	0.016	0.056	0.037	0.037	0.037	0.020	0.158
2011	0.192	0.037	0.010	0.035	0.023	0.023	0.023	0.013	0.099
2012	0.169	0.033	0.009	0.031	0.020	0.020	0.020	0.011	0.087
2013	0.170	0.033	0.009	0.031	0.020	0.020	0.020	0.011	0.087
2014	0.361	0.070	0.019	0.066	0.043	0.043	0.043	0.024	0.186
2015	0.477	0.140	0.025	0.087	0.060	0.060	0.060	0.031	0.344
2016	0.554	0.171	0.029	0.102	0.070	0.070	0.070	0.037	0.416
Trend 1990-2016, %	106.0	227.3	-58.9	107.3	116.3	116.3	116.3	106.6	200.2

Table 3.55 continues

Year	Cd	Cr	Cu	Ni	Se	Zn	B(a)p	B(b)f	PAHs Total
	kg		t	kg		t	kg		
1990	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
1995	0.040	0.200	0.007	0.280	0.040	0.004	0.120	0.200	0.320
2000	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
2005	0.080	0.400	0.014	0.560	0.080	0.008	0.240	0.400	0.640
2006	0.110	0.550	0.019	0.770	0.110	0.011	0.330	0.550	0.880
2007	0.170	0.850	0.029	1.190	0.170	0.017	0.510	0.850	1.360
2008	0.200	1.000	0.034	1.400	0.200	0.020	0.600	1.000	1.600
2009	0.080	0.400	0.014	0.560	0.080	0.008	0.240	0.400	0.640
2010	0.080	0.400	0.014	0.560	0.080	0.008	0.240	0.400	0.640
2011	0.050	0.250	0.009	0.350	0.050	0.005	0.150	0.250	0.400
2012	0.044	0.220	0.007	0.308	0.044	0.004	0.132	0.220	0.352
2013	0.044	0.221	0.008	0.309	0.044	0.004	0.133	0.221	0.354
2014	0.094	0.470	0.016	0.658	0.094	0.009	0.282	0.470	0.752
2015	0.124	0.620	0.021	0.868	0.124	0.012	0.372	0.620	0.992
2016	0.144	0.720	0.024	1.008	0.144	0.014	0.432	0.720	1.152
Trend 1990-2016, %	**105.6**	**105.6**	**105.6**	**105.6**	**105.6**	**105.6**	**105.6**	**105.6**	**105.6**

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 (Table 3.58) by respective emission factors. Default emission factors for the main pollutants are taken from EMEP/EEA Guidebook 2016 and are presented in Table 3.56.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.58) by emission factors (Table 3.57). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation:

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

where

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

Table 3.56 Emission factors for national navigation transport

Pollutant	Unit	Diesel / light fuel oil	Petrol
NO_x	kg/t	38.4	3.27
NMVOC	kg/t	7.45	233
NH_3	kg/t	0.007	0.003
$PM_{2.5}$	kg/t	4.6	12.6
PM_{10}	kg/t	4.6	12.6
TSP	kg/t	4.6	12.6
BC	kg/t	2.53	0.63
CO	kg/t	19.8	481
Cd	g/t	0.01	NE
Cr	g/t	0.05	NE
Cu	g/t	1.7	NE
Ni	g/t	0.07	NE
Se	g/t	0.01	NE
Zn	g/t	1.0	NE
B(a)p	g/t	0.03	NE
B(b)f	g/t	0.05	NE

Table 3.57 Sulphur content of fuel (by weight)

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

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Table 3.58 Fuel consumption in the navigation sector in the period of 1990-2016 (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	396	0	413
2015	17	526	9	552
2016	17	591	12	620

3.3.5.3. Uncertainty

In the 2017 submission, an uncertainty analysis was carried out to the year 2015 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 3.64.

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 30.4%, 37.0% and 37.7% respectively, in the transport sector in 2016.

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 2016, where the emissions of nitrogen oxides, non-methane volatile compounds, sulphur oxide and carbon monoxide have decreased by approximately 60.2%, 48.3%, 99.6% and 71.6% compared to 1990. Also, the amount of fuel consumed decreased by 60.7% during that period. Therefore, deviations of time series can be explained by changing statistical fuel consumption in non-road machinery sector (Figures 3.45-47) and the share of some specific sector in total non-road machinery emissions. Detailed emission data are provided in Table 3.59.

In 2016, fuel consumption decreased by approximately 10.2% when compared to 2015's figures. As a result of this, nitrogen oxide emissions decreased by 15.6% and sulphur dioxide by 8.9%. In opposition to this, NMVOC and CO emissions increased by 5.1% and 59.5% respectively. The significant growth in CO emissions was due to the increase in petrol consumption, which was approximately seven times higher in the industrial machinery sector because petrol has relatively high emission factors when compared to diesel and light fuel oil.

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 90.3% of total energy use in these sectors, with diesel being the dominant fuel type, accounting for 91% of the total energy use in 2016.

Recalculations

Recalculations have been carried out for all of the sectors listed in this chapter. The main reasons for the recalculations were updated emission factors in the new, revised EMEP/EEA Guidebook 2016. Also, some corrections have been made which concern the use of corrected sulphur content in fuels, BC emission factors, and corrections carried out in emissions calculations for petrol fuels. Recalculations led to a change in total emissions. A detailed overview is given in each transport subsector and in Chapter 8.

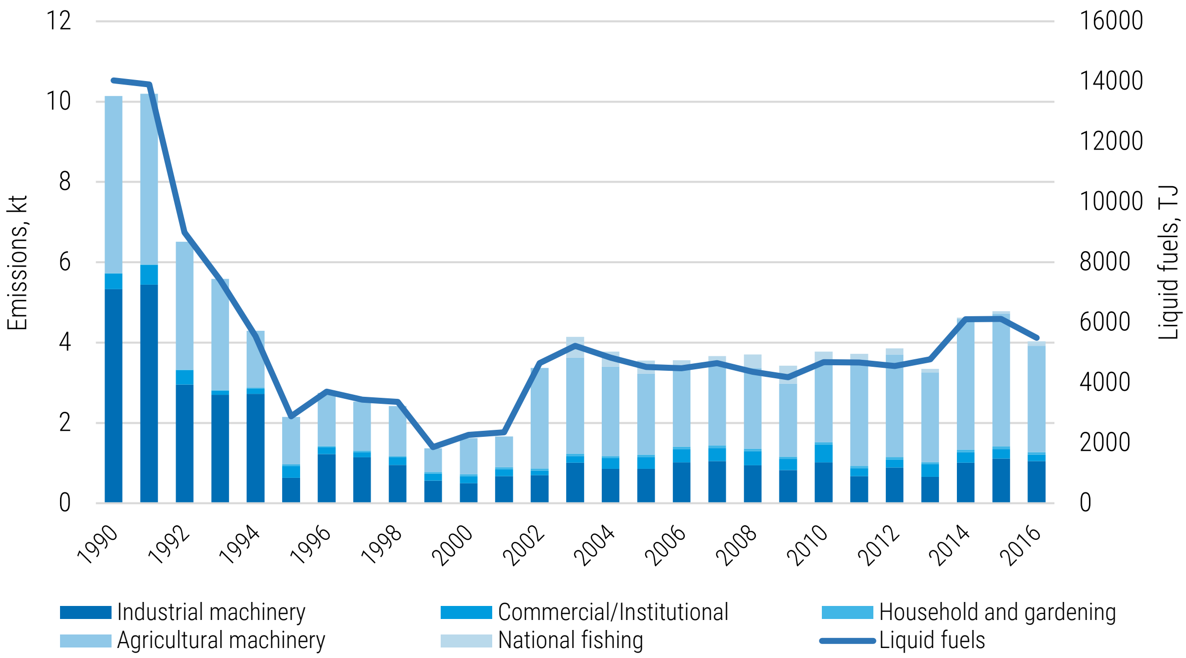

Figure 3.45 NO_x emissions from other non-road machinery

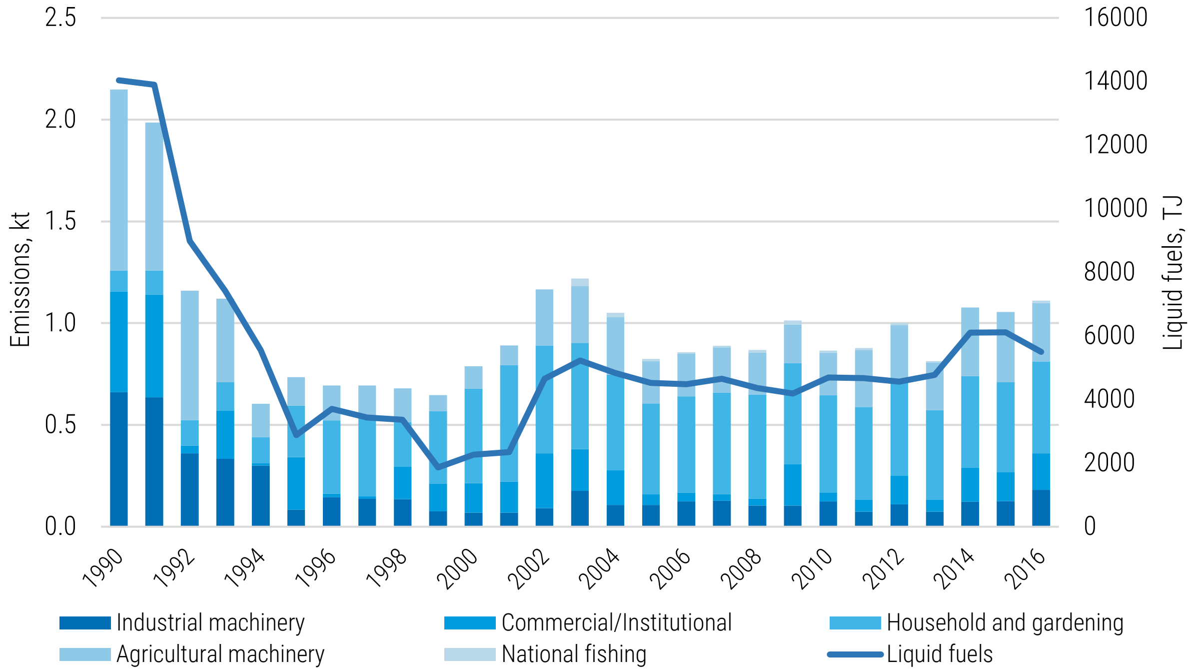

Figure 3.46 NMVOC emissions from other non-road machinery

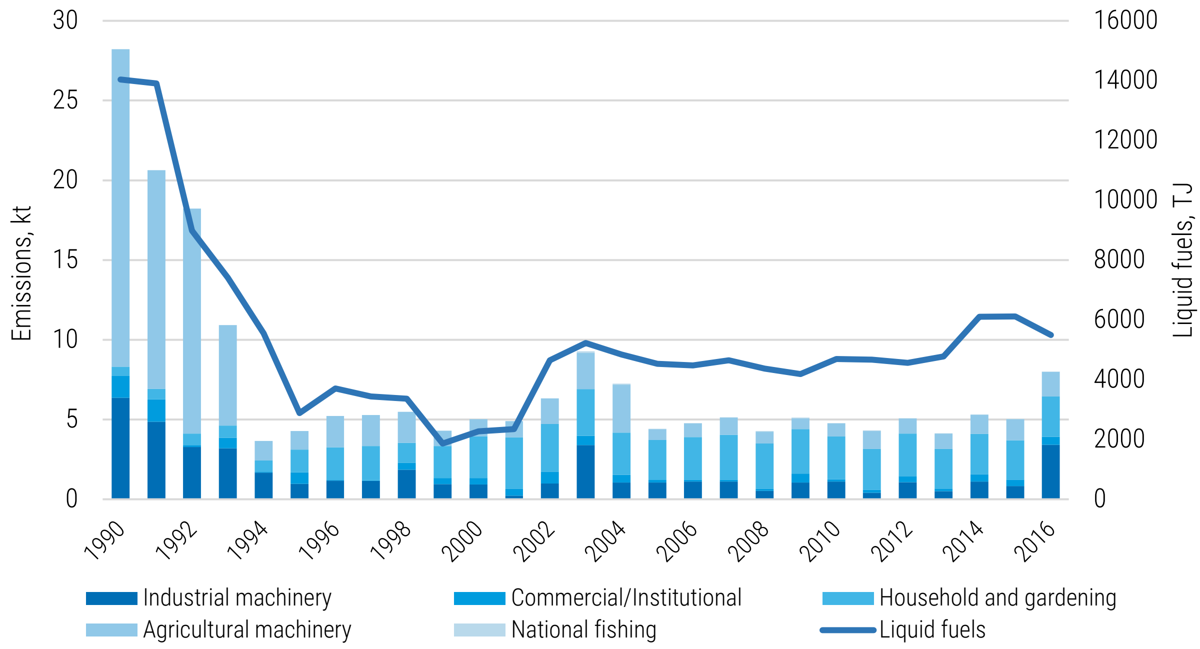

Figure 3.47 CO emissions from other non-road machinery

Table 3.59 Emissions from other non-road machinery in the period of 1990-2016

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	10.140	2.148	3.036	0.003	NR	NR	0.615	NR	28.223
1995	2.145	0.735	0.640	0.001	NR	NR	0.134	NR	4.283
2000	1.626	0.789	0.390	0.000	0.104	0.104	0.104	0.057	5.015
2005	3.553	0.825	0.094	0.001	0.202	0.202	0.202	0.115	4.426
2006	3.557	0.857	0.071	0.001	0.210	0.210	0.210	0.120	4.789
2007	3.661	0.888	0.066	0.001	0.216	0.216	0.216	0.124	5.143
2008	3.707	0.868	0.068	0.001	0.212	0.212	0.212	0.120	4.272
2009	3.426	1.014	0.016	0.001	0.193	0.194	0.194	0.107	5.130
2010	3.777	0.865	0.021	0.001	0.219	0.220	0.220	0.126	4.792
2011	3.719	0.879	0.036	0.001	0.216	0.216	0.216	0.123	4.321
2012	3.853	1.001	0.023	0.001	0.227	0.227	0.227	0.129	5.090
2013	3.343	0.813	0.003	0.001	0.198	0.198	0.198	0.113	4.140
2014	4.625	1.078	0.007	0.001	0.275	0.275	0.275	0.158	5.308
2015	4.778	1.057	0.014	0.001	0.283	0.283	0.283	0.163	5.026
2016	4.034	1.110	0.013	0.001	0.238	0.239	0.239	0.135	8.018
Trend 1990-2016, %	-60.2	-48.3	-99.5	-62.2	128.6	128.7	-61.2	136.4	-71.6

Table 3.59 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg		t				
1990	4.926	0.003	NE	NE	0.016	0.561	0.023	0.003	0.330
1995	0.756	0.001	NE	NE	0.003	0.116	0.005	0.001	0.068
2000	0.082	0.001	NE	NE	0.003	0.091	0.004	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

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg		t				
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	0.046	0.001	0.044	0.059	0.006	0.211	0.010	0.001	0.125
Trend 1990-2016, %	-99.1	-62.2	-77.9	-77.9	-62.2	-62.4	-56.2	-58.2	-62.1

Table 3.59 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	kg					g	
1990	NE	10.225	16.166	NE	NE	26.391	NA	NA
1995	NE	2.092	3.352	NE	NE	5.444	NA	NA
2000	NE	1.671	2.618	NE	NE	4.289	NA	NA
2005	0.546	3.030	4.925	NE	NE	7.955	0.336	0.159
2006	0.277	3.199	5.195	NE	NE	8.394	0.170	0.081
2007	0.273	3.307	5.364	NE	NE	8.671	0.168	0.080
2008	0.566	3.154	5.137	NE	NE	8.291	0.348	0.166
2009	0.736	2.859	4.608	NE	NE	7.467	0.453	0.215
2010	0.445	3.304	5.374	NE	NE	8.678	0.274	0.130
2011	0.232	3.316	5.409	NE	NE	8.725	0.143	0.068
2012	0.248	3.472	5.642	NE	NE	9.114	0.153	0.073
2013	0.144	3.038	4.948	NE	NE	7.986	0.088	0.042
2014	0.071	4.245	6.931	NE	NE	11.176	0.044	0.021
2015	0.090	4.356	7.129	NE	NE	11.485	0.055	0.026
2016	0.192	3.791	6.073	NE	NE	9.864	0.118	0.056
Trend 1990-2016, %	-77.9	-62.9	-62.4	NE	NE	-62.6	-77.9	-77.9

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 (Table 3.63) by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Guidebook 2013 and are presented in Table 3.60.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.63) by emission factors (Table 3.61). 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 (Table 3.62). Equation:

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

Table 3.60 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

Table 3.61 Sulphur content of fuel (by weight)

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

Table 3.62 Lead content in fuel

NFR	Fuel	Unit	1990	2000	2004
1A2gvii 1A4aii 1A4bii 1A4cii 1A4ciii	Petrol	g/l	0.150	0.013	0.005
1A4ciii	Diesel/ Light fuel oil	g/t	0.130	0.130	0.130

Table 3.63 Total fuel consumption in other mobile sectors for the period of 1990-2016 (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	399	5,494

3.3.6.3. Uncertainty

An uncertainty analysis was carried out to the year 2015 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 3.64.

Table 3.64 Uncertainties in non-road mobile machinery sector

Pollutant	Emission, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	6.308	kt	20.52	12.07	2.54
NMVOC	1.279	kt	5.58	2.28	0.69
SO_x	0.082	kt	0.26	0.08	0.04
NH_3	0.001	kt	0.01	0.004	0.001
$PM_{2.5}$	0.351	kt	3.84	1.1	0.49
PM_{10}	0.353	kt	2.52	0.66	0.25
TSP	0.354	kt	1.68	0.44	0.03
CO	4.846	kt	3.78	43435	0.55
Pb	0.025	t	0.09	0.03	0.12
Cd	0.002	t	0.23	0.07	0.01
Hg	0.00002	t	0.004	0.002	0.02
PCDD/PCDF	0.00009	g I-TEQ	0.002	0.01	0.38
B(a)p	0.005	t	0.26	0.31	0.52
B(b)f	0.009	t	0.37	0.45	0.63
B(k)f	0.001	t	0.06	0.11	0.37
I(1,2,3-cd)p	0.0002	t	0.01	0.02	0.29
HCB	0.0001	kg	0.02	0.02	0.06
PCB	0.0003	kg	0.01	0.01	0.12

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

Separate emission calculations for 1A4ciii sector for the period 1990-2002. These emissions are included under 1A4cii sector in this submission.

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.

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: 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 55.8% between 1990 and 2016. As of 2012, a significant increase in fuel consumption is apparent: fuel consumption is more than twice higher (7838 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 46.4%, 59.8%, and 56.2% in comparison to 1990's figures. Therefore, emissions from maritime transport are an increasing concern. However, sulphur oxide emissions have decreased by 37.9% 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 3.65.

Estonian maritime transport companies carried 9.1 million passengers in 2016, an increase of 4% from 2015. This is in line with the increase (3.6%) in the number of passenger and cruise ships. At the same time, freight transport continues to decrease. Cargo volumes decreased by 19.8% in 2015 in comparison to 2014's figures. In 2016, freight volumes reached the 33.6 million tons level, which was 3.8% less than the year before. One of the reasons for the constant drop in freight volume is sanctions between the European Union and Russia, but also the fact that instead of using the services of Estonian ports, Russia is more and more using Russia's own ports for sending transit goods abroad.

In 2016, emissions from the international maritime navigation sector have decreased compared to 2015. This decrease in emissions occurred due to lower fuel consumption in 2016 (−6.0%). The emissions of NO_x, NMVOC, SO_x and CO decreased by 7.1%, 6.0%, 17.4% and 6.4% respectively during the same period.

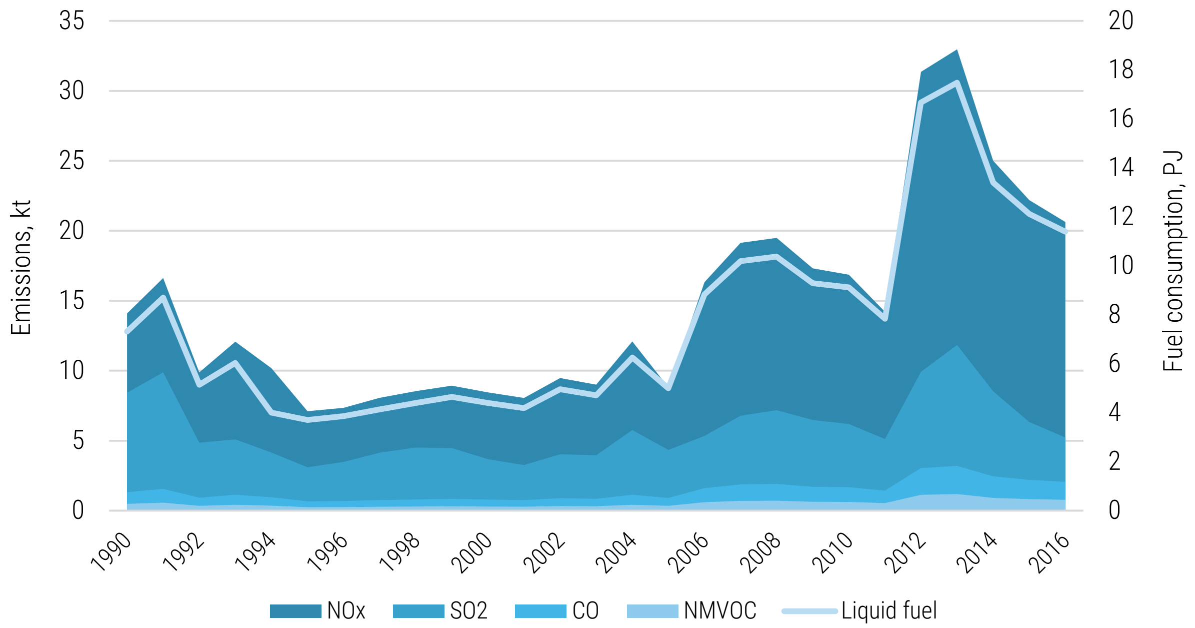

Figure 3.48 NO_x, NMVOC, SO_x and CO emissions from the international navigation sector

Table 3.65 Emissions from the international maritime navigation sector in the period of 1990-2016

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
Trend 1990-2016, %	46.4	59.8	-37.9	NE	155.7	149.5	19.1	158.4	56.2	45.0	35.3

Table 3.65 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
Trend 1990-2016, %	74.2	13.7	14.3	44.2	12.3	34.2	56.2	24.8	38.5	14.1

3.3.7.2. Methodological Issues

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

Emission calculations from hotelling and manoeuvring activities are calculated by using statistical data, such as the number of vessels and vessel size per category (Tables 3.68–69). Although there are no activity data available at the level required by the Tier 3 methodology, adjustments, suggested by the EMEP/EEA Guidebook 2016 (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 (Table 3.70) is multiplied by respective emission factors (Tables 3.66). Default emission factors for the main pollutants and heavy metals are taken from the EMEP/EEA Guidebook 2016.

SO_2 emissions are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.70) by emission factors (Table 3.67). SO_2 emissions are estimated based on the assumption that all sulphur in the fuel is completely converted into SO_2. Equation:

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

Table 3.66 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
PCB	mg/t	0.57	0.038

Table 3.67 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 3.68 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2016

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

Table 3.69 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2016 (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

Table 3.70 Fuel consumption in the international maritime navigation sector in the period of 1990-2016 (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

3.3.7.3. Uncertainty

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

3.3.7.4. Source-Specific QA/QC and Verification

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

3.3.7.5. Source-Specific Planned Improvements

There are currently no improvements planned for this sector.

3.4. Fugitive Emissions (NFR 1B)

3.4.1. Overview of the Sector

Under fugitive emissions from fuels, Estonia reports on NMVOC, TSP, PM_{10}, $PM_{2.5}$, BC, CO, NH_3, NO_x, SO_2 and HM emissions from the following activities:

(Photo: Muuga Terminal; Source: www.portoftallinn.com)

Table 3.71 Fugitive emissions activities

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

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NMVOC emissions from this sector contribute about 5% to total national emissions and have decreased by about 51% up to 2016 compared to 1990 due to decreasing emissions from terminals and also has slightly increased (by 2.5%) in comparison with 2015 due to insignificant increase in emissions from gasoline distribution (Figure 3.49, 3.51 and Table 3.73). Emissions of other pollutants are very small compared to the emissions from the other sectors (Table 3.72).

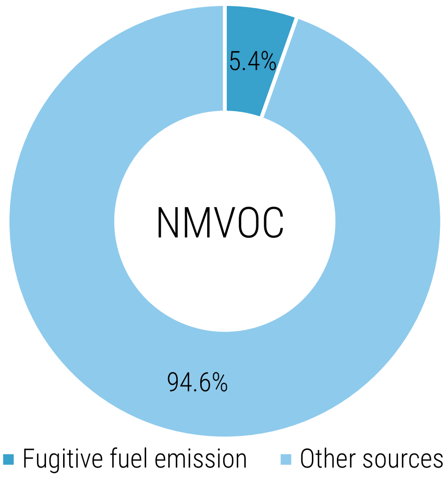

Figure 3.49 NMVOC emission distribution in 2016

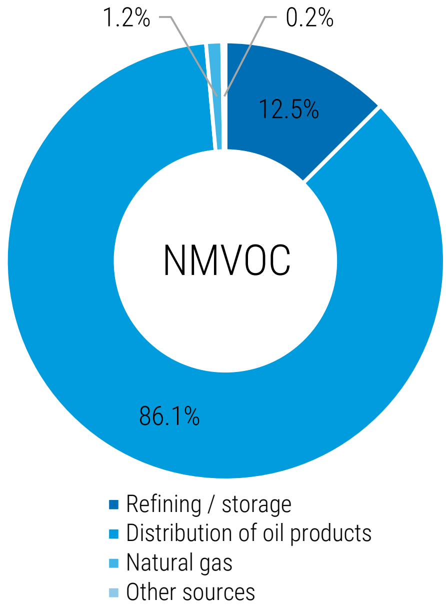

Figure 3.50 NMVOC emission distribution within the fuel fugitive emission sector in 2016

Figure 3.50 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (86%).

Table 3.72 Fugitive emission in the period of 1990-2016 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC	NO_x	CO	NH_3	SO_2
1990	2.474	NR	NR	NR	NR	NA	NA	NA	NA
1995	1.632	NR	NR	NR	NR	NA	NA	NA	NA
2000	4.326	0.010	0.050	0.110	NA	0.010	0.200	NA	NA
2005	4.284	0.010	0.090	0.180	NA	0.010	0.170	0.050	NA
2006	3.516	0.010	0.110	0.220	NA	0.010	0.250	0.060	NA
2007	1.922	0.010	0.090	0.180	NA	0.010	0.220	0.090	0.010
2008	1.593	0.014	0.102	0.202	NA	0.017	0.276	0.102	0.013
2009	1.684	0.031	0.142	0.267	0.0001	0.036	0.168	0.089	0.026
2010	1.818	0.034	0.170	0.309	0.0002	0.035	0.188	0.115	0.018
2011	2.179	0.042	0.187	0.351	0.0002	0.032	0.813	0.175	0.076
2012	1.824	0.051	0.182	0.329	0.0001	0.019	2.011	0.212	0.038
2013	1.471	0.021	0.103	0.190	0.0003	0.024	1.353	0.192	0.051
2014	1.366	0.020	0.096	0.187	0.0002	0.025	1.028	0.191	0.038
2015	1.186	0.018	0.090	0.181	0.0001	0.024	0.183	0.196	0.032
2016	1.215	0.014	0.069	0.132	0.0001	0.020	0.142	0.142	0.024
Trend 1990-2016, %	-50.9	35.7	37.4	20.2					

The emission data for 1B1c Other fugitive emissions from solid fuels. 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.

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3.4.2. Distribution of Oil Products (NFR 1B2av)

3.4.2.1. Source Category Description

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

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

(Photo by Ilmar Saabas)

In Estonia, oil terminals and service stations must have permits when the total loading turnover exceeds 2000 m^3 per year[8]. That means only the smallest service stations are regarded as diffuse sources. Emissions from oil terminals are based on the facilities data. 20 terminals presented reports on emissions in 2016. In the table below NMVOC emissions from gasoline distribution and terminals are presented.

Table 3.73 NMVOC emissions from liquid fuel distribution in the period of 1990-2016 (kt)

	1990	1995	2000	2005	2006	2007	2008	2009
Gasoline distribution	2.055	0.971	1.108	0.467	0.482	0.514	0.508	0.467
Terminals	0.323	0.625	3.157	3.199	2.626	1.2	0.629	0.799
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016. %**
Gasoline distribution	0.447	0.478	0.511	0.46	0.427	0.397	0.404	-80.3
Terminals	0.644	1.265	0.854	0.74	0.737	0.594	0.642	98.8

[8] Emission levels of pollutants and capacities of plants used, beyond which an ambient air pollution and special pollution permit are required. Regulation No. 101 of the Minister of Environment of 2 August 2004.

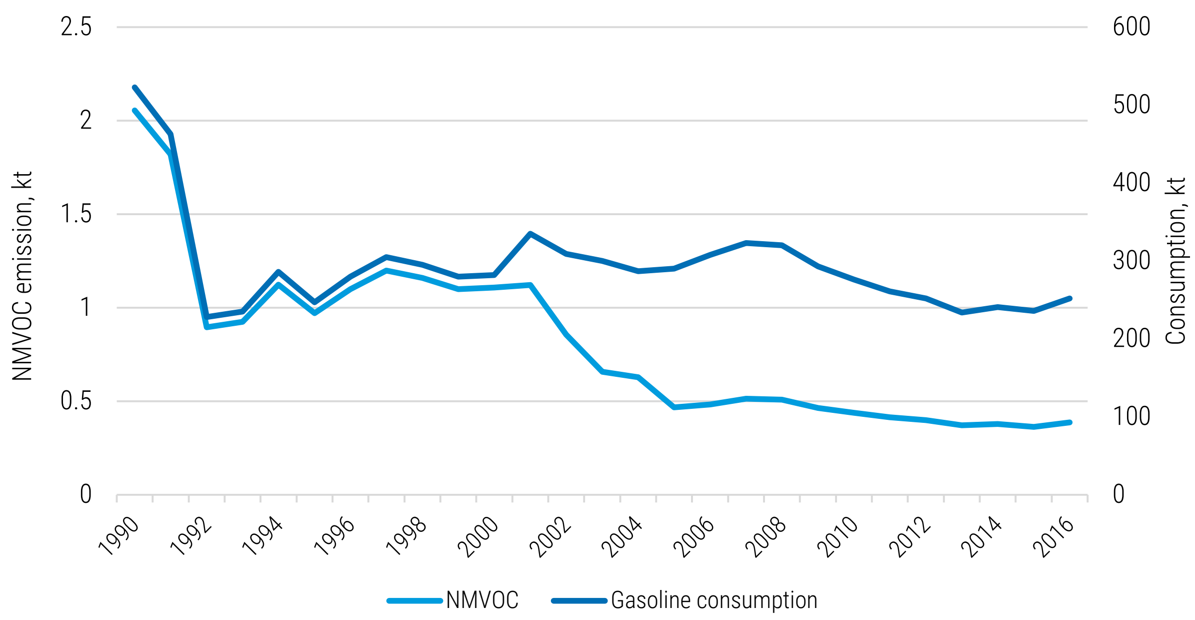

Figure 3.51 NMVOC emission and gasoline distribution in the period of 1990-2016

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.

It is likely that the majority of the non-permitted gasoline stations have a turnover between 100 and 2000 m^3. Since 2005, these must have vapour collection and recovery equipment.

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 88.1% from total gasoline distribution in 2015). Facilities are obligate to use the national method for NMVOC emission calculation Naftasaaduste laadimisel välisõhku eralduvate lenduvate orgaaniliste ühendite heitkoguste määramismeetodid - Elektrooniline Riigi Teataja

In the period 2005-2016, 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 2005-2016, the Tier 2 technology specific emission factors for Service Stations from the EMEP/EEA Guidebook 2016 is applied. 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 2016 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.

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 3.74.

Table 3.74 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.

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

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Table 3.75 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 (Table 3.76).

Table 3.76 Consumption of motor gasoline in the period of 1990-2016 (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
Trend 1990-2016, %	-51,8

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

There are currently no improvements planned for this sector.

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 (Figure 3.52).

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.

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 2,314 km long, of which 878 km are for transmission and 1,436 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. Nitrofert halted operations since 2014.

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.

Figure 3.52 Map of high-pressure gas distribution pipelines in Estonia

Table 3.77 NMVOC emissions from gas distribution in the period of 1990-2016 (kt)

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

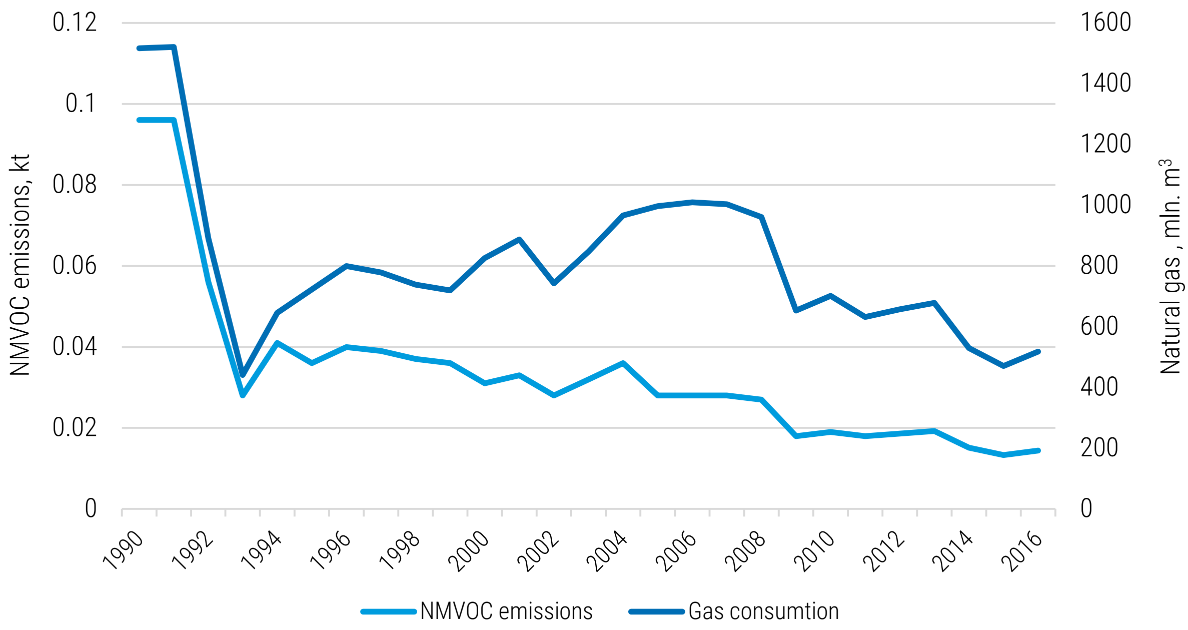

Figure 3.53 NMVOC emission from natural gas distribution in the period of 1990-2016

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 3.78-79. 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.

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.

Table 3.78 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 3.79 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

Activity data

Activity data on the subject of annual natural gas consumption are available from Statistics Estonia (Table 3.80).

Table 3.80 Gas consumption in the period 1990-2016 (mln m^3)

	1990	1995	2000	2005	2006	2007	2008	2009
Gas consumption	1 516	723	826	997	1 009	1 003	961	653
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**1990-2016, %**
Gas consumption	701	632	657	678	530	471	518	**-65.8**

3.4.3.3. Uncertainty

An uncertainty analysis was carried out to the year 2015 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 3.81.

Table 3.81 Uncertainties in fugitive emission sector

Pollutant	Emission, 2015	Unit	Share in total emission. %	Uncertainty. %	Trend uncertainty 1990-2015. %
NO_x	0.073	kt	0.24	0.04%	0.00%
NMVOC	1.186	kt	5.17	2.16%	0.13%
SO_x	0.032	kt	0.10	0.02%	0.00%
NH_3	0.196	kt	1.68	1.19%	NA
$PM_{2.5}$	0.018	kt	0.19	0.13%	0.01%
PM_{10}	0.090	kt	0.65	0.52%	0.15%
TSP	0.181	kt	0.86	0.70%	NA
CO	0.183	kt	0.14	0.13%	0.00%

3.4.3.4. Source-Specific QA/QC and Verification

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

3.4.3.5. Source-Specific Planned Improvements

To check of point sources data for NFRs 1B1c 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

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 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	Particles emissions from this sector are allocated to 1A2f.	IE
	2A5a	Quarrying and mining of minerals other than coal	Includes emissions from quarrying and mining of limestone and dolomite. Data reported by operators.	NO_X, SO_X, TSP, PM_{10}, $PM_{2.5}$, CO
	2A5b	Construction and demolition	Includes emissions from construction and demolition.	TSP, PM_{10}, $PM_{2.5}$
	2A5c	Storage, handling and transport of mineral products	Emissions from this sector are allocated to 2L. Data reported by operators.	IE
	2A6	Other Mineral products	Includes emissions mainly from crushed stone production. Data reported by operators.	TSP, PM_{10}, $PM_{2.5}$
2B		Chemical industry		
	2B10a	Other chemical industry	Includes emission from urea and formaldehyde production. Data reported by two operators.	NO_X, NMVOC, NH_3, SO_X, TSP, PM_{10}, $PM_{2.5}$, CO, BC
	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
	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}, $PM_{2.5}$

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NFR		Source	Description	Emissions reported
	2C5	Lead production	Includes emission from lead battery and accumulators recycling plant. Data reported by operators.	SO_x, TSP, PM_{10}, $PM_{2.5}$, Pb
	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, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO, BC, Pb, Cr, Cu , 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}, $PM_{2.5}$, 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}, $PM_{2.5}$
2K	2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	Includes emission from consumption of POPs and heavy metals.	NMVOC, NH_3
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.	NO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, CO

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 2016 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 2016 Tier 1 method).

BC emissions from industry are calculated for the period 2000–2016.

The share of industry sources in total emissions in 2016 was: NMVOC – 3.4%, $PM_{2.5}$ – 3%, PM_{10} – 12.6% and TSP about 27.4%. 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 95%, 86.6% and 76.4%, respectively.

The emissions of $PM_{2.5}$, PM_{10} and TSP decreased in 2016 compared to 2015 by 28.1%, 33.3% and 33.1%. Decline in construction sector (non-residential building) was the cause of increase in emissions of particulates. Emissions of other substances remained approximately at the level of 2015.

The trend of NMVOC and PM emissions in these categories are given in Figure 4.1 and 4.4. The distribution of NMVOC and PM_{10} emissions by sources of pollution inside of manufacturing industry sector in 2016 are shown in Figures 4.2 and 4.3. The biggest polluter of NMVOC emissions were Pulp, paper and food industries – 87.6% (mainly food production), the chemistry industry is responsible for the 7% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (83.7%, 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 1990-2016

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb
	kt									t
1990	0.190	15.341	NA	0.530	NR	NR	6.172	NR	0.340	NA
1995	0.070	4.379	NA	0.240	NR	NR	1.390	NR	0.000	NA
2000	0.199	2.085	0.040	0.124	0.311	1.023	2.766	0.005	0.530	0.010
2005	0.176	1.569	0.130	0.201	0.582	2.269	6.472	0.009	0.340	NA
2006	0.268	1.299	0.120	0.159	0.619	2.486	7.213	0.009	0.350	0.001
2007	0.250	1.068	0.020	0.135	0.545	2.350	7.063	0.007	0.440	0.001
2008	0.295	0.959	0.020	0.181	0.699	2.784	7.825	0.012	0.477	0.001
2009	0.058	0.881	0.025	0.083	0.367	1.804	5.207	0.005	0.424	0.006
2010	0.037	0.861	0.030	0.070	0.339	1.399	3.981	0.005	0.461	0.014
2011	0.062	0.919	0.022	0.093	0.234	1.208	3.605	0.003	0.420	0.011
2012	0.047	0.909	0.001	0.103	0.197	1.141	3.509	0.002	0.336	0.010
2013	0.200	0.892	0.000	0.162	0.365	1.736	4.988	0.006	0.381	0.011
2014	0.032	0.860	0.001	0.052	0.235	1.336	4.149	0.002	0.413	0.017
2015	0.045	0.809	0.002	0.065	0.313	2.114	6.734	0.002	0.405	0.010
2016	0.045	0.768	0.001	0.071	0.225	1.410	4.508	0.002	0.378	0.011
Trend 1990-2016, %	-76.4	-95.0	-97.4	-86.6	-27.7	37.8	-27.0	-64.2	11.1	9.4

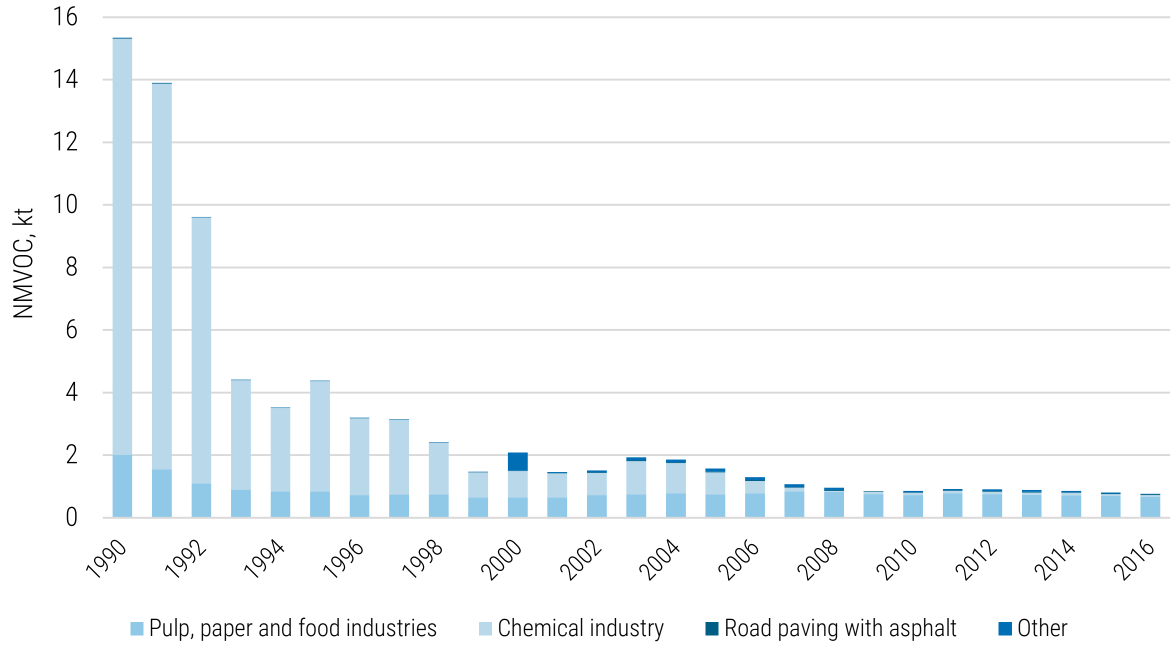

Figure 4.1 NMVOC emissions from the industrial sector in the period of 1990-2016

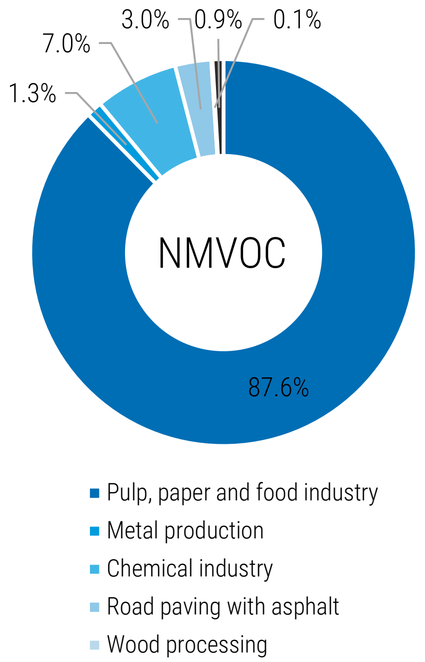

Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2016

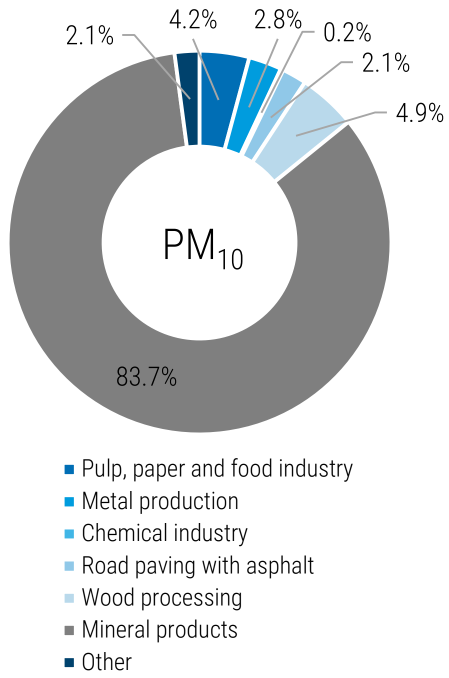

Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2016

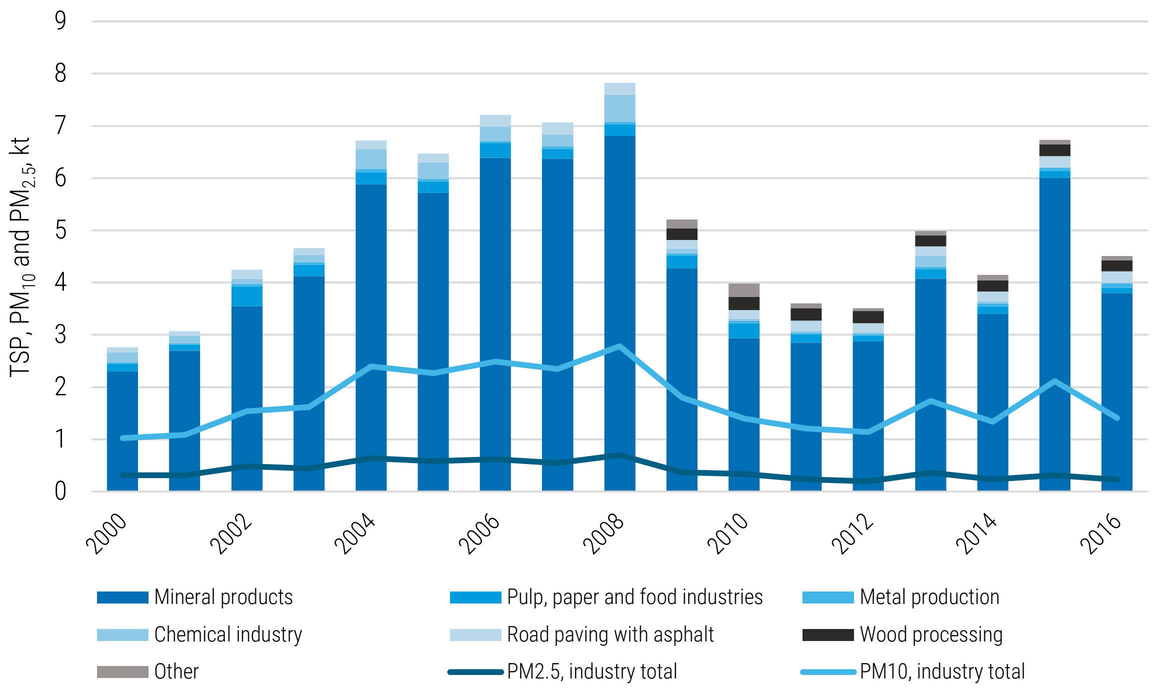

Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2016

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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 all pollutants emissions are reported Under NFR 1A2f.

Estonia's construction industry has largely been oriented to the internal market and therefore, its development is closely linked to overall economic development. In economically good times volumes are growing faster and during a slowdown of economy, construction volumes decrease significantly. The economic crisis affected very strongly the economic performance of the construction sector and the dependent areas such as spatial planning, design, real estate development, etc. In 2016, over 10,000 construction companies operated in Estonia, of whom 90% are micro-enterprises with fewer than ten employees. Larger companies carrying out general construction works of buildings in Estonia are AS Merko Ehitus, Nordecon AS, AS Ehitusfirma Rand ja Tuulberg, OÜ Astlanda Ehitus, AS Teede REV 2, Lemminkäinen Eesti AS OÜ and other.

2016 as also the fourth year in row when added value generated in the construction sector was decreasing. The drop was 1.6% as compared to 2015.[9]

The completed residential dwelling has increased by about 13% in 2016 comparing to 2015, but non-residential has decreased in the same period by 40%. It is a primary reason of the decreasing of particulates emissions from the mineral industry.

Emissions from the mineral product industry are presented in Table 4.3.

Table 4.3 Pollutant emissions from mineral products in the period of 1990-2016 (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		NA
1995	NA	NA	NA	NA	NR	NR	0.829		NA
2000	NA	0.570	NA	0.010	0.122	0.713	2.296	0.00000	0.040
2005	0.010	0.080	NA	NA	0.285	1.778	5.718	0.00030	0.020
2006	0.010	0.080	NA	NA	0.308	1.979	6.390	0.00015	NA
2007	0.010	NA	NA	NA	0.307	1.954	6.370	0.00000	NA
2008	0.003	NA	0.0022	NA	0.297	2.102	6.808	0.00006	0.003
2009	0.007	NA	0.0005	NA	0.144	1.393	4.278	0.00010	0.006
2010	0.006	NA	0.0004	NA	0.099	0.953	2.934	0.00011	0.005
2011	0.010	NA	0.0009	NA	0.098	0.928	2.848	0.00012	0.008
2012	0.008	NA	0.0009	NA	0.100	0.922	2.872	0.00021	0.007
2013	0.008	NA	0.0000	NA	0.135	1.294	4.078	0.00017	0.007
2014	0.006	NA	0.0000	NA	0.112	1.067	3.404	0.00013	0.006
2015	0.006	NA	0.0001	NA	0.191	1.859	6.005	0.00013	0.006
2016	0.006	NA	0.00001	NA	0.124	1.180	3.798	0.00014	0,006

4.1.2.2. Methodological Issues

As 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 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. Tselluloosi ja tsemendi tootmisel välisõhku eralduvate saasteainete heitkoguste määramismeetodid – Elektrooniline Riigi Teataja.

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 (Table 4.5). Now, Kunda Nordic is obliged to carry out measurements twice a year and report on dioxin emissions. It must be noted that the measured dioxin emissions are much less than the emissions calculated on the basis of the emissions factor. Dioxin emissions are also reported under NFR 1A2giii.

[9] Overview of Economy 2016. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2017

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 Dioxin emission factors for the mineral industry

Year	Cement			Lime			Bricks and tiles		
	Production, tonnes	EF, µg I-TEQ/t	Emission, g	Production, tonnes	EF, µg I-TEQ/t	Emission, g	Production, tonnes	EF, µg I-TEQ/t	Emission, g
1990	938.000	0.6	0.563	185.000	0.07	0.0130	541.401	0.2	0.108
1991	905.000	0.6	0.543	207.000	0.07	0.0140	592.206	0.2	0.118
1992	483.000	0.6	0.290	92.000	0.07	0.0060	350.444	0.2	0.071
1993	354.000	0.6	0.212	21.000	0.07	0.0010	139.217	0.2	0.028
1994	402.500	0.6	0.242	18.000	0.07	0.0010	128.283	0.2	0.026
1995	417.600	0.6	0.251	16.800	0.07	0.0010	81.343	0.2	0.016
1996	387.700	0.6	0.233	17.400	0.07	0.0010	68.009	0.2	0.014
1997	422.500	0.07	0.030	19.500	0.07	0.0010	62.674	0.2	0.013
1998	321.300	0.07	0.022	32.100	0.07	0.0020	54.674	0.2	0.011
1999	357.700	0.07	0.025	23.300	0.07	0.0020	46.139	0.2	0.009
2000	329.100	0.07	0.023	21.200	0.07	0.0010	45.072	0.2	0.009
2001	404.600	0.07	0.028	20.000	0.07	0.0010	54.140	0.2	0.011
2002	465.900	0.07	0.033	21.200	0.07	0.0010	61.608	0.2	0.012
2003	506.300	0.07	0.035	32.000	0.07	0.0020	63.741	0.2	0.013
2004	506.300	0.07	0.035	32.000	0.07	0.0020	63.741	0.2	0.013
2005	726.000	0.07	0.051	37.200	0.07	0.0020	69.342	0.2	0.014
2006	848.900	0.07	0.059	39.700	0.07	0.0027	82.667	0.2	0.016
2007	936.200	0.07	0.065	43.500	0.07	0.0030	143.485	0.2	0.029
2008	806.100	0.07	0.056	59.400	0.07	0.0041	113.081	0.2	0.023
2009	326.000	0.07	0.023	30.200	0.07	0.0021	38.938	0.2	0.007
2010	536.700	0.07	0.037	27.200	0.07	0.0019	56.500	0.2	0.011
2011	719.002	0.004	0.003	36.100	0.07	0.0025	84.544	0.2	0.017
2012	714.600	0.006	0.004	72.000	0.07	0.0050	107.213	0.2	0.021
2013	691.400	0.011	0.007	69.600	0.07	0.0049	118.148	0.2	0.024
2014	720.480	0.007	0.005	69.600	0.07	0.0049	118.148	0.2	0.024
2015	356.287	0.036	0.013	43.018	0.07	0.0030	61.341	0.2	0.012
2016	422.800	0.0175	0.0074	42.084	0.07	0.0029	54.407	0.2	0.011

Construction and demolition sector is a key source of emissions of TSP (22% of total emission, Figure 4.5) and PM_{10} (9.8% of total emission).

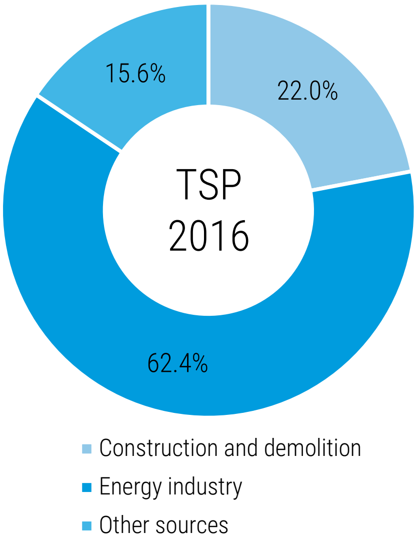

Figure 4.5 The share of construction and demolition sector in total TSP emissions

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 (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/m^2/year	0.0086	0.086	0.29
Construction and demolition of apartment buildings	kg/m^2/year	0.03	0.3	1
Non-residential construction and demolition	kg/m^2/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 2000-2016 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 (Table 4.7).

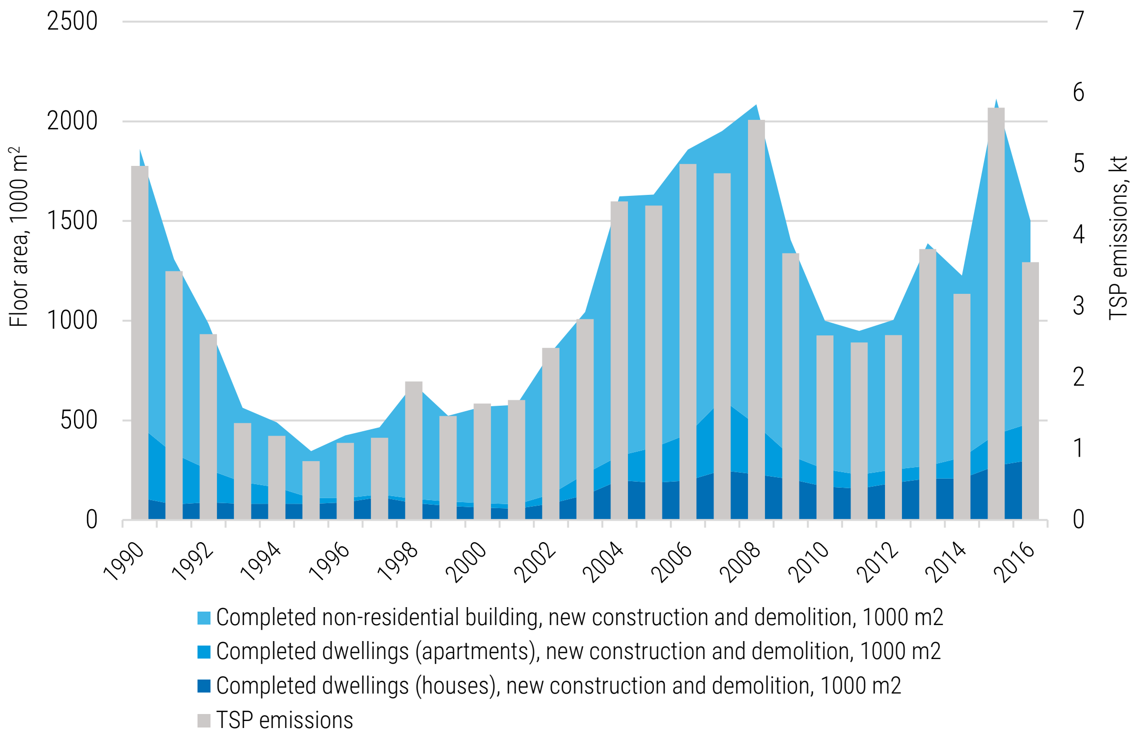

Figure 4.6 The completed dwelling and non-residential building, new construction and demolition and TSP emission in the period of 1990-2016

Table 4.7 Activity data for PM emission calculations from the construction sector in the period of 1990-2016 (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	1 682.4
2016	301.5	185.3	1015.1

4.1.3. Chemical Industry (NFR 2B)

4.1.3.1. Source Category Description

A unique part of the Estonian chemical industry is the industry based on oil-shale. However, the majority of the sector is made up of other sub-sectors such as building chemicals or household chemicals. The smallest sub-sector (a few hundred employees) is the pharmaceuticals industry. In Estonia, one hundred companies operate in the chemical industry. More than half of the chemical industry is located in Ida-Viru County, nearly one-third of the workforce is in Tallinn and Harju County. The largest companies of the chemical industry are VKG Oil AS, Kiviõli Keemiatööstuse OÜ and Enefit Energiatootmine AS (production of shale oil), Akzo Nobel Baltics AS, AS Tikkurila and AS Eskaro (paints and varnishes), NPM Silmet AS (rare metals), AS Novotrade Invest (recycling of petroleum products), OÜ Krimelte and Henkel Balti Operations OÜ (installation foam), Eastman Specialties AS (benzoic acid, sodium benzoate, plasticisers), Orica Eesti OÜ (explosives), AS Takeda Pharma (pharmaceuticals) and Interchemie Werken De Adelaar Eesti AS (veterinary medicines and supplies).[10]

In 2016, production decreased in all branches of the chemical industry. As before, production fell most in oil shale production. The oil industry suffered the most due to low oil prices.

The chemical industry produced in 2015, more than one-tenth less than the output of the previous year. In the oil industry, the production volume fell by over 14%, almost the same amount of production also fell in the chemical industry.

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 20% in 1990, and only 0.2% in 2016 (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 1990-2016 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.

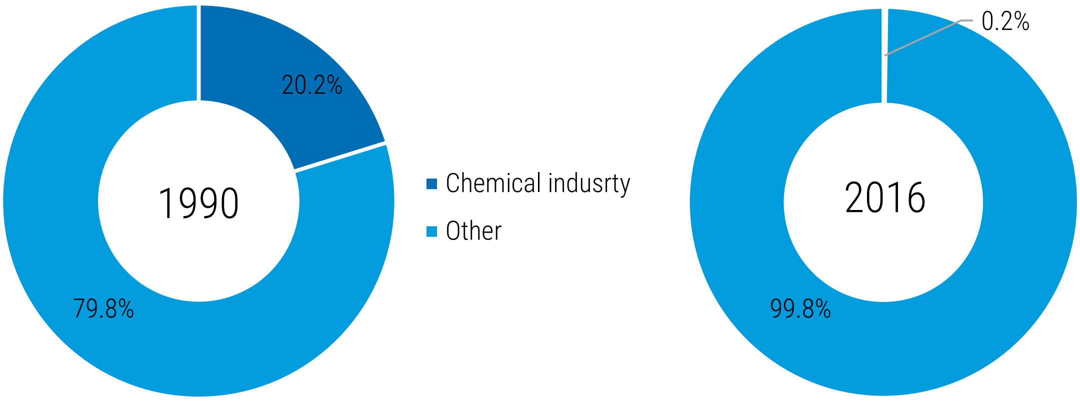

Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2016

[10] Overview of Economy 2016. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2017

Table 4.8 Emissions from the chemical industry in the period of 1990-2016 (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	0.000	0.073	0.000005	0.008	0.004	0.012	0.037	0.0001	0.367
2015	0.000	0.046	0.000005	0.007	0.001	0.002	0.007	0.00001	0.353
2016	0	0.054	0.000005	0.007	0.001	0.003	0.009	0.00001	0.353
Trend 1990-2016, %	-100.0	-99.6		-98.1	-98.9	-98.2	-99.0	-99.6	3.8

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 2016 emission factors.

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). Larger companies are AS Kohimo, Fortaco Estonia AS, OÜ Marketex Offshore Constructions, AS Remeksi Keskus, AS E-Profiil (metal structures), Ruukki Products AS, AS Saku Metall (building structures), AS HANZA Mechanics Tartu, AS FAVOR, AQ Lasertool OÜ, Metalliset Eesti AS (metalworking) and AS Metaprint (metal packaging manufacturing). In the long run, growth of production volume is expected to continue in the metals industry, fuelled mainly by exports.[11]

(Machine-building plant of BLRT Masinaehitus OÜ; Source: www.masinaehitus.ee)

The situation in the metal industry in 2016, could be assessed as satisfactory. Production grew

[11] Overview of Economy 2015. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2016

marginally. In 2016, there was a slight increase in emissions compared to 2015.

Emissions from the metal industry are presented in Table 4.9.

Table 4.9 Emissions from the metal production sector in the period of 1990-2016

Year	NO_x	SO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb
					kt					t
1990	NA	NA	NA	0.160	NR	NR	NA	NR	NA	NA
1995	NA	NA	NA	0.100	NR	NR	NA	NR	NA	NA
2000	NA	NA	0.010	0.040	0.014	0.018	0.030	0.00005	0.010	0.0100
2005	0.010	NA	0.010	0.060	0.023	0.030	0.050	0.000084	0.010	NA
2006	0.030	NA	0.010	0.080	0.014	0.018	0.030	0.00005	0.020	0.0010
2007	0.020	NA	0.010	0.060	0.023	0.030	0.050	0.000017	0.020	0.0010
2008	0.015	0.0002	0.008	0.034	0.022	0.029	0.048	0.000081	0.023	0.0005
2009	0.008	0.0000	0.004	0.066	0.016	0.021	0.035	0.000066	0.012	0.0058
2010	0.013	0.0000	0.006	0.052	0.020	0.027	0.044	0.000095	0.009	0.0142
2011	0.014	0.0001	0.008	0.070	0.015	0.020	0.033	0.000081	0.009	0.0112
2012	0.014	0.0001	0.007	0.072	0.015	0.020	0.034	0.000081	0.009	0.0095
2013	0.015	0.0001	0.008	0.074	0.021	0.028	0.045	0.000095	0.012	0.0109
2014	0.020	0.0001	0.007	0.043	0.023	0.033	0.056	0.000106	0.021	0.0170
2015	0.022	0.0001	0.008	0.058	0.029	0.035	0.061	0.000148	0.027	0.0099
2016	0.025	0.0001	0.010	0.051	0.030	0.039	0.087	0.000159	0.026	0.0109

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 2016 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 2016. 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 1990-2016 (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	0.0003
2005	0.0186	0.0012	0.0233	0.1746	0.0006
2006	0.0237	0.0015	0.0296	0.2223	0.0008
2007	0.0238	0.0015	0.0297	0.2230	0.0008
2008	0.0241	0.0015	0.0301	0.2260	0.0008
2009	0.0188	0.0012	0.0235	0.1762	0.0006
2010	0.0179	0.0011	0.0224	0.1677	0.0006
2011	0.0204	0.0013	0.0256	0.1917	0.0006
2012	0.0181	0.0011	0.0226	0.1693	0.0006
2013	0.0189	0.0012	0.0237	0.1775	0.0006
2014	0.0206	0.0013	0.0258	0.1934	0.0007
2015	0.0232	0.0015	0.0291	0.2180	0.0007
2016	0.0232	0.0015	0.0291	0.2179	0.0007
Trend 1990-2016, %	-15.1	117.8	117.8	-15.1	145.5

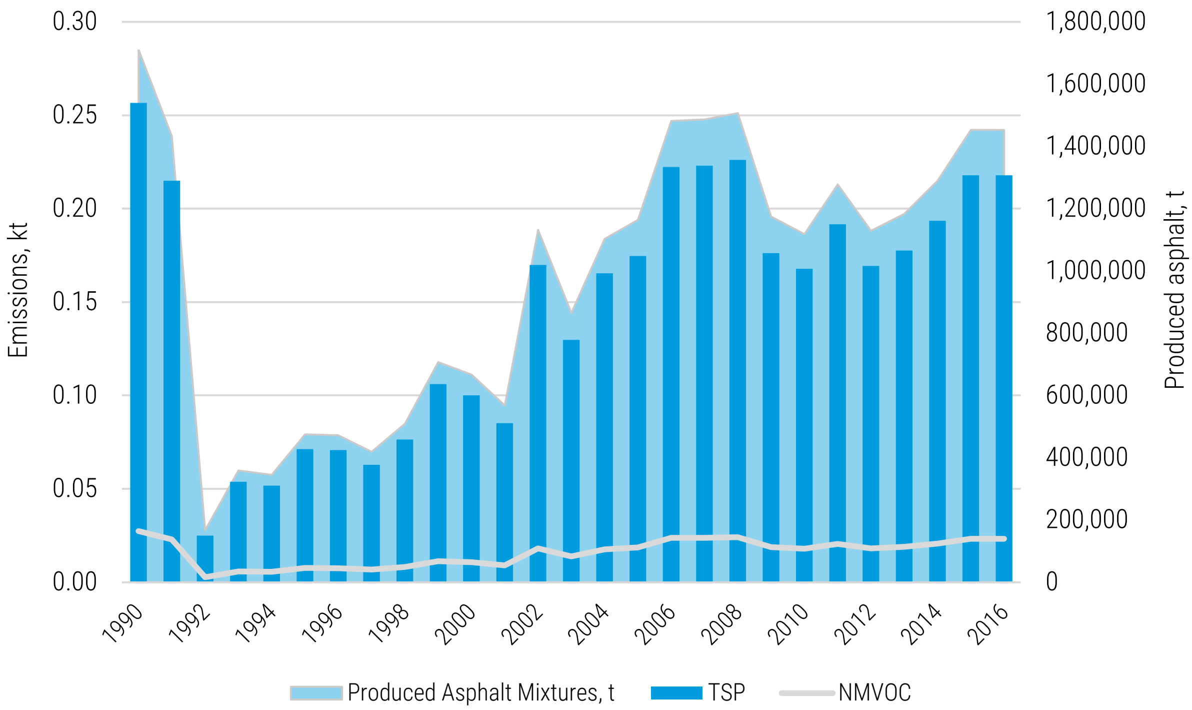

Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production in the period of 1990-2016

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 (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 1990-2016 (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 1990-2016 (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

4.1.6. Pulp, Paper and Food Industries (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.[12]

In 2016, sales volumes in the paper decreasing by 1.8%.

The paper industry is a heavily concentrated industry in Estonia. Horizon Tselluloosi ja Paberi AS is the largest paper and cardboard producer. Horizon produces a wide range of high-quality paper products for the packaging industry. The product range is completely based on 100% virgin long fibre softwood pulp – the raw material that has brought Nordic sack craft qualities to the fore globally.

(Photo by Rauno Volmar: Horizon Tselluloosi ja Paberi AS)

[12] Overview of Economy 2016. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2017

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. 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 2016 was somewhat more successful for beverage producers as they were successful in foreign markets and managed to increase exports by more than a fifth.[13]

The emissions from sector NFR 2H are presented in Table 4.13. Emissions of all pollutants has decreased in 2016 compared to 2015 due to emissions reduction in pulp and paper industry.

Table 4.13 Pollutant emissions from the pulp, paper and food industries in the period of 1990-2016 (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
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

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

[13] Overview of Economy 2016. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2017

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 2016 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 (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 1990-2016 (Tables 4.16-17). In this year submission the NMVOC emissions from food and drink industry for 2014 were recalculated due to the correction of activity data.

Table 4.16 Activity data for the food industries in the period of 1990-2016 (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	11.2	77.9	76.4	..	..	109.9

Table 4.17 Activity data for the drinks industries in the period of 1990-2016 (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

4.1.6.4. Uncertainty

An uncertainty analysis was carried out to the year 2015 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, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	0.0	kt	0.15	0.04%	0.05%
NMVOC	0.8	kt	3.53	1.44%	3.54%
SO_x	0.0	kt	0.01	0.00%	0.00%
NH_3	0.1	kt	0.56	1.00%	0.31%
$PM_{2.5}$	0.3	kt	3.42	2.03%	0.99%
PM_{10}	2.1	kt	15.09	12.58%	4.82%
TSP	6.7	kt	31.98	27.57%	1.94%
CO	0.4	kt	0.32	0.14%	0.04%
Pb	0.0	t	0.04	0.02%	NA

4.1.6.5. 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.

4.1.6.6. 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.
- Correction in allocation emission in NFR 2A6, 2A1, 2A5 and inside of NFR 2C.
- Correction in allocation NH_3 emission between NFR 2B10a and 2B1 (for ammonia and urea production).

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 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 emissions 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 2016.

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 Estonia's 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	NMVOC, Hg
2D3d	Coating application	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 1 / Tier 3	NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10}, TSP, Pb, Cr, Cu
2D3f	Dry cleaning	Includes emissions from dry cleaning	Tier 1 / Tier 3	NMVOC
2D3g	Chemical products	Includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other use of solvents	Tier 3	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, 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, 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/PCDF, 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 2016, the solvent and other product use sector, which was the largest pollution source of NMVOC emissions in Estonia, accounted for 33.1% of total NMVOC emissions. The largest share was for coating application at 46.20%, with the others being domestic solvent use at 21.27%, degreasing 14.72%, other solvent use 9.49%, printing 6.45%, chemical products 1.69%, other product use 0.12% and dry cleaning 0.06% (Figure 4.9).

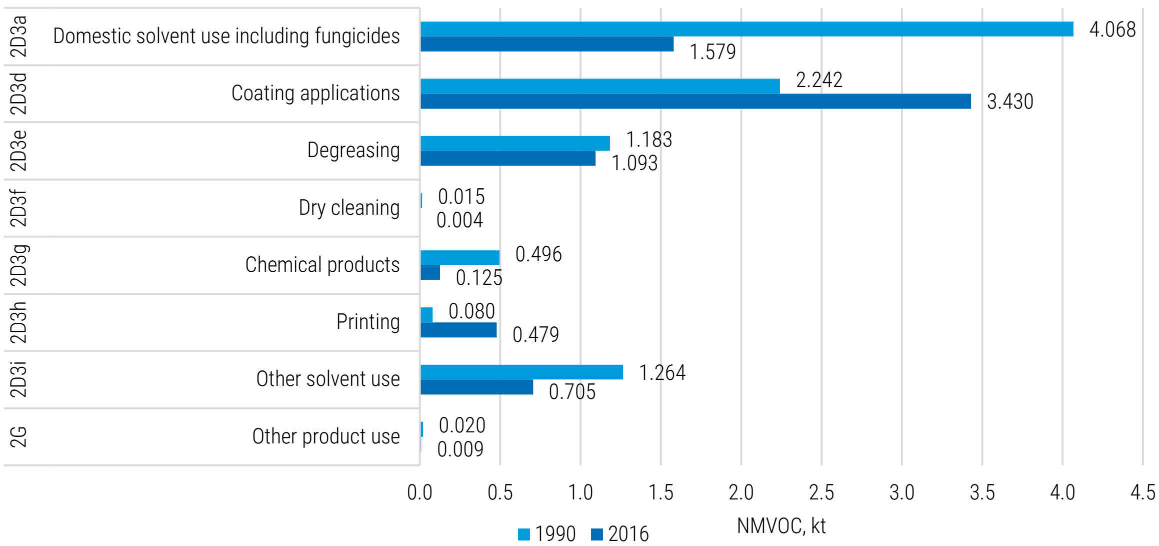

Figure 4.9 NMVOC emissions by sectors in 1990 and 2016

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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 decreased in the solvent sector by 20.7% (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 1990-2016 has mostly occurred due to the welfare of the economic state of the country. The decrease in emissions between 1991 and 1993 was due to the renewed independence of the Republic of Estonia and the cessation of large-scale production that was distinctive of the Soviet Union. Between 1993 and 1998, the economic growth induced the growing usage of NMVOC containing paints in decorative and industrial coating applications. At the end of 1998, the world was struck by an economic crisis that affected the construction sector, resulting in a knock-on effect on the usage of decorative coatings. From 2001, the economy began to grow again until 2008, when the world suffered its worst ever economic depression, which also greatly affected the Estonian economy. As a result, by the year 2010, NMVOC emissions fell 39.7% in comparison with 2006 (Figure 4.11). In 2011, there was a slight increase in NMVOC emissions by 13.2% compared to 2010, which meant that the bottom of the emissions was reached, and henceforward, the emissions have been started to rise again.

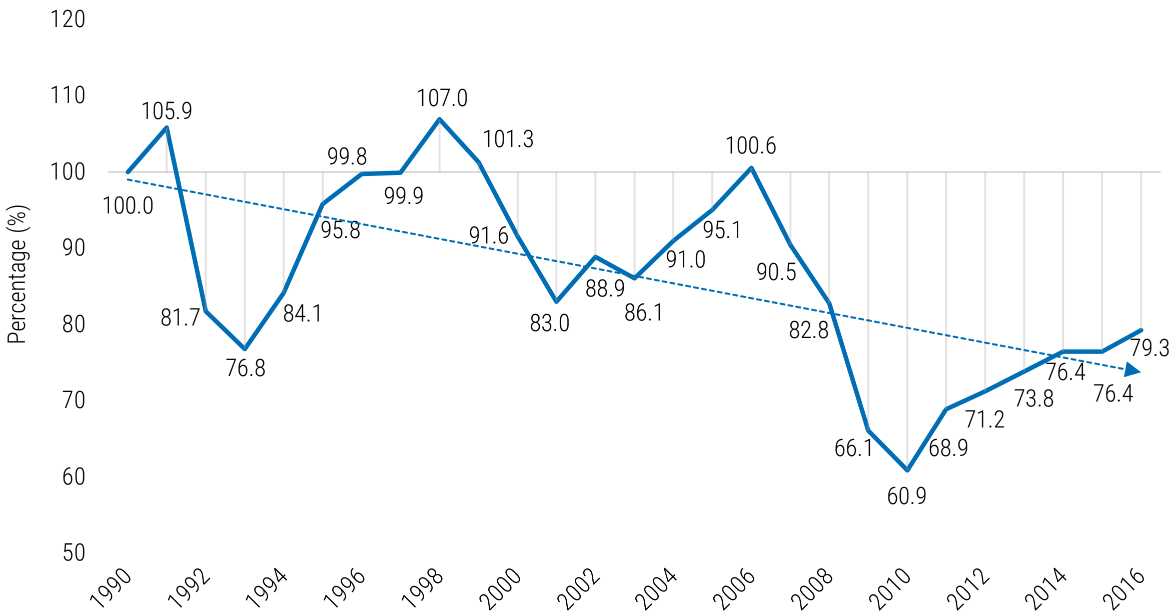

Figure 4.10 The dynamics of NMVOC emissions from the solvent and other product use sector in the period of 1990-2016 (1990 = 100%)

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.

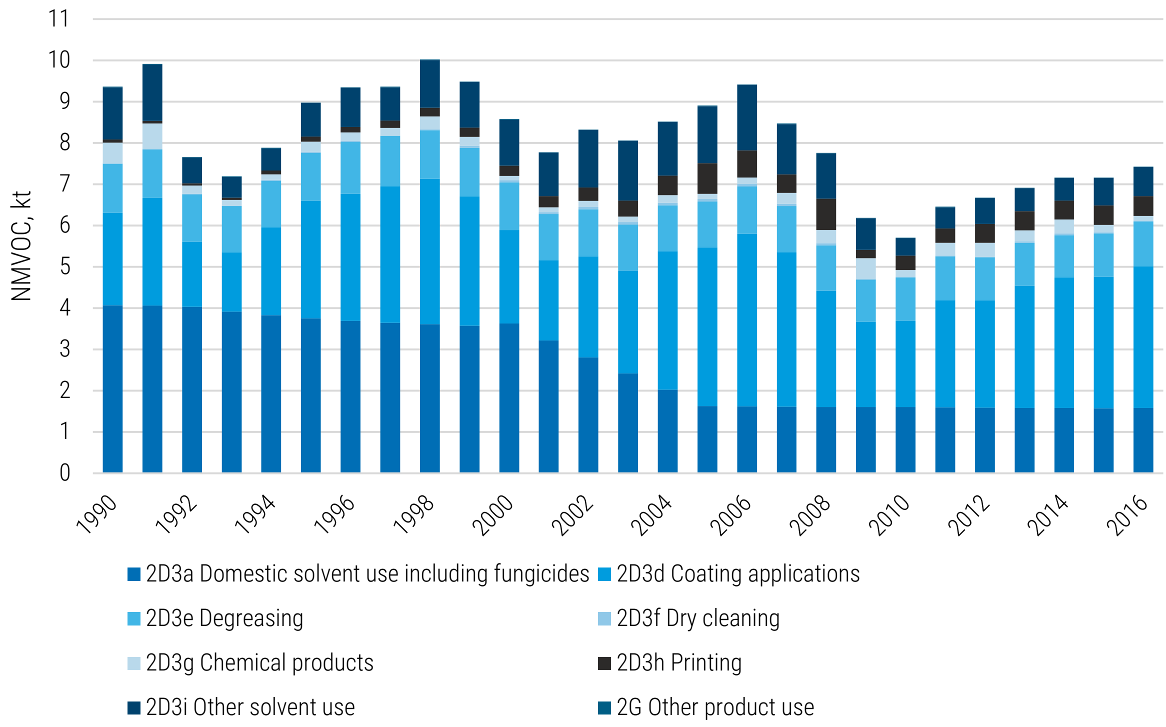

Figure 4.11 NMVOC emissions from the solvent and other product use sector in the period of 1990-2016

Table 4.20 NMVOC emissions from the solvent and other product use sector in the period of 1990-2016 (kt)

Year	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G
1990	4.068	2.242	1.183	0.015	0.496	0.080	1.264	0.020
1995	3.751	2.848	1.157	0.025	0.250	0.126	0.810	0.011
2000	3.629	2.258	1.160	0.050	0.107	0.248	1.115	0.009
2005	1.631	3.842	1.105	0.062	0.125	0.744	1.384	0.013
2006	1.621	4.177	1.145	0.065	0.158	0.655	1.588	0.012
2007	1.612	3.742	1.116	0.054	0.265	0.452	1.216	0.017
2008	1.606	2.815	1.100	0.051	0.314	0.765	1.097	0.007
2009	1.603	2.066	1.022	0.022	0.497	0.204	0.764	0.012
2010	1.600	2.092	1.051	0.012	0.164	0.354	0.425	0.006
2011	1.596	2.600	1.056	0.018	0.313	0.344	0.517	0.009
2012	1.590	2.599	1.045	0.008	0.337	0.456	0.630	0.009
2013	1.584	2.961	1.033	0.039	0.268	0.461	0.562	0.009
2014	1.579	3.167	1.019	0.041	0.338	0.458	0.551	0.009
2015	1.576	3.179	1.051	0.030	0.178	0.473	0.665	0.009
2016	1.579	3.430	1.093	0.004	0.125	0.479	0.705	0.009
Trend 1990-2016, %	-61.2	53.0	-7.6	-69.4	-74.7	500.1	-44.3	-54.3

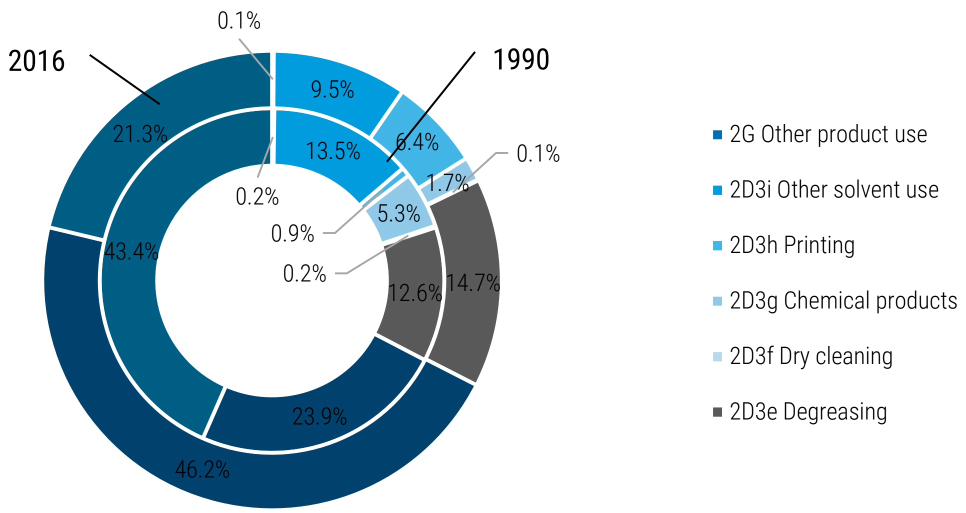

Figure 4.12 The share of NMVOC emissions in 1990 and 2016 by NFR solvent subcategory codes

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 the 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); 1,2 kg/person/year (since 2005, GB2016); EFs for the years 2001-2004 are interpolated
		060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: 1.9% share of the previous emission factors
2D3d	Coating application: 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: 720 g/kg paint applied (1990-2006, GB2016, solvent based), 2007-2016 IEF from the PS; 216 g/kg paint applied (1990-2007, GB2016, water based), 2008-2016 IEF from the PS; PS: facility specific

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		060103	Construction and buildings	Statistics Estonia and expert estimate	DS: 230 g/kg of paint (1990-2016, GB2016, solvent based); 69 g/kg of paint applied (1990-2016, GB2016, water based)
		060104	Domestic use	Statistics Estonia and expert estimate	
		060105	Coil coating	Reported by operators (since 2012)	PS: facility specific
		060106	Boat building	Reported by operators (since 2000)	PS: facility specific
		060107	Wood coating	Reported by operators (since 1993)	PS: facility specific
		060108	Other industrial paint application	Reported by operators (since 1990)	PS: facility specific
		060109	Other non-industrial paint application	Included in 060103 and 060104	NA
2D3e	Degreasing: Solvents in products	060200	Degreasing (vapour and cold cleaning)	Statistics Estonia / Eurostat	DS: 460 g/kg cleaning products (vapour, GB2016); 0.7 kg/person/year (cold, Finnish EF)
		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 / Eurostat; reported by operators (since 2002)	DS: 400 g/kg solvent use (GB2016) PS: facility specific
2D3g	Solvents in chemical products manufacture and processing	060300	Chemical products manufacturing or processing	Aggregated emissions for the whole SNAP 0603, reported by operators (1990-2005)	PS: facility specific
		060301	Polyester processing	Not relevant	NA
		060302	Polyvinylchloride processing	Not relevant	NA
		060303	Polyurethane processing	Reported by operators (since 2006)	PS: facility specific
		060304	Polystyrene foam processing	Reported by operators (since 2006)	PS: facility specific
		060305	Rubber processing	Reported by operators (since 2006)	PS: facility specific
		060306	Pharmaceutical products manufacturing	Not included	NA
		060307	Paints manufacturing	Reported by operators (since 2006)	PS: facility specific
		060308	Inks manufacturing	Reported by operators (2007-2010)	PS: facility specific
		060309	Glues manufacturing	Reported by operators (2006-2014)	PS: facility specific
		060310	Asphalt blowing	Not occurring	NO
		060311	Adhesive, magnetic tapes, films and photographs manufacturing	Not included	NA
		060312	Textile finishing	Reported by operators (since 2006)	PS: facility specific

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NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		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 / Eurostat; reported by operators (since 2001)	DS: 500 g/kg ink (GB2016); 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 / Eurostat; reported by operators (since 1990)	DS: 780 g/kg adhesives (1990-2000, GB2009); 522 g/kg adhesive (since 2005, GB2016); 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 / Eurostat	DS: 4.84 kg/Mg tobacco (GB2016)
		060603	Use of shoes	Not included	NA

Emissions, other than NMVOC, are taken from the OSIS database (reported by operators and are facility specific), except emissions from fireworks and tobacco use, where Tier 2 emission factors are taken from the EMEP/EEA Guidebook 2016.

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 in tonnes per year;
- Emissions of pollutants by the used solvent or solvent containing mixture – CAS number, name of the substance, maximum emission in grams per second (not required since 2012), NMVOC emissions 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 2015 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_2 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, 2016	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2016, %
NO_x	0.003553	kt	0.011	0.01%	0.00%
NMVOC	7.424519	kt	33.055	9.35%	2.39%
SO_x	0.001294	kt	0.004	0.00%	0.00%
NH_3	0.011687	kt	0.098	0.05%	0.02%
$PM_{2.5}$	0.073486	kt	0.982	0.40%	0.13%
PM_{10}	0.094068	kt	0.841	0.34%	0.11%
TSP	0.102095	kt	0.620	0.23%	0.02%
CO	0.110661	kt	0.079	0.04%	0.01%
Pb	0.333740	t	1.029	0.59%	0.08%
Cd	0.010904	t	1.347	0.73%	0.08%
Hg	0.012531	t	2.037	0.55%	0.07%
PCDD/PCDF	0.000190	g I-TEQ	0.005	0.01%	0.00%
B(a)p	0.000211	t	0.011	0.02%	0.02%
B(b)f	0.000086	t	0.004	0.01%	0.01%
B(k)f	0.000086	t	0.007	0.01%	0.01%
I(1,2,3-cd)p	0.000086	t	0.006	0.01%	0.01%

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:

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 (cleaning) 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 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.
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.

Pesticides such as garden 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 sector. Domestic use of pharmaceutical products and emissions of other pollutants, such as mercury (Hg), are also included in this category.

For most products, all of the NMVOC will be emitted to the atmosphere. However, in some products, the NMVOC will be mainly lost to waste water.

In 2016, NMVOC emissions from the NFR 2D3a sector decreased by 61.2% 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 by population.

Tier 1 emission factors are 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.

At the moment there is no detailed information about the use of domestic solvent products in Estonia, thus the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 (Chapter 2.D.3.a Domestic solvent use including fungicides, Table 3.1 on Page 8) Tier 1 NMVOC emission factor 1.2 kg/capita is used to calculate NMVOC emissions from the NFR sector 2D3a for the years 2005 and onward.

Although the EMEP/EEA Guidebook 2016 provides 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 then, when the product statistics for the use of Tier 2a approach is not complete in terms of the product types covered by domestic solvent use.

Table 4.24 presents the EMEP/EEA Guidebook 2016 default Tier 2b emission factors for NFR source category 2D3a for NMVOC by the four main subcategories: household products, car care products, cosmetics and toiletries, DIY/buildings in addition to pharmaceutical products and other various products and a Tier 2 emission factor for calculating Hg emissions from the use of fluorescent tubes. For those Tier 2b emission factors the share for different product categories has been calculated and those shares are being used to divide NMVOC emission, calculated using Tier 1 emission factor, between different product types covered in the Guidebook 2016.

Table 4.24 Tier 2 emission factors for NFR source category 2D3a domestic solvent use including fungicides

Source category	Pollutant	Tier 2 EFs	Unit	Share, %	EFs to Tier 1	Unit
Domestic solvent use including fungicides, total	Σ NMVOC	2,462	g/person	100.0	1,200	g/person
Household products (aerosol)	NMVOC	200	g/person	8.1	97	g/person
Household (cleaning) products – aerosols	NMVOC	201	g/person	8.2	98	g/person
Household (cleaning) products – non-aerosols	NMVOC	252	g/person	10.2	123	g/person
Car care product – aerosol	NMVOC	161	g/person	6.5	78	g/person
Car care product – non-aerosol	NMVOC	303	g/person	12.3	148	g/person
Cosmetics and toiletries – aerosol	NMVOC	355	g/person	14.4	173	g/person
Cosmetics and toiletries – non-aerosol	NMVOC	494	g/person	20.1	241	g/person
DIY/buildings – adhesives	NMVOC	76	g/person	3.1	37	g/person
DIY/buildings – paint thinner	NMVOC	205	g/person	8.3	100	g/person
DIY/buildings – paint and varnish removers, solvents	NMVOC	68	g/person	2.8	33	g/person
DIY/buildings – sealants, filling agents	NMVOC	23	g/person	0.9	11	g/person
Pharmaceutical products (SNAP 060411)	NMVOC	48	g/person	1.9	23	g/person
Pesticides	NMVOC	76	g/person	3.1	37	g/person
Domestic solvent use including fungicides (fluorescent tubes)	Hg	5.6	mg/person	--		

NMVOC emissions for years 1990-2000 are calculated using EMEP/Corinair Emission Inventory Guidebook 2007 Tier 1 default emission factor for domestic solvent use 2.59 kg/capita, because it describes probably better the situation in 1990s when high NMVOC containing products were produced and used. The emission factors for years 2001-2004 are interpolated gradually:

- 2001 – 2.312 kg/capita;
- 2002 – 2.034 kg/capita;
- 2003 – 1.756 kg/capita;
- 2004 – 1.478 kg/capita.

4.2.5.3. Activity Data and Results

The basic activity statistics for using the Tier 1 emission factor are national population figures obtained from the Statistics Estonia.

Table 4.25 NMVOC and Hg emissions from domestic solvent use (other than paint application) and the population of Estonia in the period of 1990-2016

Year	Population, mln. inhab.	NMVOC emissions by domestic solvent use categories, kt						
		Household products (aerosol)	Household (cleaning) products: aerosols	Household (cleaning) products: non-aerosols	Car care product: aerosol	Car care product: non-aerosol	Cosmetics and toiletries: aerosol	Cosmetics and toiletries: non-aerosol
1990	1.571	0.330	0.332	0.416	0.266	0.501	0.587	0.816
1995	1.448	0.305	0.306	0.384	0.245	0.462	0.541	0.753
2000	1.401	0.295	0.296	0.371	0.237	0.447	0.523	0.728
2005	1.359	0.132	0.133	0.167	0.107	0.201	0.235	0.327
2006	1.351	0.132	0.132	0.166	0.106	0.199	0.234	0.325
2007	1.343	0.131	0.132	0.165	0.105	0.198	0.232	0.323
2008	1.338	0.130	0.131	0.164	0.105	0.198	0.232	0.322
2009	1.336	0.130	0.131	0.164	0.105	0.197	0.231	0.322
2010	1.333	0.130	0.131	0.164	0.105	0.197	0.231	0.321
2011	1.330	0.130	0.130	0.163	0.104	0.196	0.230	0.320
2012	1.325	0.129	0.130	0.163	0.104	0.196	0.229	0.319
2013	1.320	0.129	0.129	0.162	0.104	0.195	0.228	0.318
2014	1.316	0.128	0.129	0.162	0.103	0.194	0.228	0.317
2015	1.313	0.128	0.129	0.162	0.103	0.194	0.228	0.317
2016	1.316	0.128	0.129	0.162	0.103	0.194	0.228	0.317

Table 4.25 continues

Year	NMVOC emissions by domestic solvent use categories, kt							Hg emissions, kg
	DIY/building: adhesives	DIY/building: paint thinner	DIY/building: paint and varnish removers, solvents	DIY/building: sealants, filling agents	Pharma-ceutical products (SNAP 060411)	Pesticides	Total (SNAP 060408)	Fluorescent tubes
1990	0.126	0.339	0.112	0.038	0.079	0.126	4.068	8.795
1995	0.116	0.312	0.104	0.035	0.073	0.116	3.751	8.109
2000	0.112	0.302	0.100	0.034	0.071	0.112	3.629	7.847
2005	0.050	0.136	0.045	0.015	0.032	0.050	1.631	7.610
2006	0.050	0.135	0.045	0.015	0.032	0.050	1.621	7.564
2007	0.050	0.134	0.045	0.015	0.031	0.050	1.612	7.520
2008	0.050	0.134	0.044	0.015	0.031	0.050	1.606	7.495
2009	0.049	0.133	0.044	0.015	0.031	0.049	1.603	7.480
2010	0.049	0.133	0.044	0.015	0.031	0.049	1.600	7.466
2011	0.049	0.133	0.044	0.015	0.031	0.049	1.596	7.446
2012	0.049	0.132	0.044	0.015	0.031	0.049	1.590	7.421
2013	0.049	0.132	0.044	0.015	0.031	0.049	1.584	7.393
2014	0.049	0.131	0.044	0.015	0.031	0.049	1.579	7.369
2015	0.049	0.131	0.044	0.015	0.031	0.049	1.579	7.354
2016	0.049	0.131	0.044	0.015	0.031	0.049	1.579	7.369

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

No major improvements are planned for the next submission, but in the future, it is planned to investigate the possibilities to acquire detailed activity data so that it is possible to use a Tier 2 methodology for emission calculations.

4.2.6. Coating Application (NFR 2D3d)

4.2.6.1. Source Category Description

The use of paint is a major source of NMVOC emissions; they comprise about 9% of total NMVOC emissions in the CORINAIR90 inventory. This number may have changed over time, but it is certain that paint use is still one of the main sources of NMVOC. The use of paints is generally not considered relevant for emissions of particulate matter or heavy metals and POPs.

Most paints contain organic solvent, which must be removed by evaporation after the paint has been applied to a surface in order for the paint to dry or 'cure'. Unless captured and either recovered or destroyed, these solvents can be considered to be 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 pollutant released from painting activities is NMVOC. 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. As mentioned earlier, 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 2016, NMVOC emissions from this sector had increased by 53% compared to 1990.

Coating application is 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 (from the year 1995), and from the OSIS air emissions database for point sources (from the year 2006). The amounts of coatings used are distinguished between solvent and water-based paints, which means that a Tier 2 methodology has been 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), and 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 which is 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 equations 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 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 25% in 2016. This is due to the fact that, over time, more solvent users were being permitted and thanks to that they have an annual reporting obligation. Emissions without activity data for the 1990-1999 period are received from facilities via paper reports; emissions for the 2000-2005 period were submitted into the CollectER database by an air specialist, but they are also based on paper reports which have been 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	GB2016	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	GB2016	DS: for the years 1990-2006. For 2007 and onwards, annual IEFs from point sources are applied.
060102	Paint application: car repairing	WB	216	g/kg paint applied	2	GB2016	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	GB2016	DS: for the whole time series
060103	Paint application: construction and buildings	WB	69	g/kg paint applied	2	GB2016	DS: for the whole time series

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SNAP	SNAP name	Chemical Type	Value	Unit	Tier	Source	Comment
060103	Paint application: construction and buildings	Other paints and varnishes (SB; WB)	149.5	g/kg paint applied	2	-	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	GB2016	DS: for the whole time series
060104	Paint application: domestic use (except 060107)	WB	69	g/kg paint applied	2	GB2016	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	-	DS: for the whole time series. Expert estimate; calculated as an average of SB and WB emissions factors

Decorative coating application

A decorative coating application (SNAP 060103 and 060104) only encompasses NMVOC emissions from diffuse sources. The paint used for a decorative coating application 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 2016 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 EMEP/EEA Guidebook 2016 Tier 2 emissions factors (see Table 1) 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 Tables 3-4 and 3-5 in the EMEP/EEA Guidebook 2016, from the '2.D.3.d Coating applications' chapter. Emission factors for water-based paints are calculated from the emission factors for solvent-based paints using the abatement efficiencies default value of 70% which is shown in Table 3-17 and which describes the rate of substitution for solvent-based paints with water-based paints, calculated as follows: *230 g/kg paint applied x (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

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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 don't take into account the impact that EU Directive 2004/42/EC has had when it came into force on 1 January 2007. This is most 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 application

Industrial coating application mostly covers pollutant emissions from point sources and, therefore, is considered to be as a Tier 3 methodology. To a small degree, industrial coating application also includes diffuse sources emissions from car repairs. There is no statistical information regarding the amount of paint used for car repairs. Therefore expert opinion was sought from a representative of the 'repair unit' at the Association of Estonian Automobile Sales and Maintenance Companies.

The expert opinion in question was supplied by Benefit AS, which is the leading car body and car paint shops technology and materials supplier in Estonia. The total amount of paint used for car repairs in Estonia is estimated to have risen from 100 tonnes in 1990 to 214.4 tonnes in 2016. As this is a rough estimate, the annual growth is estimated to be equal. The EMEP/EEA Guidebook 2016 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 subsequent periods, implied emission factors in year-by-year calculated point sources (see Table 4.27) are applied for emissions calculations from diffuse sources.

Precisely how much paint has been used by all the permitted companies between 1990 and 2005 is unknown. Therefore, a reverse calculation is carried out by applying the EMEP/EEA Guidebook 2016 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
WB	-	181	255	234	76	110	113	114	133	151
SB	569	443	448	341	349	332	364	421	449	456

Emissions

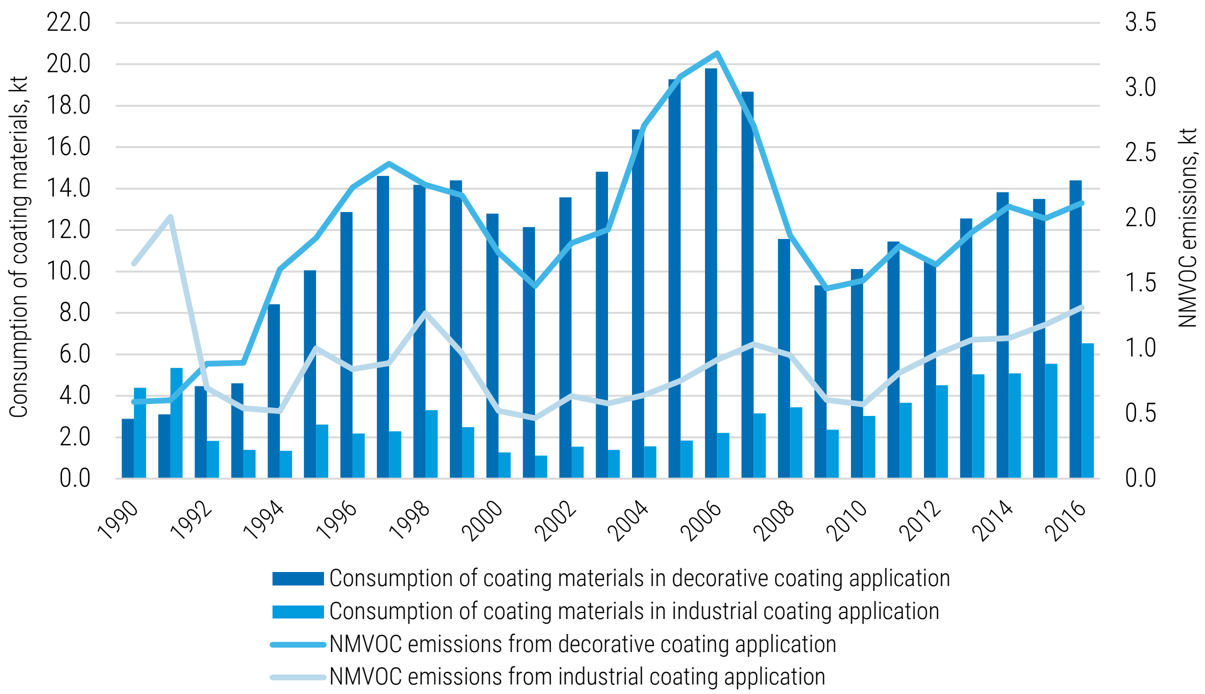

Figure 4.13 The consumption of coating materials and NMVOC emissions from decorative and industrial coating applications in the 1990-2016 period

The huge drop in industrial paint consumption and NMVOC emissions in 1992 (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. A huge 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 1990-2016 (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	1.269	8.642	0.846	5.761

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Table 4.29 NMVOC emissions and consumption of coating materials from industrial paint application by SNAP codes in the period of 1990-2016 (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

NMVOC emissions presented in the Table 4.27 are collected from point sources. Emissions for the period 1990-1999 are received from facilities on paper reports; emissions for the period of 2000-2005 were submitted into the CollectER database by an air specialist, but they are 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.

4.2.6.3. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Calculated emissions and 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. 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. Also, the 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.

The contribution of metal degreasing to total NMVOC emissions (including natural sources) is about 1.8% in CORINAIR countries (CORINAIR 1990 inventory). In addition, metal degreasing could be a significant source of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (ETC/AEM-CITEPA-RISOE, 1997[14]).

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 2016, NMVOC emissions from this sector had decreased by 7.6% 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 Tier 1 methodology for emissions from degreasing is based on solvent sales data, in combination with assumptions about the distribution over the different environmental compartments (emissions to air, water, soil and conversion to waste).

If total solvent sales are not known, the following two approaches are applied:

1) Vapour cleaning – consumption of most common organic solvents for vapour cleaning (according to the EMEP Guidebook 2016) is considered for emission calculations.

2) Cold cleaning – emission from the rest of vapour cleaning is estimated by different emission factors by the inhabitant.

Emission factor for vapour cleaning

The EMEP/EEA Guidebook 2016 Tier 1 emission factor 460 g/kg cleaning products are used for calculations. The general equation is:

[14] ETC/AEM-CITEPA-RIOSE (1997). Selected nomenclature for air pollution for Corinair94 inventory (SNAP 94), version 0.3 (draft).

$$E_{pollutant} = AR_{production} \times EF_{pollutant}$$

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.

Emission factor for cold cleaning

The emission factor used for cold cleaning is 0.7 kg/person/year, which is derived from an expert estimate made by the VTT Technical Research Centre of Finland[15].

4.2.7.3. Activity Data

Vapour cleaning operations

Consumption of the most common organic solvents for vapour cleaning methylene chloride (MC), tetrachloroethylene (PER), trichloroethylene (TRI) and xylenes (XYL) is used as a basis for emission calculations from vapour cleaning.

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 1995-2016. 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 for the years 1990-2005. The OSIS database provides some information regarding xylenes production between 2006 and 2016.

Cold cleaning operations

The basic activity statistics for using the Finnish emission factor are national population figures. Data regarding population by counties are available from Statistics Estonia.

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 vapour cleaning operations.

Between 2006 and 2016, the OSIS database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2016, 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.

Table 4.30 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2016

SNAP code	060200		060200		060201		060203		060204	
Year	NMVOC (vapour cleaning), kt	Activity data, kt	NMVOC (cold cleaning), kt	Activity data, mln.inhab.	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt
1990	0.084	0.183	1.099	1.571	NA	NA	NA	NA	NA	NA
1995	0.143	0.312	1.014	1.448	NA	NA	NA	NA	NA	NA
2000	0.179	0.388	0.981	1.401	NA	NA	0.001	0.001	NA	NA
2005	0.150	0.326	0.951	1.359	0.000	0.001	0.003	0.006	0.001	0.001
2006	0.175	0.342	0.945	1.351	0.002	0.003	0.018	0.056	0.005	0.006

[15] SYKE (2011). Air Pollutant Emissions in Finland 1980-2009. Informative Inventory Report. p 252.

SNAP code	060200		060200		060201		060203		060204	
Year	NMVOC (vapour cleaning), kt	Activity data, kt	NMVOC (cold cleaning), kt	Activity data, mln.inhab.	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt
2007	0.149	0.277	0.940	1.343	0.005	0.006	0.009	0.021	0.013	0.014
2008	0.118	0.184	0.937	1.338	0.001	0.001	0.013	0.026	0.032	0.038
2009	0.063	0.096	0.935	1.336	0.006	0.007	0.005	0.008	0.012	0.018
2010	0.085	0.125	0.933	1.333	0.011	0.012	0.005	0.008	0.016	0.020
2011	0.085	0.121	0.931	1.330	0.007	0.008	0.005	0.008	0.027	0.028
2012	0.069	0.086	0.928	1.325	0.005	0.006	0.003	0.008	0.040	0.036
2013	0.066	0.071	0.924	1.320	0.005	0.007	0.002	0.006	0.036	0.048
2014	0.047	0.016	0.921	1.316	0.011	0.013	0.005	0.009	0.035	0.057
2015	0.080	0.062	0.919	1.313	0.010	0.011	0.004	0.013	0.038	0.062
2016	0.105	0.082	0.921	1.316	0.008	0.009	0.003	0.005	0.056	0.077

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 2001-2016.

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[16]; UBA, 1989[17]). Also, a significant amount of the solvent goes back to the producers and to the recyclers, along with the sludge.

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

The Tier 1 default emission factors for NMVOC emissions from dry cleaning are a weighted average, calculated from the sum of all activity and emission data from the GAINS model (IIASA, 2008[18]) – 40 g/kg textile treated.

Situation in Estonia

In order to understand the market situation, a descriptive interview with the representative of the main dry cleaning service provider, SOL Estonia, was carried out in 2010. SOL Estonia operates eight dry cleaning facilities in Tallinn, Pärnu, Kunda and Tartu.

Main findings for Estonia are:

- closed-circuit equipment is mainly used for dry cleaning;
- closed-circuit equipment was the main practice as far back as the 1990s;
- the main cleaning agent is PER (tetrachloroethylene / perchloroethylene);
- solvent waste (used solvent) is collected and given to hazardous waste companies;
- the quantity of cleaned textile is registered by cleaned items (for example, the number of cleaned coats or curtains), not by mass units.

In addition, four dry cleaning facilities were questioned by phone and e-mail. Questions and answers are presented in the Table 4.31.

Table 4.31 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.

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

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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.

According to OSIS, no production of tetrachloroethylene/PER is reported for the years 2006-2016.

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 4.32 NMVOC emissions and the consumption of solvents from dry cleaning in the period of 1990-2016 (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	0.065	0.158
2007	0.054	0.131
2008	0.051	0.124
2009	0.022	0.052
2010	0.012	0.027
2011	0.018	0.042
2012	0.008	0.017
2013	0.039	0.094
2014	0.041	0.098
2015	0.030	0.071
2016	0.004	0.006

For the dry cleaning sector for the years 1990 to 2001, only statistical data are used, whereas for the period 2002 to 2016, 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 2D3h)

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 0.6% to the total national NMVOC emissions in 2016 and only 1.7% to the whole solvent sector.

By 2016, NMVOC emissions from the chemical products sector had decreased by 74.7% 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 2006-2016 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 2006-2016.

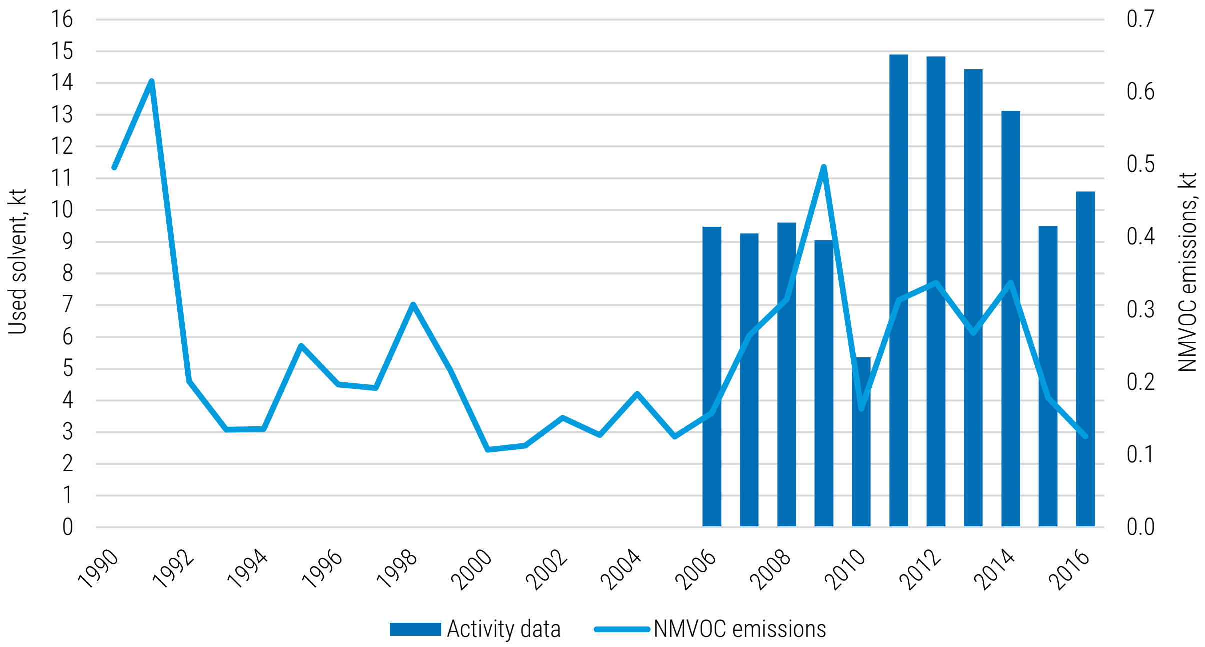

Figure 4.14 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 1990-2016

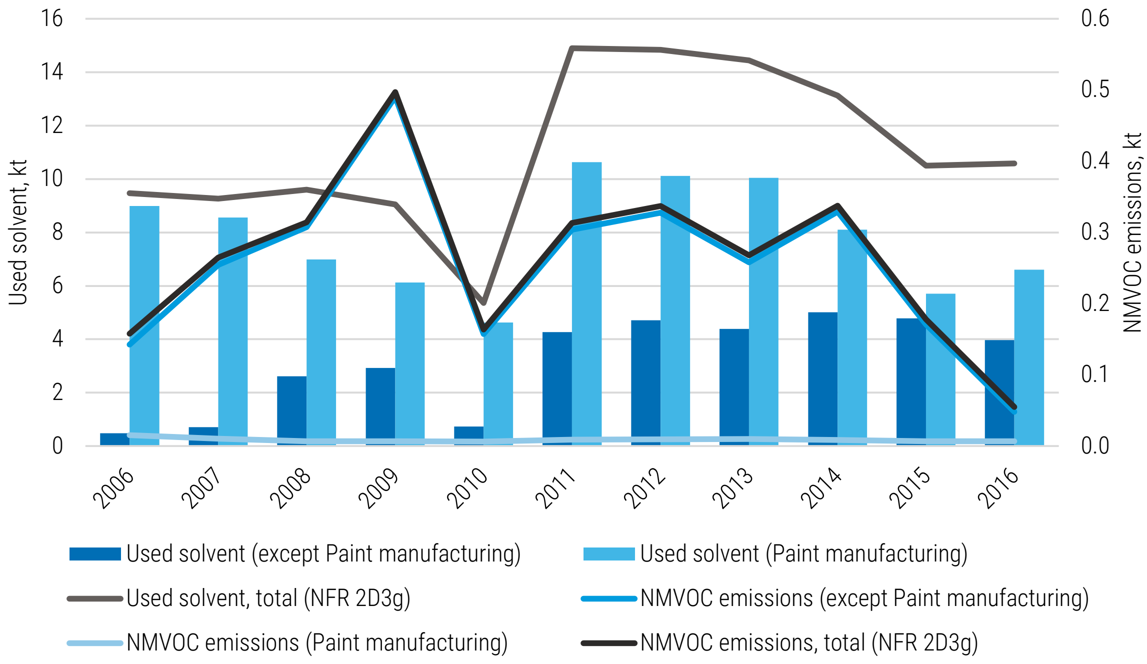

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 2006-2016

Figure 4.15 explains quite well why Figure 4.14 indicates that NMVOC emissions still grew from 2006 to 2009, although the amount of used solvent remained almost constant through that period. It is clear that the dynamics of emissions are dependent on the changes in used solvent within the sector, except the solvent used in paint manufacturing. It is because the emissions in paint manufacturing are marginal and do not affect the dynamics of the total NMVOC emissions in that sector.

NMVOC emissions for the period 1990 to 2005 came only from point sources, but without the availability of the activity data for that period.

Table 4.33 NMVOC emissions and the consumption of solvents from chemical products manufacturing or processing by SNAP codes in the period of 1990-2016 (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

Table 4.31 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

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

According to the RAINS model, at EU-25 level for 2000, NMVOC emissions from the heat set accounted for 40 kt representing 0.38% of the total NMVOC emissions. The total activity was 123.59 kt with an average emission factor of 3239 g NMVOC/kg, which indicates that this industry has already reduced some emissions (EGTEI, 2005[19]).

[19] EGTEI (2005), Heatset Offset: synopsis sheet

- Publication and packaging

At the EU-25 level for 2000, (according to the RAINS model) NMVOC emissions accounted for 61 kt representing 0.58% of the total NMVOC emissions. The total activity was 191.48 kt of ink, with an average emission of 0.32 kg NMVOC/kg non-diluted ink, which means that this industry has already reduced emissions significantly (EGTEI, 2005).

- Rotogravure and Flexography

At the EU-25 level for 2000, (according to the RAINS model) NMVOC emissions accounted for 127.56 kt representing 1.2% of total NMVOC emissions. The total activity was 91.69 kt of non-diluted ink and an average emission of 1.4 kg NMVOC/kg non-diluted ink (EGTEI, 2005).

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.

4.2.10.2. Methodological Issues

The EMEP/EEA Guidebook 2016 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[20], it can be concluded that the following techniques are applied (with relevant

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

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 (1995-2016). 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.

4.2.10.4. Results

A number of printing facilities are permitted.

Between 2006 and 2016, activity data regarding ink use in point sources were collected in the OSIS database. For the years 2006 to 2016, activity data for calculations were 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 were available. Emissions from point sources were subtracted from the total calculated NMVOC emissions.

Table 4.34 NMVOC emissions and the consumption of solvents from the printing industry by SNAP code in the period of 1990-2016 (kt)

SNAP code	060403	
Year	NMVOC	Activity data
1990	0.080	0.160
1995	0.126	0.252
2000	0.248	0.497
2005	0.744	1.488
2006	0.655	1.740
2007	0.452	2.012
2008	0.765	2.314
2009	0.204	1.660
2010	0.354	2.150
2011	0.344	2.063
2012	0.456	2.385
2013	0.461	2.305
2014	0.458	2.490
2015	0.473	2.492
2016	0.479	2.694

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.

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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[21]).

In 2016, NMVOC emissions from the NFR 2D3i sector had decreased by 44.3% compared to the year 1990.

4.2.11.2. Methodological Issues

1) Glass and Mineral wool enduction (SNAP 060401, 060402)

This is not included in the emissions inventory due to the lack of information on whether these activities have been conducted in Estonia.

2) Fat, edible and non-edible oil extraction (SNAP 060404)

The major type of seed used for oil production in Estonia is rape. Some smaller units also press oil out from other seeds, such as flax.

The main oil extracting company in Estonia is Werol Industries plc.

An interview carried out in 2010 with a representative of the company determined that the company does not use solvents for oil extraction.

At Werol Industries, they use mechanical hot pressing for oil extraction, which leaves 8%-10% of the oil in rape cake. This technology has been in use since the factory was opened in 1999.

In the second largest oil producer, Oru Vegetable Oil Industry, the oil is only pressed out mechanically. The production began in 1985, but no solvents have ever been employed.

It was discovered that some small farms also produce small amounts of oil: Kaarli farm in Väike-Maarja, Raismiku farm in Vändra and in Mooste. The oil is mechanically cold pressed.

As solvents are not used in oil production in Estonia, the NMVOC emissions that have occurred in the process are of natural origin and are reported by operators who adhere to the environmental permit.

3) Application of glues and adhesives (SNAP 060405)

The Tier 2 emission factor is used for calculations: 780 g/kg adhesive[22] for the period of 1990-2000, 522 g/kg adhesive[23] 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.

[21] 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.
[22] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[23] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016

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 2006-2016. At present, there is no information available regarding adhesive production between 1990 and 1999.

Results

A number of facilities using adhesives are permitted.

In the period from 2006 to 2016, activity data regarding adhesives use in point sources are collected in the OSIS database (SNAP 060405).

For the years 2006-2016, 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[24]). The largest wood impregnation companies were the following (only waterborne preservatives were used):

- Hansacom Ltd. – 33,000 m^3;
- Kestvuspuit plc – 30,000 m^3;
- Imprest plc – 15,000 m^3;
- Kehra Wood Industries Ltd. – 8,000 m^3;
- Natural plc – 5,000 m^3.

Solvent borne preservatives are used by some companies that produce windows, doors and log houses.

The major solvent borne supplier VBH was contacted, and it was discovered that companies that apply solvent borne preservatives use more than five tonnes a year. This is the threshold for an air pollution permit. Therefore, it is estimated that these installations are covered with permits (point sources) and are not subject to diffuse emissions.

5) Underseal treatment and conservation of vehicles (SNAP 060407)

There is no statistical information regarding the treatment of vehicles. Therefore, in 2010 expert opinion was sought from a representative of the Association of Estonian Automobile Sales and Maintenance Companies "repair unit". Expert opinion was received from Benefit AS, which is 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

[24] 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.

in the European Union, a reduction coefficient for the emission factor is applied.

Table 4.35 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 2000-2016 are gathered from OSIS and CollectER databases, and are reported by operators.

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4.2.11.3. Results

Table 4.36 NMVOC emissions from other solvent use and the activity data by SNAP codes in the period of 1990-2016

SNAP code	060400		060404		060405		060406		060407		060412	
Year	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, kt	NMVOC, kt	Activity data, mln.inhab.	NMVOC, kt	Activity data, kt
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	2.642	0.00001	NA	NO	--	0.003	NA
2006	--	--	0.0018	NA	1.555	3.364	0.00306	0.0690	NO	--	0.028	0.238
2007	--	--	0.0017	NA	1.194	3.967	0.01457	0.0290	NO	--	0.005	0.289
2008	--	--	0.0017	NA	1.068	2.516	0.00736	0.0170	NO	--	0.020	0.353
2009	--	--	0.0016	NA	0.736	1.794	0.01376	0.0260	NO	--	0.013	0.052
2010	--	--	0.0015	NA	0.399	1.260	0.01143	0.0180	NO	--	0.012	0.069
2011	--	--	0.0009	NA	0.483	1.476	0.01075	0.0220	NO	--	0.022	0.081
2012	--	--	0.0003	NA	0.584	1.721	0.01061	0.0220	NO	--	0.034	0.137
2013	--	--	0.0012	NA	0.513	1.817	0.01128	0.0290	NO	--	0.037	0.108
2014	--	--	0.0032	NA	0.499	1.825	0.01293	0.0360	NO	--	0.036	0.132
2015	--	--	0.0021	NA	0.605	2.509	0.01321	0.0300	NO	--	0.044	0.093
2016	--	--	0.0024	NA	0.652	2.696	0.000005	0.0002	NO	--	0.042	0.042

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 2016 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.

Table 4.37 Emission factors from the EMEP/EEA Guidebook 2016 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	g/t product
Cd	1	g/t product
Cr	16	g/t product
Cu	444	g/t product
Hg	0	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.

Table 4.38 Emission factors from the EMEP/EEA Guidebook 2016 for calculating pollutant emissions from tobacco combustion

Pollutant	Emission Factor	Unit
NMVOC	4.840	kg/t tobacco
NO_x	1.800	kg/t tobacco
CO	55.100	kg/t tobacco
NH_3	4.150	kg/t tobacco
TSP	27.000	kg/t tobacco
PM_{10}	27.000	kg/t tobacco
$PM_{2.5}$	27.000	kg/t tobacco
BC	0.450	% of $PM_{1.8}$
PCDD/F	0.100	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	5.400	g/t tobacco
Ni	2.700	g/t tobacco
Zn	2.700	g/t tobacco
Cu	5.400	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 are 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.

Table 4.39 The use of fireworks and pollutant emissions in the period of 1990-2016

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

Table 4.39 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

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 (Table 4.40).

Table 4.40 The use of tobacco and pollutant emissions from tobacco combustion in the period of 1990-2016

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	0.112	0.112	0.051	0.0004
1995	2.218	0.011	0.004	0.122	0.009	0.060	0.060	0.060	0.027	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	1.795	0.009	0.003	0.099	0.007	0.048	0.048	0.048	0.022	0.0002
2013	1.825	0.009	0.003	0.101	0.008	0.049	0.049	0.049	0.022	0.0002
2014	1.812	0.009	0.003	0.100	0.008	0.049	0.049	0.049	0.022	0.0002
2015	1.878	0.009	0.003	0.103	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

Table 4.40 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	19.181	9.591	9.591	19.181
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	1.795	0.199	0.081	0.081	0.081	9.694	4.847	4.847	9.694
2013	1.825	0.203	0.082	0.082	0.082	9.854	4.927	4.927	9.854
2014	1.812	0.201	0.082	0.082	0.082	9.783	4.891	4.891	9.783
2015	1.878	0.208	0.085	0.085	0.085	10.143	5.071	5.071	10.143
2016	1.903	0.211	0.086	0.086	0.086	10.275	5.137	5.137	10.275

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

No major improvements are planned for the next submission.

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	NO_x, NMVOC, NH_3	Tier 2
			TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B1b	Cattle non-dairy	Includes emissions from young cattle, beef cattle and suckling cows	NO_x, NH_3	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	NO_x, NH_3	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, NMVOC, NH_3, 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 1
3F	Field burning of agricultural residues	Since 2004, the burning of crop residues was prohibited	NO	

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The share of agricultural sources in total emissions in 2016 was as follows: NO_x – 8.8%, NH_3 – 88.6%, NMVOC – 20%, PM_{10} and TSP – 8.8%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 46.6%, 54.7%, 53.5% and 60% 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.[25]

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 2016, the emissions of NMVOC, NH_3 and particles decreased by 8%, 6% and 7% respectively compared to 2015, mainly due to the decrease in the numbers of dairy cattle, swine, poultry and fur animals. The number of dairy cattle has decreased mainly due to the a fall of milk production with are related to the economic sanctions imposed by Russia on EU. The number of swine has decreased 17.5% compared to 2014 in Estonia as a result of the outbreak of African swine fever. The number of fur animals has fallen more than half compared to 2015 due to the renewing of farms.

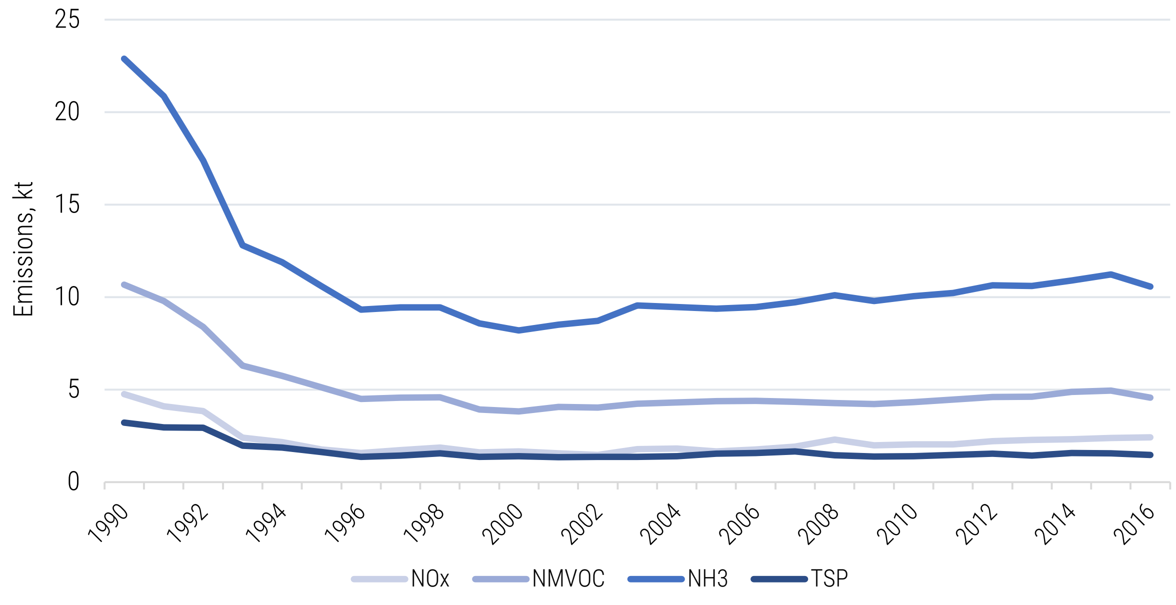

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector in the period of 1990-2016 (kt)

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

Table 5.2 Total emissions from the agriculture sector in the period of 1990-2016 (kt)

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
1990	4.752	10.674	22.887	3.210	NR	NR
1995	1.760	5.117	10.584	1.620	NR	NR
2000	1.649	3.812	8.203	1.392	0.111	0.939
2005	1.647	4.367	9.373	1.541	0.111	1.065
2006	1.752	4.384	9.453	1.561	0.113	1.107
2007	1.913	4.344	9.719	1.656	0.110	1.175
2008	2.296	4.267	10.093	1.444	0.106	0.986
2009	1.977	4.223	9.790	1.375	0.101	0.906
2010	2.031	4.317	10.041	1.397	0.103	0.925
2011	2.039	4.466	10.229	1.471	0.108	1.002
2012	2.204	4.604	10.634	1.527	0.110	1.037
2013	2.282	4.605	10.607	1.437	0.106	0.967
2014	2.309	4.880	10.893	1.571	0.115	1.071
2015	2.379	4.944	11.218	1.551	0.117	1.069
2016	2.418	4.569	10.563	1.455	0.114	1.050
Trend 1990-2016, %	-49.1	-57.2	-53.8	-54.7	3.2	11.8

More than half of NH_3 emissions comes from the agricultural soil sector (including animal manure application to soils and grazing) – 62% – and 38% is from the manure management (Figure 5.2). The main source of pollution of PM_{10} is agricultural crop operations – 76% (Figure 5.3).

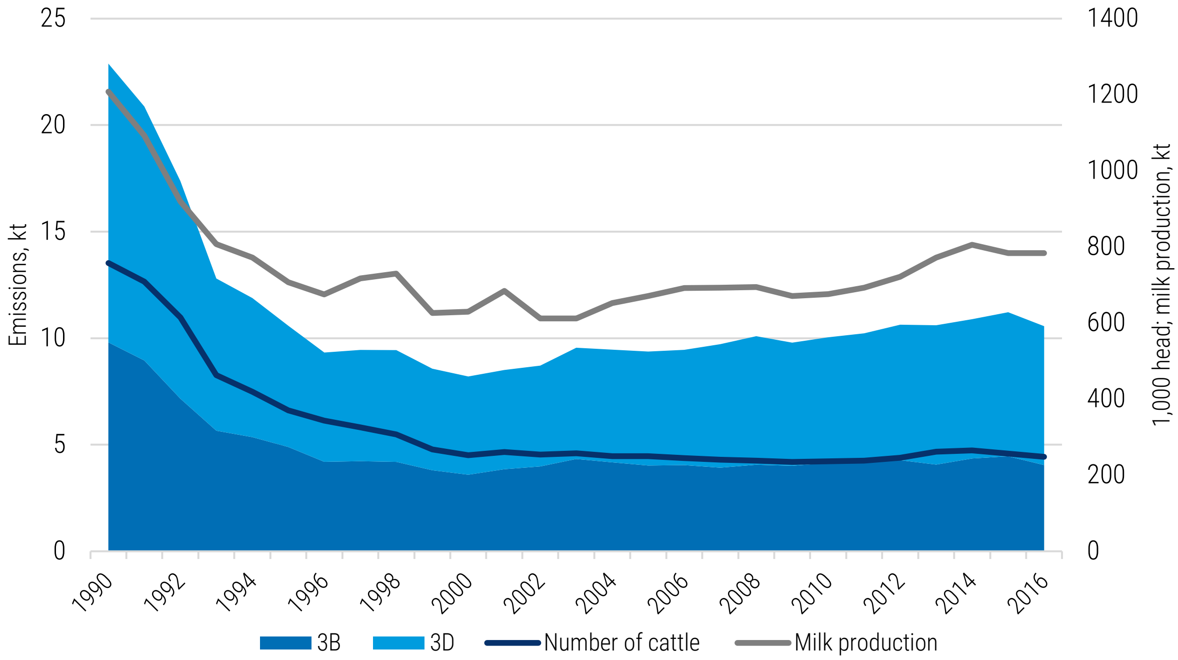

Figure 5.2 NH_3 emission distributions by the agriculture sector activities in the period of 1990-2016

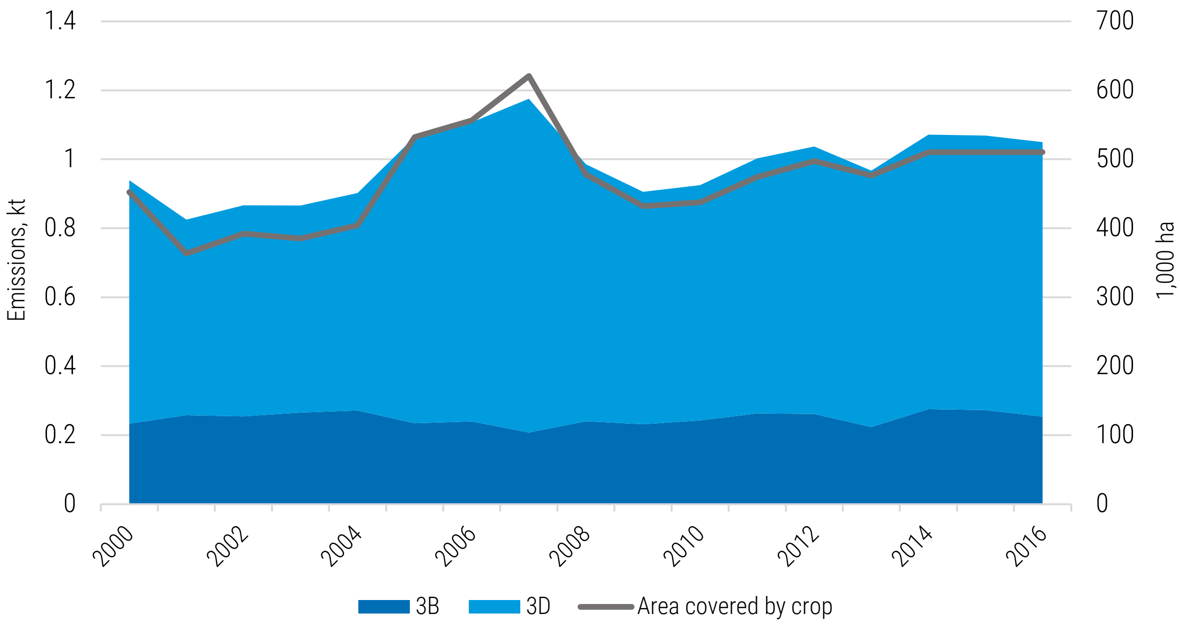

Figure 5.3 PM_{10} emissions from livestock (3B) and agricultural soils (3D) in in the period of 2000-2016

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 2016. 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 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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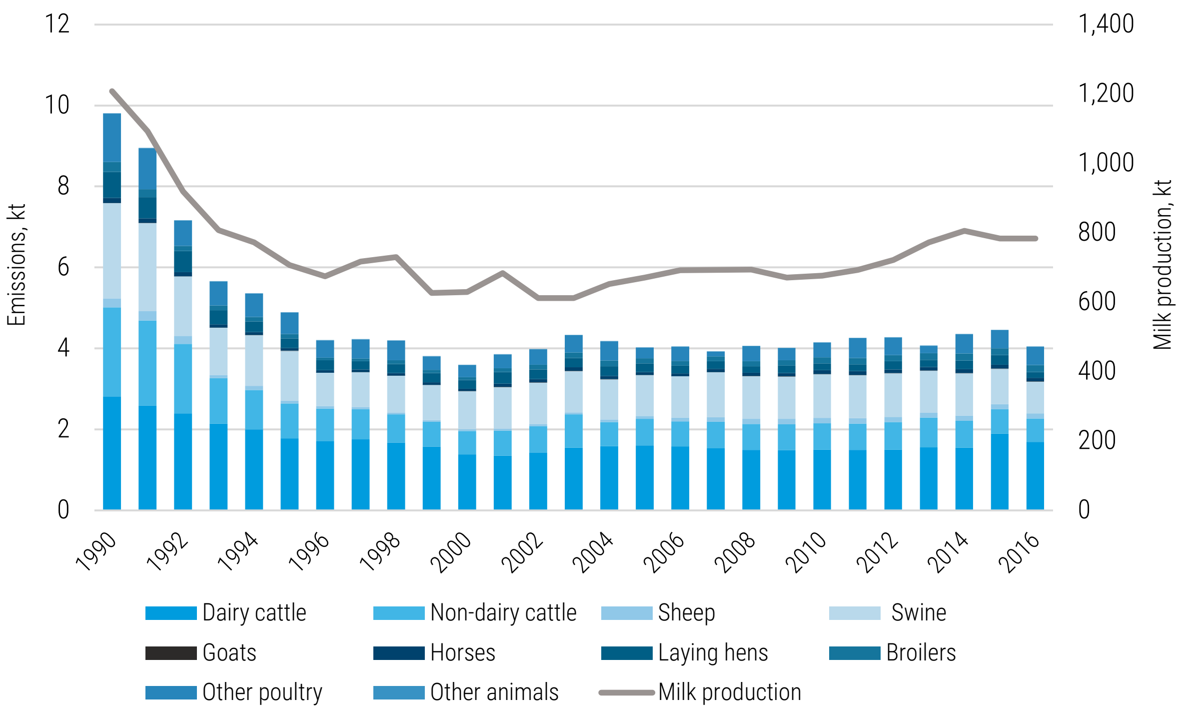

Figure 5.4 NH_3 emissions from manure management in the period of 1990-2016

During the period of 1990–2016, the emission of NH_3 decreased by 58% (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 affected mainly by changes in livestock housing systems. Dairy cattle farmers have adopted a loose-housing technology system instead of the tie-stall housing technology and, due to this, liquid manure technology has been used in place of solid manure technology. Changes in manure-handling technology have decreased the levels of emissions of ammonia because liquid manure generates less ammonia than 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 1990-2016 the annual average nitrogen production per head of dairy cattle was increased by 43%.

In 2016, ammonia emissions decreased by 10% in comparison to 2015's figures, due mainly to a decrease in the numbers of dairy cattle, swine, and fur animals during the same period. The numbers of dairy cattle has decreased due mainly to a fall in milk production, which is related to the economic sanctions that have been imposed by Russia on the EU. The number of swine has decreased by 17.5% in Estonia in comparison to 2014 as a result of the outbreak of African swine fever. The number of fur animals has fallen by more than half in comparison to 2015 due to changes on farms.

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Table 5.3 Total emissions of NO_x from manure management in the period of 1990-2016 (kt)

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

Year	Dairy cattle*	Non-dairy cattle*	Sheep	Swine*	Goats	Horses	Laying hens*	Broilers*	Other poultry	Other animals
1990	0.030	0.030	0.001	0.008	0.000	0.002	0.011	0.006	0.005	0.000
1995	0.018	0.012	0.000	0.004	0.000	0.001	0.004	0.003	0.002	0.000
2000	0.015	0.008	0.000	0.004	0.000	0.001	0.004	0.002	0.001	0.000
2005	0.016	0.009	0.000	0.004	0.000	0.001	0.004	0.003	0.001	0.000
2006	0.015	0.009	0.001	0.005	0.000	0.001	0.003	0.003	0.001	0.000
2007	0.014	0.009	0.001	0.005	0.000	0.001	0.003	0.003	0.001	0.000
2008	0.013	0.009	0.001	0.005	0.000	0.001	0.003	0.003	0.002	0.000
2009	0.012	0.009	0.001	0.005	0.000	0.001	0.003	0.003	0.001	0.000
2010	0.011	0.010	0.001	0.005	0.000	0.001	0.003	0.004	0.002	0.000
2011	0.011	0.010	0.001	0.005	0.000	0.001	0.003	0.004	0.002	0.000
2012	0.012	0.010	0.001	0.004	0.000	0.001	0.003	0.004	0.002	0.000
2013	0.012	0.011	0.001	0.004	0.000	0.001	0.003	0.004	0.001	0.000
2014	0.012	0.010	0.001	0.005	0.000	0.001	0.004	0.004	0.002	0.000
2015	0.015	0.010	0.001	0.004	0.000	0.001	0.004	0.004	0.002	0.000
2016	0.024	0.009	0.001	0.003	0.000	0.001	0.003	0.004	0.002	0.000
Trend 1990-2016, %	-20.7	-70.0	-41.7	-60.3	150.0	-33.5	-76.9	-27.4	-62.3	-71.4

Table 5.4 Total emissions of NMVOC from manure management in the period of 1990-2016 (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	0.085	0.153	0.233	0.098
Trend 1990-2016, %	-35.8	-71.9	-42.4	-67.7	160.3	-33.7	-77.0	-27.4	-62.2	-78.2

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Table 5.5 Total emissions of NH_3 from manure management in the period of 1990-2016 (kt)

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

Year	Dairy cattle*	Non-dairy cattle *	Sheep	Swine*	Goats	Horses	Laying hens*	Broilers*	Other poultry	Other animals
1990	2.818	2.194	0.222	2.355	0.003	0.127	0.643	0.240	1.197	0.005
1995	1.780	0.858	0.078	1.225	0.003	0.068	0.239	0.106	0.533	0.003
2000	1.380	0.578	0.047	0.935	0.005	0.062	0.209	0.076	0.298	0.001
2005	1.600	0.656	0.078	1.008	0.004	0.071	0.210	0.127	0.266	0.003
2006	1.584	0.614	0.096	1.015	0.005	0.073	0.184	0.121	0.351	0.002
2007	1.534	0.652	0.114	1.113	0.006	0.078	0.186	0.118	0.120	0.002
2008	1.496	0.640	0.126	1.051	0.006	0.078	0.159	0.127	0.376	0.002
2009	1.483	0.647	0.128	1.047	0.007	0.080	0.186	0.133	0.299	0.002
2010	1.501	0.646	0.134	1.076	0.007	0.101	0.167	0.149	0.358	0.002
2011	1.492	0.651	0.132	1.063	0.007	0.096	0.164	0.160	0.488	0.002
2012	1.504	0.675	0.127	1.075	0.008	0.092	0.200	0.156	0.434	0.002
2013	1.558	0.734	0.116	1.037	0.007	0.093	0.171	0.168	0.182	0.002
2014	1.545	0.671	0.120	1.047	0.006	0.093	0.217	0.172	0.480	0.002
2015	1.895	0.606	0.120	0.874	0.007	0.093	0.238	0.170	0.452	0.002
2016	1.689	0.579	0.128	0.782	0.008	0.084	0.148	0.174	0.452	0.001
Trend 1990-2016, %	-40.1	-73.6	-42.4	-66.8	159.5	-33.7	-77.0	-27.4	-62.2	-78.4

Table 5.6 Total emissions of $PM_{2.5}$ from manure management in the period of 2000-2016 (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	0.000	0.001	0.002	0.001	0.006	0.000
2001	0.053	0.018	0.001	0.002	0.000	0.001	0.003	0.001	0.007	0.000
2002	0.047	0.019	0.001	0.002	0.000	0.001	0.003	0.002	0.008	0.000
2003	0.048	0.019	0.001	0.002	0.000	0.001	0.002	0.002	0.009	0.000
2004	0.048	0.019	0.001	0.002	0.000	0.001	0.003	0.002	0.010	0.000
2005	0.046	0.019	0.001	0.002	0.000	0.001	0.002	0.002	0.006	0.001
2006	0.044	0.019	0.001	0.002	0.000	0.001	0.002	0.002	0.007	0.000
2007	0.042	0.020	0.002	0.002	0.000	0.001	0.002	0.002	0.003	0.000
2008	0.041	0.020	0.002	0.002	0.000	0.001	0.002	0.002	0.008	0.000
2009	0.040	0.020	0.002	0.002	0.000	0.001	0.002	0.002	0.006	0.000
2010	0.040	0.020	0.002	0.002	0.000	0.001	0.002	0.002	0.008	0.000
2011	0.039	0.021	0.002	0.002	0.000	0.001	0.002	0.003	0.010	0.000
2012	0.040	0.022	0.002	0.002	0.000	0.001	0.002	0.003	0.009	0.000
2013	0.040	0.024	0.002	0.002	0.000	0.001	0.002	0.003	0.004	0.000
2014	0.039	0.025	0.002	0.002	0.000	0.001	0.002	0.003	0.010	0.000
2015	0.047	0.020	0.002	0.002	0.000	0.001	0.002	0.003	0.010	0.000
2016	0.047	0.019	0.002	0.001	0.000	0.001	0.002	0.003	0.010	0.000
Trend 2000-2016, %	-13.1	10.0	173.1	-17.1	37.5	35.6	-29.2	129.8	51.7	0.0

Table 5.7 Total emissions of PM_{10} from manure management in the period of 2000-2016 (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	0.000	0.001	0.029	0.012	0.044	0.000
2001	0.081	0.028	0.002	0.041	0.000	0.001	0.040	0.014	0.050	0.001
2002	0.073	0.030	0.002	0.040	0.000	0.001	0.033	0.018	0.057	0.001
2003	0.074	0.030	0.002	0.040	0.000	0.001	0.032	0.022	0.063	0.001
2004	0.073	0.029	0.003	0.038	0.000	0.001	0.034	0.023	0.069	0.001
2005	0.071	0.030	0.003	0.039	0.000	0.001	0.029	0.021	0.039	0.001
2006	0.068	0.030	0.004	0.039	0.000	0.001	0.026	0.020	0.052	0.001
2007	0.065	0.030	0.005	0.043	0.000	0.001	0.026	0.019	0.018	0.001
2008	0.063	0.030	0.005	0.042	0.000	0.001	0.022	0.021	0.055	0.001
2009	0.061	0.030	0.005	0.041	0.000	0.001	0.026	0.022	0.044	0.001
2010	0.061	0.031	0.006	0.043	0.000	0.002	0.023	0.024	0.053	0.001
2011	0.061	0.031	0.006	0.042	0.000	0.001	0.023	0.026	0.072	0.001
2012	0.061	0.033	0.005	0.042	0.000	0.001	0.028	0.025	0.064	0.001
2013	0.062	0.036	0.005	0.041	0.000	0.001	0.024	0.027	0.027	0.001
2014	0.060	0.038	0.005	0.041	0.000	0.001	0.030	0.028	0.071	0.001
2015	0.073	0.030	0.005	0.035	0.000	0.001	0.033	0.028	0.067	0.001
2016	0.072	0.029	0.005	0.030	0.000	0.001	0.021	0.028	0.067	0.000
Trend 2000-2016, %	-13.0	10.0	174.0	-15.5	37.5	35.5	-29.1	129.8	51.7	0.0

5.2.2. Methodological Issues

Emission calculations from manure management are based on the Tier 2 (mass flow approach) and Tier 1 methods from the EMEP/EEA Guidebook 2016, and stem from country-specific values 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.

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 being used.

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 (Table 5.14). According to the EMEP/EEA Guidebook 2016, there are different emission factors for solid and slurry manure types (Table 5.8).

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

AAP_{animal_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, buildings, storage and grazing.

NMVOC emissions from dairy cattle have been recalculated for the years 1990–2015. Recalculations entail using corrected emission factor (Frac silage_store).

For the calculation method for gross feed intake by dairy cattle, use was made of the Estonian GHG National Inventory Report 2018[26] (Table 5.11) and the emission factor from the EMEP/EEA Guidebook 2016 (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 2 methods from the EMEP/EEA Guidebook 2016 were used to calculate NO and NH_3 emissions from manure management and NH_3 emissions from urine and dung deposited by grazing animals (NFR 3Da3), and from animal manure applied to soils (NFR 3D2a) by dairy cattle, non-dairy cattle, boilers, laying hens and swine. For non-dairy cattle and swine, category emissions were calculated separately for sub-categories as presented in Tables 5.11 and 5.12.

[26] Estonian GHG National Inventory Report 2018, Ch. 5 Agriculture (CFR 3).

For broilers and laying hens the Tier 2 approach was used for the first time. For NFR 3B4giv (Manure Management - Other Poultry) a Tier 1 emission factor is still being used for emission calculations due to the lack of clear knowledge of the distribution of poultry types (e.g. turkeys, ducks and geese). There is an on-going project at the Estonian University of Life Sciences working with improving activity data for the agricultural sector which may resolve the problem.

NH_3 emission from dairy cattle, non-dairy cattle, broilers, laying hens, 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 method uses 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 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 covering excretion by dairy cattle and non-dairy cattle as described in the Estonian GHG National Inventory Report 2018.[27] The results for nitrogen excretion estimations are presented in Tables 5.10 and 5.11. For nitrogen excretion, use was made of rates from 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 on the proportions of TAN excreta. According to the EMEP/EEA Guidebook 2016, there are different emissions factors for housing, manure storage, and grazing (Table 5.14).

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock in 1990-2016[28]

Year	Nitrogen excretion rate, kg N/head/yr	Gross energy intake, MJ/head/year
1990	85.1	87,965
1995	82.1	79,205
2000	88.5	92,345
2005	106.3	103,660
2006	108.2	106,945
2007	109.7	108,770
2008	110.7	110,960
2009	111.2	111,690
2010	111.4	113,150
2011	112.0	114,245
2012	113.0	117,165
2013	116.4	120,815
2014	118.1	123,005
2015	119.6	123,005
2016	122.0	123.005

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

Livestock category of non-dairy cattle	Nitrogen excretion rate, kg N/head/yr
Mature males (2 years and over)	80.3
Mature females (2 years and over)	44.8
Bovine animals (aged between 1 and 2 years)	58.5
Calves (6-12 months)	18.7
Calves (0-6 months)	4.4

Table 5.12 Average N excretion factors used in the estimates, kg N/head/year

Swine category	Nitrogen excretion rate, kg N/head/year
Piglets, live weight less than 20 kg	4.5
Young pigs, live weight 20–<50 kg	8.7
Fattening pigs	
…live weight 50–<80 kg	10.6
…live weight 80–<110 kg	10.6
…live weight 110 kg or more	10.6
Breeding pigs, live weight 50 kg or more	25.1

For assessing the proportions of different manure management types for different livestock categories separately, a country-specific manure management system (liquid/slurry, solid storage,

[27] Estonian GHG National Inventory Report 2018, Ch. 5 Agriculture (CFR 3).
[28] https://www.riigiteataja.ee/akt/122122016004

and pasture/range) was used. MMS used to store animal waste generated by cattle and swine are presented in Table 5.13.

In the beginning of 2000´s a loose-housing technology system started to replace tie-stall housing technology in dairy farms, because of that liquid manure technology has been used in place of solid manure technology. At the same time tie stall housing technology with solid storage is still used for mature non-dairy cattle. Calves are kept in individual boxes. Liquid manure technology is manly used for pig category.

For further insight regarding the activity data and methodology applied to manure management system and N excretions estimations, see the Estonian GHG National Inventory Report 2018 Annex A.3.2. submitted under the UNFCCC.

The share of the proportion of pasture was used to calculate the housed period (in days). To calculate the mass of bedding, EMEP/EEA Guidebook standards were used.

Table 5.13 Manure management system usage for swine and cattle in 2016

Livestock category	Liquid/ Slurry	Solid Storage +deep litter	Pasture/ Range
		%	
Fattening pig	75.8	23.9	0.3
Piglets	75.8	23.9	0.3
Shows	75.8	23.9	0.3
Young pig	76.8	22.9	0.3
Dairy cattle	24.9	35.4	39.7
Bowine animals		56.2	43.8
Calvess		56.2	43.8
Mature females	4.5	57.3	38.2
Mature males	4.5	57.3	38.2

Table 5.14 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	0.190	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 1990-2016. 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 5.15 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

Year	Cattle dairy	Cattle non-dairy	Sheep	Goats	Horses	Fattening pigs	Sows	Laying hens	Broilers	Other poultry	Fur animals
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	113.9	134.3	91.3	5.5	5.7	278.6	25.9	512.6	1 417.1	475.6	50.2

5.2.3. Uncertainty

An uncertainty analysis was carried out for the 2015 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 5.16.

Table 5.16 Uncertainties in agriculture sector

Pollutant	Emission, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	1.6	kt	5.152	0.047	0.004
NMVOC	5.0	kt	22.013	0.111	0.016
NH_3	10.6	kt	90.789	0.366	0.049
$PM_{2.5}$	0.1	kt	1.281	0.007	0.002
PM_{10}	1.1	kt	7.630	0.057	0.015
TSP	1.6	kt	7.366	0.041	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. In addition, this year, NO_x emissions from animal manure applied to soils and grazing are reported, for the first time, under NFR 3Da2a and 3Da3 respectively.

The share of agricultural soils in the total of NH_3 emissions in 2016 was at 54.7%.

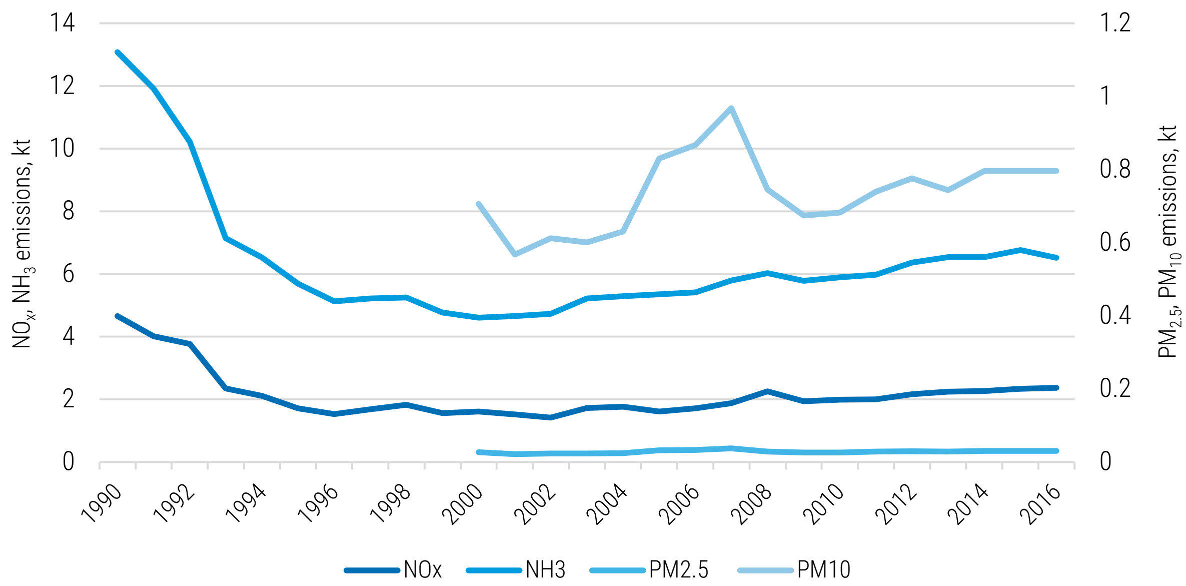

Figure 5.5 NO_x, NH_3, $PM_{2.5}$ and PM_{10} emissions from agricultural soils in the period of 1990-2016

During the period of 1990–2016, the emission of NH_3 decreased to 50.2% (Figure 5.5), mainly due to changes in Estonian agriculture. All the emission time series are presented in Tables 5.17–5.19.

In 2016, NH_3 emissions decreased by 3.9% compared to 2016, mainly due to a decrease in the cattle dairy and swine sectors.

Table 5.17 NMVOC, NH_3, $PM_{2.5}$, PM_{10} and TSP emissions from agricultural soils in the period 1990-2016 (kt)

Year	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
1990	0.679	13.084	NR	NR	1.231
1995	0.358	5.692	NR	NR	0.649
2000	0.389	4.612	0.027	0.706	0.706
2005	0.458	5.351	0.032	0.830	0.830
2006	0.478	5.409	0.033	0.867	0.867
2007	0.534	5.796	0.037	0.968	0.968
2008	0.411	6.031	0.029	0.745	0.745
2009	0.372	5.779	0.026	0.674	0.674
2010	0.376	5.899	0.026	0.682	0.682
2011	0.408	5.974	0.028	0.740	0.740
2012	0.428	6.360	0.030	0.776	0.776
2013	0.410	6.541	0.029	0.744	0.744
2014	0.439	6.539	0.031	0.796	0.796
2015	0.439	6.760	0.031	0.796	0.796
2016	0.439	6.519	0.031	0.796	0.796
Trend 1990-2016, %	**-35.3**	**-50.2**	**12.8**	**12.8**	**-35.3**

Table 5.18 NH_3 emissions from agricultural soils in the period 1990-2016 (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	2.966	6.025	0.010	0.010	4.073
1995	0.806	3.095	0.010	0.013	1.769
2005	0.901	2.993	0.009	0.137	1.310
2006	0.963	2.970	0.009	0.142	1.325
2007	1.109	3.077	0.009	0.281	1.321
2008	1.447	3.016	0.009	0.262	1.297
2009	1.121	3.058	0.009	0.300	1.292
2010	1.160	3.142	0.009	0.285	1.303
2011	1.278	3.171	0.009	0.195	1.321
2012	1.508	3.250	0.009	0.217	1.377
2013	1.386	3.383	0.009	0.268	1.494
2014	1.604	3.327	0.009	0.188	1.412
2015	1.634	3.506	0.009	0.219	1.392
2016	1.617	3.250	0.009	0.298	1.345
Trend 1990-2016, %	-45.5	-46.1	-16.2	2 905.3	-67.0

Table 5.19 NO_x emissions from agricultural soils in the period 1990-2016 (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	1.061	0.003	0.005	0.721
1995	0.756	0.566	0.003	0.007	0.384
2000	0.896	0.419	0.003	0.014	0.282
2005	0.803	0.451	0.003	0.068	0.283
2006	0.904	0.456	0.003	0.071	0.280
2007	0.999	0.462	0.003	0.141	0.273
2008	1.418	0.439	0.003	0.131	0.268
2009	1.093	0.435	0.003	0.150	0.261
2010	1.145	0.443	0.003	0.143	0.261
2011	1.192	0.446	0.003	0.098	0.263
2012	1.319	0.466	0.003	0.109	0.271
2013	1.346	0.473	0.003	0.134	0.287
2014	1.432	0.463	0.003	0.094	0.278
2015	1.432	0.484	0.003	0.110	0.310
2016	1.432	0.481	0.003	0.149	0.306
Trend 1990-2016, %	-50.1	-54.6	-16.2	2 905.3	-57.6

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.

Emissions from the use of mineral fertilizers are based conditionally on the Tier 2 method. Statistics Estonia can only separately submit data covering the use of urea fertilizers (a detailed description is included in the activity data chapter). There are no statistics available for the whole data series on the distribution of other fertilizer types. With that in mind, two different emission factors were implemented in order to calculate NH_3 emissions. For urea EF 0.155 (kg kg-1 fertilizer-N applied) was used and for others the EF 0.0405 (kg kg-1 fertilizer-N applied) was used with an arithmetical mean of Tier 2 emission factors (except urea) as represented in Table 3.2

of the EMEP/EEA Guidebook 2016 crop production and agricultural soils chapter. The previously described approach was used instead of Tier 1 for the first time.

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. For calculating NH_3 emissions from laying hens and broilers manure which is applied to soils, the Tier 2 methodology was used instead of Tier 1 for the first time.

In addition, according to the 2016 review of the expert team recommendation, the particles from cultivated crops were reported under NFR 3Dc instead of 3Da1 as was the case in the 2016 submission. The Tier 1 method uses readily available statistical data (Table 5.21) and default emission factors (Table 5.20).

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 5.20 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	0.0405
	NH3	kg NH_3 kg^{-1} fertilizer-N applied	0.155
3Da2a	NO_x	NO kg kg^{-1} fertiliser and manure-N applied	0.040
3Da2b	NH_3	kg NH_3 capita^{-1}	0.0066
	NO_x	kg NO_2 capita^{-1}	0.002
3Da2c	NH_3	kg kg^{-1} waste-N applied	0.080
	NO_x	kg kg^{-1} waste-N applied	0.040
3Da3	NO_x	NO kg kg^{-1} fertiliser and manure-N applied	0.040
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

Activity Data

Information regarding the use of synthetic N-fertilizer use, the area covered by these crops and the population is available from Statistics Estonia (www.stat.ee) for the years 1990-2016.

In 2015 Statistics Estonia stopped gathering mineral fertilizer data on their own and started to use data gathered by the Estonian Rural Economy Research in the framework of the Centre Farm Accounting Data Network (FADN). The change of methodology has caused a gap of publishing in comparable data in accordance to the former methodology of inorganic fertilizer use in 1990-2014. Due to a lack of comparable data, the data for 2014 were applied to estimate 2015 and 2016 emissions from the application of inorganic fertilizers on to the soils. Estonia is trying to find solutions to ensure consistency in the mineral fertilizer activity data used in emission estimations all through the timeline.

Information regarding urea fertilizer is also available from Statistics Estonia. In 2014-2016 there was no production of urea fertilizers in Estonia therefore use was made of urea fertiliser marketing data, which was provided by the Estonian Agricultural Board.

In addition, use was also made of information regarding compost application from the Estonian Environment Agency.

Table 5.21 Active data for agricultural soil sector in the period of 1990-2016

Year	Synthetic N-fertilizers, tonnes	Urea N, tonnes	Area covered by crop, ha	Compost applied on soils, tonnes	Population, mln.inhab
1990	58,360	544.097	952,103	6,775	1.571
1995	18,905	349.209	415,952	8,899	1.448
2000	22,396	237.165	452,538	19,010	1.401
2005	20,083	767.864	532,319	93,578	1.359
2006	22,610	416.432	556,083	97,332	1.351
2007	24,982	846.980	620,449	192,256	1.343
2008	35,455	100.691	477,786	179,204	1.338
2009	27,328	121.600	432,051	204,876	1.336
2010	28,628	4.661	437,302	195,002	1.333
2011	29,803	618.040	474,102	133,383	1.330
2012	32,978	1501.800	497,269	148,362	1.325
2013	33,659	199.564	476,623	183,237	1.320
2014	35,803	1344.800	510,317	128,368	1.316
2015	35,803	1607.972	510,317	149,984	1.313
2016	35,803	1462.560	510,317	203,611	1.316

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2015 inventory. The uncertainty in the emission factors for NOx, NMVOC, NH3, PM2.5, PM10 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 5.14.

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 residues was prohibited by an Estonian act (Regulation of the Minister of Agriculture No. 5, 20.04.2004, No. 57, 20.04.2007, and No. 20, 23.02.2011).

As no other official records of agricultural burning of crop residues exist in Estonia, then for the reporting period of 1990–2004, an inquiry was made to the Estonian Ministry of Agriculture and according to their best knowledge, no widespread practice of agricultural residues burning has taken place during the reporting period or it has been marginal, as the generation of agricultural residues in the form of litter is scant and often insufficient to cover the demand for it. In the 2018 submission, notation key NO was applied to the entire time-series.

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 database and the emissions for diffuse sources are calculated from the data received from Statistics Estonia, Estonian Rescue Board and the waste management system in ESTEA. The emission factors given in EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and expert opinions are used in the additional calculations.

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 1 / 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 sources emissions from municipal solid waste (MSW) incineration process with heat recovery (*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 1 / Tier 3	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Cu, PCDD/F
5C1bii	Hazardous waste incineration	--	--	NA
5C1biii	Clinical waste incineration	Includes point sources emissions from the incineration of hospital wastes	Tier 2	NO_x, SO_x, NMVOC, NH_3, TSP, CO, HM, PAHs Total, HCB, PCBs (*all IE under NFR 5C1bi*), 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 3	NO_x, NMVOC, SO_x, NH_3
5D2	Industrial wastewater handling	Includes point sources emissions from industrial wastewater handling	Tier 1 / 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, NH_3, $PM_{2.5}$, PM_{10}, TSP, Pb, Cd, Hg, As, Cr, Cu, PCDD/F

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The waste sector in the emission inventory is mostly an insignificant sector, except dioxin emissions, which in 2016 comprised about 38.3% of the total dioxin emissions. Over the years that share has been decreasing, reaching the peak of 44.4% in 2002. The main reason for that decrease is over 3 times less unintentional car and building fires in 2016 compared to the year 2002, which is one of the main sources for dioxin emissions in the waste sector beside industrial waste incineration.

6.2. Uncertainty

An uncertainty analysis was carried out to the year 2016 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, 2016	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2016, %
NO_x	0.028	kt	0.09	0.05	0.001
NMVOC	0.195	kt	0.87	0.70	0.41
SO_x	0.049	kt	0.17	0.07	0.001
NH_3	0.059	kt	0.50	0.25	0.13
$PM_{2.5}$	0.097	kt	1.30	0.80	0.40
PM_{10}	0.113	kt	1.01	0.58	0.10
TSP	0.128	kt	0.78	0.43	0.02
CO	0.012	kt	0.01	0.00	0.0002
Pb	0.338	t	1.04	1.19	0.11
Cd	0.011	t	1.42	1.49	0.15
Hg	0.021	t	3.42	2.00	0.14
PCDD/F	1.540	g I-TEQ	38.34	57.14	4.90
B(a)p	0.000014	t	0.00	0.001	0.001
B(b)f	0.000010	t	0.00	0.001	0.001
B(k)f	0.000010	t	0.00	0.002	0.001
I(1,2,3-cd)p	0.0000001	t	0.00	0.00	0.00
HCB	0.008	kg	2.71	5.83	20.32
PCB	0.020	kg	0.49	0.62	0.06

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. 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.

Table 6.3 Emissions from solid waste disposal on land in the period of 1990-2016

Year	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
	kt	t			
1990	1.213	NE	NR	NR	0.360
1995	1.107	NE	NR	NR	0.329
2000	0.810	NE	0.017	0.114	0.240
2005	0.789	NE	0.017	0.111	0.234
2006	0.766	NE	0.016	0.108	0.227
2007	0.817	0.036	0.017	0.115	0.243
2008	0.699	0.038	0.015	0.098	0.485
2009	0.545	0.038	0.012	0.077	0.173
2010	0.508	0.025	0.011	0.071	0.209
2011	0.493	0.025	0.010	0.311	0.920
2012	0.318	0.025	0.007	0.327	0.951
2013	0.168	0.025	0.004	0.267	0.825
2014	0.130	0.025	0.003	0.285	0.984
2015	0.122	0.025	0.003	0.327	0.943
2016	0.158	0.025	0.003	0.428	1.095

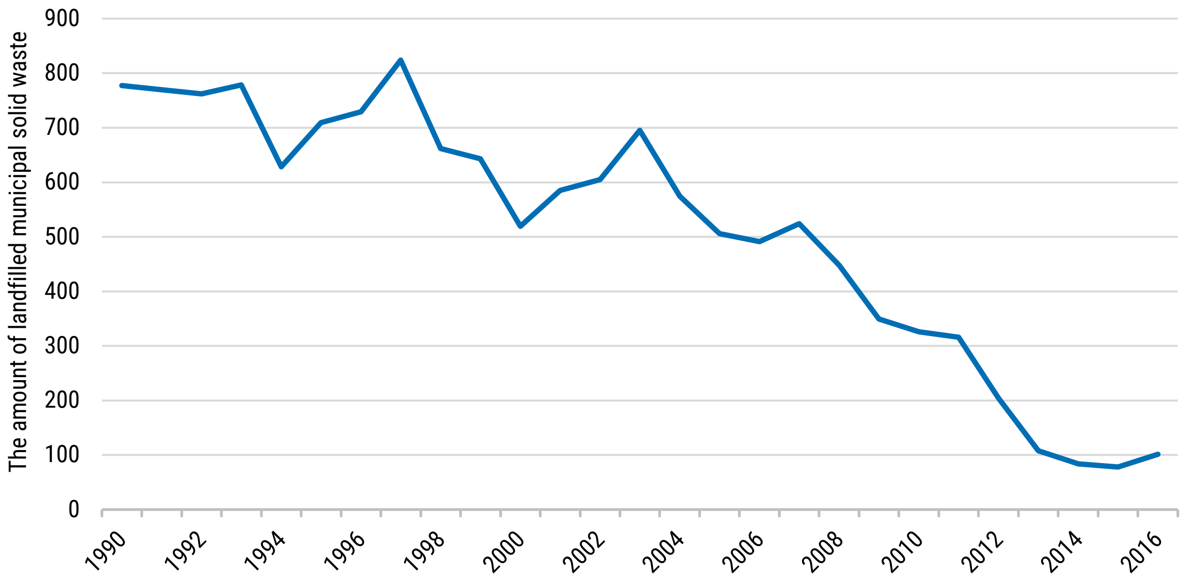

Figure 6.1 The amount of landfilled solid waste in the period of 1990-2016 (kt)

6.3.2. Methodological Issues

For diffuse sources EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 Tier 1 methodology is used for calculating NMVOC and particulate emissions. The annual amount of landfilled solid waste is gathered from the waste management system.

Also some point sources emissions from OSIS database, reported by operators, are used. In 2016 there were 6 operators.

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 5B1) and anaerobic digestion at biogas facilities (NFR 5B2).

Table 6.4 Emissions of NMVOC and NH_3 from compost production in the period of 1990-2016 (kt)

Year	NMVOC	NH_3
1990	NE	0.002
1995	NE	0.002
2000	NE	0.005
2005	0.001	0.025
2006	0.003	0.028
2007	0.004	0.045
2008	0.003	0.050
2009	0.004	0.055
2010	0.004	0.052
2011	0.004	0.038
2012	0.004	0.036
2013	0.004	0.043
2014	0.004	0.031
2015	0.003	0.039
2016	0.003	0.058

Table 6.5 Emissions from anaerobic digestion at biogas facilities in the period of 2011-2016

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

6.4.2. Methodological Issues

Point sources emissions are based on operator reports. In 2016 there were 8 anaerobic digestion operators and 2 composting operators.

Additional data to calculate diffuse sources emission of NH_3 in compost production sector is obtained from the waste management system. 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 2016 (Table 6.6).

Table 6.6 Emission factors 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 will end in Estonia because for the first time the waste that previously went into landfills can 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 emission that occur in the process are reported in the combustion sector (NFR 1A1a).

The Table 6.7 will give overview of emissions from industrial waste incineration in the period of 1990-2016.

Table 6.7 Emissions from industrial waste incineration in the period of 2000-2016

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	0.010	0.020	NE	NA	NA	4.000	NA
2004	NA	0.0100	0.050	NA	NE	NA	NA	NA	NA
2005	NA	0.0100	0.020	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	0.0004	0.005	0.003	NE	0.022	0.039	0.055	0.001
2009	0.016	0.0010	0.017	0.013	0.118	0.042	0.074	0.106	0.001
2010	0.016	0.0050	0.010	0.015	0.229	0.065	0.113	0.162	0.002
2011	0.014	0.0280	0.010	0.015	0.108	0.324	0.402	0.583	0.011
2012	0.011	0.0006	0.050	0.005	0.300	0.076	0.133	0.190	0.003
2013	0.006	0.0006	0.039	0.002	0.137	0.031	0.053	0.076	0.001
2014	0.007	0.0005	0.006	0.003	0.246	0.052	0.092	0.131	0.002
2015	0.004	0.0003	0.019	0.001	0.110	0.032	0.055	0.079	0.001
2016	0.009	0.0004	0.041	0.002	0.152	0.049	0.085	0.122	0.002

Table 6.7 continues

Year	Pb	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F
	kg							g I-Teq
2000	NA	NA	NE	NE	NA	NE	NE	0.120
2001	NA	NA	NE	NE	NA	NE	NE	0.140
2002	NA	NA	NE	NE	NA	NE	NE	0.080
2003	NA	NA	NE	NE	NA	NE	NE	NA
2004	240.000	NA	NE	NE	NA	NE	NE	0.160
2005	270.000	NA	NE	NE	NA	NE	NE	0.120
2006	210.000	NA	NE	NE	NA	NE	NE	0.010
2007	NA	NA	NE	NE	NA	NE	NE	0.260
2008	NA	NA	NE	3.000	NA	NE	NE	0.430
2009	NA	NA	NE	24.000	NA	NE	NE	0.508
2010	NA	NA	NE	9.400	NA	NE	NE	0.255
2011	0.048	0.029	0.010	8.923	0.019	0.029	0.085	0.295
2012	NA	NA	NE	7.200	NA	NE	NE	0.140
2013	NA	NA	NE	9.500	NA	NE	NE	0.220
2014	NA	NA	NE	6.000	NA	NE	NE	0.250
2015	NA	NA	NE	4.100	NA	NE	NE	0.638
2016	NA	NA	NE	1.300	NA	NE	NE	0.639

Table 6.8 Emissions from clinical waste incineration in the period of 1990-2016

Year	PCDD/F	PCBs
	g I-TEQ	kg
1990	0.470	NE
1995	0.430	NE
2000	0.280	NE
2005	0.520	NE
2006	0.040	NE
2007	0.040	NE
2008	0.026	NE
2009	0.074	NE
2010	0.066	NE
2011	0.066	IE
2012	0.068	IE
2013	0.017	IE
2014	0.073	IE
2015	0.085	IE
2016	0.086	IE

The first crematorium was established in Estonia in 1993. By the year 2016 there were already 7 crematoriums and 2 new crematoriums have started their work in 2017 and 2018. As in 1993 there was only 39 cremations then in 2016 the number of cremations was over 7200 which is roughly half of deceased people in that year. For pollutants emissions calculation the EMEP/EEA Guidebook 2016 Tier 1 emission factors are used and calculated emissions are presented in the following Table 6.9.

Table 6.9 Pollutants emissions from cremation in the period of 1993-2016

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	t								
1993	0.032	0.001	0.004	NA	NR	NR	0.002	NR	0.005
1995	0.723	0.011	0.099	NA	NR	NR	0.034	NR	0.123
2000	2.527	0.040	0.346	NA	0.106	0.106	0.118	NE	0.429
2005	3.920	0.062	0.537	NA	0.165	0.165	0.183	NE	0.665
2006	4.325	0.068	0.592	NA	0.182	0.182	0.202	NE	0.734
2007	4.622	0.073	0.633	NA	0.194	0.194	0.216	NE	0.784
2008	4.622	0.073	0.633	NA	0.194	0.194	0.216	NE	0.784
2009	4.731	0.075	0.648	1.543	0.199	0.199	0.221	NE	0.803
2010	5.124	0.081	0.702	1.619	0.216	0.216	0.239	NE	0.870
2011	5.777	0.091	0.791	1.678	0.243	0.243	0.270	NE	0.980
2012	6.046	0.095	0.828	0.004	0.254	0.254	0.283	NE	1.026
2013	6.071	0.096	0.832	0.007	0.255	0.255	0.284	NE	1.030
2014	6.202	0.098	0.850	0.007	0.261	0.261	0.290	NE	1.053
2015	6.400	0.101	0.877	0.013	0.269	0.269	0.299	NE	1.086
2016	6.400	0.101	0.877	0.008	0.269	0.269	0.299	NE	1.086

Table 6.9 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	kg								
1993	0.001	0.000	0.058	0.001	0.001	0.001	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	7.079	0.065	0.064	0.059	0.082	0.094	0.761
2006	0.157	0.026	7.811	0.071	0.071	0.065	0.091	0.104	0.839
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	0.210	0.035	10.434	0.095	0.095	0.087	0.121	0.139	1.121
2012	0.220	0.037	10.919	0.100	0.099	0.091	0.127	0.145	1.173
2013	0.221	0.037	10.965	0.100	0.100	0.091	0.128	0.146	1.178
2014	0.226	0.038	11.202	0.102	0.102	0.093	0.130	0.149	1.204
2015	0.233	0.039	11.559	0.106	0.105	0.096	0.134	0.153	1.242
2016	0.233	0.039	11.559	0.106	0.105	0.096	0.134	0.153	1.242

Table 6.9 continues

Year	PCDD/ PCDF	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	0.128	0.063	0.034	0.031	0.033	0.713	1.948
2006	0.142	0.069	0.038	0.034	0.037	0.786	2.149
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	0.189	0.092	0.051	0.045	0.049	1.050	2.871
2012	0.198	0.097	0.053	0.047	0.051	1.099	3.004
2013	0.199	0.097	0.053	0.047	0.051	1.104	3.017
2014	0.203	0.099	0.054	0.048	0.053	1.128	3.082
2015	0.209	1.024	0.559	0.500	0.542	1.164	3.181
2016	0.209	1.024	0.559	0.500	0.542	1.164	3.181

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 6.10-11. The share of this sector into total emission for all pollutants is not significant compared to other pollution sources.

Table 6.10 Amount of domestic waste burned in the period of 1990-2016 (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
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

Table 6.11 Pollutants emissions from domestic waste burning in the period of 1990-2016

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

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Table 6.11 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

Table 6.11 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

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/PCDF emissions from clinical and industrial waste incineration are calculated. In these calculations, data from the waste data management system were used.

UNEP Standardized Toolkit emission factors were used in the calculation of dioxin 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 total amount of municipal waste and from 2004 – 1% of MSW) and EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 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 5C1a). Emission factors are presented in mass per unit mass of waste burned (Table 6.12).

Table 6.12 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/PCDF	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. 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 6.13 Emissions from domestic wastewater handling in the period of 2013-2016 (tonnes)

Year	NO_x	NMVOC	SO_x	NH_3
2013	0.128	0.051	0.068	0.173
2014	0.128	0.033	0.068	0.032
2015	0.128	0.031	0.068	0.042
2016	0.128	0.031	0.068	0.191

Table 6.14 Emissions from industrial wastewater handling in the period of 1994-2016 (tonnes)

Year	NO_x	NMVOC	SO_x	NH_3
1994	NA	29.427	NA	NA
1995	NA	27.735	NA	NA
2000	NA	22.428	NA	NA
2005	NA	24.296	NA	NA
2006	NA	24.225	NA	NA
2007	NA	28.204	NA	NA
2008	1.234	24.886	0.124	0.979
2009	0.444	22.173	0.124	1.074
2010	0.441	28.490	0.126	0.426
2011	0.444	28.995	0.124	0.229
2012	0.441	25.478	0.125	0.318
2013	1.236	26.936	1.763	0.149
2014	1.486	26.432	2.183	0.134
2015	0.317	26.625	0.056	0.530
2016	1.085	27.301	1.833	0.522

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 2016 there were 7 operators.

In addition to the facility data, NMVOC emissions from diffuse sources are based on the Tier 1 method, whereby emissions are calculated using a default emission factor (NMVOC 15 mg/m^3 waste water). In this calculation, data from

Statistics Estonia was used. Data is available from the year 1994.

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 system and to compare the data with the GHG inventory data. Also, specify data for latrines.

6.7. Other Waste (NFR 5E)

6.7.1. Source Category Description

This chapter covers emissions from other waste sector, which includes data from facilities (3 operators in 2016) and from car fires, detached and undetached house fires, apartment and industrial building fires. Detailed data about fires is obtained from the Estonian Rescue Service and is available since 1998.

Pollutants emissions are presented in the following Table 6.15.

Table 6.15 Emissions from other waste in the period of 1998-2016

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

Table 6.15 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	0.001	0.001
2013	0.906	0.497	0.581	0.689	0.658	1.529	0.000	0.001
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

Table 6.15 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	5.000
2013	0.757	0.600	0.700	0.400	0.200
2014	0.843	NE	NE	NE	NE
2015	0.662	NE	NE	NE	NE
2016	0.684	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 Tier 2 method giving default emission factors. In this calculation, data from the Estonian Rescue Service were used.

Table 6.16 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

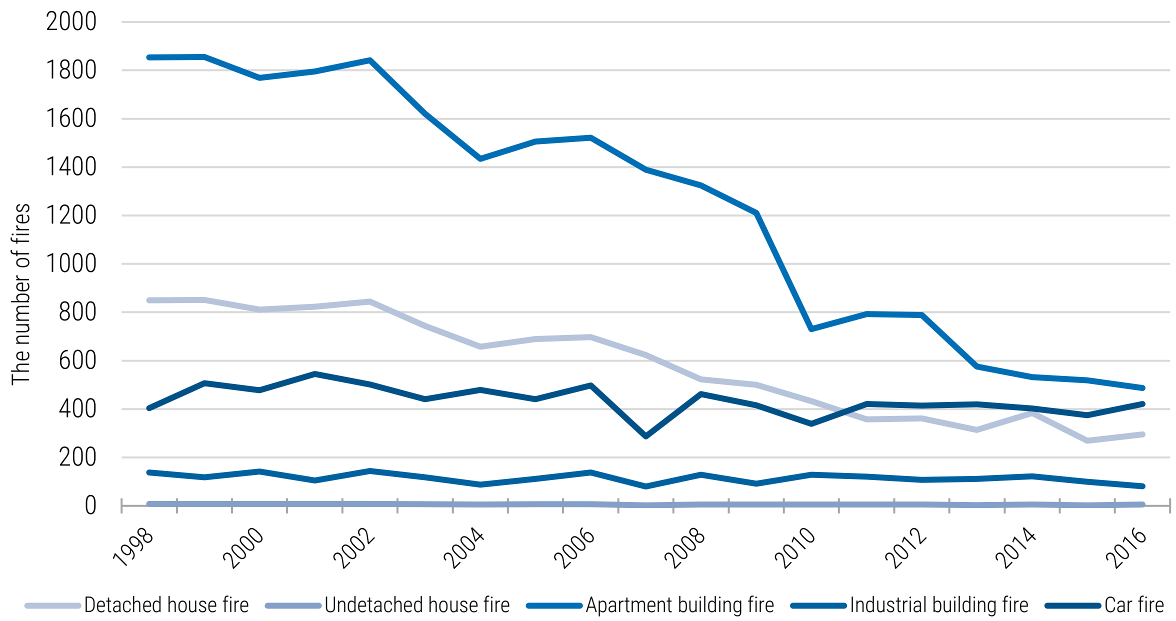

Figure 6.2 The number of fires according to the Estonian Rescue Service

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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 natural 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 (Figures 7.1 and 7.2). 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 1990–2015

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	0.257	0.314	0.485	0.257	0.582
1995	0.019	0.056	0.004	0.004	0.246	0.301	0.465	0.246	0.558
2000	0.068	0.205	0.014	0.014	0.914	1.117	1.726	0.914	2.051
2005	0.009	0.026	0.002	0.002	0.115	0.140	0.217	0.115	0.260
2006	0.310	0.929	0.062	0.062	4.201	5.135	7.936	4.201	9.287
2007	0.029	0.088	0.006	0.006	0.401	0.490	0.757	0.401	0.877
2008	0.128	0.384	0.026	0.026	1.811	2.214	3.422	1.811	3.839
2009	0.006	0.018	0.001	0.001	0.086	0.105	0.162	0.086	0.178
2010	0.002	0.007	0.000	0.000	0.036	0.044	0.068	0.036	0.074
2011	0.002	0.006	0.000	0.000	0.028	0.035	0.054	0.028	0.058
2012	0.000	0.001	0.000	0.000	0.004	0.004	0.007	0.004	0.008
2013	0.008	0.024	0.002	0.002	0.115	0.141	0.218	0.115	0.236
2014	0.008	0.023	0.002	0.002	0.114	0.139	0.215	0.114	0.233
2015	0.008	0.025	0.002	0.002	0.121	0.147	0.228	0.121	0.249

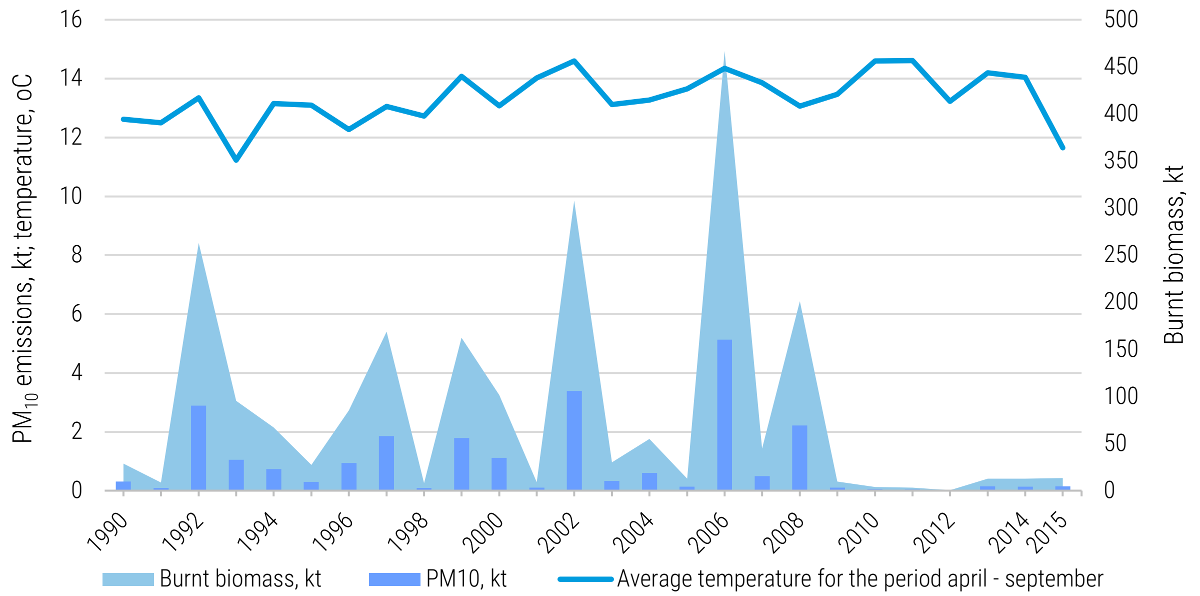

Figure 7.1 Burnt biomass, particulates emission and average temperature in the period 1990-2015

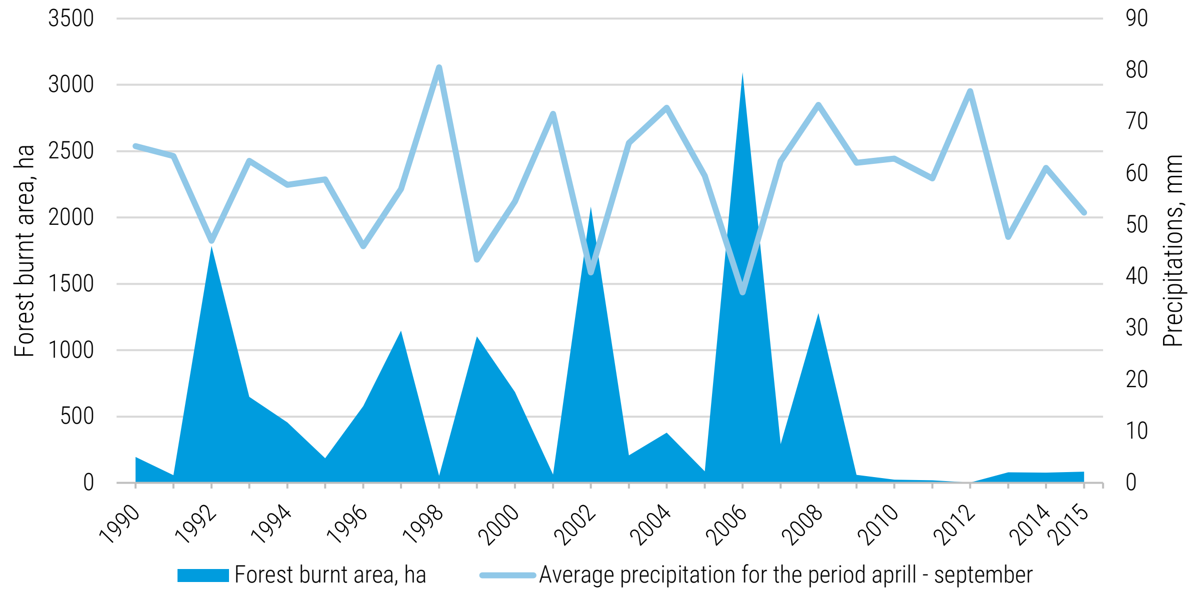

Figure 7.2 The forest burnt area and average precipitation amount

The cause of most forest fires in 2014 (97%) has been human activity. Natural factors (lightning) were the cause of 3 fires. In 2013, lightning caused 2 forest fires. 60% of forest fires in 2014 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 2014 were transport and power transmission lines, arson, the production of peat, as well as other reasons. For unknown reasons, 26 fires started. If we analyse the causes of fires in the period of 1999-2014, it appears that, on average, 2% 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.[29]

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.

[29] Yearbook Forest 2014

The emissions of NO_x, NMVOC, SO_x, NH_3 and CO are calculated using EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 Tier 1 emission factors (Table 7.3) and burnt forest area (1990-2014) received from the Yearbook Forest 2014 (Table 7.4).

The emissions of particulates are calculated on the base of EMEP/EEA Guidebook 2016 Tier 1emissioon factors and biomass burnt. Data about biomass amount are available in statistical database only for the years 2000-2014. Data for 1990-1999 are expert assessment and are calculated with use of surrogate data.

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	300	20	20	9	11	17	9	3000

Activity Data

Table 7.4 Forest burnt area and burnt biomass in the period 1990-2015

Year	Forest burnt area	Burnt biomass
	ha	t
1990	194.000	28553.955
1995	185.900	27361.754
2000	683.800	101529.709
2005	86.500	12758.291
2006	3095.600	466831.161
2007	292.400	44540.377
2008	1279.800	201273.862
2009	59.300	9522.107
2010	24.800	4023.925
2011	19.300	3150.840
2012	2.500	408.858
2013	78.500	12804.316
2014	77.800	12620.303
2015	83.100	13395.389

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 years 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 (m^2) – area used per vegetation type;

D (g/m^2) – foliar biomass density per vegetation type;

Γ – the integrated value of a unitless environmental correction factor over the growing season of the vegetation concerned;

ε-iso (μg/g.h) – isoprenes standard emission potential[30] 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*

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

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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.

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 2015. 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 2017 and 2018 are made by using exact calculation numbers.

1A1a Public electricity and heat production

In comparison with the previous submission, the emissions of NH_3 from wood combustion and all pollutants except SO_x, NH_3, NMVOC and CO from natural gas combustion were firstly calculated for period 1990–2015. The recommendations of TERT in the frame of NEC review were the cause of carrying out calculations (NH_3 from wood and $PM_{2.5}$ from gas combustion; other pollutants from gas were calculated in addition). Emission calculations were carried out based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 emission factors (Table 8.1). Ammonia emission factor for wood combustion is 37 g/GJ. Due to the fact that ammonia EF for large combustion plants is not provided in the Guidebook, the biomass for LCP is excluded from the total amount and thus, the emissions are calculated only for combustion plants with a capacity of less than 50 MW. Emissions of substances from natural gas combustion are very insignificant and practically don't influence emissions at the country level in general (Table 8.2).

Table 8.1 Pollutants EF from natural gas combustion

Pollutant	Unit	EF
$PM_{2.5}$	g/GJ	0.45
PM_{10}	g/GJ	0.45
TSP	g/GJ	0.45
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
B(a)p	µg/GJ	0.56
B(b)f	µg/GJ	0.84
B(k)f	µg/GJ	0.84
I(1,2,3-cd)p	µg/GJ	0.84

Table 8.2 The differences in the sector NFR 1A1a emissions between 2017 and 2018 submissions (%)

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
1990	100	NR	NR	NR	0.009	0.00009	0.0008	0.35
1991	100	NR	NR	NR	0.01	0.00010	0.0009	0.41
1992	100	NR	NR	NR	0.006	0.00006	0.0006	0.26
1993	100	NR	NR	NR	0.003	0.00003	0.0003	0.13
1994	100	NR	NR	NR	0.005	0.00005	0.0005	0.19
1995	100	NR	NR	NR	0.008	0.00006	0.0006	0.26
1996	100	NR	NR	NR	0.009	0.00007	0.0006	0.31
1997	100	NR	NR	NR	0.009	0.00007	0.0007	0.29
1998	100	NR	NR	NR	0.009	0.00007	0.0007	0.29
1999	100	NR	NR	NR	0.009	0.00007	0.0008	0.31

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
2000	100	0.09	0.03	0.04	0.013	0.00008	0.0008	0.31
2001	100	0.1	0.03	0.04	0.014	0.00008	0.0009	0.33
2002	100	0.1	0.04	0.04	0.022	0.00008	0.0008	0.3
2003	100	0.15	0.05	0.06	0.024	0.00006	0.0005	0.24
2004	100	0.12	0.06	0.05	0.028	0.00006	0.0006	0.26
2005	100	0.15	0.08	0.07	0.044	0.00007	0.0008	0.28
2006	100	0.27	0.14	0.12	0.079	0.00008	0.0008	0.3
2007	100	0.12	0.06	0.05	0.047	0.00006	0.0007	0.24
2008	100	0.19	0.1	0.08	0.075	0.00006	0.0006	0.26
2009	100	0.16	0.09	0.07	0.072	0.00006	0.0005	0.25
2010	100	0.09	0.04	0.04	0.037	0.00005	0.0005	0.2
2011	100	0.04	0.02	0.02	0.015	0.00004	0.0003	0.16
2012	100	0.17	0.09	0.08	0.062	0.00005	0.0006	0.19
2013	5109.64	0.08	0.04	0.03	0.039	0.00003	0.0003	0.13
2014	7850.8	0.13	0.07	0.06	0.049	0.00003	0.0003	0.12
2015	5654.37	0.11	0.07	0.04	0.062	0.00003	0.0004	0.13

Table 8.2 continues

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
1990	0.023	0.0002	0.00006	0.00009	0.00006	0.0032	0.004	0.008	0.012
1991	0.027	0.0002	0.00007	0.0001	0.00007	0.0034	0.004	0.008	0.011
1992	0.017	0.0001	0.00006	0.00008	0.00005	0.0020	0.003	0.005	0.007
1993	0.009	0.0001	0.00004	0.00004	0.00002	0.0010	0.001	0.003	0.004
1994	0.013	0.0001	0.00004	0.00006	0.00003	0.0012	0.001	0.003	0.004
1995	0.017	0.0001	0.00004	0.00009	0.00004	0.0015	0.002	0.004	0.005
1996	0.020	0.0001	0.00004	0.00011	0.00005	0.0018	0.002	0.005	0.005
1997	0.019	0.0001	0.00004	0.0001	0.00005	0.0017	0.002	0.005	0.005
1998	0.019	0.0001	0.00005	0.0001	0.00005	0.0014	0.002	0.004	0.004
1999	0.020	0.0001	0.00005	0.00012	0.00005	0.0015	0.002	0.004	0.005
2000	0.021	0.0001	0.00005	0.00014	0.00006	0.0022	0.002	0.006	0.007
2001	0.022	0.0002	0.00005	0.00016	0.00006	0.0029	0.003	0.008	0.009
2002	0.020	0.0001	0.00005	0.00014	0.00006	0.0027	0.003	0.007	0.009
2003	0.016	0.0001	0.00004	0.00012	0.00004	0.0022	0.003	0.007	0.007
2004	0.017	0.0001	0.00005	0.00012	0.00005	0.0020	0.002	0.005	0.005
2005	0.019	0.0001	0.00005	0.00012	0.00005	0.0019	0.002	0.005	0.006
2006	0.021	0.0001	0.00005	0.00015	0.00006	0.0022	0.003	0.007	0.026
2007	0.016	0.0001	0.00004	0.00011	0.00004	0.0033	0.004	0.009	0.010
2008	0.017	0.0001	0.00004	0.00013	0.00005	0.0023	0.003	0.007	0.007
2009	0.017	0.0001	0.00004	0.00012	0.00005	0.0011	0.001	0.003	0.003
2010	0.013	0.0001	0.00004	0.00010	0.00004	0.0009	0.001	0.003	0.003
2011	0.011	0.0001	0.00004	0.00008	0.00003	0.0009	0.001	0.002	0.002
2012	0.013	0.0001	0.00005	0.00009	0.00003	0.0009	0.001	0.002	0.002
2013	0.009	0.0001	0.00004	0.00006	0.00002	0.0007	0.001	0.002	0.002
2014	0.009	0.0001	0.00004	0.00007	0.00002	0.0005	0.001	0.001	0.001
2015	0.010	0.0001	0	0.00007	0.00003	0.0004	0	0.001	0.001

1A1c Manufacture of solid fuels and other energy industries

In comparison with the 2017 submission NMVOC emissions from the sector 1A1c for 1990-2014 have been recalculated. The main reason - carrying out new measurements of emissions on old Enefit-140 installation for oil shale production. Emissions for previous years are recalculated, using the calculated IEF.

Also the emissions of NH_3 from wood combustion and all pollutants except SO_x, NH_3, NMVOC and CO from natural gas combustion were firstly calculated for period 1990–2015. The recommendations of TERT in the frame of NEC review were the cause of carrying out calculations (NH_3 from wood and $PM_{2.5}$ from gas combustion; other pollutants from gas were calculated in addition). Emission calculations were carried out based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 emission factors (Table 8.1). Ammonia emission factor for wood combustion is 37 g/GJ. Emissions of substances from natural gas combustion are very insignificant and practically don't influence emissions at the country level in general (Table 8.3).

Table 8.3 The differences in the sector NFR 1A1c emissions between 2017 and 2018 submissions (%)

Year	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
1990	22.9	NA	NR	NR	NR	NA	NA	NA	NA
1991	12.3	NA	NR	NR	NR	NA	NA	NA	NA
1992	21.5	NA	NR	NR	NR	NA	NA	NA	NA
1993	52.6	NA	NR	NR	NR	NA	NA	NA	NA
1994	82.8	NA	NR	NR	NR	NA	NA	NA	NA
1995	61.4	NA	NR	NR	NR	NA	NA	NA	NA
1996	55.7	NA	NR	NR	NR	NA	NA	NA	NA
1997	74.8	NA	NR	NR	NR	NA	NA	NA	NA
1998	72.2	NA	NR	NR	NR	NA	NA	NA	NA
1999	90	NA	NR	NR	NR	NA	NA	NA	NA
2000	167.1	100	0.001	0	0	0	0	0	0.02
2001	126	100	0	0	0	0	0	100	0.002
2002	90.5	-71.36	0.032	0.013	0.102	0.006	0.00021	100	0.218
2003	90.7	100	0.072	0.027	0.234	0.01	0.00046	100	100
2004	112.8	100	0.061	0.023	0.198	0.009	0.003	100	100
2005	119.9	100	0	0	0	0	0	0	100
2006	382.5	100	0.05	0.025	0.165	0.013	0.001	100	100
2007	310.6	100	0.054	0.027	0.19	0.016	0.00167	100	100
2008	1 133.7	265.73	0.095	0.05	0.317	0.035	0.00507	0.038	23.46
2009	883.8	2 634.56	0.063	0.032	0.208	0.023	0.00274	0.012	6.147
2010	1 066.2	4 186.93	0.036	0.021	0.118	0.016	0.00389	0.018	6.495
2011	811.8	1 856.67	0.054	0.027	0.173	0.021	0.31202	0.045	6.709
2012	1 087.5	665.49	0.049	0.023	0.175	0.017	0.0072	0.016	4.958
2013	1 051.5	86.09	0.062	0.029	0.182	0.022	0.01064	0.2	404
2014	463.1	0.15	0.055	0.026	0.244	0.019	0.01013	0.714	773.333
2015	0	0.03	0.025	0.739	0.114	0.008	0.00417	0	650

Table 8.3 continues

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
2000	0.0024	0	0	0	0	0	0	0	0
2001	0.0006	0	0	0	0	0	0	0	0
2002	0.0522	0.0005	0	0.0001	0.0002	0.0002	0.0003	0.0007	0.0007
2003	0.094	0.0007	0	0.0002	0.0005	0.0004	0.0005	0.0013	0.0013
2004	100	100	100	100	0.003	0.0002	0.0002	0.0007	0.0007
2005	0	0	100	0	0	0	0	0	0
2006	0.304	0.002	100	0.0005	0.001	0.0002	0.0002	0.0007	0.0007
2007	0.433	0.003	100	0.0007	0.0012	0.0004	0.0004	0.001	0.001
2008	1.3522	0.017	0	0.005	0.0016	0.0018	0.0023	0.0054	0.005
2009	0.7446	0.0068	0	0.0016	0.0016	0.001	0.0015	0.0039	0.004
2010	0.6922	0.0088	0	0.0017	0.0014	0.0009	0.0014	0.0035	0.0036
2011	1.0207	0.1267	0.6963	0.0959	0.6955	0.0011	0.0016	0.0041	0.0043
2012	0.8449	0.0045	0	0.0034	0.0012	0.0056	0.0087	0.019	0.024
2013	5.9124	0.0568	0	0.0232	0.0031	0.0196	0.0316	0.0557	0.0909
2014	2.1976	0.0826	0	0.0212	0.0019	0.0276	0.0446	0.0769	0.129
2015	0.7059	0	0	0	0.0007	0	0.0247	0.0431	0.0714

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

All pollutants emission from combustion processes which have been mistakenly given under a NFR 2A2 in 2008 are considered under a NFR 1A2f in this year submission. The differences are presented in Table 8.4.

Table 8.4 The differences in the sector NFR 1A2f emissions for 2008 between 2017 and 2018 submissions (%)

Year	Unit	2017	2018	%
NO_x	kt	1.2816	1.2844	0.22
NMVOC	kt	0.0643	0.0644	0.10
SO_x	kt	1.0841	1.0863	0.21
CO	kt	1.7514	1.7549	0.20
Pb	t	0.0953	0.0954	0.13
Cd	t	0.0096	0.0096	0.02
Hg	t	0.0043	0.0043	0.01
Cr	t	0.0278	0.0278	0.04
Cu	t	0.0524	0.0524	0.09
Ni	t	0.0211	0.0224	6.27
Zn	t	0.0381	0.0384	0.71

1A2giii Stationary combustion in manufacturing industries and construction: Other

In comparison with the previous submission, the emissions of NH_3 from wood combustion and all pollutants except SO_x, NH_3, NMVOC and CO from natural gas combustion were firstly calculated for period 1990–2015. The recommendations of TERT in the frame of NEC review were the cause of carrying out calculations (NH3 from wood and $PM_{2.5}$ from gas combustion; other pollutants from gas were calculated in addition). Emission calculations were carried out based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 emission factors (Table 8.1). Ammonia emission factor for wood combustion is 37 g/GJ. Emissions of substances from natural gas combustion are very insignificant and practically don't influence emissions at the country level in general (Table 8.5).

Also all pollutants emissions from combustion processes which have been mistakenly given under a NFR 1B2aiv in 2012 are considered under a NFR 1A2giii in this year submission.

Table 8.5 The differences in the sector NFR 1A2giii emissions between 2017 and 2018 submissions (%)

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
1990	100	NR	NR	NR	0.001	0.0000	0.0000	0.29
1991	100	NR	NR	NR	0.001	0.0000	0.0000	0.33
1992	100	NR	NR	NR	0.001	0.0000	0.0000	0.24
1993	100	NR	NR	NR	0.001	0.0000	0.0000	0.30
1994	100	NR	NR	NR	0.001	0.0000	0.0000	0.17
1995	100	NR	NR	NR	0.001	0.0000	0.0000	0.34
1996	100	NR	NR	NR	0.003	0.0000	0.0001	1.18
1997	100	NR	NR	NR	0.015	0.0003	0.0001	1.58
1998	100	NR	NR	NR	0.023	0.0003	0.0001	1.46
1999	100	NR	NR	NR	0.026	0.0002	0.0001	100
2000	100	0.20	0.16	0.04	0.129	0.0027	0.0383	7.24
2001	100	0.08	0.08	0.02	0.063	0.0011	0.0094	7.66
2002	100	0.07	0.06	0.01	0.053	0.0010	0.0053	7.97
2003	100	0.06	0.06	0.01	0.056	0.0009	0.0068	34.78
2004	100	0.06	0.06	0.01	0.054	0.0010	0.0156	100
2005	100	0.06	0.05	0.01	0.044	0.0009	0.0066	100
2006	100	0.07	0.05	0.01	0.039	0.0007	0.0083	100
2007	100	0.18	0.14	0.03	0.086	0.0013	0.0046	3.59
2008	200,389	0.11	0.09	0.02	0.073	0.0008	0.0040	2.57
2009	13,752	0.13	0.10	0.03	0.071	0.0008	0.0058	8.00
2010	81,143	0.10	0.08	0.02	0.069	0.0009	0.0057	10.25
2011	100	0.11	0.10	0.02	0.092	0.0014	0.0098	15.57
2012	100	0.20	0.19	0.04	0.165	0.0222	0.0116	17.15
2013	100	0.13	0.12	0.02	0.112	0.0016	0.0099	16.93
2014	100	0.22	0.19	0.04	0.135	0.0015	0.0092	12.60
2015	100	0.06	0.06	0.01	0.053	0.0008	0.0051	9.58

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Table 8.5 continues

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
1990	0.06	0.000	0.0000	0.0000	0.0000	0.001	0.001	0.001	0.002
1991	0.45	0.001	0.0000	0.0000	0.0000	0.001	0.001	0.002	0.002
1992	0.24	0.001	0.0000	0.0000	0.0000	0.001	0.001	0.001	0.002
1993	0.21	0.002	0.0000	0.0000	0.0000	0.001	0.001	0.002	0.003
1994	0.09	0.001	0.0000	0.0000	0.0000	0.001	0.001	0.001	0.002
1995	0.15	0.002	0.0000	0.0000	0.0000	0.001	0.001	0.002	0.004
1996	0.16	0.002	0.0000	0.0000	0.0001	0.001	0.001	0.002	0.002
1997	0.24	0.002	0.0000	0.0001	0.0001	0.001	0.001	0.002	0.004
1998	0.35	0.002	0.0000	0.0001	0.0001	0.001	0.001	0.003	0.004
1999	0.38	0.002	0.0000	0.0002	0.0001	0.001	0.001	0.002	0.004
2000	3.62	0.007	0.0019	0.0010	0.0015	0.002	0.003	0.006	0.007
2001	1.69	0.003	0.0011	0.0005	0.0005	0.001	0.001	0.003	0.004
2002	1.38	0.001	0.0010	0.0007	0.0005	0.001	0.001	0.003	0.003
2003	1.00	0.001	0.0007	0.0009	0.0004	0.001	0.001	0.003	0.003
2004	2.26	0.002	0.0013	0.0009	0.0004	0.001	0.001	0.002	0.003
2005	2.06	0.001	0.0008	0.0007	0.0004	0.001	0.001	0.002	0.002
2006	1.16	0.001	0.0005	0.0006	0.0003	0.000	0.001	0.001	0.001
2007	1.17	0.001	0.0006	0.0011	0.0010	0.001	0.002	0.004	0.005
2008	1.00	0.001	0.0008	0.0010	0.0007	0.001	0.001	0.004	0.004
2009	0.71	0.001	0.0004	0.0008	0.0009	0.001	0.001	0.004	0.004
2010	0.87	0.002	0.0004	0.0012	0.0006	0.001	0.001	0.003	0.003
2011	1.59	0.004	0.0010	0.0024	0.0009	0.001	0.001	0.003	0.003
2012	1.51	0.031	0.0568	0.0140	0.1180	0.001	0.001	0.003	0.003
2013	2.26	0.004	0.0027	0.0033	0.0011	0.001	0.001	0.002	0.003
2014	1.07	0.003	0.0013	0.0019	0.0020	0.001	0.001	0.003	0.003
2015	1.41	0.002	0.0015	0.0016	0.0005	0.001	0.001	0.002	0.002

1A4ai Commercial/institutional: Stationary

In comparison with the previous submission, the emissions of NH_3 from wood combustion and all pollutants except SO_x, NH_3, NMVOC and CO from natural gas combustion were firstly calculated for period 1990–2015. The recommendations of TERT in the frame of NEC review were the cause of carrying out calculations (NH_3 from wood and $PM_{2.5}$ from gas combustion; other pollutants from gas were calculated in addition). Emission calculations were carried out based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 emission factors (Table 8.1). Ammonia emission factor for wood combustion is 37 g/GJ. Emissions of substances from natural gas combustion are very insignificant and practically don't influence emissions at the country level in general (Table 8.6)

The corrections or interpolation of emissions of some heavy metals and POPs for point sources have been in addition made.

Table 8.6 The differences in the sector NFR 1A4ai emissions between 2017 and 2018 submissions (%)

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
1990	100	NR	NR	NR	0.023	0.0004	100	100
1991	100	NR	NR	NR	0.035	0.0003	100	100
1992	100	NR	NR	NR	0.000	0.0000	0.00	100
1993	100	NR	NR	NR	0.000	0.0000	0.00	100
1994	100	NR	NR	NR	0.001	0.0000	0.00	100
1995	100	NR	NR	NR	0.000	0.0000	0.00	100
1996	100	NR	NR	NR	0.000	0.0000	0.00	100
1997	100	NR	NR	NR	0.001	0.0000	0.00	100
1998	100	NR	NR	NR	0.000	0.0000	0.00	100
1999	100	NR	NR	NR	0.002	0.0000	0.00	100

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
2000	100	0.07	0.05	0.01	0.036	1.1082	100.00	100
2001	100	0.09	0.06	0.02	0.039	-1.0073	36.70	100
2002	100	0.11	0.09	0.02	0.064	-1.1622	4.61	100
2003	100	0.21	0.16	0.04	0.103	-0.2217	4.91	100
2004	100	0.18	0.14	0.03	0.085	1.0409	-47.39	100
2005	100	0.15	0.11	0.03	0.067	1.4725	-25.40	100
2006	100	0.28	0.23	0.05	0.156	0.0028	0.01	100
2007	100	0.30	0.24	0.06	0.162	0.3111	-23.69	100
2008	100	0.48	0.38	0.09	0.246	0.0037	0.02	23.52
2009	100	0.41	0.33	0.08	0.221	0.0036	0.02	35.81
2010	100	0.35	0.31	0.07	0.223	0.0034	0.02	43.19
2011	100	0.44	0.38	0.08	0.295	0.0046	0.03	66.26
2012	100	0.70	0.61	0.13	0.399	0.0063	0.03	66.84
2013	100	0.42	0.38	0.08	0.308	0.0052	0.03	87.60
2014	100	0.76	0.64	0.15	0.443	0.0065	0.03	24.61
2015	100	0.47	0.42	0.09	0.338	0.0051	0.03	51.40

Table 8.6 continues

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
1990	0.40	0.001	0.0000	0.0001	0.0002	0.001	0.001	0.001	0.001
1991	0.32	0.001	0.0000	0.0000	0.0002	0.001	0.001	0.001	0.001
1992	0.00	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	0.000
1993	100	100	0.0000	0.0000	0.0000	0.000	0.000	100	100
1994	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	0.000
1995	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	0.000
1996	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	100
1997	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	100
1998	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	100
1999	100	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.000	0.000
2000	-23.60	10.726	16.800	0.474	-1.794	0.301	-5.599	-13.198	36.604
2001	2.55	-1.741	6.300	-0.226	-0.691	5.051	-1.584	-4.563	19.406
2002	8.22	-3.440	7.701	0.123	-0.444	4.502	2.102	-11.870	-6.027
2003	7.83	-1.131	9.950	0.048	-1.059	0.003	0.003	0.008	0.009
2004	6.96	-0.863	3.634	-0.461	-0.635	-0.977	3.203	-12.260	13.360
2005	1.64	-2.853	-27.633	-2.869	0.272	-8.315	-5.940	-8.961	-14.461
2006	2.14	0.004	0.001	0.002	0.002	-86.486	0.372	-3.090	-8.890
2007	-9.07	4.366	1.834	1.985	0.285	1.484	-5.296	-9.856	19.016
2008	2.34	0.006	0.001	0.002	0.003	0.005	0.006	0.015	0.017
2009	2.09	0.006	0.001	0.002	0.003	0.004	0.005	0.013	0.014
2010	2.34	0.005	0.001	0.002	0.002	0.004	0.005	0.013	0.014
2011	3.40	0.008	0.002	0.004	0.003	0.006	0.007	0.018	0.019
2012	3.16	0.010	0.002	0.005	0.004	0.007	0.008	0.021	0.023
2013	5.30	0.011	0.002	0.007	0.002	0.004	0.007	0.012	0.016
2014	4.88	0.010	0.004	0.006	0.005	0.003	0.003	0.009	0.009
2015	5.53	0.010	0.003	0.006	0.003	0.003	0.004	0.009	0.009

1A4bi Residential: Stationary

SO_2 emissions from residential sector have been recalculated for the period between 1990-2015. Recalculations entail the use of updated national emission factors for wood combustion in advanced boilers (11 g/GJ instead of 0.83 g/GJ).

Emissions of BC, Cd, Hg and Se have been recalculated for the period 1990-2015 (BC for 2000-2015). Recalculation concern using correct emission factors for solid fuels.

The reason for recalculation emissions of B(k)f and I(1,2,3-cd)p for the year 2015 was activities data correction.

The differences in the residential sector emissions between the submissions for 2017 and 2018 are presented in Table 8.7.

Table 8.7 The differences in the sector NFR 1A4bi emissions between 2017 and 2018 submissions (%)

Year	SO_2	Cd	Hg	Se	BC
1990	0.01	-0.89	-12.15	-13.65	NR
1991	0.01	-1.00	-12.30	-14.02	NR
1992	0.03	-0.36	-9.76	-9.37	NR
1993	0.07	-0.19	-7.38	-6.36	NR
1994	0.34	40.09	28.17	34.80	NR
1995	0.25	-0.06	-3.82	-2.59	NR
1996	0.29	-0.09	-4.96	-3.57	NR
1997	0.41	-0.08	-4.82	-3.46	NR
1998	0.54	-0.07	-4.42	-3.16	NR
1999	0.40	-0.13	-6.06	-4.85	NR
2000	0.57	-0.10	-5.20	-3.98	0.06
2001	0.87	-0.08	-4.32	-3.16	0.05
2002	0.88	-0.08	-4.45	-3.34	0.06
2003	1.38	-0.05	-3.25	-2.29	0.04
2004	1.25	-0.07	-3.83	-2.84	0.06
2005	1.36	-0.07	-3.68	-2.76	0.06
2006	1.67	-0.05	-3.12	-2.25	0.05
2007	3.07	-0.02	-1.68	-1.09	0.02
2008	3.08	-0.02	-1.68	-1.09	0.02
2009	4.23	-0.01	-1.09	-0.68	0.01
2010	4.21	-0.01	-1.15	-0.72	0.01
2011	3.55	-0.02	-1.48	-0.96	0.02
2012	4.45	-0.02	-1.18	-0.75	0.01
2013	4.74	-0.01	-1.12	-0.72	0.01
2014	5.77	-0.01	6.52	-0.64	4.00
2015	6.34	-0.01	-0.66	-0.41	0.00

Table 8.7 continues

Year	B(k)f			I(1,2,3-cd)p			PAHs Total		
	2017	2018	%	2017	2018	%	2017	2018	%
2015	0.55941	0.55930	-0.020	0.89277	0.89261	-0.018	3.01194	3.01166	-0.009

1A4ci Agriculture/Forestry/Fishing: Stationary

In comparison with the previous submission, the emissions of NH_3 from wood combustion and all pollutants except SO_x, NH_3, NMVOC and CO from natural gas combustion were firstly calculated for period 1990–2015. The recommendations of TERT in the frame of NEC review were the cause of carrying out calculations (NH_3 from wood and $PM_{2.5}$ from gas combustion; other pollutants from gas were calculated in addition). Emission calculations were carried out based on EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 emission factors (Table 8.1). Ammonia emission factor for wood combustion is 37 g/GJ. Emissions of substances from natural gas combustion are very insignificant and practically don't influence emissions at the country level in general (Table 8.8).

The corrections or interpolation of emissions of some heavy metals and POPs for point sources have been in addition made.

Table 8.8 The differences in the sector NFR 1A4ci emissions between 2017 and 2018 submissions (%)

Year	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	Pb	Cd	Hg
1990	100	NR	NR	NR	0	0	0	0
1991	100	NR	NR	NR	0	0	0	0
1992	100	NR	NR	NR	0.005	0	0	100
1993	100	NR	NR	NR	0.002	0	0	100
1994	100	NR	NR	NR	0.003	0	0	100
1995	100	NR	NR	NR	0.002	0	0	100
1996	100	NR	NR	NR	0.002	0	0	100
1997	100	NR	NR	NR	0.003	0	0	100
1998	100	NR	NR	NR	0.004	0	0	100
1999	100	NR	NR	NR	0	0	0	100
2000	100	0.05	0.04	0.01	0.038	7.251	100	100
2001	100	0.02	0.02	0	0.014	-4.444	100	100
2002	100	0.04	0.03	0.01	0.029	-1.683	100	100
2003	100	0.1	0.09	0.02	0.066	-8.599	100	100
2004	100	0.09	0.08	0.02	0.06	0.001	100	100
2005	100	0.08	0.07	0.01	0.053	-2.359	100	100
2006	100	0.05	0.05	0.01	0.049	0.001	100	100
2007	100	0.21	0.18	0.04	0.129	-9.749	100	100
2008	100	0.18	0.17	0.03	0.162	0.003	0.023	90.46
2009	10.9	0	0	0	0.002	0	0	0.81
2010	1254.5	0.2	0.19	0.04	0.178	0.003	0.025	96.19
2011	100	0.24	0.23	0.04	0.204	0.005	0.032	128.53
2012	100	0.36	0.33	0.07	0.274	0.006	0.034	149.56
2013	100	0.09	0.08	0.02	0.071	0.001	0.01	31.79
2014	100	0.27	0.24	0.05	0.189	0.004	0.001	1.13
2015	100	0.18	0.15	0.04	0.109	0.002	0.006	7.42

Table 8.8 continues

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
1990	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0
1992	0.082	0.0002	0	0	0.00005	0	0.00033	0.0005	0.001
1993	0.029	0	0	0	0	0	0	0	0
1994	0.022	0	0	0	0	0	0	0	0
1995	100	0	0	0	0	0	0	0	100
1996	0.01	0	0	0	0	0	0	0	0
1997	0.022	0	0	0	0	0	0	0	0
1998	0.023	0	0	0	0	0	0	0	0
1999	100	0	100	0	0	0	0	0	0
2000	100	-9.5	100	2.8	0.91	-18.25	8.35	-16.9	-19
2001	100	4.75	-44.6	15.55	-0.06	12.3	-3.74	-13.9	-16.35
2002	100	-12.35	100	-12.25	6.87	4.9	32.4	-46.5	-49.6
2003	100	-22.45	100	-23.6	-5.3	-21.54	1.09	100	100
2004	-97.666	-50	-96.7	-70	-95.71	1.5	31.2	-48.398	100
2005	100	-21	100	-24.55	-4.61	1.8	-34.05	-48.998	100
2006	100	0.003	100	0.002	0	1.65	-9.63	1.603	1.6
2007	100	36.8	100	36.1	7.52	-34.2	-15.5	100	100
2008	2.115	0.009	0	0.006	0.001	0.003	0.004	0.01	0.01
2009	0.039	0	0	0	0	0	0	0	0
2010	5.182	0.01	0	0.005	0.001	0.004	0.004	0.012	0.011
2011	3.664	0.012	0	0.008	0.002	0.004	0.007	0.016	0.019
2012	2.294	0.016	0	0.01	0.002	0.008	0.009	0.019	0.024

Year	As	Cr	Cu	Ni	Zn	B(a)p	B(b)f	B(k)f	I(1.2.3-cd)p
2013	2.244	0.004	0	0.003	0.001	0.001	0.003	0.003	0.005
2014	0.509	0.007	0	0.003	0.002	0.004	0.003	0.008	0.009
2015	1.048	0.002	0	0.002	0.001	0.003	0.003	0.007	0.008

8.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2017 and 2018 are made by using exact calculation numbers.

1A2gii Mobile Combustion in manufacturing industries and construction

All emissions, except SO_x, NH_3 and Pb, have been recalculated. Recalculations in the mobile combustion sector were carried out based on the correction in emission factors in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. Table 8.9 provides a short overview of those emissions factors that have changed, where older EMEP/EEA Guidebook emissions factors were used to calculate emissions in the 2017 submissions, and updated EMEP/EEA Guidebook 2016 emissions factors are used in the 2018 submission.

Table 8.9 Emission factors for the mobile combustion sector (kg/t)

Pollutant	Diesel / Light fuel oil		Petrol	
	2017	2018	2017	2018
NO_x	32.792	32.629		
NMVOC	3.385	3.377	17.602	18.893
$PM_{2.5}$	2.086	2.104		
PM_{10}	2.086	2.104		
TSP	2.086	2.104		
BC	1.293	1.306		
CO	10.722	10.774		

In addition, there were mistakes in emission calculations for petrol fuel consumption. In the 2017 submission, pollutant emissions were reported as being one thousand times lower than they should have been. This mistake has been corrected in the 2018 submissions. In general, changes in emissions have been low since petrol consumption has a relatively minor share in the total fuel consumption in the mobile combustion sector. The only exceptions are NMVOC and CO emissions, where emissions factors have a great deal of difference when a comparison is made between diesel and petrol fuels. In detail, the NMVOC emission factor for diesel or light fuel oil is 3.377 kg/t and for petrol it is 18.893 kg/t (approximately 5.6 times higher); the CO emission factor for diesel or light fuel oil is 10.774 kg/t and for petrol 770.368 kg/t (approximately 71.5 times higher). Therefore the fluctuation in emissions has mainly been caused by the fact that the share of different fuel types varies and the influence upon total emissions changes from year to year.

The differences in the mobile combustion sector emissions between the submissions for 2017 and 2018 are presented in Table 8.10.

Table 8.10 The differences in the mobile combustion sector emissions between 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Cd
1990	0.3	20.4	NR	NR	1.1	NR	265.6	3.7
1991	0.0	13.2	NR	NR	1.0	NR	173.1	2.4
1992	0.2	18.3	NR	NR	1.1	NR	239.2	3.3
1993	0.3	20.1	NR	NR	1.1	NR	262.1	3.7
1994	-0.2	6.5	NR	NR	1.0	NR	86.7	1.2
1995	0.6	28.7	NR	NR	1.3	NR	371.9	5.2
1996	0.1	14.7	NR	NR	1.1	NR	192.3	2.7
1997	0.1	15.8	NR	NR	1.1	NR	206.1	2.9

Year	NO_x	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Cd
1998	1.0	38.5	NR	NR	1.4	NR	496.2	6.9
1999	0.8	32.8	NR	NR	1.3	NR	423.9	5.9
2000	1.0	37.0	1.4	1.4	1.4	1.0	477.7	6.7
2001	-0.5	-0.2	0.9	0.9	0.9	1.0	0.5	0.0
2002	0.5	26.0	1.2	1.2	1.2	1.0	337.4	4.7
2003	2.4	74.2	1.9	1.9	1.9	1.0	949.7	13.3
2004	0.3	21.2	1.2	1.2	1.2	1.0	275.8	3.8
2005	0.3	21.2	1.2	1.2	1.2	1.0	275.8	3.8
2006	0.2	17.7	1.1	1.1	1.1	1.0	231.5	3.2
2007	0.2	17.2	1.1	1.1	1.1	1.0	224.3	3.1
2008	-0.3	5.1	0.9	0.9	0.9	1.0	69.0	1.0
2009	0.4	22.1	1.2	1.2	1.2	1.0	286.8	4.0
2010	0.2	17.7	1.1	1.1	1.1	1.0	231.5	3.2
2011	-0.2	6.7	1.0	1.0	1.0	1.0	89.3	1.2
2012	0.3	20.4	1.1	1.1	1.1	1.0	265.6	3.7
2013	-0.1	10.1	1.0	1.0	1.0	1.0	133.1	1.8
2014	0.2	18.0	1.1	1.1	1.1	1.0	234.1	3.3
2015	-0.1	9.5	1.0	1.0	1.0	1.0	125.4	1.7

Table 8.10 continues

Year	Cr	Cu	Ni	Se	Zn	B(a)p	B(b)f	PAHs Total
1990	3.7	3.7	3.7	3.7	3.7	4.9	3.0	3.7
1991	2.4	2.4	2.4	2.4	2.4	3.2	1.9	2.4
1992	3.3	3.3	3.3	3.3	3.3	4.4	2.7	3.3
1993	3.7	3.7	3.7	3.7	3.7	4.9	2.9	3.7
1994	1.2	1.2	1.2	1.2	1.2	1.6	1.0	1.2
1995	5.2	5.2	5.2	5.2	5.2	6.9	4.2	5.2
1996	2.7	2.7	2.7	2.7	2.7	3.6	2.1	2.7
1997	2.9	2.9	2.9	2.9	2.9	3.8	2.3	2.9
1998	6.9	6.9	6.9	6.9	6.9	9.2	5.5	6.9
1999	5.9	5.9	5.9	5.9	5.9	7.9	4.7	5.9
2000	6.7	6.7	6.7	6.7	6.7	8.9	5.3	6.7
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	4.7	4.7	4.7	4.7	4.7	6.3	3.8	4.7
2003	13.3	13.3	13.3	13.3	13.3	17.8	10.7	13.3
2004	3.8	3.8	3.8	3.8	3.8	5.1	3.1	3.8
2005	3.8	3.8	3.8	3.8	3.8	5.1	3.1	3.8
2006	3.2	3.2	3.2	3.2	3.2	4.3	2.6	3.2
2007	3.1	3.1	3.1	3.1	3.1	4.2	2.5	3.1
2008	1.0	1.0	1.0	1.0	1.0	1.3	0.8	1.0
2009	4.0	4.0	4.0	4.0	4.0	5.3	3.2	4.0
2010	3.2	3.2	3.2	3.2	3.2	4.3	2.6	3.2
2011	1.2	1.2	1.2	1.2	1.2	1.6	1.0	1.2
2012	3.7	3.7	3.7	3.7	3.7	4.9	3.0	3.7
2013	1.8	1.8	1.8	1.8	1.8	2.5	1.5	1.8
2014	3.3	3.3	3.3	3.3	3.3	4.3	2.6	3.3
2015	1.7	1.7	1.7	1.7	1.7	2.3	1.4	1.7

1A3b Road transport

All emissions from road transport have been recalculated for the period between 1990-2015. Recalculations entail the use of corrected activity data, new emission factors from the updated EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and taking into use an improved new edition of the COPERT 5 programme (Version 5.1.1) for emission calculations.

A major role was played in changing emissions thanks to the changed emissions factors in the updated EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. With regard to emissions that are related to heavy metals, the fuel metal content factors which had been provided in the older EMEP/EEA Guidebook, and which were also used in COPERT 4, are assumed to already include fuel and lubricant content and engine wear. Therefore, these emissions factor values, given in Table 8.11, are higher and already include equivalent heavy metal emissions for fuel, lubricant oil, and engine wear. The updated EMEP/EEA Guidebook 2016 provides new emissions factors when it comes to calculating separate heavy metal emissions for fuel and lubricant oil combustion. The emissions factors changed significantly and, therefore, the influence upon the total level of emissions is noticeable. Table 8.11 provides a comparison, which was made in order to explain the differences in emission levels.

There has been a correction in petrol fuel consumption for 1998. In the 2018 submission, petrol consumption as used in emission calculations was at 287.6 kt, which is 31.5% higher than the figure used in the 2017 submission (218.6 kt). Also, the number of motorcycles and mopeds was corrected for 2014 and to a small extent so were vehicle mileages for the period between 1990-2015 in order to maintain a balance between calculated and statistical fuel consumption as calculated by COPERT 5.

SO_x emissions factors are adjusted using corrected sulphur content in fuels for the 2010-2015 period according to the FQMS report data. In addition, other pollutant emissions also changed because sulphur content is related to correction functions in emission calculations for petrol fuel in the COPERT programme.

In addition, no BC emissions were calculated for the 1A3bvi and 1A3bvii sector in the 2017 submission. In 2018, BC emissions are being calculated separately by using appropriate default emission factors taken from the EMEP/EEA Guidebook 2016. Therefore, there has been a large increase in total BC emissions in the 2018 submission.

The differences in road transport emissions between the submissions for 2017 and 2018 are presented in Table 8.12.

Table 8.11 Heavy metal emission factors for the road transport sector

COPERT 5	Cd	Cu	Cr	Ni	Se	Zn	Hg	As	Pb
Unit	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt
Petrol	0.0002	0.0045	0.0063	0.0023	0.0002	0.033	0.0087	0.0003	equation
Diesel	0.00005	0.0057	0.0085	0.0002	0.0001	0.018	0.0053	0.0001	equation
Lubricant	4.5600	778.0000	19.2000	31.8900	4.5400	450.200	0	0	0.0332
COPERT 4	Cd	Cu	Cr	Ni	Se	Zn	Hg	As	Pb
Unit	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	ppm/wt	g/l
Petrol	0.0108	0.0418	0.0159	0.0130	0.0002	2.164	NE	NE	equation
Diesel	0.00870	0.0212	0.0300	0.0088	0.0001	1.738	NE	NE	equation

Table 8.12 The differences in road transport emissions between the 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Cr
1990	-0.6	1.0	-0.2	-5.2	NR	NR	-1.7	NR	-1.4	-0.8	-21.1	11.2
1991	-0.1	1.4	-0.3	-5.4	NR	NR	-0.3	NR	-1.4	-0.9	-17.9	12.9
1992	-1.2	2.7	-0.4	-7.1	NR	NR	-2.1	NR	-2.3	-1.5	-23.2	9.3
1993	-1.2	1.4	-0.3	-6.2	NR	NR	-2.3	NR	-2.1	-1.3	-22.7	9.2
1994	-1.7	3.9	-0.3	-4.7	NR	NR	0.8	NR	4.9	-1.2	-17.3	10.6
1995	-1.2	1.1	-0.3	-4.8	NR	NR	-1.2	NR	-2.7	-1.6	-18.6	10.4
1996	-3.2	5.3	-0.3	-5.7	NR	NR	1.3	NR	10.3	-1.3	-19.8	8.3

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Cr
1997	-1.6	-0.3	-0.3	-3.9	NR	NR	-1.5	NR	-3.4	-1.2	-19.2	10.6
1998	14.9	29.5	4.8	2.7	NR	NR	2.7	NR	33.7	29.7	-8.7	24.0
1999	-1.6	0.0	-0.2	-3.3	NR	NR	-1.9	NR	-3.3	-1.0	-20.2	10.1
2000	-1.4	2.8	-0.2	-2.7	-0.5	-0.6	-1.2	8.3	3.4	-0.9	-19.0	10.5
2001	-1.2	-0.3	-0.2	-1.7	-0.6	-0.7	-1.1	13.2	3.8	-0.4	-16.0	11.3
2002	-1.3	-0.3	-0.2	-1.8	-0.8	-0.8	-1.1	11.4	3.4	-0.4	-17.0	10.2
2003	-1.3	-0.7	-0.1	-1.7	-0.9	-1.0	-0.9	11.6	3.6	-0.4	-15.9	10.5
2004	-1.0	-1.1	-0.1	-28.3	-0.7	-0.7	-0.6	10.7	3.2	-0.4	-14.2	10.7
2005	-0.6	-1.3	-0.1	-1.7	1.6	1.2	1.6	14.8	3.3	-0.3	-14.2	10.8
2006	-0.2	0.3	0.2	0.3	1.4	1.1	1.7	15.9	5.4	-0.3	-12.5	11.8
2007	-0.5	0.8	0.1	0.3	1.0	0.8	1.5	16.4	5.4	-0.3	-12.2	11.7
2008	-4.2	0.0	0.8	0.3	-3.6	-3.5	-3.1	12.3	4.9	-4.7	-14.0	8.8
2009	-0.7	0.8	0.3	0.4	0.7	0.4	1.0	18.5	5.2	-0.6	-10.3	12.3
2010	-1.0	1.0	0.4	-1.3	3.2	2.2	1.8	23.6	5.2	19.4	-12.1	10.3
2011	3.4	1.6	0.4	-1.5	7.8	6.5	5.8	31.1	6.3	25.0	-9.1	13.4
2012	-0.2	2.1	-0.3	-1.2	3.1	2.1	1.7	24.8	4.4	23.0	-10.8	9.9
2013	0.2	0.2	-0.4	-2.1	0.3	-0.1	0.2	20.4	1.7	26.9	-9.8	10.2
2014	0.7	-1.7	-0.8	-3.1	0.2	-0.2	0.3	22.9	-1.2	-12.8	-9.1	10.4
2015	1.1	-1.3	-1.0	-0.4	-0.3	-0.5	0.3	23.4	2.5	-12.4	-6.4	11.3

Table 8.12 continues

Year	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	41.0	128.7	261.7	-40.8	-0.6	-0.6	-0.5	-0.5	-0.6	-0.5	-0.4	-63.0
1991	44.8	139.0	276.1	-39.6	-0.1	-0.1	0.0	0.1	-0.2	-0.1	-0.2	-65.9
1992	38.1	121.6	249.7	-41.6	-1.2	-1.1	-1.1	-1.0	-1.2	-1.1	-1.7	-58.2
1993	38.9	124.2	254.3	-41.6	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.7	-59.2
1994	42.9	139.1	273.5	-39.7	-2.0	-1.8	-1.8	-1.6	-2.0	-1.8	-2.6	-68.8
1995	44.7	140.4	276.2	-40.3	-1.2	-1.0	-0.9	-0.6	-1.3	-0.9	-1.9	-66.9
1996	41.3	135.7	266.9	-41.3	-3.9	-3.6	-3.2	-2.5	-4.2	-3.3	-5.2	-69.2
1997	44.2	138.9	274.0	-40.7	-1.6	-1.4	-1.2	-0.9	-1.7	-1.3	-2.3	-67.7
1998	61.9	168.4	322.3	-31.9	14.7	13.1	9.0	3.9	18.1	9.8	24.8	-55.2
1999	43.4	136.3	270.3	-41.0	-1.6	-1.5	-1.4	-1.2	-1.7	-1.4	-2.3	-64.8
2000	43.3	136.9	269.5	-40.2	-1.4	-1.2	-1.0	-0.8	-1.4	-1.1	-1.6	-60.3
2001	45.0	143.4	274.6	-38.7	-1.1	-1.0	-0.9	-0.8	-1.2	-0.9	-1.4	-57.3
2002	44.1	141.1	268.6	-38.9	-1.2	-1.1	-1.0	-0.8	-1.2	-1.0	-1.3	-50.9
2003	45.3	144.7	273.3	-38.6	-1.2	-1.1	-1.0	-1.0	-1.2	-1.1	-1.3	-47.1
2004	46.0	147.9	275.7	-37.7	-1.0	-0.9	-0.8	-0.7	-1.1	-0.9	-1.3	-38.9
2005	46.9	149.8	278.1	-37.7	-0.9	-0.8	-0.7	-0.6	-0.9	-0.7	-1.0	-39.1
2006	48.8	154.6	284.9	-36.9	-0.4	-0.5	-0.6	-0.6	-0.4	-0.5	-0.5	-36.5
2007	48.9	155.3	285.9	-36.8	-0.6	-0.8	-0.8	-0.9	-0.7	-0.8	-0.7	-32.8
2008	44.3	148.7	278.7	-38.3	-4.1	-4.6	-4.9	-5.3	-4.2	-4.8	-4.1	-27.1
2009	49.9	159.8	295.2	-36.2	-0.9	-1.0	-1.1	-1.1	-0.9	-1.0	-0.8	-25.0
2010	46.7	153.2	284.2	-37.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.5	-21.9
2011	51.0	160.7	293.7	-34.8	2.3	2.6	2.8	3.0	2.3	2.7	2.1	-16.2
2012	46.9	155.5	285.1	-36.3	-1.5	-1.5	-1.6	-1.6	-1.5	-1.6	-1.5	-14.5
2013	48.1	158.9	290.3	-35.9	-1.2	-1.2	-1.1	-1.1	-1.2	-1.2	-1.3	-11.4
2014	48.3	160.2	291.0	-35.7	-1.4	-1.2	-1.2	-1.1	-1.4	-1.2	-1.4	-7.0
2015	50.2	166.6	299.2	-34.4	-0.5	-0.7	-1.0	-1.2	-0.8	-1.0	0.2	-5.3

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1A3c Railways

In the railways sector, SO_x emissions have been recalculated for the 2011-2015 period and BC emissions for the 2000-2002 period.

According to a suggestion made by the expert team following the 2017 review ('A Comprehensive Technical Review of National Emission Inventories'), SO_2 emissions factors and emission calculations were checked for the railway sector. There was an overestimation of SO_2 emissions for the 2011-2015 period. Therefore, corrections have been made to SO_2 emissions factors and SO_2 emissions have been recalculated for this period.

In addition, BC emission calculations did not concerned emissions factors for coal in the previous submission. Recalculations for this sector were carried out by adding default emissions factors for coal (6.912 g/GJ). This means that BC emissions were changed for the 2000-2002 period, since coal was used until 2002.

The differences in the railways sector emissions between the 2017 and 2018 submissions are presented in Table 8.13.

Table 8.13 The differences in railway pollutant emissions between the 2017 and 2018 submissions (%)

Year	SO_x			BC		
	2017	2018	%	2017	2018	%
2000				0.038	0.038	0.11
2001				0.036	0.036	0.16
2002				0.045	0.045	0.02
2011	0.068	0.001	-99.0			
2012	0.060	0.001	-98.5			
2013	0.052	0.001	-98.6			
2014	0.040	0.000	-98.8			
2015	0.038	0.000	-99.0			

1A3dii National navigation (shipping)

In comparison with the previous submission, SO_x emissions were recalculated for the year 2015. The reason for the recalculation was a correction in the emissions factor used for petrol fuel.

The differences in emissions between 2017 and 2018 submissions are presented in Table 8.14.

Table 8.14 The differences in national navigation pollutant emissions (kt) between the 2017 and 2018 submissions (%)

Year	SO_x		
	2017	2018	%
2015	0.029	0.025	-14.2

1A4aii Commercial/institutional: Mobile

All of the main pollutants, particulate matter, and CO emissions are being recalculated, with the exception of NH_3. Recalculations in the commercial and institutional mobile sector were carried out based on the correction in emissions factors in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. Table 8.14 provides a short overview of emissions factors that have changed, where older EMEP/EEA Guidebook emissions factors were used to calculate emissions in the 2017 submission, and updated emissions factors from the EMEP/EEA Guidebook 2016 are being used in the 2018 submission.

Additionally, SO_x emission calculations are being revised and emissions factors are being corrected using amended sulphur content in fuels for the 2010-2015 period according to the FQMS report data.

In general, emissions have not seen excessive changes since the emissions factors themselves changed only to a small extent (Table 8.15). Changes in NMVOC emissions depend upon the petrol fuel share in total fuel consumption in the commercial combustion sector and a relatively high decrease in emissions factors for petrol when compared to diesel fuel. A significant jump can be seen in BC emissions, which is caused by the fact that in 2017 there were no BC emissions factors being used for diesel fuel in emission calculations and therefore BC emissions were very low. In the 2018 submission, on the other hand, BC emissions factors for diesel fuel were added to the emission calculations. Therefore, BC emissions rose significantly since the majority of fuel being used in this sector is diesel which has significantly higher emissions factors when compared to petrol (1.306 kg/t for diesel and 0.188 kg/t for petrol).

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The differences in the commercial and institutional mobile sector emissions between the submissions for 2017 and 2018 are presented in Table 8.16.

Table 8.15 Emission factors for the mobile combustion sector (kg/t)

Pollutant	Diesel		Petrol	
	2017	2018	2017	2018
NO_x	32.792	32.629		
NMVOC	3.385	3.377	242.197	227.289
$PM_{2.5}$	2.086	2.104		
PM_{10}	2.086	2.104		
TSP	2.086	2.104		
BC	-	1.306		
CO	10.722	10.774		

Table 8.16 The differences in the commercial and institutional mobile sectors emissions between the 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-0.5	-5.7	0.0	NR	NR	0.7	NR	0.0
1991	-0.5	-5.6	0.0	NR	NR	0.7	NR	0.1
1992	-0.5	-0.2	0.0	NR	NR	0.9	NR	0.5
1993	-0.5	-5.9	0.0	NR	NR	0.5	NR	0.0
1994	-0.5	-0.2	0.0	NR	NR	0.9	NR	0.5
1995	-0.5	-5.5	0.0	NR	NR	0.7	NR	0.1
1996	-0.5	-0.2	0.0	NR	NR	0.9	NR	0.5
1997	-0.5	-0.2	0.0	NR	NR	0.9	NR	0.5
1998	-0.5	-5.5	0.0	NR	NR	0.7	NR	0.1
1999	-0.5	-5.4	0.0	NR	NR	0.7	NR	0.1
2000	-0.5	-5.4	0.0	0.7	0.7	0.7	6828.6	0.1
2001	-0.5	-5.5	0.0	0.7	0.7	0.7	6272.5	0.1
2002	-0.5	-5.9	0.0	0.5	0.5	0.5	2040.0	0.0
2003	-0.5	-5.7	0.0	0.7	0.7	0.7	4417.9	0.0
2004	-0.5	-5.2	0.0	0.8	0.8	0.8	9103.5	0.1
2005	-0.5	-2.8	0.0	0.8	0.8	0.8	66949.3	0.3
2006	-0.5	-1.6	0.0	0.9	0.9	0.9	173335.0	0.4
2007	-0.5	-0.2	0.0	0.9	0.9	0.9		0.5
2008	-0.5	-0.2	0.0	0.9	0.9	0.9		0.5
2009	-0.5	-5.4	0.0	0.7	0.7	0.7	7640.1	0.1
2010	-0.5	-0.2	0.0	0.9	0.9	0.9		0.5
2011	-0.5	-4.1	0.0	0.8	0.8	0.8	26125.6	0.2
2012	-0.5	-5.3	-0.2	0.7	0.7	0.7	8046.1	0.1
2013	-0.5	-3.0	0.0	0.8	0.8	0.8	58134.6	0.3
2014	-0.5	-5.2	-11.5	0.8	0.8	0.8	8980.2	0.1
2015	-0.5	-5.2	6.8	0.8	0.8	0.8	9845.0	0.1

1A4bii Residential: Household and gardening (mobile)

All of the emissions for the household and gardening sector are being recalculated, with the exception of NH_3 and Pb. Recalculations in this sector were carried out based on the correction in emissions factors in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. Table 8.17 provides a short overview of those emissions factors that have changed, where the older EMEP/EEA Guidebook emissions factors were used to calculate emissions in the 2017 submission, and emissions factors in the updated EMEP/EEA Guidebook 2016 values are being used in the 2018 submission.

SO_x emission calculations are being revised and emissions factors are being corrected using amended sulphur content levels in fuels for the

2010-2015 period according to the FQMS report data. In addition, there were mistakes made in emissions calculation for diesel fuel consumption in the 2009-2015 period. In the 2017 submission, pollutant emissions were reported at one thousand times lower for that period than they should have been. This mistake has been corrected in the 2018 submissions.

A significant jump can be seen in BC emissions, which is caused by the fact that in 2017 there were no BC emissions factors being used for diesel fuel in emission calculations and therefore BC emissions were very low. In the 2018 submission, BC emissions factors for diesel fuel were added to the emission calculations. Therefore, BC emissions rose significantly since diesel duel has significantly higher emissions levels when compared to petrol (1.306 kg/t for diesel and 0.188 kg/t for petrol two-stroke engines and 0.008 kg/t for petrol four-stroke engines).

Heavy metals and PAHs emissions are also much higher than those presented in submissions for the 2009-2015 period thanks to the amendments made in the emissions calculation formulas. All of the other emissions changed to a small extent during the same period.

The differences in the household and gardening sector emissions between the submissions for 2017 and 2018 are presented in Table 8.18.

Table 8.17 Emission factors for the household and gardening sector (kg/t)

Pollutant	Diesel		Petrol (2-stroke)		Petrol (4-stroke)	
	2017	2018	2017	2018	2017	2018
NO_x	32.792	32.629				
NMVOC	3.385	3.377	242.197	227.289	17.602	18.893
$PM_{2.5}$	2.086	2.104				
PM_{10}	2.086	2.104				
TSP	2.086	2.104				
BC	-	1.306				
CO	10.722	10.774				

Table 8.18 The differences in the household and gardening sector emissions between the 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	-0.1	-5.2	0.0	NR	NR	0.1	NR	0.000
1991	0.0	-5.2	0.0	NR	NR	0.0	NR	0.000
1992	-0.2	-5.2	0.0	NR	NR	0.1	NR	0.001
1993	-0.3	-5.2	0.0	NR	NR	0.2	NR	0.002
1994	-0.4	-5.2	0.0	NR	NR	0.3	NR	0.004
1995	-0.4	-5.2	0.0	NR	NR	0.2	NR	0.003
1996	-0.3	-5.2	0.0	NR	NR	0.1	NR	0.001
1997	-0.3	-5.2	0.0	NR	NR	0.2	NR	0.002
1998	-0.3	-5.2	0.0	NR	NR	0.2	NR	0.002
1999	-0.3	-5.2	0.0	NR	NR	0.2	NR	0.002
2000	-0.3	-5.2	0.0	0.2	0.2	0.2	313.6	0.002
2001	-0.3	-5.2	0.0	0.1	0.1	0.1	253.9	0.001
2002	-0.3	-5.2	0.0	0.2	0.2	0.2	280.3	0.002
2003	-0.3	-5.2	0.0	0.2	0.2	0.2	322.2	0.002
2004	-0.3	-5.2	0.0	0.2	0.2	0.2	378.9	0.002
2005	-0.3	-5.2	0.0	0.2	0.2	0.2	429.5	0.002
2006	-0.3	-5.2	0.0	0.2	0.2	0.2	432.7	0.002
2007	-0.3	-5.2	0.0	0.2	0.2	0.2	457.6	0.003
2008	-0.3	-5.2	0.0	0.2	0.2	0.2	422.7	0.002
2009	-0.3	-4.4	0.0	0.2	0.2	0.2	406.6	0.002

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Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2010	-0.3	-4.3	-2.0	0.2	0.2	0.2	472.1	0.003
2011	-0.3	-4.5	-0.8	0.2	0.2	0.2	376.7	0.002
2012	-0.3	-4.3	-2.2	0.2	0.2	0.2	467.6	0.003
2013	-0.4	-4.3	-1.3	0.2	0.2	0.2	497.0	0.003
2014	-0.4	-4.2	-1.4	0.3	0.3	0.3	515.5	0.003
2015	-0.4	-4.2	-2.2	0.3	0.3	0.3	549.8	0.003

Table 8.18 continues

Year	Cd	Cr	Cu	Ni	Se	Zn	B(a)p	B(b)f	PAHs Total
1990	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
1992	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
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	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
1998	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
2000	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
2002	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
2004	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
2006	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
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2009	30.5	30.5	30.5	30.5	30.5	30.5	22.8	38.1	30.5
2010	35.4	35.4	35.4	35.4	35.4	35.4	26.5	44.2	35.4
2011	28.2	28.2	28.2	28.2	28.2	28.2	21.2	35.3	28.2
2012	35.0	35.0	35.0	35.0	35.0	35.0	26.3	43.8	35.0
2013	37.2	37.2	37.2	37.2	37.2	37.2	27.9	46.5	37.2
2014	38.6	38.6	38.6	38.6	38.6	38.6	29.0	48.3	38.6
2015	41.2	41.2	41.2	41.2	41.2	41.2	30.9	51.5	41.2

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

All of the emissions for the agricultural mobile sector are being recalculated, with the exception of SO_2 and Pb. Recalculations in this sector were carried out based on the correction in emissions factors in the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. Table 8.19 provides a short overview of emissions factors that have changed, where older EMEP/EEA Guidebook emissions factors were used to calculate emissions in the 2017 submission, and emissions factors in the updated EMEP/EEA Guidebook 2016 are being used in the 2018 submission.

In addition, there were mistakes made in the emissions calculation regarding petrol fuel consumption for the 1990-2015 period. In the 2017 submission, pollutant emissions were reported as being one thousand times lower than they should have been. This mistake has been corrected in the 2018 submissions.

Therefore, all of the emissions have increased during the 1990-2015 period, with the exception of NO_x emissions. Emissions have changed more significantly between 1990 and 2004 where the share of petrol consumption was greater (Table 8.20).

The differences in the agricultural sector emissions between the submissions for 2017 and 2018 are presented in Table 8.20.

Table 8.19 Emission factors for the agricultural sector (kg/t)

Pollutant	Diesel / Light fuel oil		Petrol	
	2017	2018	2017	2018
NO_x	35.043	34.457		
NMVOC	3.366	3.542	17.602	18.893
$PM_{2.5}$	1.738	1.913		
PM_{10}	1.738	1.913		
TSP	1.738	1.913		
BC	0.991	1.111		
CO	10.939	11.469		

Table 8.20 The differences in the agricultural sector emissions between the 2017 and 2018 submissions (%)

Year	NO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	2.3	114.5	9.8	NR	NR	11.8	NR	1358.9
1991	1.0	79.9	6.7	NR	NR	11.3	NR	934.1
1992	2.2	112.2	9.6	NR	NR	11.8	NR	1330.8
1993	0.1	54.9	4.4	NR	NR	10.9	NR	624.3
1994	-1.2	18.9	1.2	NR	NR	10.3	NR	176.1
1995	-1.1	21.7	1.5	NR	NR	10.3	NR	211.3
1996	-0.6	34.7	2.6	NR	NR	10.5	NR	373.7
1997	-0.5	37.3	2.9	NR	NR	10.6	NR	405.2
1998	-0.5	36.4	2.8	NR	NR	10.6	NR	394.2
1999	-0.5	38.2	2.9	NR	NR	10.6	NR	417.0
2000	-0.9	26.8	1.9	10.4	10.4	10.4	12.1	274.7
2001	-0.7	30.7	2.3	10.5	10.5	10.5	12.1	323.7
2002	-1.4	12.9	0.7	10.2	10.2	10.2	12.1	101.6
2003	-1.1	20.7	1.4	10.3	10.3	10.3	12.1	199.2
2004	-0.7	31.1	2.3	10.5	10.5	10.5	12.1	328.9
2005	-1.7	5.2	0.0	10.1	10.1	10.1	12.1	4.8
2006	-1.6	7.8	0.2	10.1	10.1	10.1	12.1	36.5
2007	-1.5	10.2	0.4	10.1	10.1	10.1	12.1	66.9
2008	-1.6	6.0	0.1	10.1	10.1	10.1	12.1	15.1
2009	-1.6	6.0	0.1	10.1	10.1	10.1	12.1	15.1
2010	-1.6	7.3	0.2	10.1	10.1	10.1	12.1	31.3
2011	-1.6	7.6	0.2	10.1	10.1	10.1	12.1	34.5
2012	-1.6	6.0	0.1	10.1	10.1	10.1	12.1	14.9
2013	-1.6	7.9	0.2	10.1	10.1	10.1	12.1	37.8
2014	-1.6	6.2	0.1	10.1	10.1	10.1	12.1	16.4
2015	-1.6	6.9	0.1	10.1	10.1	10.1	12.1	25.7

Table 8.20 continues

	Cd	Cr	Cu	Ni	Se	Zn	b(a)p	b(b)f	PAHs Total
1990	19.5	19.5	19.5	19.5	19.5	19.5	26.0	15.6	19.5
1991	13.3	13.3	13.3	13.3	13.3	13.3	17.8	10.7	13.3
1992	19.1	19.1	19.1	19.1	19.1	19.1	25.4	15.3	19.1
1993	8.9	8.9	8.9	8.9	8.9	8.9	11.8	7.1	8.9
1994	2.4	2.4	2.4	2.4	2.4	2.4	3.2	1.9	2.4
1995	2.9	2.9	2.9	2.9	2.9	2.9	3.9	2.4	2.9
1996	5.3	5.3	5.3	5.3	5.3	5.3	7.0	4.2	5.3
1997	5.7	5.7	5.7	5.7	5.7	5.7	7.6	4.6	5.7
1998	5.5	5.5	5.5	5.5	5.5	5.5	7.4	4.4	5.5

	Cd	Cr	Cu	Ni	Se	Zn	b(a)p	b(b)f	PAHs Total
1999	5.9	5.9	5.9	5.9	5.9	5.9	7.8	4.7	5.9
2000	3.8	3.8	3.8	3.8	3.8	3.8	5.1	3.1	3.8
2001	4.5	4.5	4.5	4.5	4.5	4.5	6.1	3.6	4.5
2002	1.4	1.4	1.4	1.4	1.4	1.4	1.8	1.1	1.4
2003	2.8	2.8	2.8	2.8	2.8	2.8	3.7	2.2	2.8
2004	4.6	4.6	4.6	4.6	4.6	4.6	6.2	3.7	4.6
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4
2007	0.9	0.9	0.9	0.9	0.9	0.9	1.2	0.7	0.9
2008	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
2009	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
2010	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.4
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.3	0.4
2012	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
2013	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.4	0.5
2014	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2
2015	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.2	0.3

1A4ciii Agriculture/Forestry/Fishing: National fishing

In the national fishing sector, BC emissions factors were corrected for diesel and light fuel oil. In the previous submission, a BC emissions factor of 0.91 kg/t was used since there was a lack of more detailed data. The updated EMEP/EEA Guidebook covers this sector and a new emissions factor of 0.434 kg/t is being used. Therefore, emissions reduced by approximately 52%.

All of the PCB emissions have been recalculated for the 1990-2015 period. Recalculations in the national fishing sector were carried out based on the correction in PCB emissions factors in the EMEP/EEA Guidebook. In detail, the PCB emissions factor for diesel and gas oil was 0.38 mg/tonne of fuel in the EMEP/EEA Guidebook 2009, and this changed to 0.038 mg/tonne of fuel in the EMEP/EEA Guidebook for 2013 and 2016. Therefore the total level of PCB emissions was reduced by 90%.

The differences in the national fishing sector emissions between the submissions for 2017 and 2018 are presented in Table 8.21.

Table 8.21 The differences in the national fishing sector emissions between the 2017 and 2018 submissions (%)

Year	BC, t			PCBs, g		
	2017	2018	%	2017	2018	%
2003	6.124	2.944	-51.9	2.539	0.254	-90.0
2004	4.310	2.067	-52.0	1.791	0.179	-90.0
2005	3.819	1.821	-52.3	1.595	0.159	-90.0
2006	1.942	0.929	-52.2	0.809	0.081	-90.0
2007	1.914	0.915	-52.2	0.798	0.080	-90.0
2008	3.964	1.891	-52.3	1.655	0.166	-90.0
2009	5.169	2.473	-52.2	2.152	0.215	-90.0
2010	3.121	1.490	-52.3	1.302	0.130	-90.0
2011	1.642	0.792	-51.8	0.679	0.068	-90.0
2012	1.754	0.845	-51.9	0.726	0.073	-90.0
2013	1.011	0.485	-52.0	0.420	0.042	-90.0
2014	0.497	0.237	-52.2	0.207	0.021	-90.0
2015	0.631	0.301	-52.3	0.263	0.026	-90.0

8.2. Industry Sector (NFR2)

8.2.1. Industrial Processes

2A2 Lime production

All pollutants emissions from combustion processes which have been mistakenly given under a NFR 2A2 in 2008 are considered under a NFR 1A2f in this year submission. The differences are presented in Table 8.22.

Table 8.22 The differences in NFR 2A2 emissions for the year 2008 between 2017 and 2018 submissions (%)

Pollutant	Unit	2017	2018	%
NO_x	kt	0.00278	IE	100
NMVOC	kt	0.00006	IE	100
SO_x	kt	0.00224	IE	100
CO	kt	0.00348	IE	100
Pb	t	0.00013	IE	100
Cd	t	0.00000	IE	100
Hg	t	0.00000	IE	100
As	t	0.00000	IE	100
Cr	t	0.00001	IE	100
Cu	t	0.00004	IE	100
Ni	t	0.00132	IE	100
Zn	t	0.00027	IE	100
PCDD/F	g	0.00400	IE	100

2B1 Ammonia production

NO_x and NH_3 emission from ammonia production have been corrected for the period 2000–2007. Emissions of NMVOC have been calculated in addition for the period between 1990-2004 and corrected for the 2005-2007. All correction were made base on point source data. Emissions of NMVOC during 1990-2004 haven't been provided by the facility and defined on the basis of calculated by the expert IEF.

The differences in emissions between 2015 and 2016 submissions are presented in Table 8.23.

Table 8.23 The differences in NFR 2B1 emissions (kt) for the year 1990-2015 between 2017 and 2018 submissions (%)

Year	NO_x			NMVOC			NH_3		
	2017	2018	%	2017	2018	%	2017	2018	%
1990	0.1900	0.1900	0.0	NA	0.0052	100	NA	IE	
1991	0.1000	0.1000	0.0	NA	0.0027	100	NA	IE	
1992	0.0900	0.0900	0.0	NA	0.0024	100	NA	IE	
1993	0.0500	0.0500	0.0	NA	0.0014	100	NA	IE	
1994	0.1900	0.1900	0.0	NA	0.0052	100	NA	IE	
1995	0.0700	0.0700	0.0	NA	0.0019	100	NA	IE	
1996	0.1500	0.1500	0.0	NA	0.0041	100	NA	IE	
1997	0.1500	0.1500	0.0	NA	0.0041	100	NA	IE	
1998	0.1400	0.1400	0.0	NA	0.0038	100	NA	IE	
1999	0.1900	0.1900	0.0	NA	0.0052	100	NA	IE	
2000	0.1900	0.1889	-0.6	NA	0.0052	100	NA	0.0002	100
2001	0.3100	0.3087	-0.4	NA	0.0084	100	NA	0.0019	100
2002	0.1000	0.0967	-3.3	NA	0.0027	100	NA	0.0019	100
2003	0.1300	0.1324	1.8	0.0000	0.0035	100	0.0200	0.0165	-17.8
2004	0.3200	0.3160	-1.2	0.0000	0.0087	100	0.0400	0.0382	-4.4
2005	0.1600	0.1555	-2.8	0.0100	0.0060	-39.9	0.0500	0.0484	-3.1
2006	0.2300	0.2285	-0.7	0.0100	0.0060	-40.1	0.0000	0.0019	100
2007	0.2000	0.1998	-0.1	0.0100	0.0055	-44.5	0.0010	0.0011	10.7
2008	0.2550	0.2550	0.0	0.0058	0.0058	0.0	0.0158	0.0158	0.0
2009	0.0248	0.0248	0.0	0.0006	0.0006	0.0	0.0029	0.0029	0.0
2010	NA	NO	NO	NA	NO	NO	NA	NO	NO
2011	NA	NO	NO	NA	NO	NO	NA	NO	NO
2012	0.0243	0.0243	0.0	0.0006	0.0006	0.0	0.0018	0.0018	0.0
2013	0.1344	0.1344	0.0	0.0035	0.0035	0.0	0.0107	0.0107	0.0
2014	NO	NO	NO	NO	NO	NO	NO	NO	NO
2015	NO	NO	NO	NO	NO	NO	NO	NO	NO

2B10a Chemical industry: Other

The NH_3 emission from urea production have been corrected for the period 2000–2007. All correction were made base on facility data.

Table 8.24 The difference in emissions of ammonia in NFR 2B10a for the year 2000-2007 between 2017 and 2018 submissions (%)

Year	2017	2018	%
2000	0.04	0.0435	8.7
2001	0.03	0.0294	-1.9
2002	0.02	0.0176	-12.3
2003	0.03	0.0267	-11.1
2004	0.04	0.0410	2.5
2005	0.08	0.0828	3.4
2006	0.06	0.0595	-0.9
2007	0.07	0.0670	-4.2

2K Consumption of POPs and heavy metals

2L Other production, consumption, storage, transportation or handling of bulk products

The ammonia emissions which are mistakenly given under the sector 2K have been reallocated to the sector 2L.

Table 8.25 The difference in emissions of ammonia in the sectors 2K and 2L for 2006-2015 between 2017 and 2018 submissions (%)

Year	NFR 2K			NFR 2L		
	2017	2018	%	2017	2018	%
2006	0.0073	NA	-100	0.0100	0.0173	73.4
2007	0.0072	NA	-100	0.0000	0.0072	100
2008	0.0059	NA	-100	0.0090	0.0149	64.8
2009	0.0003	NA	-100	0.0047	0.0050	6.4
2010	0.0087	NA	-100	NA	0.0087	100
2011	0.0004	NA	-100	0.0058	0.0062	6.8
2012	NA	NA	NA	0.0081	0.0081	0.0
2013	NA	NA	NA	0.0111	0.0111	0.0
2014	0.0011	NA	-100	0.0000	0.0011	100
2015	0.0002	NA	-100	0.0000	0.0002	2 857.1

8.2.2. Solvent and Other Product Use

2D3a Domestic solvent use, 2D3d Coating applications, 2D3e Degreasing, 2D3i Other solvent use

The NMVOC emissions have been recalculated for the following years:

- 2D3a – 2015 – due to the correction of the number of population of Estonia;
- 2D3d – 1990-2015 – the recommendatios of the TERT in the frame of the NEC review was the cause of carrying out recalculations of the NMVOC emissions using the Tier 2 emission factors instead of Tier 1 emission factors;
- 2D3e – 2000-2015 – due to the correction of emission data that was reported wrongly in previous submission;
- 2D3i – 2013-2015 – due to the correction of emission data from the OSIS point sources database.

The differences in the solvents sector emissions between the submissions for 2017 and 2018 are presented in the Tables 8.26 and 8.27.

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Table 8.26 The differences in NFR 2D3a, 2D3d, 2D3e and 2D3i NMVOC emissions (kt) for the years 1990-2015 between 2017 and 2018 submissions (%)

Year	2D3a			2D3d			2D3e			2D3i		
	2017	2018	Difference	2017	2018	Difference	2017	2018	Difference	2017	2018	Difference
	kt	kt	%	kt	kt	%	kt	kt	%	kt	kt	%
1990	4.068	4.068	0	2.242	2.350	4.83	1.183	1.183	0	1.264	1.264	0
1991	4.060	4.060	0	2.612	2.768	5.96	1.169	1.169	0	1.365	1.365	0
1992	4.027	4.027	0	1.579	1.700	7.68	1.149	1.149	0	0.628	0.628	0
1993	3.914	3.914	0	1.431	1.568	9.51	1.124	1.124	0	0.505	0.505	0
1994	3.825	3.825	0	2.127	2.374	11.64	1.136	1.136	0	0.540	0.540	0
1995	3.751	3.751	0	2.848	3.225	13.22	1.157	1.157	0	0.810	0.810	0
1996	3.691	3.691	0	3.077	3.668	19.22	1.258	1.258	0	0.949	0.949	0
1997	3.642	3.642	0	3.305	4.094	23.87	1.223	1.223	0	0.808	0.808	0
1998	3.608	3.608	0	3.525	4.398	24.76	1.178	1.178	0	1.154	1.154	0
1999	3.572	3.572	0	3.137	4.124	31.48	1.173	1.173	0	1.111	1.111	0
2000	3.629	3.629	0	2.258	2.418	7.10	1.160	1.159	-0.05	1.115	1.115	0
2001	3.217	3.217	0	1.944	2.264	16.46	1.118	1.115	-0.27	1.055	1.055	0
2002	2.809	2.809	0	2.444	2.651	8.49	1.139	1.134	-0.49	1.393	1.393	0
2003	2.420	2.420	0	2.488	2.778	11.66	1.115	1.110	-0.46	1.446	1.446	0
2004	2.022	2.022	0	3.355	3.151	-6.06	1.109	1.103	-0.53	1.303	1.303	0
2005	1.631	1.631	0	3.842	3.624	-5.69	1.105	1.101	-0.33	1.384	1.384	0
2006	1.621	1.621	0	4.177	3.867	-7.43	1.145	1.128	-1.54	1.588	1.588	0
2007	1.612	1.612	0	3.742	3.764	0.58	1.116	1.095	-1.92	1.216	1.216	0
2008	1.606	1.606	0	2.815	2.588	-8.05	1.100	1.067	-3.01	1.097	1.097	0
2009	1.603	1.603	0	2.066	2.012	-2.58	1.022	1.003	-1.84	0.764	0.764	0
2010	1.600	1.600	0	2.092	2.246	7.38	1.051	1.023	-2.63	0.425	0.425	0
2011	1.596	1.596	0	2.600	2.526	-2.86	1.056	1.026	-2.78	0.517	0.517	0
2012	1.590	1.590	0	2.599	2.569	-1.15	1.045	1.016	-2.85	0.630	0.630	0
2013	1.584	1.584	0	2.961	2.974	0.45	1.033	1.000	-3.20	0.562	0.562	-0.0002
2014	1.579	1.579	0	3.167	3.175	0.24	1.019	0.979	-3.94	0.551	0.551	-0.0013
2015	1.576	1.579	0.20	3.179	3.265	2.71	1.051	0.999	-4.89	0.665	0.669	0.62

2G Other product use

Pollutant emissions for tobacco combustion have been recalculated for 2015 due to the correction of statistical activity data.

Table 8.27 The differences in NFR 2G pollutant emissions for the year 2015 between 2017 and 2018 submissions (%)

Pollutant	Submission year; Difference	Unit	2015
NOx	2017	kt	0.003476
	2018	kt	0.003422
	%		1.58
NMVOC	2017	kt	0.009091
	2018	kt	0.008944
	%		1.64
NH_3	2017	kt	0.007795
	2018	kt	0.007669
	%		1.64
$PM_{2.5}$	2017	kt	0.069797
	2018	kt	0.068974
	%		1.19
PM_{10}	2017	kt	0.087424
	2018	kt	0.086601
	%		0.95
TSP	2017	kt	0.091065
	2018	kt	0.090242
	%		0.91
BC	2017	kt	0.022822
	2018	kt	0.022451
	%		1.65
CO	2017	kt	0.106122
	2018	kt	0.104442
	%		1.61
Cd	2017	t	0.010687
	2018	t	0.010522
	%		1.57
Hg	2017	t	0.005092
	2018	t	0.005010
	%		1.64
As	2017	t	0.005560
	2018	t	0.005478
	%		1.50

Pollutant	Submission year; Difference	Unit	2015
Cu	2017	t	0.173265
	2018	t	0.173100
	%		0.10
PCDD/F	2017	g I-TEQ	0.000188
	2018	g I-TEQ	0.000185
	%		1.62
B(a)p	2017	t	0.000208
	2018	t	0.000205
	%		1.46
B(b)f	2017	t	0.000085
	2018	t	0.000083
	%		2.41
B(k)f	2017	t	0.000085
	2018	t	0.000083
	%		2.41
I(1,2,3-cd)p	2017	t	0.000085
	2018	t	0.000083
	%		2.41
PAHs Total	2017	t	0.000463
	2018	t	0.000454
	%		1.98

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 2018 and 2017 are made by using exact calculation numbers.

NMVOC emissions from dairy cattle and swine have been recalculated for the years 1990–2015. Recalculations entail using corrected activity data (aggregations between fattening pigs and shows) and emission factor (Frac silage_store for dairy cattle). For calculating NH_3 and NO_x emissions from laying hens and broilers manure management, the tier 2 methodology was used instead of tier 1 for the first time.

NH_3 emissions from non-dairy cattle manure management have been recalculated for the years 1990–2015. Recalculations entail using corrected activity data.

Table 8.28 The differences in dairy cattle manure management NMVOC emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NMVOC		
	Old	Recalc.	Difference
1990	3.074	3.144	2.3
1991	2.800	2.863	2.3
1992	2.544	2.602	2.3
1993	2.245	2.296	2.3
1994	2.046	2.093	2.3
1995	1.816	1.857	2.3
1996	1.762	1.801	2.3
1997	1.802	1.843	2.2
1998	1.794	1.834	2.2
1999	1.537	1.571	2.2
2000	1.517	1.551	2.2
2001	1.589	1.625	2.2
2002	1.438	1.469	2.2
2003	1.552	1.585	2.2
2004	1.620	1.655	2.1
2005	1.628	1.663	2.1
2006	1.632	1.667	2.1
2007	1.592	1.626	2.1
2008	1.581	1.614	2.1
2009	1.562	1.595	2.1
2010	1.595	1.629	2.1
2011	1.603	1.637	2.1
2012	1.654	1.689	2.1
2013	1.729	1.764	2.1
2014	1.720	1.756	2.1
2015	2.084	2.127	2.1

Table 8.29 The differences in non-dairy cattle manure management ammonia emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	1.360	2.194	61.3
1991	1.219	2.107	72.9
1992	0.996	1.719	72.6
1993	0.651	1.128	73.3
1994	0.584	0.978	67.5
1995	0.527	0.858	62.6
1996	0.487	0.799	64.2
1997	0.443	0.744	67.8
1998	0.421	0.693	64.5
1999	0.368	0.615	66.8
2000	0.352	0.578	64.3
2001	0.374	0.614	64.3
2002	0.491	0.659	34.4
2003	0.491	0.819	66.9
2004	0.351	0.586	66.8
2005	0.391	0.656	67.7
2006	0.372	0.614	64.9

Year	NH_3		
	Old	Recalc.	Difference
2007	0.401	0.652	62.6
2008	0.424	0.640	50.8
2009	0.425	0.647	52.3
2010	0.428	0.646	50.9
2011	0.440	0.651	48.2
2012	0.458	0.675	47.5
2013	0.502	0.734	46.1
2014	0.441	0.671	52.4
2015	0.380	0.606	59.3

Table 8.30 The differences in swine manure management NMVOC emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NMVOC		
	Old	Recalc.	Difference
1990	1.225	0.851	-30.5
1991	1.132	0.788	-30.4
1992	0.766	0.534	-30.4
1993	0.608	0.421	-30.8
1994	0.653	0.454	-30.6
1995	0.637	0.443	-30.4
1996	0.428	0.296	-30.8
1997	0.446	0.306	-31.3
1998	0.475	0.326	-31.2
1999	0.433	0.280	-35.2
2000	0.473	0.306	-35.4
2001	0.537	0.354	-34.1
2002	0.530	0.354	-33.3
2003	0.530	0.354	-33.3
2004	0.526	0.360	-31.6
2005	0.532	0.363	-31.9
2006	0.541	0.372	-31.3
2007	0.576	0.393	-31.8
2008	0.553	0.376	-31.9
2009	0.555	0.380	-31.5
2010	0.562	0.380	-32.4
2011	0.555	0.375	-32.5
2012	0.569	0.392	-31.2
2013	0.545	0.373	-31.4
2014	0.541	0.366	-32.4
2015	0.452	0.308	-31.8

Table 8.31 The differences in laying hens manure management emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.011	0.011	-2.3	1.068	0.64253	-39.8
1991	0.009	0.009	-2.3	0.859	0.51683	-39.8
1992	0.009	0.009	-2.3	0.872	0.52469	-39.8
1993	0.006	0.006	-2.3	0.580	0.34895	-39.8
1994	0.005	0.004	-2.3	0.438	0.26363	-39.8
1995	0.004	0.004	-2.3	0.398	0.2393	-39.8
1996	0.004	0.004	-2.3	0.405	0.24367	-39.8
1997	0.004	0.004	-2.3	0.345	0.20778	-39.8
1998	0.004	0.004	-2.3	0.375	0.22561	-39.8
1999	0.004	0.004	-2.3	0.380	0.22873	-39.8
2000	0.004	0.004	-2.3	0.347	0.20903	-39.8
2001	0.005	0.005	-2.3	0.478	0.28762	-39.8
2002	0.004	0.004	-2.3	0.388	0.24104	-37.8
2003	0.004	0.004	-2.3	0.388	0.23342	-39.8
2004	0.004	0.004	-2.3	0.403	0.24258	-39.8
2005	0.004	0.004	-2.3	0.348	0.20966	-39.8
2006	0.003	0.003	-2.3	0.306	0.18422	-39.8
2007	0.003	0.003	-2.3	0.309	0.18585	-39.8
2008	0.003	0.003	-2.3	0.264	0.15893	-39.8
2009	0.003	0.003	-2.3	0.310	0.18629	-39.8
2010	0.003	0.003	-2.3	0.278	0.16705	-39.8
2011	0.003	0.003	-2.3	0.273	0.16436	-39.8
2012	0.003	0.003	-2.3	0.333	0.20047	-39.8
2013	0.003	0.003	-2.3	0.284	0.17069	-39.8
2014	0.004	0.004	-2.3	0.361	0.21749	-39.8
2015	0.004	0.004	-2.3	0.396	0.23835	-39.8

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Table 8.32 The differences in broilers manure management emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NO_x			NH_3		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.004	0.006	55.5	0.429	0.240	-44.0
1991	0.003	0.005	55.5	0.364	0.204	-44.0
1992	0.002	0.003	55.6	0.225	0.126	-44.0
1993	0.002	0.003	55.5	0.212	0.119	-44.0
1994	0.002	0.003	55.6	0.199	0.111	-44.0
1995	0.002	0.003	55.6	0.190	0.106	-44.0
1996	0.001	0.002	55.6	0.116	0.065	-44.0
1997	0.001	0.002	55.6	0.114	0.064	-44.0
1998	0.002	0.002	55.6	0.171	0.096	-44.0
1999	0.001	0.002	55.5	0.142	0.079	-44.0
2000	0.001	0.002	55.6	0.136	0.076	-44.0
2001	0.001	0.002	55.5	0.159	0.089	-44.0
2002	0.002	0.003	55.5	0.243	0.114	-53.1
2003	0.002	0.003	55.6	0.243	0.136	-44.0
2004	0.002	0.004	55.6	0.251	0.141	-44.0
2005	0.002	0.003	55.5	0.227	0.127	-44.0
2006	0.002	0.003	55.5	0.216	0.121	-44.0
2007	0.002	0.003	55.5	0.210	0.118	-44.0
2008	0.002	0.003	55.5	0.227	0.127	-44.0
2009	0.002	0.003	55.6	0.238	0.133	-44.0
2010	0.002	0.004	55.6	0.267	0.149	-44.0
2011	0.003	0.004	55.5	0.286	0.160	-44.0
2012	0.003	0.004	55.5	0.279	0.156	-44.0
2013	0.003	0.004	55.5	0.300	0.168	-44.0
2014	0.003	0.004	55.5	0.308	0.172	-44.0
2015	0.003	0.004	55.5	0.303	0.170	-44.0

8.3.2. Agricultural Soils

NH_3 from inorganic N-fertilizer have been recalculated for 1990–2015 the Tier 2 methodology was used instead of Tier 1 for the first time. The NH_3 emission from laying hens and broiler manure application to soils (NFR 3D2a) were calculated separately from 3B sector for the first time. In addition, there were mistakes in the NH_3 calculation from non-dairy cattle grazing, which has now been corrected.

This year, for the first time, NO_x emissions from grazing and manure application to soil are reported under NFR 3Da2a and 3D3 respectively.

Table 8.33 The differences in fertilizer application emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	3.585	2.966	-17.3
1991	2.918	2.422	-17.0
1992	2.918	2.394	-18.0
1993	1.497	1.225	-18.2
1994	1.303	1.097	-15.9
1995	0.945	0.806	-14.8
1996	0.828	0.708	-14.5
1997	1.024	0.859	-16.1
1998	1.247	1.032	-17.2
1999	0.995	0.835	-16.1
2000	1.120	0.934	-16.6
2001	0.980	0.822	-16.1
2002	1.163	0.694	-40.3
2003	1.163	0.966	-16.9
2004	1.242	1.046	-15.7
2005	1.004	0.901	-10.2
2006	1.131	0.963	-14.8
2007	1.249	1.109	-11.2
2008	1.773	1.447	-18.3
2009	1.366	1.121	-18.0
2010	1.431	1.160	-19.0
2011	1.490	1.278	-14.3
2012	1.649	1.508	-8.6
2013	1.683	1.386	-17.6
2014	1.790	1.604	-10.4
2015	1.790	1.634	-8.7

Table 8.34 The differences in animal manure applied to soils category emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	4.646	6.025	29.7
1991	4.256	5.592	31.4
1992	3.446	4.554	32.2
1993	2.860	3.610	26.2
1994	2.776	3.401	22.5
1995	2.551	3.095	21.3
1996	2.244	2.744	22.3
1997	2.286	2.754	20.4
1998	2.255	2.716	20.4
1999	2.160	2.579	19.4
2000	2.018	2.405	19.2
2001	2.073	2.518	21.5
2002	2.386	2.645	10.9
2003	2.386	2.932	22.9
2004	2.397	2.845	18.7
2005	2.521	2.993	18.7
2006	2.531	2.970	17.3
2007	2.620	3.077	17.4
2008	2.595	3.016	16.2
2009	2.611	3.058	17.1
2010	2.692	3.142	16.7
2011	2.716	3.171	16.8
2012	2.765	3.250	17.5
2013	2.874	3.383	17.7
2014	2.795	3.327	19.0
2015	2.977	3.506	17.8

Table 8.35 The differences in grazing emissions (kt) between the 1990–2015 and 2017 and 2018 submissions (%)

Year	NH_3		
	Old	Recalc.	Difference
1990	3.042	4.073	33.9
1991	2.751	3.885	41.2
1992	2.322	3.247	39.9
1993	1.676	2.287	36.5
1994	1.516	2.010	32.6
1995	1.363	1.769	29.8
1996	1.273	1.660	30.4
1997	1.208	1.584	31.2
1998	1.149	1.486	29.3
1999	1.026	1.335	30.2
2000	0.952	1.235	29.7
2001	0.985	1.282	30.1
2002	0.933	1.359	45.7
2003	0.933	1.216	30.4
2004	0.967	1.293	33.8
2005	0.977	1.310	34.1
2006	0.983	1.325	34.8
2007	0.979	1.321	34.9
2008	1.005	1.297	29.0
2009	0.982	1.292	31.5
2010	0.993	1.303	31.2
2011	1.015	1.321	30.1
2012	1.057	1.377	30.3
2013	1.147	1.494	30.3
2014	1.067	1.412	32.3
2015	1.055	1.392	32.0

8.4. Waste Sector (NFR 5)

There were some recalculations of pollutant emissions in the waste sector due to the usage of the different EMEP/EEA Guidebook 2016 emission factor for emission calculations in the NFR 5B1 (Composting) sector and correction of

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activity data in the NFR 5D2 (Industrial wastewater handling) sector.

The comparison between the submissions for 2017 and 2018 are made by using exact calculation numbers. The differences between 2017 and 2018 submissions are presented in the Tables 8.36 and 8.37.

Table 8.36 The differences in NFR 5B1 pollutant emissions (kt) for the years 1990-2015 between 2017 and 2018 submissions (%)

Year	NH_3			CO		
	2018 kt	2017 kt	Difference %	2018 kt	2017 kt	Difference %
1990	0.0016	0.0045	-63.64	NE	0.0038	-100.00
1991	0.0017	0.0047	-63.64	NE	0.0040	-100.00
1992	0.0018	0.0049	-63.65	NE	0.0042	-100.00
1993	0.0019	0.0052	-63.63	NE	0.0044	-100.00
1994	0.0020	0.0054	-63.64	NE	0.0046	-100.00
1995	0.0021	0.0059	-63.64	NE	0.0050	-100.00
1996	0.0014	0.0040	-63.63	NE	0.0034	-100.00
1997	0.0027	0.0074	-63.64	NE	0.0063	-100.00
1998	0.0005	0.0014	-63.65	NE	0.0012	-100.00
1999	0.0015	0.0042	-63.64	NE	0.0036	-100.00
2000	0.0046	0.0125	-63.64	NE	0.0106	-100.00
2001	0.0043	0.0118	-63.64	NE	0.0100	-100.00
2002	0.0039	0.0108	-63.64	NE	0.0092	-100.00
2003	0.0162	0.0444	-63.64	NE	0.0377	-100.00
2004	0.0183	0.0502	-63.64	NE	0.0426	-100.00
2005	0.0253	0.0695	-63.66	NE	0.0589	-100.00
2006	0.0277	0.0763	-63.72	NE	0.0646	-100.00
2007	0.0445	0.1228	-63.73	NE	0.1039	-100.00
2008	0.0497	0.1370	-63.69	NE	0.1161	-100.00
2009	0.0554	0.1527	-63.71	NE	0.1293	-100.00
2010	0.0522	0.1438	-63.68	NE	0.1219	-100.00
2011	0.0377	0.1039	-63.70	NE	0.0880	-100.00
2012	0.0355	0.0979	-63.70	NE	0.0829	-100.00
2013	0.0432	0.1190	-63.69	NE	0.1008	-100.00
2014	0.0310	0.0855	-63.71	NE	0.0784	-100.00
2015	0.0387	0.1067	-63.74	NE	0.0966	-100.00

Table 8.37 The difference in NFR 5D2 NMVOC emissions (kt) for the years 2014 and 2015 between 2017 and 2018 submissions (%)

Year	NMVOC		
	2018 kt	2017 kt	Difference %
2014	0.0264	0.0011	2307.29
2015	0.0246	0.0008	2862.33

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ANNEX I – Recommendations from the TERT during the NECD Review

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-1A1-2017-0001	No	1A1 Energy Production, NH_3, 2005, 2010, 2015	For categories 1A1a Public Electricity and Heat Production/1A1c Manufacture of Solid Fuel and Other Energy Industries/1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other/1A4ai Commercial/Institutional: Stationary/1A4ci Agriculture/Forestry/Fishing: Stationary and pollutants NH_3 for the whole period, the TERT noted that, depending on years and categories, NH_3 emissions are not estimated in the NFR tables whereas biomass consumptions occur and NH_3 EFs are available for biomass in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia explained that for 1A1c ammonia emissions are mainly reported by one shale oil producing facility where emissions are very insignificant. Due to the format of the number reported (only 2 decimals), emissions were reported as 0 or 'NE' instead of the real value. Emissions will be updated in the next submission. For the other categories, Estonia confirmed that emissions of ammonia from combustion of biomass were not calculated (except for households). Estonia provided a revised estimate for years 2005/2010/2015 and stated that it will be included in the next year submission. The TERT agreed with the revised estimate provided by Estonia. The TERT noted that these revised estimates had an impact on the national totals that was above the threshold of significance. The TERT recommends that Estonia includes the revised estimate in its next submission along with the additional explanations provided during the review.	RE	Emissions of ammonia have been calculated from wood and wood waste combustion for categories 1A1a, 1A1c, 1A2gviii, 1A4ai and 1A4ci.	Chapter 3 "Energy sector (NFR 1)", chapter 8.1 "Energy sector"
EE-1A1-2017-0002	Yes	1A1 Energy Production, SO_2, NO_x, NMVOC, $PM_{2.5}$, 2005-2015	For the key categories 1A1a Public Electricity and Heat Production (SO_2, NO_x, $PM_{2.5}$, NMVOC), 1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other (SO_2, $PM_{2.5}$, NMVOC) and 1A4a Commercial/Institutional ($PM_{2.5}$), the TERT noted that there is a lack of transparency regarding the EF used or IEF analysis in the IIR. This issue of transparency had already been highlighted in recommendation 49 of the CLRTAP review of Estonia in 2016. In response to a question raised during the review, Estonia agreed the IIR needs transparency improvement by submitting more detailed description of methodology on energy sector. Estonia also provided more details on methodologies for the mentioned key categories during the review. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Estonia improves the transparency of its IIR especially by clarifying the use of EF from table 3.6 to 3.11 (national EF for small combustion plants with a capacity < 50 MW) and if possible by analysing IEF trends.	no	In 2018 submission the chapters of energy industries (1A1), stationary combustion in manufacturing industries (1A2) and non-industrial combustion (NFR 1A4) are provided separately with the description of methodologies, activity data. Also have been calculated IEF and the short analysis is carried out. The improvements of the corresponding chapters will continue in coming reporting year.	Chapters 3.2.2; 3.2.3; 3.2.4
EE-1A1-2017-0003	No	1A1 Energy Production, SO_2, NH_3, NMVOC, $PM_{2.5}$, 2005-2015	1A1 Energy Production for SO_2, NH_3, NMVOC, $PM_{2.5}$ for Other fuels 2005-2015, in the NFR tables, for activity data of NFR 1A1a Public Electricity and Heat Production/1A1c Manufacture of Solid Fuel and Other Energy Industries/1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other/1A4ai Commercial/Institutional: Stationary/1A4ci Agriculture/Forestry/Fishing: Stationary, the TERT noted that there is consumption of 'other fuels' but that there is no description in the IIR of what these fuels are. In response to a question raised during the review, Estonia explained that "other fuels" include oil shale gas, solid and liquid industrial waste, agricultural waste and other fuels including biogas which are reported by facilities. Estonia also stated that next year's IIR will include more detailed description for fuel consumption by each sector. The TERT acknowledged the explanation provided by Estonia. The TERT recommends that Estonia refers to international admitted fuel definitions (e.g. 'Energy statistical Manual' from IEA/Eurostat/OECD or 2006 IPCC Guidelines-Vol2-chapter 1-Table 1.1) for the aggregation by fuel groups (e.g. biogas should be included in 'biomass' fuel group instead of 'other') in order to ensure comparability between countries and with international statistics (Eurostat, IEA).	no	In 2018 submission the 2006 IPCC Guideline approach for the fuel aggregation only for 2016 data were used. Biomass are reported under biomass, generator or semi – coke gas under solid fuels and waste under other fuels group.	Corrections in activity data for the period between 1990-2015 together with explanations will be presented next year submission.

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Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-1A1-2017-0004	No	1A1 Energy Production, $PM_{2.5}$, 2005-2015	For category 1A1 Energy Production, 1A2 Stationary Combustion in Manufacturing Industries and Construction and 1A4 Small Combustion and Non-Road Mobile Machinery, $PM_{2.5}$ of natural gas for the whole period, the TERT noted that there is no $PM_{2.5}$ estimate made by Estonia despite there being emission factors available in the 2016 EMEP/EEA Guidebook. In response to a question raised during the review, Estonia confirming that emissions of particles from combustion of natural gas are not estimated (except for households). Estonia agreed that it is an under-estimate of $PM_{2.5}$ emissions. Estonia indicated that it had completed preliminary estimates using Tier 2 methods from the 2016 EMEP Guidebook. The TERT noted that the preliminary revised estimate calculated by Estonia is below the threshold of significance for technical correction. The TERT recommends that Estonia includes the revised estimate in its next submission.	no	Emissions of $PM_{2.5}$ from natural gas combustion have been calculated for the 2000-2016 for the NFR 1A1a, 1A2giii, 1A4ai and 1A4i. The emissions of PM_{10} (2000-2016), TSP, heavy metals and PAHs (1990-2016) for the same sectors have been calculated in addition.	Chapter 8.1.1
EE-1A1-2017-0005	Yes	1A1 Energy Production, SO_2, NO_X, $PM_{2.5}$, 2005-2015	For NFR 1A1 Energy Production (including waste incineration with energy recovery) and 1A2 Stationary Combustion in Manufacturing Industries and Construction, for years 2005-2015, the TERT noted that Estonia is estimating NO_X, SO_2 and TSP emissions using annual emissions reported by operators on the basis of stack measurements. When continuously measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED and have used validated average values (after having subtracted the value of the confidence interval) although this subtraction must not be applied in the context of reporting annual emissions. In response to a question raised during the review, Estonia explained that at this time the national legislation does not regulate the use of those continuously measured validated average values in the context of reporting annual emissions. Estonia also explained from first contact with operators, some are calculating emissions based on validated average values. In the opinion of the TERT, bottom-up data based on the "validated average values" defined in the IED cannot be used by the inventory team without adjustment in the framework of a national inventory. The TERT notes that this issue relates to an underestimate, which could correspond to 20% of SO_2, 20% of NO_X, 30% of dust of the sector (depending on the fraction of the operators subtracting confidence interval). The TERT recommends that Estonia organise a survey among operators to identify whether any are reporting emissions on the basis of the validated average values and try to derive a methodology to adjust the national emissions over the time series in order to compensate for any under reporting.	no	Estonia has organised a survey amongst its operators in order to be able to understand whether any operator is reporting emissions on the basis of the validated average values. Our investigation shows that in Estonia there is one operator (covering three facilities) who is using validated average values for reporting emissions. We have contacted the operator in question and are in the process of carrying out negotiations. Unfortunately, at this stage we don't have enough information to identify the real value of any underestimation of emissions. The correction to the inventory will be made as soon as we have received the necessary information from the operator.	Chapter 3.2.2.2
EE-1A1c-2017-0001	No	1A1c Manufacture of Solid Fuels and Other Energy Industries, NMVOC, $PM_{2.5}$, 2014-2015	For category 1A1c Manufacture of Solid Fuels and Other Energy Industries, the TERT observed a sharp increase in NMVOC between 2014 and 2015. A sharp decrease is also observed for $PM_{2.5}$ between those two same years. In response to a question raised during the review, Estonia explained that for NMVOC, new measurements were made in 2015 at a shale oil plant they plan to use for NMVOC emissions for the entire time series. Estonia provided a revised estimate based on shale oil production of this plant and the recalculated 2015 NMVOC EF for years 1990 to 2014. Estonia stated that these revisions will be included in the next submission either by applying this methodology or with more operator data. For $PM_{2.5}$, Estonia explained that a mistake has been made in the calculations. During the review Estonia provided a new estimate for 2015 and stated that it will be corrected in the next year submission. The TERT agreed with the revised estimates provided by Estonia. The TERT notes that the revised estimate is above the threshold of significance for NMVOC in 2010. The TERT recommends that Estonia includes the revised estimate in its next submission.	RE	NMVOC emissions from the shale oil production (Enefit-140) have been recalculated for the period 1990-2014. $PM_{2.5}$ emission for 2015 are corrected.	Chapter 8.1.1; NFR tables.

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
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	For 1A1c Manufacture of Solid Fuels and Other Energy Industries, SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$, 2005-2015, the TERT noted in the NFR tables that activity data (AD) for NFR 1A1c shows significant consumptions of solid fuels (approx. 60,000 TJ in 2015). When comparing this AD to the Eurostat energy balance ("consumption in the energy branch"), the TERT noted only a solid fuel consumption of about 500 TJ for year 2015. This observation is relevant for all years from 2005. In response to a question raised during the review, Estonia explained that the AD for this sector includes fuel consumption in conversion industry, namely oil shale consumption for the oil shale, oil production. The TERT acknowledged the explanation provided by Estonia and understood that all emissions are taken into account in the inventory but some fuel consumption needs to be reallocated if not used for combustion purposes. The TERT recommends that Estonia only reports energy use of fuels in the NFR tables for the subcategories of NFR 1A Energy (the consumption of oil shale can be considered as a non-energy use of fuel or a raw material).	no	Data on the oil shale used for shale oil production for 2016 aren't included in activity data under NFR 1A1c. Oil shale consumption for shale oil production are provided in IIR energy chapter. Activity data correction for sector 1A1c will be made in the coming reporting year.	Chapter 3.2.2.2, table 3.19
EE-1A2gviii-2017-0001	Yes	1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other, SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$, 2006	For category 1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other in the NFR tables, year 2006, the TERT noted that AD for this year are not reported whereas emissions are reported. In response to a question raised during the review, Estonia explained that there was an error in reporting and provided the missing AD. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Estonia reports 2006 AD in the NFR tables of its next submission.	no	The missing 2006 activity data for NFR 1A2giii are reported.	2018 submission, NFR table for 2006.
EE-1A2gviii-2017-0002	Yes	1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other, SO_2, 2005-2010	For NFR 1A2gviii Stationary Combustion in Manufacturing Industries and Construction: Other, the TERT noted a drop in the SO_2 emissions between 2005 (10.20 kt) and 2006 (4.05 kt). In response to a question raised during the review, Estonia explained that a shale oil production plant changed its main activity during the period from manufacturing industry to thermal power plant and thus has a different NFR allocation for different years. The TERT notes that this issue does not relate to an over- or under-estimate and recommends that Estonia includes this explanation in its IIR.	no	The relevant explanations are included in the IIR.	Chapter 3.2.3 "Manufacturing industries and construction (NFR 1A2)
EE-1A3c-2017-0001	No	1A3c Railways, SO_2, 2000-2015	For 1A3c Railways/SO_2/years: 2000 - 2015, the TERT noted that in response to a question raised during the review Estonia explained that there was an under-estimation of SO_2 emissions for the period 2000 - 2010 and an over-estimation for the period 2012 to 2015, but did not provide a revised estimate. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that revised estimates are included in next year's submission.	no	SO_2 emissions factors and emission calculations were checked for the railway sector. There was an overestimation of SO_2 emissions for the 2011-2015 period. Therefore, corrections have been made to SO_2 emissions factors and SO_2 emissions have been recalculated for this period.	Chapter 8.1.2.
EE-1A4bi-2017-0001	Yes	1A4bi Residential: Stationary, SO_2, 2005-2015	In the 2016 in-depth CLRTAP review of Estonia, for NFR 1A4bi Residential: Stationary wood combustion, recommendation 51 "encouraged Estonia to provide an explanation of the technical equipment of advanced small boilers in the IIR to confirm low SO_2 EF for these equipment, to include information on the use of the different stoves in the IIR and to explain how the emissions were calculated from the EFs presented in the IIR". The TERT did not notice any of these explanations in the 2017 IIR. In response to a question raised during the review, Estonia explained that after checking the measurement results, the conclusion was made that SO_2 emission factor from the wood gasification technology has been calculated incorrectly. Estonia provided a revised estimate for SO_2 emissions from the wood combustion in advanced boilers and stated that it will be included in the next submission. Estonia also mentioned that a detailed description of the activity data for the residential sector will be provided in the next submission of the IIR. The TERT agreed with the explanation and the revised estimate provided by Estonia. The TERT noted that the issue is below the threshold of significance for technical correction. The TERT recommends that Estonia includes the revised estimate in its next submission along with the explanations in the IIR.	RE	Emissions of SO_2 from the wood and wood waste combustion for the period 1990-2015 have been recalculated on the base of Guidebook 2016 EF.	Chapter 3.2.4 "Non-industrial combustion (1A4), table 3.28; chapter 8.1.1

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-1A4cii-2017-0001	No	1A4cii Agriculture/Forestry/Fishing: Off-Road Vehicles and Other Machinery, NO_x, 2001,2002	For 1A4cii Agriculture/Forestry/Fishing: Off-Road Vehicles and Other Machinery /all pollutants/years: 2000-2015 the TERT noted that the activity data is very variable across the time series. For example, in 2002 activity levels are 3 times those in 2001 and in 2011 activity is ~32% higher than in 2010. In response to a question raised during the review, Estonia explained that fuel consumption data is taken from the Energy Balance, prepared by Estonian Statistics and that the variability in the time series can be explained by statistical fuel consumption deviations in the agricultural sector. The TERT notes that this issue does not relate to an over- or under-estimate and is likely to be due to an allocation issue. The TERT recommends that this issue is looked into further to ensure that this variability is reasonable.	no	No improvement has been made, but it has been taken into workplan and will be investigated in coming years.	
EE-1B-2017-0001	No	1B Fugitive Emission from Fuels, SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$, 2005-2015	For category 1B Fugitive Emission from Fuels, all pollutants and all years the TERT noted that the use of notation keys is inconsistent and in many cases incorrect. For instance, in 1B1b Fugitive Emission from Solid Fuels: Solid Fuel Transformation NMVOC emissions are 'NA' during part of the time series. In response to a question raised during the review, Estonia explained some of the background for choosing the notation keys. The TERT noted that the proposed use of notation keys is not in line with the reporting guidelines. The TERT recommends that Estonia reviews the use of notation keys throughout the inventory and reports notation keys in accordance with the reporting guidelines for NECD and LRTAP.	no	No improvement has been made, but it has been taken into workplan and will be investigated in coming years.	
EE-2A1-2017-0001	No	2A1 Cement Production, $PM_{2.5}$, 2005-2015	For category 2A1 Cement Production and pollutant $PM_{2.5}$ for all years the TERT noted that the IIR does not clearly explain how emissions were calculated and the NFR uses for some years the notation key 'IE' instead of an emission value. In response to a question raised during the review, Estonia explained that combustion activities are reported under NFR 1A2f Stationary Combustion in Manufacturing Industries and Construction: Non-Metallic Minerals. Estonia also indicated that fugitive emissions, for example from the cement mill are usually reported under NFR 2A1. Estonia also explained that in some years diffuse PM emissions are reported in NFR 2A6 Other Mineral Products. Estonia confirmed it will try to correct this for the next submission. The TERT recommends that Estonia reviews the allocation of emissions, ensures time series consistency and to document clearly in the IIR how emissions have been allocated between different NFR source categories.	no	As for this NFR the data submitted by the enterprises and provided in accordance with the snap codes, it is necessary to carry out a detailed analysis of the facilities data, which are already begun. The reallocation will not affect the amount of emissions in the sector and for the whole country, but we understand that this is important for the accuracy and consistency of the data. Results will be provided next year.	
EE-2A5a-2017-0001	No	2A5a Quarrying and Mining of Minerals Other than Coal, SO_2, NO_x, NMVOC, $PM_{2.5}$, 2005-2015	For category 2A5a Quarrying and Mining of Minerals Other than Coal and pollutant $PM_{2.5}$ the TERT noted that for the years prior to 2009, emissions were reported as 'NA' (Not Applicable). In response to a question raised during the review, Estonia explained that before 2009 emissions from this source are included in 2A6 Other Mineral Products and 'IE' would be the more appropriate notation key to use. The TERT agreed with the explanation provided by Estonia. The TERT recommends that Estonia reports all emissions from quarrying and mining of minerals other than coal in 2A5a (also prior to 2009), or, in case that is not possible, use the notation key 'IE' when emissions are allocated elsewhere. In the latter case, this should be clearly documented in the IIR.	no	As for this NFR the data submitted by the enterprises and provided in accordance with the snap codes, it is necessary to carry out a detailed analysis of the facilities data, which are already begun. The reallocation will not affect the amount of emissions in the sector and for the whole country, but we understand that this is important for the accuracy, consistency or transparency of the data. Results will be provided next year.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-2A5c-2017-0001	No	2A5c Storage, handling and transport of mineral products, $PM_{2.5}$, 2005-2015	For category 2A5c Storage, Handling and Transport of Mineral Products and pollutant $PM_{2.5}$, for 2005 - 2015 the TERT noted that emissions are reported as 'IE' for some of the years, and as 'NA' for all other years. In response to a question raised during the review, Estonia explained that these emissions are reported under NFR 2L Other Production, Consumption, Storage, Transportation or Handling of Bulk Products and partly under 2A6 Other Mineral Products, and that emissions do not exceed the threshold. The TERT agreed that emissions are below the threshold, but disagrees with the allocation of emissions. The TERT recommends that Estonia reports emissions from this source consistently in 2A5c. In case emissions are allocated to other sectors, this should be clearly documented in the IIR.	no	No improvement has been made, but it has been taken into workplan and will be investigated in coming years.	
EE-2B1-2017-0001	No	2B1 Ammonia Production, SO_2, NH_3, NMVOC, $PM_{2.5}$, 1990-2013	For 2B1 Ammonia Production, SO_2, NH_3, NMVOC, $PM_{2.5}$, 1990-2013, in response to a question raised during the review Estonia explained that no production occurred in 2011-2012 (the TERT suspects that Estonia meant 2010-2011). The TERT recommends that the notation key is corrected to the proper 'NO' for these years for the next submission. Estonia also explained that SO_2 emissions are reported from the operator, but only for the years 2008-2009. The TERT notes that it is likely that the SO_2 emissions reported by Nitrofert in 2008-2009 are related to energy consumption and thus belongs under 1A2c Stationary Combustion in Manufacturing Industries and Construction: Chemicals. Before SO_2 emissions are removed from 2B1, the TERT recommends that Estonia ensures that SO_2 emissions are included in 1A2c. Finally, Estonia explained that NH_3 emissions in 2006 were omitted from the inventory by mistake. The TERT recommends that this NH_3 emission is included in the next submission. The TERT also notes that emissions should be estimated using extrapolations, IEFs, surrogate data or expert judgements to complete any gaps in the time series 2005-2015, preferably 2000-2004 also. The TERT recommends that Estonia estimates $PM_{2.5}$ emissions to complete the time series. The TERT recommends that a split of the NH_3 emissions from ammonia and urea productions in 1990-2002 is estimated as best possible to complete the time series reported under 2B1. If urea production continued after 2002 with separate NH_3 emissions available, then estimation of this split should be possible. The TERT noted that the all the identified issues are below the threshold of significance for a technical correction.	no	NO_x and NH_3 emission from ammonia production have been corrected for the period 2000−2007. Emissions of NMVOC have been calculated in addition for the period between 1990-2004 and corrected for the 2005-2007. All correction were made base on point source data. Emissions of NMVOC during 1990-2004 haven't been provided by the facility and defined on the basis of calculated by the expert IEF. The SO_2 emissions for 2008-2009 data have been removed from reporting tables as it was a mistake. The split of ammonia emission between NFRs 2B1 and 2B10a and corrections in $PM_{2.5}$ emissions will be provided in the next year submission.	Chapter 8.2
EE-2C1-2017-0002	No	2C1 Iron and Steel Production, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2007-2015	For 2C1 Iron and Steel Production, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2007-2015 in response to a question raised during the review Estonia explained that production (SNAP 040210) ceased from 2013 causing a sharp decrease in emissions. Estonia also explained that emissions from 2C1 in 2000-2006 are reported under NFR 2C7c Other Metal Production. Furthermore, Estonia explained that they agree with the TERT that data from 2000-2006 should be allocated to NFR 2C1 for the next submission as well as a more detailed description of all activities included in the IIR. The TERT noted that the issue is a matter of allocation and transparency only. The TERT recommends that Estonia follows through on its intent to improve the data and descriptions of the iron and steel production source category.	no	As for this NFR the data submitted by the enterprises and provided in accordance with the snap codes, it is necessary to carry out a detailed analysis of the facilities data, which are already begun. The reallocation will not affect the amount of emissions in the sector and for the whole country, but we understand that this is important for the accuracy, consistency or transparency of the data. Results will be provided next year.	

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-2C-2017-0002	No	2C Metal Industry, SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$, 2009-2015	For NFR categories 2C3 Aluminium Production, 2C5 Lead Production, 2C6 Zinc Production and 2C7a Copper Production for 1990 - 2008, the in response to a question raised during the review Estonia explained that emissions are estimated using Tier 3 and that emissions prior to 2009 are estimated differently and reported inconsistently in different categories in energy and waste. Estonia explained that it will attempt to allocate emissions correctly for the next submission. The TERT noted that the issue regards transparency/allocation and does not relate to under- or over-estimation. The TERT recommends that Estonia implements its intent to estimate and report emissions under the correct NFR categories for the full time series for its next submission.	no	As for this NFR the data submitted by the enterprises and provided in accordance with the snap codes, it is necessary to carry out a detailed analysis of the facilities data, which are already begun. The reallocation will not affect the amount of emissions in the sector and for the whole country, but we understand that this is important for the accuracy, consistency or transparency of the data. Results will be provided next year.	
EE-2D3a-2017-0001	Yes	2D3a Domestic solvent use including fungicides, NMVOC, 1990-2015	For Key Category 2D3a (Domestic Solvent Use Including Fungicides; NMVOC; whole time series) the TERT noted that there is a lack of transparency regarding the used EF. In response to a question raised during the review, the MS explained that no AD are available other than population (2016 EMEP/EEA Guidebook: Tier 1 EF of 1.2 kg NMVOC/capita is used). Estonia suggested that the methodology could be improved by using Tier 2 per capita EFs for specific product types, to derive more differentiated emissions into product types. These estimates will be included in the next submission. The TERT recommends that MS investigates the possibilities to find AD from national statistics and Eurostat in order to perform a Tier 2 level assessment in the future.	no	No emissions recalculations were done, as the methodology the TERT suggested, was already implemented. The description of the used methodology was rewritten, so it could be better understood what was done.	Chapter 4.2.5.2
EE-2D3d-2017-0001	Yes	2D3d Coating Applications, NMVOC, 1990-2015	For Key Category 2D3 (Coating Applications; NMVOC; whole time series) the TERT noted some inconsistencies regarding used EFs for water and solvent based paints for domestic/construction use and industries (point sources). In response to a question raised during the review, Estonia explained that at present there is no differentiation between solvent and waterborne paint emissions in Estonian statistics. Estonia provided revised estimates for years 2005, 2010 and 2015 using expert judgement. The changes do not exceed the limit of significance. The TERT agreed with the revised estimate provided by Estonia. The TERT recommends that Estonia include the revised estimates in its next submission.	RE	NMVOC emissions from coating application are recalculated according to the recommendations of the TERT. The used paint has been distinguished between water and solvent based paints and NMVOC emissions are recalculated according to the EMEP/EEA Guidebook 2016 Tier 2 EFs.	Chapters 4.2.6 and 8.2.2
EE-3B1a-2017-0001	Yes	3B1a Manure Management - Dairy Cattle, NMVOC, 2000-2015	For 3B1a Manure Management - Dairy Cattle, NMVOC, 2000-2015, the TERT noted that the NMVOC emission from NFR 3B1a dairy cattle is based on a Tier 2 calculation. The Implied EF is (18 kg NMVOC/cow/year), which correspond to Tier 1 default with silage feeding. The TERT have checked the variable used in the Tier 2 calculation and found that for "Frac silage_store" 0.20 is used, which is different from the tentative default 0.25 recommended in the 2016 EMEP/EEA Guidebook (page 28 (top)). In response to a question raised during the review, Estonia agree that the "Frac silage_store" should be the tentative default recommended in the 2016 EMEP/EEA Guidebook and plan to correct this in next submission. The TERT noted that the issue is below the threshold of significance for technical correction.	no	NMVOC emissions are recalculated according to the corrected Frac silage_store (0.25 instead of 0.2).	Chapter 8.4
EE-3B-2017-0001	Yes	3B Manure Management, NH_3, 2000-2015	The TERT noted that a Tier 2 approach is used to estimate the NH_3 emission from Manure Management - Dairy Cattle (3B1a), Manure Management - Non-Dairy Cattle (3B1b) and Manure Management - Swine (3B3) 2000-2015. Data for N-excretion is included in IIR, but during the review Estonia provided data for allocation of manure management system (MMS) for all cattle and swine subcategories. The TERT have checked the Tier 2 calculation based on use of Excel spread sheet 3.B Manure management - appendix B and agree with the calculation provided by Estonia. The TERT recommends that Estonia includes information on the allocation of MMS in IIR or refer to a specific chapter in NIR where this information can be found.	no	The exact reference is included in the IIR. Also data about the manure management system usage for swine and cattle in 2016 are included in the IIR.	Chapter 5 "Agriculture (NFR 3)"

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-3B-2017-0002	Yes	3B Manure management, NH_3, 2015	For 3B Manure Management, NH_3, 2015, the NFR 3B4gi Manure Management - Laying Hens and 3B4giv Manure Management - Other Poultry is considered as key category, which mean that Tier 2 approach should be used. In response to a question raised during the review, Estonia explained that there is an on-going project at the Estonian University of Life Sciences working with improving activity data for the agricultural sector. Estonia clarified that it plans to include this work in its next submission. Furthermore, Estonia inform the TERT that the NH_3 emission from '3B4giv Manure Management – Other Poultry' are considered to be over-estimated due to lack of clear knowledge of the distribution of poultry types (e.g. turkeys, ducks and geese). The TERT agreed with the explanation provided by Estonia, and recommend that Estonia use a Tier 2 estimation for NH_3 emission for laying hens and other poultry.	no	For laying hens (3B4gi) the Tier 2 approach were used for the first time. For the 3B4giv Estonia still used the Tier 1 approach due to lack of clear knowledge of the distribution of poultry types. The project about improving activity data for agricultural sector is still on-going.	Chapter 8.4
EE-3B-2017-0003	No	3B Manure Management, NO_x, 2000-2015	The TERT noted that the NO_x emission from NFR 3B1a Manure Management - Dairy Cattle, 3B1b Manure Management Non-Dairy Cattle and 3B3 Manure Management -Swine is based on Tier 2 methodology. No information regarding distribution of manure management system (MMS) and housing days are mentioned in IIR and the TERT asked Estonia for further information. During another question raised (EE-3B-2017-001) Estonia provided data for allocation of manure management system (MMS) for all cattle and swine subcategories 1990-2015. The TERT have checked the Tier 2 calculation based on data for MMS and agree the NO_x emission provided by Estonia. The TERT recommend that Estonia include information of allocation of MMS in IIR or refer to specific chapter in NIR where this information can be found.	no	The exact reference is included in the IIR. Also data about the manure management system usage for swine and cattle in 2016 are included in the IIR.	Chapter 5 "Agriculture (NFR 3)"
EE-3B3-2017-0001	Yes	3B3 Manure Management - Swine, NMVOC, 2000-2015	For 3B3 Manure Management - Swine, NMVOC, 2000-2015, the TERT noted that the NMVOC IEF for swine (NFR 3B3) is approximately 1.5 kg NMVOC/head/year for all years 2000-2015. This IEF is closer to the default for sows (1.704 kg NMVOC/head/year), than the default for fattening pigs (0.551 kg NMVOC/head/year) – refer to 2016 EMEP/EEA Guidebook Table 3.4. Because the number of fattening pigs is more than ten times higher than the number of sows, the IEF is expected to be closer to the IEF default for fattening pigs, which indicates a possible error in calculation of NMVOC emission from swine. By applying the default EF for fattening pigs to the number of fattening pigs and the sows EF to the number of sows, the IEF for swine is reduced by over 50% to 0.646 kg NMVOC/head/year. The TERT notes that this change in NMVOC emission from swine accounts for 1 % compared with the total NMVOC emission and thus below the threshold of significance. The TERT recommends that Estonia correct the calculation of NMVOC emission from swine (NFR 3B3) in next submission.	no	The NMVOC emissions have been recalculated using corrected activity data.	Chapter 8.4
EE-3Da2a-2017-0001	No	3Da2a Animal Manure Applied to Soils, NO_x, 2000-2015	TERT noted that notation key 'NA' is used for NO_x emission from Animal Manure Applied to Soils NFR 3Da2a. In response to a question raised during the review, Estonia indicated that it plans to include the NO_2 emission from animal manure applied to soils NFR 3Da2a in the next submission. A Tier 1 approach is available in 2016 EMEP/EEA Guidebook Table 3.1 and a Tier 1 calculation based on the amount of N in manure applied registered in CRF Table 3.D can be applied. The calculation shows that the NO_2 emission from NFR 3Da2a accounts for less than 1.5% and thus below the threshold of significance. The TERT recommends that Estonia include this estimate in future submissions.	no	NO_x emissions from Animal Manure Applied to soils have been calculated.	Chapter 5.3.1
EE-5B1-2017-0002	No	5B1 Biological Treatment of Waste - Composting, NH_3, 2005;2010;2015	For NH_3 emissions from 5B1 Biological Treatment of Waste - Composting the TERT noted that in response to a question raised during the review, Estonia provided detailed information on the type of waste composted (using waste codes) and indicated that they could be divided between wood, sludge, paper and organic waste. However, Estonia explained that it couldn't provide a rationale why the EF of 0.66 kg NH_3/Mg proposed for garden and park waste in the 2016 EMEP/EEA Guidebook is applied instead of the EF of 0.24 kg NH_3/Mg of organic waste. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Estonia investigate further which EF is the most appropriate to the type of waste composted (including the possibility of splitting the AD between "garden and park waste" and "organic waste" if necessary or relevant).	no	NH_3 emissions are recalculated according to the EF of 0.24 kg NH_3/Mg of organic waste.	Chapter 8.4

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Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Improvement made	IIR Chapter, page
EE-5B2-2017-0001	No	5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities, NH_3, 2005;2010;2015	For NH_3 emissions from 5B2 Biological Treatment of Waste - Anaerobic Digestion at Biogas Facilities the TERT noted that in response to a question raised during the review Estonia explained that emissions are estimated using emission values reported by 1 facility although there are more facilities in the country. The TERT noted that this issue is expected to be below the threshold of significance for a technical correction and that this category has been added in the 2016 EMEP/EEA Guidebook. The TERT recommends that Estonia increases the completeness of its inventory by including all emissions related to biogas production facilities. The TERT recommends that Estonia compare the Tier 1 approach to data reported by facilities and to check out if the methodology used by facilities to report their emissions is relevant.	no	No improvement has been made, but it has been taken into workplan and will be investigated in coming years.	
EE-5C-2017-0001	No	5C Waste incineration, SO_2, NO_X, NH_3, NMVOC, $PM_{2.5}$, 2005;2010;2015	For 5C Waste Incineration the TERT noted that Estonia is estimating NO_X, SO_2, NMVOC, NH_3 and TSP emissions from waste incinerators with and/or without energy recovery using annual emissions reported by operators on the basis of stack measurements. When continuous measurements are used to estimate annual emissions, there is a risk that operators have misinterpreted the IED and have subtracted the value of the confidence interval (IC95) although this subtraction must not be applied in the context of reporting annual emissions. In response to a question raised during the review, Estonia explained that at this time it is not regulated on the national legislation level that those continuously measured validated average values cannot be used in the context of reporting annual emissions and that the reported annual emissions from the facilities are based on the validated average measured values. In the opinion of the TERT the validated average values defined in the IED include the subtraction of IC 95 and cannot be used in the framework of an inventory report. The TERT notes that this issue relates to an under-estimate, which could correspond, at a maximum, to 20% of SO_2, 20% of NO_X, 30% of dust of the sector (depending on the fraction of the operators subtracting IC95), however the 5C sector is far below the threshold of significance for a technical correction. The TERT recommends Estonia to organise a survey among operators to identify which one are reporting emissions on the basis of the validated average values and try to derive a methodology to adjust the national emissions over the time series in order to compensate the fact that national emissions are estimated on the basis of data reported by operators using validated average values.	no	Estonia has organised a survey amongst its operators in order to be able to understand whether any operator is reporting emissions on the basis of the validated average values. Our investigation shows that in Estonia there is one operator (covering three facilities) who is using validated average values for reporting emissions. We have contacted the operator in question and are in the process of carrying out negotiations. Unfortunately, at this stage we don't have enough information to identify the real value of any underestimation of emissions. The correction to the inventory will be made as soon as we have received the necessary information from the operator.	Chapter 3.2.2.2
EE-5D-2017-0001	No	5D Wastewater Handling, NMVOC, 2005;2010;2015	During the review, the TERT clarified the issue with Estonia and concluded that a default Tier 1 methodology is applied rather than the stated (in the IIR) use of reported data by operators. The TERT recommends that Estonia update the IIR to include an accurate description of the methods, data sources and assumptions used.	no	The IIR has been updated according to the TERTs recommendations.	Chapter 6.6.2
EE-5D2-2017-0001	No	5D2 Industrial Wastewater Handling, NMVOC, 2005;2010;2015	For 5D Wastewater Handling the TERT noted that that there is a dip of NMVOC from 5D2 emissions (Industrial Wastewater Handling) between the 1990-2013 period (around 0.03 kt/year) and 2014-2015 (around 0.001 kt/year). Over the 1990-2013 period NMVOC from 5D1 emissions (Domestic Wastewater Handling) were reported as 'IE' and emissions are reported starting from 2013 (around 0.001 kt/year). In response to a question raised during the review Estonia acknowledges that there was an error in NMVOC emission calculations under NFR 5D2 for the years 2014 and 2015 and provided a file illustrating that this error was well below the threshold of significance. The TERT recommends that Estonia includes the updated estimate in its next submission.	no	The NMVOC emissions have been recalculated using corrected activity data.	Chapters 6.6.1 and 8.4

ANNEX II – 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 sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	NO_x	25.6900	7.5767	2%	20%	20.10%	0.002455	-3.40838	9.80547	-0.68168	0.27734	0.00542
1A1c	Manufacture of solid fuels and other energy industries	NO_x	0.0000	0.2544	2%	20%	20.10%	0.000003	0.32924	0.32924	0.06585	0.00931	0.00004
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	NO_x	IE	0.0010	2%	20%	20.10%	0.000000	0.00000	0.00125	0.00000	0.00004	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NO_x	IE	0.0051	2%	20%	20.10%	0.000000	0.00000	0.00656	0.00000	0.00019	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	NO_x	IE	0.0028	2%	20%	20.10%	0.000000	0.00000	0.00362	0.00000	0.00010	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NO_x	IE	0.0944	2%	20%	20.10%	0.000000	0.00000	0.12214	0.00000	0.00345	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	NO_x	IE	0.1067	2%	20%	20.10%	0.000000	0.00000	0.13803	0.00000	0.00390	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NO_x	IE	0.5092	2%	20%	20.10%	0.000011	0.00000	0.65904	0.00000	0.01864	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	NO_x	5.3123	1.1133	2%	100%	100.02%	0.001312	-1.29308	1.44082	-1.29308	0.04075	0.01674

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NO_x	5.6000	0.6854	2%	20%	20.10%	0.000020	-1.99441	0.88702	-0.39888	0.02509	0.00160
1A3ai(i)	International aviation LTO (civil)	NO_x	0.0507	0.0776	2%	30%	30.07%	0.000001	0.07430	0.10041	0.02229	0.00284	0.00001
1A3aii(i)	Domestic aviation LTO (civil)	NO_x	0.0016	0.0016	2%	30%	30.07%	0.000000	0.00129	0.00212	0.00039	0.00006	0.00000
1A3bi	Road transport: Passenger cars	NO_x	13.0815	3.3016	2%	20%	20.10%	0.000466	-2.45735	4.27283	-0.49147	0.12085	0.00256
1A3bii	Road transport: Light duty vehicles	NO_x	1.5775	0.6332	2%	20%	20.10%	0.000017	0.00732	0.81943	0.00146	0.02318	0.00001
1A3biii	Road transport: Heavy duty vehicles and buses	NO_x	10.4714	4.2124	2%	20%	20.10%	0.000759	0.06082	5.45156	0.01216	0.15419	0.00024
1A3biv	Road transport: Mopeds & motorcycles	NO_x	0.1194	0.0131	2%	20%	20.10%	0.000000	-0.04446	0.01699	-0.00889	0.00048	0.00000
1A3c	Railways	NO_x	2.4310	0.9956	2%	100%	100.02%	0.001050	0.03699	1.28847	0.03699	0.03644	0.00003
1A3dii	National navigation (shipping)	NO_x	0.2688	0.4767	2%	100%	100.02%	0.000241	0.47847	0.61686	0.47847	0.01745	0.00229
1A4ai	Commercial/institutional: Stationary	NO_x	0.3000	0.3068	2%	50%	50.04%	0.000025	0.24261	0.39706	0.12131	0.01123	0.00015
1A4aii	Commercial/institutional: Mobile	NO_x	0.3990	0.2432	2%	50%	50.04%	0.000016	0.10935	0.31477	0.05467	0.00890	0.00003
1A4bi	Residential: Stationary, liquid fuels	NO_x	0.1526	0.0131	3%	50%	50.09%	0.000000	-0.06157	0.01697	-0.03078	0.00072	0.00001
1A4bi	Residential: Stationary, solid fuels	NO_x	0.3496	0.0302	2%	50%	50.04%	0.000000	-0.14091	0.03907	-0.07046	0.00111	0.00005
1A4bi	Residential: Stationary, gaseous fuels	NO_x	0.1181	0.1161	2%	50%	50.04%	0.000004	0.08947	0.15029	0.04474	0.00425	0.00002
1A4bi	Residential: Stationary, biomass	NO_x	3.4491	4.6318	5%	50%	50.25%	0.005734	4.21685	5.99434	2.10843	0.42386	0.04625
1A4bi	Residential: Stationary, waste	NO_x	0.0722	0.0905	50%	50%	70.71%	0.000004	0.07991	0.11706	0.03995	0.08277	0.00008
1A4bii	Residential: Household and gardening (mobile)	NO_x	0.0058	0.0654	2%	50%	50.04%	0.000001	0.08161	0.08460	0.04081	0.00239	0.00002
1A4ci	Agriculture/Forestry/Fishing: Stationary	NO_x	0.3300	0.0848	2%	50%	50.04%	0.000002	-0.06011	0.10977	-0.03005	0.00310	0.00001

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NO_x	4.3105	3.3591	2%	50%	50.04%	0.002991	2.12699	4.34720	1.06350	0.12296	0.01146
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NO_x	IE	0.0544	2%	50%	50.04%	0.000001	0.00000	0.07042	0.00000	0.00199	0.00000
1B1c	Other fugitive emissions from solid fuels	NO_x	NE	0.0234	2%	50%	50.04%	0.000000	0.00000	0.03031	0.00000	0.00086	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	NO_x	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NO_x	NO	0.0007	2%	50%	50.04%	0.000000	0.00000	0.00094	0.00000	0.00003	0.00000
2A5a	Quarrying and mining of minerals other than coal	NO_x	NA	0.0059	2%	50%	50.04%	0.000000	0.00000	0.00757	0.00000	0.00021	0.00000
2B1	Ammonia production	NO_x	0.1900	0.0000	2%	50%	50.04%	0.000000	-0.09781	0.00000	-0.04890	0.00000	0.00002
2B10a	Chemical industry: Other	NO_x	NA	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C1	Iron and steel production	NO_x	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00012	0.00012	0.00006	0.00000	0.00000
2C7c	Other metal production	NO_x	0.0000	0.0224	2%	50%	50.04%	0.000000	0.02900	0.02900	0.01450	0.00082	0.00000
2G	Other product use	NO_x	0.0075	0.0034	5%	50%	50.25%	0.000000	0.00057	0.00443	0.00028	0.00031	0.00000
2H1	Pulp and paper industry	NO_x	0.0000	0.0144	2%	50%	50.04%	0.000000	0.01864	0.01864	0.00932	0.00053	0.00000
2H2	Food and beverages industry	NO_x	NA	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00034	0.00000	0.00001	0.00000
2I	Wood processing	NO_x	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	NO_x	NA	0.0015	2%	50%	50.04%	0.000000	0.00000	0.00200	0.00000	0.00006	0.00000
3B1a	Manure management - Dairy cattle	NO_x	0.0297	0.0150	2%	100%	100.02%	0.000000	0.00407	0.01938	0.00407	0.00055	0.00000
3B1b	Manure management - Non-dairy cattle	NO_x	0.0303	0.0095	2%	100%	100.02%	0.000000	-0.00330	0.01230	-0.00330	0.00035	0.00000
3B2	Manure management - Sheep	NO_x	0.0013	0.0007	2%	100%	100.02%	0.000000	0.00024	0.00089	0.00024	0.00003	0.00000
3B3	Manure management - Swine	NO_x	0.0084	0.0037	2%	100%	100.02%	0.000000	0.00049	0.00483	0.00049	0.00014	0.00000
3B4d	Manure management - Goats	NO_x	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00004	0.00005	0.00004	0.00000	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
3B4e	Manure management - Horses	NO_x	0.0017	0.0013	2%	100%	100.02%	0.000000	0.00075	0.00164	0.00075	0.00005	0.00000
3B4gi	Manure management - Laying hens	NO_x	0.0111	0.0041	2%	100%	100.02%	0.000000	-0.00039	0.00534	-0.00039	0.00015	0.00000
3B4gii	Manure management - Broilers	NO_x	0.0039	0.0028	2%	100%	100.02%	0.000000	0.00155	0.00356	0.00155	0.00010	0.00000
3B4giv	Manure management - Other poultry	NO_x	0.0050	0.0019	2%	100%	100.02%	0.000000	-0.00014	0.00246	-0.00014	0.00007	0.00000
3B4h	Manure management - Other animals	NO_x	0.0001	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
3Da1	Inorganic N-fertilizers (includes also urea application)	NO_x	2.8680	1.4321	2%	100%	100.02%	0.002172	0.37681	1.85339	0.37681	0.05242	0.00145
3Da2b	Sewage sludge applied to soils	NO_x	0.0031	0.0026	2%	100%	100.02%	0.000000	0.00178	0.00340	0.00178	0.00010	0.00000
3Da2c	Other organic fertilisers applied to soils (including compost)	NO_x	0.0050	0.1097	2%	100%	100.02%	0.000013	0.13944	0.14199	0.13944	0.00402	0.00019
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NO_x	NA	0.0079	2%	100%	100.02%	0.000000	0.00000	0.01018	0.00000	0.00029	0.00000
5C1bi	Industrial waste incineration	NO_x	NA	0.0042	2%	100%	100.02%	0.000000	0.00000	0.00537	0.00000	0.00015	0.00000
5C1bv	Cremation	NO_x	NA	0.0064	2%	100%	100.02%	0.000000	0.00000	0.00828	0.00000	0.00023	0.00000
5C2	Open burning of waste	NO_x	0.0138	0.0057	10%	100%	100.50%	0.000000	0.00031	0.00739	0.00031	0.00105	0.00000
5D1	Domestic wastewater handling	NO_x	NA	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00017	0.00000	0.00000	0.00000
5D2	Industrial wastewater handling	NO_x	NA	0.0003	2%	100%	100.02%	0.000000	0.00000	0.00041	0.00000	0.00001	0.00000
5E	Other waste	NO_x	NE	0.0004	2%	100%	100.02%	0.000000	0.00000	0.00050	0.00000	0.00001	0.00000
TOTAL			77.270	30.737				0.017297					0.08868
							Uncertainty in total inventory:	13.15%				Trend uncertainty:	2.98%

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	NMVOC	0.9000	0.4811	2%	50%	50.04%	0.000110	0.25335	0.73556	0.12667	0.02080	0.00016
1A1c	Manufacture of solid fuels and other energy industries	NMVOC	0.7022	0.7477	2%	50%	50.04%	0.000267	0.76686	1.14315	0.38343	0.03233	0.00148
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	NMVOC	IE	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00007	0.00000	0.00000	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	NMVOC	IE	0.0005	2%	50%	50.04%	0.000000	0.00000	0.00070	0.00000	0.00002	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	NMVOC	IE	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00021	0.00000	0.00001	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	NMVOC	IE	0.0160	2%	50%	50.04%	0.000000	0.00000	0.02445	0.00000	0.00069	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	NMVOC	IE	0.0169	2%	50%	50.04%	0.000000	0.00000	0.02587	0.00000	0.00073	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	NMVOC	IE	0.0122	2%	50%	50.04%	0.000000	0.00000	0.01869	0.00000	0.00053	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	NMVOC	0.5485	0.1149	2%	50%	50.04%	0.000006	-0.11810	0.17573	-0.05905	0.00497	0.00004
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	NMVOC	0.6200	0.8104	2%	50%	50.04%	0.000313	0.90689	1.23914	0.45344	0.03505	0.00207
1A3ai(i)	International aviation LTO (civil)	NMVOC	0.0096	0.0113	2%	30%	30.07%	0.000000	0.01216	0.01728	0.00365	0.00049	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	NMVOC	0.0025	0.0034	2%	30%	30.07%	0.000000	0.00380	0.00513	0.00114	0.00015	0.00000

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A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3bi	Road transport: Passenger cars	NMVOC	10.3155	1.0759	2%	20%	20.10%	0.000089	-3.87532	1.64508	-0.77506	0.04653	0.00603
1A3bii	Road transport: Light duty vehicles	NMVOC	0.7885	0.0633	2%	20%	20.10%	0.000000	-0.32556	0.09684	-0.06511	0.00274	0.00004
1A3biii	Road transport: Heavy duty vehicles and buses	NMVOC	2.4947	0.1528	2%	20%	20.10%	0.000002	-1.10248	0.23363	-0.22050	0.00661	0.00049
1A3biv	Road transport: Mopeds & motorcycles	NMVOC	0.4668	0.0562	2%	20%	20.10%	0.000000	-0.16409	0.08598	-0.03282	0.00243	0.00001
1A3bv	Road transport: Gasoline evaporation	NMVOC	3.3239	0.3633	2%	20%	20.10%	0.000010	-1.22466	0.55548	-0.24493	0.01571	0.00060
1A3c	Railways	NMVOC	0.2245	0.0884	2%	100%	100.02%	0.000015	0.01483	0.13508	0.01483	0.00382	0.00000
1A3dii	National navigation (shipping)	NMVOC	0.0522	0.1401	2%	100%	100.02%	0.000037	0.18623	0.21417	0.18623	0.00606	0.00035
1A4ai	Commercial/institutional: Stationary	NMVOC	0.0600	0.0718	2%	50%	50.04%	0.000002	0.07761	0.10975	0.03880	0.00310	0.00002
1A4aii	Commercial/institutional: Mobile	NMVOC	0.5250	0.1509	2%	50%	50.04%	0.000011	-0.05055	0.23072	-0.02527	0.00653	0.00001
1A4bi	Residential: Stationary, liquid fuels	NMVOC	0.0004	0.0000	3%	50%	50.09%	0.000000	-0.00015	0.00005	-0.00008	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	NMVOC	1.7563	0.0817	2%	50%	50.04%	0.000003	-0.81583	0.12490	-0.40791	0.00353	0.00166
1A4bi	Residential: Stationary, gaseous fuels	NMVOC	0.0041	0.0041	2%	50%	50.04%	0.000000	0.00400	0.00621	0.00200	0.00018	0.00000
1A4bi	Residential: Stationary, biomass	NMVOC	2.5062	3.2059	5%	50%	50.25%	0.004941	3.55770	4.90177	1.77885	0.34661	0.03284
1A4bi	Residential: Stationary, waste	NMVOC	0.0612	0.0767	50%	50%	70.71%	0.000006	0.08454	0.11734	0.04227	0.08297	0.00009
1A4bii	Residential: Household and gardening (mobile)	NMVOC	0.1093	0.4598	2%	100%	100.02%	0.000403	0.64453	0.70309	0.64453	0.01989	0.00416
1A4ci	Agriculture/Forestry/Fishing: Stationary	NMVOC	0.0400	0.0136	2%	50%	50.04%	0.000000	-0.00059	0.02084	-0.00030	0.00059	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NMVOC	0.4144	0.3227	2%	50%	50.04%	0.000050	0.27128	0.49333	0.13564	0.01395	0.00019
1A4ciii	Agriculture/Forestry/Fishing: National fishing	NMVOC	IE	0.0021	2%	50%	50.04%	0.000000	0.00000	0.00324	0.00000	0.00009	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	NMVOC	NA	0.1780	2%	50%	50.04%	0.000015	0.00000	0.27218	0.00000	0.00770	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1B2av	Distribution of oil products	NMVOC	2.3780	0.9910	2%	50%	50.04%	0.000468	0.24116	1.51526	0.12058	0.04286	0.00016
1B2b	Fugitive emissions from natural gas	NMVOC	0.0960	0.0133	2%	50%	50.04%	0.000000	-0.03106	0.02037	-0.01553	0.00058	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	NMVOC	NO	0.0034	2%	50%	50.04%	0.000000	0.00000	0.00525	0.00000	0.00015	0.00000
2B10a	Chemical industry: Other	NMVOC	13.3000	0.0257	2%	50%	50.04%	0.000000	-7.07174	0.03935	-3.53587	0.00111	0.12502
2B10b	Storage, handling and transport of chemical products	NMVOC	NA	0.0206	2%	50%	50.04%	0.000000	0.00000	0.03149	0.00000	0.00089	0.00000
2C3	Aluminium production	NMVOC	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2C7c	Other metal production	NMVOC	NA	0.0082	2%	50%	50.04%	0.000000	0.00000	0.01251	0.00000	0.00035	0.00000
2D3a	Domestic solvent use including fungicides	NMVOC	4.0679	1.5791	2%	20%	20.10%	0.000192	0.23495	2.41445	0.04699	0.06829	0.00007
2D3b	Road paving with asphalt	NMVOC	0.0270	0.0232	2%	100%	100.02%	0.000001	0.02108	0.03555	0.02108	0.00101	0.00000
2D3d	Coating applications	NMVOC	2.3504	3.2654	2%	50%	50.04%	0.005084	3.73222	4.99277	1.86611	0.14122	0.03502
2D3e	Degreasing	NMVOC	1.1834	0.9994	2%	100%	100.02%	0.001902	0.89384	1.52802	0.89384	0.04322	0.00801
2D3f	Dry cleaning	NMVOC	0.0146	0.0302	2%	20%	20.10%	0.000000	0.03840	0.04620	0.00768	0.00131	0.00000
2D3g	Chemical products	NMVOC	0.4959	0.1784	2%	20%	20.10%	0.000002	0.00706	0.27273	0.00141	0.00771	0.00000
2D3h	Printing	NMVOC	0.0798	0.4731	2%	100%	100.02%	0.000426	0.68057	0.72330	0.68057	0.02046	0.00464
2D3i	Other solvent use	NMVOC	1.2644	0.6687	2%	50%	50.04%	0.000213	0.34499	1.02244	0.17250	0.02892	0.00031
2G	Other product use	NMVOC	0.0202	0.0089	5%	50%	50.25%	0.000000	0.00288	0.01368	0.00144	0.00097	0.00000
2H1	Pulp and paper industry	NMVOC	0.2200	0.0511	2%	50%	50.04%	0.000001	-0.03973	0.07813	-0.01986	0.00221	0.00000
2H2	Food and beverages industry	NMVOC	1.7884	0.6550	2%	50%	50.04%	0.000205	0.04332	1.00149	0.02166	0.02833	0.00001
2I	Wood processing	NMVOC	NA	0.0019	2%	50%	50.04%	0.000000	0.00000	0.00289	0.00000	0.00008	0.00000
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NMVOC	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	NMVOC	NA	0.0231	2%	50%	50.04%	0.000000	0.00000	0.03529	0.00000	0.00100	0.00000
3B1a	Manure management - Dairy cattle	NMVOC	3.0744	2.0838	2%	100%	100.02%	0.008271	1.53821	3.18604	1.53821	0.09011	0.02374

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
3B1b	Manure management - Non-dairy cattle	NMVOC	4.2472	1.2507	2%	100%	100.02%	0.002980	-0.36283	1.91234	-0.36283	0.05409	0.00135
3B2	Manure management - Sheep	NMVOC	0.0442	0.0240	2%	100%	100.02%	0.000001	0.01296	0.03665	0.01296	0.00104	0.00000
3B3	Manure management - Swine	NMVOC	1.2247	0.4517	2%	100%	100.02%	0.000389	0.03445	0.69057	0.03445	0.01953	0.00002
3B4d	Manure management - Goats	NMVOC	0.0013	0.0031	2%	100%	100.02%	0.000000	0.00407	0.00477	0.00407	0.00013	0.00000
3B4e	Manure management - Horses	NMVOC	0.0669	0.0490	2%	100%	100.02%	0.000005	0.03911	0.07497	0.03911	0.00212	0.00002
3B4gi	Manure management - Laying hens	NMVOC	0.3670	0.1361	2%	100%	100.02%	0.000035	0.01153	0.20813	0.01153	0.00589	0.00000
3B4gii	Manure management - Broilers	NMVOC	0.2108	0.1487	2%	100%	100.02%	0.000042	0.11443	0.22737	0.11443	0.00643	0.00013
3B4giv	Manure management - Other poultry	NMVOC	0.6159	0.2326	2%	100%	100.02%	0.000103	0.02562	0.35559	0.02562	0.01006	0.00001
3B4h	Manure management - Other animals	NMVOC	0.4480	0.2262	2%	100%	100.02%	0.000097	0.10586	0.34587	0.10586	0.00978	0.00011
3De	Cultivated crops	NMVOC	0.6788	0.4389	2%	100%	100.02%	0.000367	0.30732	0.67102	0.30732	0.01898	0.00095
5A	Biological treatment of waste - Solid waste disposal on land	NMVOC	1.2128	0.1217	2%	100%	100.02%	0.000028	-0.46364	0.18604	-0.46364	0.00526	0.00215
5B1	Biological treatment of waste – Composting	NMVOC	NE	0.0034	2%	100%	100.02%	0.000000	0.00000	0.00523	0.00000	0.00015	0.00000
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NMVOC	NA	0.0015	2%	100%	100.02%	0.000000	0.00000	0.00229	0.00000	0.00006	0.00000
5C1bi	Industrial waste incineration	NMVOC	NA	0.0003	2%	100%	100.02%	0.000000	0.00000	0.00044	0.00000	0.00001	0.00000
5C1bv	Cremation	NMVOC	NA	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00015	0.00000	0.00000	0.00000
5C2	Open burning of waste	NMVOC	0.0002	0.0001	10%	100%	100.50%	0.000000	0.00001	0.00010	0.00001	0.00001	0.00000
5D1	Domestic wastewater handling	NMVOC	NA	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00005	0.00000	0.00000	0.00000
5D2	Industrial wastewater handling	NMVOC	NA	0.0008	2%	100%	100.02%	0.000000	0.00000	0.00127	0.00000	0.00004	0.00000
5E	Other waste	NMVOC	NE	0.0027	2%	100%	100.02%	0.000000	0.00000	0.00417	0.00000	0.00012	0.00000
TOTAL			65.404	22.917				0.027095					0.00252
							Uncertainty in total inventory:	16.46%				Trend uncertainty:	5.02%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	SO_x (SO_2)	220.4000	24.8608	2%	10%	10.20%	0.006353	-0.31880	9.12686	-0.03188	0.25815	0.00068
1A1c	Manufacture of solid fuels and other energy industries	SO_x (SO_2)	0.4800	1.4090	2%	10%	10.20%	0.000020	0.49669	0.51727	0.04967	0.01463	0.00003
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	SO_x (SO_2)	IE	0.0008	2%	10%	10.20%	0.000000	0.00000	0.00030	0.00000	0.00001	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	SO_x (SO_2)	IE	0.0139	2%	10%	10.20%	0.000000	0.00000	0.00510	0.00000	0.00014	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	SO_x (SO_2)	IE	0.0013	2%	10%	10.20%	0.000000	0.00000	0.00048	0.00000	0.00001	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	SO_x (SO_2)	IE	0.0418	2%	10%	10.20%	0.000000	0.00000	0.01534	0.00000	0.00043	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	SO_x (SO_2)	IE	0.1076	2%	10%	10.20%	0.000000	0.00000	0.03951	0.00000	0.00112	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	SO_x (SO_2)	IE	0.2708	2%	10%	10.20%	0.000001	0.00000	0.09940	0.00000	0.00281	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	SO_x (SO_2)	38.5100	4.4790	2%	10%	10.20%	0.000206	-0.00654	1.64432	-0.00065	0.04651	0.00002
1A2gvii	Mobile Combustion in manufacturing industries and construction	SO_x (SO_2)	1.6320	0.0007	2%	50%	50.04%	0.000000	-0.06970	0.00025	-0.03485	0.00001	0.00001
1A3ai(i)	International aviation LTO (civil)	SO_x (SO_2)	0.0053	0.0070	2%	30%	30.07%	0.000000	0.00235	0.00257	0.00070	0.00007	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	SO_x (SO_2)	0.0003	0.0003	2%	30%	30.07%	0.000000	0.00009	0.00010	0.00003	0.00000	0.00000
1A3bi	Road transport: Passenger cars	SO_x (SO_2)	0.9088	0.0057	2%	20%	20.10%	0.000000	-0.03686	0.00209	-0.00737	0.00006	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3bii	Road transport: Light duty vehicles	SO_x (SO_2)	0.3208	0.0008	2%	20%	20.10%	0.000000	-0.01347	0.00028	-0.00269	0.00001	0.00000
1A3biii	Road transport: Heavy duty vehicles and buses	SO_x (SO_2)	1.9668	0.0025	2%	20%	20.10%	0.000000	-0.08338	0.00093	-0.01668	0.00003	0.00000
1A3biv	Road transport: Mopeds & motorcycles	SO_x (SO_2)	0.0234	0.0000	2%	20%	20.10%	0.000000	-0.00099	0.00001	-0.00020	0.00000	0.00000
1A3c	Railways	SO_x (SO_2)	0.5671	0.0380	2%	50%	50.04%	0.000000	-0.01036	0.01395	-0.00518	0.00039	0.00000
1A3dii	National navigation (shipping)	SO_x (SO_2)	0.0700	0.0289	2%	50%	50.04%	0.000000	0.00760	0.01061	0.00380	0.00030	0.00000
1A4ai	Commercial/institutional: Stationary	SO_x (SO_2)	1.3000	0.0692	2%	20%	20.10%	0.000000	-0.03032	0.02541	-0.00606	0.00072	0.00000
1A4aii	Commercial/institutional: Mobile	SO_x (SO_2)	0.1240	0.0001	2%	20%	20.10%	0.000000	-0.00528	0.00004	-0.00106	0.00000	0.00000
1A4bi	Residential: Stationary, liquid fuels	SO_x (SO_2)	0.3051	0.0262	3%	20%	20.22%	0.000000	-0.00345	0.00963	-0.00069	0.00041	0.00000
1A4bi	Residential: Stationary, solid fuels	SO_x (SO_2)	2.6205	0.1431	2%	20%	20.10%	0.000001	-0.05980	0.05254	-0.01196	0.00149	0.00000
1A4bi	Residential: Stationary, gaseous fuels	SO_x (SO_2)	0.0006	0.0006	2%	20%	20.10%	0.000000	0.00020	0.00023	0.00004	0.00001	0.00000
1A4bi	Residential: Stationary, biomass	SO_x (SO_2)	0.0774	0.1641	5%	20%	20.62%	0.000001	0.05692	0.06023	0.01138	0.00426	0.00000
1A4bi	Residential: Stationary, waste	SO_x (SO_2)	0.0063	0.0080	50%	50%	70.71%	0.000000	0.00265	0.00292	0.00132	0.00206	0.00000
1A4bii	Residential: Household and gardening (mobile)	SO_x (SO_2)	0.0022	0.0001	2%	20%	20.10%	0.000000	-0.00007	0.00002	-0.00001	0.00000	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	SO_x (SO_2)	1.7800	0.0477	2%	20%	20.10%	0.000000	-0.05879	0.01751	-0.01176	0.00050	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	SO_x (SO_2)	1.2780	0.0131	2%	20%	20.10%	0.000000	-0.04999	0.00479	-0.01000	0.00014	0.00000
1A4ciii	Agriculture/Forestry/Fishing: National fishing	SO_x (SO_2)	IE	0.0014	2%	20%	20.10%	0.000000	0.00000	0.00051	0.00000	0.00001	0.00000
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	SO_x (SO_2)	NE	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1B1c	Other fugitive emissions from solid fuels	SO_x (SO_2)	NE	0.0284	2%	20%	20.10%	0.000000	0.00000	0.01044	0.00000	0.00030	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	SO_x (SO_2)	NA	0.0030	2%	20%	20.10%	0.000000	0.00000	0.00108	0.00000	0.00003	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	SO_x (SO_2)	NO	0.0007	2%	20%	20.10%	0.000000	0.00000	0.00025	0.00000	0.00001	0.00000

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			kt	kt	%	%	%		%	%	%	%	%
2A5a	Quarrying and mining of minerals other than coal	SO_x (SO_2)	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2B10a	Chemical industry: Other	SO_x (SO_2)	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C5	Lead production	SO_x (SO_2)	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C7c	Other metal production	SO_x (SO_2)	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2G	Other product use	SO_x (SO_2)	0.0000	0.0011	5%	50%	50.25%	0.000000	0.00041	0.00041	0.00020	0.00003	0.00000
2H1	Pulp and paper industry	SO_x (SO_2)	0.0000	0.0016	5%	50%	50.25%	0.000000	0.00060	0.00060	0.00030	0.00004	0.00000
2H2	Food and beverages industry	SO_x (SO_2)	NA	0.0000	5%	50%	50.25%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2I	Wood processing	SO_x (SO_2)	NA	0.0000	5%	50%	50.25%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	SO_x (SO_2)	NA	0.0046	5%	50%	50.25%	0.000000	0.00000	0.00170	0.00000	0.00012	0.00000
5C1bi	Industrial waste incineration	SO_x (SO_2)	NA	0.0189	5%	50%	50.25%	0.000000	0.00000	0.00692	0.00000	0.00049	0.00000
5C1bv	Cremation	SO_x (SO_2)	NA	0.0009	5%	50%	50.25%	0.000000	0.00000	0.00032	0.00000	0.00002	0.00000
5C2	Open burning of waste	SO_x (SO_2)	0.0130	0.0054	10%	50%	50.99%	0.000000	0.00142	0.00198	0.00071	0.00028	0.00000
5D1	Domestic wastewater handling	SO_x (SO_2)	NA	0.0001	10%	50%	50.99%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
5D2	Industrial wastewater handling	SO_x (SO_2)	NA	0.0001	10%	50%	50.99%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
TOTAL			272.392	31.807				0.006584					0.00075
						Uncertainty in total inventory:		8.11%				Trend uncertainty:	0.27%

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	NE	0.0025	2%	50%	50.04%	0.000000	0.00000	0.01136	0.00000	0.00032	0.00000
1A1c	Manufacture of solid fuels and other energy industries	NH_3	NE	0.2059	2%	50%	50.04%	0.000078	0.00000	0.94716	0.00000	0.02679	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	NH_3	0.0013	0.0003	2%	50%	50.04%	0.000000	-0.00199	0.00126	-0.00100	0.00004	0.00000
1A3bi	Road transport: Passenger cars	NH_3	0.0108	0.1466	2%	20%	20.10%	0.000006	0.64782	0.67432	0.12956	0.01907	0.00017
1A3bii	Road transport: Light duty vehicles	NH_3	0.0011	0.0035	2%	20%	20.10%	0.000000	0.01350	0.01609	0.00270	0.00046	0.00000
1A3biii	Road transport: Heavy duty vehicles and buses	NH_3	0.0040	0.0041	2%	20%	20.10%	0.000000	0.00895	0.01874	0.00179	0.00053	0.00000
1A3biv	Road transport: Mopeds & motorcycles	NH_3	0.0006	0.0001	2%	20%	20.10%	0.000000	-0.00104	0.00052	-0.00021	0.00001	0.00000
1A3c	Railways	NH_3	0.0003	0.0001	2%	50%	50.04%	0.000000	-0.00018	0.00061	-0.00009	0.00002	0.00000
1A3dii	National navigation (shipping)	NH_3	0.0000	0.0001	2%	50%	50.04%	0.000000	0.00028	0.00040	0.00014	0.00001	0.00000
1A4aii	Commercial/institutional: Stationary	NH_3	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00003	0.00028	0.00001	0.00001	0.00000
1A4bi	Commercial/institutional: Mobile	NH_3	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, liquid fuels	NH_3	0.0011	0.0001	2%	100%	100.02%	0.000000	-0.00229	0.00032	-0.00229	0.00001	0.00000
1A4bi	Residential: Stationary, solid fuels	NH_3	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, gaseous fuels	NH_3	0.2944	0.3274	5%	100%	100.12%	0.000793	0.78069	1.50587	0.78069	0.10648	0.00621
1A4bi	Residential: Stationary, biomass	NH_3	0.0010	0.0012	50%	50%	70.71%	0.000000	0.00325	0.00568	0.00163	0.00402	0.00000
1A4bii	Residential: Stationary, waste	NH_3	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00010	0.00011	0.00005	0.00000	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	NH_3	0.0010	0.0008	2%	50%	50.04%	0.000000	0.00110	0.00353	0.00055	0.00010	0.00000
1B1c	Other fugitive emissions from solid fuels	NH_3	NE	0.1959	2%	50%	50.04%	0.000071	0.00000	0.90110	0.00000	0.02549	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	NH_3	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00012	0.00000	0.00000	0.00000
2B10a	Chemical industry: Other	NH_3	0.3700	0.0001	2%	20%	20.10%	0.000000	-0.91051	0.00063	-0.18210	0.00002	0.00033

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			kt	kt	%	%	%		%	%	%	%	%
2B10b	Storage, handling and transport of chemical products	NH_3	NA	0.0067	2%	20%	20.10%	0.000000	0.00000	0.03063	0.00000	0.00087	0.00000
2C7c	Other metal production	NH_3	0.1600	0.0581	2%	200%	200.01%	0.000099	-0.12703	0.26704	-0.25406	0.00755	0.00065
2D3g	Chemical products	NH_3	0.0000	0.0031	2%	100%	100.02%	0.000000	0.01431	0.01431	0.01431	0.00040	0.00000
2D3i	Other solvent use	NH_3	NE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
2G	Other product use	NH_3	0.0173	0.0077	5%	50%	50.25%	0.000000	-0.00730	0.03527	-0.00365	0.00249	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	NH_3	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00003	0.00003	0.00006	0.00000	0.00000
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NH_3	NA	0.0002	2%	200%	200.01%	0.000000	0.00000	0.00092	0.00000	0.00003	0.00000
3B1a	Manure management - Dairy cattle	NH_3	2.8178	1.8950	2%	100%	100.02%	0.026494	1.77282	8.71531	1.77282	0.24651	0.03204
3B1b	Manure management - Non-dairy cattle	NH_3	1.3600	0.3803	2%	100%	100.02%	0.001067	-1.59941	1.74916	-1.59941	0.04947	0.02561
3B2	Manure management - Sheep	NH_3	0.2219	0.1203	2%	100%	100.02%	0.000107	0.00657	0.55308	0.00657	0.01564	0.00000
3B3	Manure management - Swine	NH_3	2.3550	0.8737	2%	100%	100.02%	0.005632	-1.78032	4.01812	-1.78032	0.11365	0.03182
3B4d	Manure management - Goats	NH_3	0.0029	0.0070	2%	100%	100.02%	0.000000	0.02495	0.03219	0.02495	0.00091	0.00001
3B4e	Manure management - Horses	NH_3	0.1273	0.0932	2%	100%	100.02%	0.000064	0.11532	0.42881	0.11532	0.01213	0.00013
3B4gi	Manure management - Laying hens	NH_3	1.0675	0.3960	2%	100%	100.02%	0.001157	-0.80764	1.82121	-0.80764	0.05151	0.00655
3B4gii	Manure management - Broilers	NH_3	0.4294	0.3029	2%	100%	100.02%	0.000677	0.33548	1.39313	0.33548	0.03940	0.00114
3B4giv	Manure management - Other poultry	NH_3	1.1965	0.4518	2%	100%	100.02%	0.001506	-0.86865	2.07793	-0.86865	0.05877	0.00758
3B4h	Manure management - Other animals	NH_3	0.0046	0.0023	2%	100%	100.02%	0.000000	-0.00066	0.01072	-0.00066	0.00030	0.00000
3Da1	Inorganic N-fertilizers (includes also urea application)	NH_3	3.5850	1.7902	2%	100%	100.02%	0.023643	-0.59582	8.23294	-0.59582	0.23286	0.00409
3Da2a	Animal manure applied to soils	NH_3	4.6459	2.9766	2%	100%	100.02%	0.065368	2.24205	13.68954	2.24205	0.38720	0.05177
3Da2b	Sewage sludge applied to soils	NH_3	0.0104	0.0087	2%	100%	100.02%	0.000001	0.01433	0.03986	0.01433	0.00113	0.00000
3Da2c	Other organic fertilisers applied to soils (including compost)	NH_3	0.0099	0.2194	2%	100%	100.02%	0.000355	0.98473	1.00915	0.98473	0.02854	0.00971

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			kt	kt	%	%	%		%	%	%	%	%
3Da3	Urine and dung deposited by grazing animals	NH_3	3.0422	1.0546	2%	100%	100.02%	0.008205	-2.63899	4.85014	-2.63899	0.13718	0.06983
5A	Biological treatment of waste - Solid waste disposal on land	NH_3	NE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00011	0.00000	0.00000	0.00000
5B1	Biological treatment of waste - Composting	NH_3	0.0045	0.1067	2%	50%	50.04%	0.000021	0.47992	0.49094	0.23996	0.01389	0.00058
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	NH_3	NA	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00158	0.00000	0.00004	0.00000
5C1bi	Industrial waste incineration	NH_3	NE	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00051	0.00000	0.00001	0.00000
5C1bv	Cremation	NH_3	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00006	0.00000	0.00000	0.00000
5D1	Industrial wastewater handling	NH_3	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00019	0.00000	0.00001	0.00000
5D2	Other wastewater handling	NH_3	NA	0.0005	2%	50%	50.04%	0.000000	0.00000	0.00244	0.00000	0.00007	0.00000
5E	Other waste	NH_3	NE	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00076	0.00000	0.00002	0.00000
TOTAL			21.744	11.645				0.135345					0.24822
						Uncertainty in total inventory:		36.79%				Trend uncertainty:	4.98%

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			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	PM_{10}	20.5700	4.0135	2%	20%	20.10%	0.003318	-0.15400	0.12515	-0.03080	0.00354	0.00096
1A1c	Manufacture of solid fuels and other energy industries	PM_{10}	0.8200	0.0039	2%	20%	20.10%	0.000000	-0.01104	0.00012	-0.00221	0.00000	0.00000
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	PM_{10}	IE	0.0011	2%	20%	20.10%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	PM_{10}	IE	0.0006	2%	20%	20.10%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	PM_{10}	IE	0.0007	2%	20%	20.10%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	PM_{10}	IE	0.1610	2%	20%	20.10%	0.000005	0.00000	0.00502	0.00000	0.00014	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	PM_{10}	IE	0.0345	2%	20%	20.10%	0.000000	0.00000	0.00108	0.00000	0.00003	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	PM_{10}	1.4013	0.0240	2%	20%	20.10%	0.000000	-0.01833	0.00075	-0.00367	0.00002	0.00001
1A2gvii	Mobile Combustion in manufacturing industries and construction	PM_{10}	0.0312	0.0708	2%	50%	50.04%	0.000006	0.00178	0.00221	0.00089	0.00006	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PM_{10}	1.2757	2.6829	2%	30%	30.07%	0.003317	0.06626	0.08366	0.01988	0.00237	0.00040
1A3ai(i)	International aviation LTO (civil)	PM_{10}	0.0003	0.0005	2%	30%	30.07%	0.000000	0.00001	0.00002	0.00000	0.00000	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	PM_{10}	0.0000	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A3bi	Road transport: Passenger cars	PM_{10}	0.1110	0.1548	2%	20%	20.10%	0.000005	0.00332	0.00483	0.00066	0.00014	0.00000
1A3bii	Road transport: Light duty vehicles	PM_{10}	0.2048	0.0338	2%	20%	20.10%	0.000000	-0.00173	0.00105	-0.00035	0.00003	0.00000

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			kt	kt	%	%	%		%	%	%	%	%
1A3biii	Road transport: Heavy duty vehicles and buses	PM_{10}	0.2962	0.0746	2%	20%	20.10%	0.000001	-0.00171	0.00233	-0.00034	0.00007	0.00000
1A3biv	Road transport: Mopeds & motorcycles	PM_{10}	0.0003	0.0010	2%	20%	20.10%	0.000000	0.00003	0.00003	0.00001	0.00000	0.00000
1A3bvi	Road transport: Automobile tyre and brake wear	PM_{10}	0.1183	0.1796	2%	20%	20.10%	0.000007	0.00399	0.00560	0.00080	0.00016	0.00000
1A3bvii	Road transport: Automobile road abrasion	PM_{10}	0.0690	0.0970	2%	20%	20.10%	0.000002	0.00208	0.00302	0.00042	0.00009	0.00000
1A3c	Railways	PM_{10}	0.0626	0.0274	2%	20%	20.10%	0.000000	0.00000	0.00085	0.00000	0.00002	0.00000
1A3dii	National navigation (shipping)	PM_{10}	0.0322	0.0596	2%	20%	20.10%	0.000001	0.00142	0.00186	0.00028	0.00005	0.00000
1A4ai	Commercial/institutional: Stationary	PM_{10}	0.4500	0.3094	2%	20%	20.10%	0.000020	0.00352	0.00965	0.00070	0.00027	0.00000
1A4aii	Commercial/institutional: Mobile	PM_{10}	0.0135	0.0173	2%	50%	50.04%	0.000000	0.00036	0.00054	0.00018	0.00002	0.00000
1A4bi	Residential: Stationary, liquid fuels	PM_{10}	0.0008	0.0003	3%	20%	20.22%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	PM_{10}	0.4023	0.0640	2%	20%	20.10%	0.000001	-0.00348	0.00200	-0.00070	0.00006	0.00000
1A4bi	Residential: Stationary, gaseous fuels	PM_{10}	0.0031	0.0036	2%	20%	20.10%	0.000000	0.00007	0.00011	0.00001	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	PM_{10}	3.0557	1.8202	5%	20%	20.62%	0.000718	0.01513	0.05676	0.00303	0.00401	0.00003
1A4bi	Residential: Stationary, waste	PM_{10}	0.5088	0.4275	50%	50%	70.71%	0.000466	0.00640	0.01333	0.00320	0.00943	0.00010
1A4bii	Residential: Household and gardening (mobile)	PM_{10}	0.0092	0.0100	2%	50%	50.04%	0.000000	0.00019	0.00031	0.00009	0.00001	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	PM_{10}	0.1600	0.0957	2%	20%	20.10%	0.000002	0.00081	0.00299	0.00016	0.00008	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	PM_{10}	0.0452	0.1666	2%	50%	50.04%	0.000035	0.00458	0.00520	0.00229	0.00015	0.00001
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PM_{10}	IE	0.0010	2%	50%	50.04%	0.000000	0.00000	0.00003	0.00000	0.00000	0.00000
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	PM_{10}	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1B1c	Other fugitive emissions from solid fuels	PM_{10}	0.0500	0.0700	2%	100%	100.02%	0.000025	0.00150	0.00218	0.00150	0.00006	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	PM_{10}	NA	0.0197	2%	100%	100.02%	0.000002	0.00000	0.00061	0.00000	0.00002	0.00000

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			kt	kt	%	%	%		%	%	%	%	%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	PM_{10}	NO	0.0006	2%	100%	100.02%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
2A1	Cement production	PM_{10}	IE	0.0076	2%	100%	100.02%	0.000000	0.00000	0.00024	0.00000	0.00001	0.00000
2A2	Lime production	PM_{10}	IE	0.0002	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2A5a	Quarrying and mining of minerals other than coal	PM_{10}	NA	0.0920	2%	100%	100.02%	0.000043	0.00000	0.00287	0.00000	0.00008	0.00000
2A5b	Construction and demolition	PM_{10}	0.4956	1.7535	2%	100%	100.02%	0.015680	0.04792	0.05468	0.04792	0.00155	0.00230
2A6	Other mineral products	PM_{10}	0.2178	0.0059	2%	100%	100.02%	0.000000	-0.00278	0.00018	-0.00278	0.00001	0.00001
2B10a	Chemical industry: Other	PM_{10}	0.1626	0.0020	2%	20%	20.10%	0.000000	-0.00215	0.00006	-0.00043	0.00000	0.00000
2B10b	Storage, handling and transport of chemical products	PM_{10}	NA	0.0003	2%	20%	20.10%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2C1	Iron and steel production	PM_{10}	NA	0.0002	2%	20%	20.10%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2C3	Aluminium production	PM_{10}	NA	0.0027	2%	20%	20.10%	0.000000	0.00000	0.00008	0.00000	0.00000	0.00000
2C5	Lead production	PM_{10}	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C6	Zinc production	PM_{10}	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C7a	Copper production	PM_{10}	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2C7c	Other metal production	PM_{10}	0.0180	0.0317	2%	20%	20.10%	0.000000	0.00074	0.00099	0.00015	0.00003	0.00000
2D3b	Road paving with asphalt	PM_{10}	0.0133	0.0291	2%	100%	100.02%	0.000004	0.00072	0.00091	0.00072	0.00003	0.00000
2D3d	Coating applications	PM_{10}	NA	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2G	Other product use	PM_{10}	0.0595	0.0866	5%	50%	50.25%	0.000010	0.00189	0.00270	0.00094	0.00019	0.00000
2H1	Pulp and paper industry	PM_{10}	0.1120	0.0698	2%	100%	100.02%	0.000025	0.00065	0.00218	0.00065	0.00006	0.00000
2H2	Food and beverages industry	PM_{10}	0.0033	0.0154	2%	100%	100.02%	0.000001	0.00043	0.00048	0.00043	0.00001	0.00000
2I	Wood processing	PM_{10}	NA	0.0739	2%	100%	100.02%	0.000028	0.00000	0.00231	0.00000	0.00007	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	PM_{10}	NA	0.0293	2%	100%	100.02%	0.000004	0.00000	0.00091	0.00000	0.00003	0.00000
3B1a	Manure management - Dairy cattle	PM_{10}	0.0825	0.0729	2%	100%	100.02%	0.000027	0.00115	0.00227	0.00115	0.00006	0.00000
3B1b	Manure management - Non-dairy cattle	PM_{10}	0.0262	0.0302	2%	100%	100.02%	0.000005	0.00059	0.00094	0.00059	0.00003	0.00000
3B2	Manure management - Sheep	PM_{10}	0.0020	0.0052	2%	100%	100.02%	0.000000	0.00013	0.00016	0.00013	0.00000	0.00000

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			kt	kt	%	%	%		%	%	%	%	%
3B3	Manure management - Swine	PM_{10}	0.0359	0.0347	2%	100%	100.02%	0.000006	0.00059	0.00108	0.00059	0.00003	0.00000
3B4d	Manure management - Goats	PM_{10}	0.0001	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
3B4e	Manure management - Horses	PM_{10}	0.0009	0.0014	2%	100%	100.02%	0.000000	0.00003	0.00004	0.00003	0.00000	0.00000
3B4gi	Manure management - Laying hens	PM_{10}	0.0289	0.0330	2%	100%	100.02%	0.000006	0.00063	0.00103	0.00063	0.00003	0.00000
3B4gii	Manure management - Broilers	PM_{10}	0.0123	0.0275	2%	100%	100.02%	0.000004	0.00069	0.00086	0.00069	0.00002	0.00000
3B4giv	Manure management - Other poultry	PM_{10}	0.0439	0.0666	2%	100%	100.02%	0.000023	0.00148	0.00208	0.00148	0.00006	0.00000
3B4h	Manure management - Other animals	PM_{10}	0.0004	0.0009	2%	100%	100.02%	0.000000	0.00002	0.00003	0.00002	0.00000	0.00000
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	PM_{10}	0.7060	0.7961	2%	100%	100.02%	0.003232	0.01521	0.02482	0.01521	0.00070	0.00023
5A	Biological treatment of waste - Solid waste disposal on land	PM_{10}	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00001	0.00000	0.00000
5C1bi	Industrial waste incineration	PM_{10}	NA	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C1bv	Cremation	PM_{10}	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00001	0.00000	0.00000
5C2	Open burning of waste	PM_{10}	0.1563	0.0435	10%	100%	100.50%	0.000010	-0.00077	0.00136	-0.00077	0.00019	0.00000
5E	Other waste	PM_{10}	0.1995	0.0651	2%	100%	100.02%	0.000022	-0.00069	0.00203	-0.00069	0.00006	0.00000
TOTAL			32.069	14.006				0.027062					0.00406
						Uncertainty in total inventory:		16.45%				Trend uncertainty:	6.37%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	$PM_{2.5}$	7.3000	2.4595	2%	20%	20.10%	0.002918	-12.33699	16.04888	-2.46740	0.45393	0.06294
1A1c	Manufacture of solid fuels and other energy industries	$PM_{2.5}$	0.3600	0.0032	2%	20%	20.10%	0.000000	-1.38165	0.02078	-0.27633	0.00059	0.00076
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	$PM_{2.5}$	IE	0.0006	2%	20%	20.10%	0.000000	0.00000	0.00393	0.00000	0.00011	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	$PM_{2.5}$	IE	0.0006	2%	20%	20.10%	0.000000	0.00000	0.00361	0.00000	0.00010	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	$PM_{2.5}$	IE	0.0005	2%	20%	20.10%	0.000000	0.00000	0.00350	0.00000	0.00010	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	$PM_{2.5}$	IE	0.1525	2%	20%	20.10%	0.000011	0.00000	0.99487	0.00000	0.02814	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	$PM_{2.5}$	IE	0.0265	2%	20%	20.10%	0.000000	0.00000	0.17304	0.00000	0.00489	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	$PM_{2.5}$	0.5946	0.0181	2%	20%	20.10%	0.000000	-2.19750	0.11841	-0.43950	0.00335	0.00193
1A2gvii	Mobile Combustion in manufacturing industries and construction	$PM_{2.5}$	0.0312	0.0708	2%	50%	50.04%	0.000015	0.34046	0.46213	0.17023	0.01307	0.00029
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	$PM_{2.5}$	1.0654	2.5223	2%	20%	20.10%	0.003069	12.29858	16.45860	2.45972	0.46552	0.06267
1A3ai(i)	International aviation LTO (civil)	$PM_{2.5}$	0.0003	0.0005	2%	30%	30.07%	0.000000	0.00197	0.00316	0.00059	0.00009	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	$PM_{2.5}$	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00007	0.00011	0.00002	0.00000	0.00000
1A3bi	Road transport: Passenger cars	$PM_{2.5}$	0.1110	0.1548	2%	20%	20.10%	0.000012	0.57759	1.01004	0.11552	0.02857	0.00014

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3bii	Road transport: Light duty vehicles	$PM_{2.5}$	0.2048	0.0338	2%	20%	20.10%	0.000001	-0.57711	0.22066	-0.11542	0.00624	0.00013
1A3biii	Road transport: Heavy duty vehicles and buses	$PM_{2.5}$	0.2962	0.0746	2%	20%	20.10%	0.000003	-0.66698	0.48692	-0.13340	0.01377	0.00018
1A3biv	Road transport: Mopeds & motorcycles	$PM_{2.5}$	0.0003	0.0010	2%	20%	20.10%	0.000000	0.00497	0.00621	0.00099	0.00018	0.00000
1A3bvi	Road transport: Automobile tyre and brake wear	$PM_{2.5}$	0.0630	0.0965	2%	20%	20.10%	0.000004	0.38410	0.62949	0.07682	0.01780	0.00006
1A3bvii	Road transport: Automobile road abrasion	$PM_{2.5}$	0.0375	0.0528	2%	20%	20.10%	0.000001	0.19829	0.34426	0.03966	0.00974	0.00002
1A3c	Railways	$PM_{2.5}$	0.0596	0.0260	2%	20%	20.10%	0.000000	-0.06221	0.16985	-0.01244	0.00480	0.00000
1A3dii	National navigation (shipping)	$PM_{2.5}$	0.0322	0.0596	2%	20%	20.10%	0.000002	0.26343	0.38891	0.05269	0.01100	0.00003
1A4ai	Commercial/institutional: Stationary	$PM_{2.5}$	0.3300	0.2800	2%	20%	20.10%	0.000038	0.54095	1.82692	0.10819	0.05167	0.00014
1A4aii	Commercial/institutional: Mobile	$PM_{2.5}$	0.0135	0.0173	2%	50%	50.04%	0.000001	0.06051	0.11313	0.03025	0.00320	0.00001
1A4bi	Residential: Stationary, liquid fuels	$PM_{2.5}$	0.0008	0.0003	3%	20%	20.22%	0.000000	-0.00143	0.00186	-0.00029	0.00008	0.00000
1A4bi	Residential: Stationary, solid fuels	$PM_{2.5}$	0.3917	0.0605	2%	20%	20.10%	0.000002	-1.13125	0.39478	-0.22625	0.01117	0.00051
1A4bi	Residential: Stationary, gaseous fuels	$PM_{2.5}$	0.0031	0.0036	2%	20%	20.10%	0.000000	0.01169	0.02360	0.00234	0.00067	0.00000
1A4bi	Residential: Stationary, biomass	$PM_{2.5}$	2.9495	1.7586	5%	20%	20.62%	0.001569	-0.01769	11.47518	-0.00354	0.81142	0.00658
1A4bi	Residential: Stationary, waste	$PM_{2.5}$	0.4833	0.4061	50%	50%	70.71%	0.000985	0.76646	2.65002	0.38323	1.87385	0.03658
1A4bii	Residential: Household and gardening (mobile)	$PM_{2.5}$	0.0092	0.0100	2%	50%	50.04%	0.000000	0.02943	0.06514	0.01471	0.00184	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	$PM_{2.5}$	0.1500	0.0818	2%	20%	20.10%	0.000003	-0.05070	0.53377	-0.01014	0.01510	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	$PM_{2.5}$	0.0452	0.1666	2%	50%	50.04%	0.000083	0.91099	1.08709	0.45550	0.03075	0.00208
1A4ciii	Agriculture/Forestry/Fishing: National fishing	$PM_{2.5}$	IE	0.0010	2%	50%	50.04%	0.000000	0.00000	0.00639	0.00000	0.00018	0.00000
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	$PM_{2.5}$	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00012	0.00000	0.00000	0.00000
1B1c	Other fugitive emissions from solid fuels	$PM_{2.5}$	0.0100	0.0071	2%	100%	100.02%	0.000001	0.00768	0.04664	0.00768	0.00132	0.00000

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1B2aiv	Fugitive emissions oil: Refining / storage	$PM_{2.5}$	NA	0.0099	2%	100%	100.02%	0.000001	0.00000	0.06488	0.00000	0.00184	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	$PM_{2.5}$	NO	0.0005	2%	100%	100.02%	0.000000	0.00000	0.00318	0.00000	0.00009	0.00000
2A1	Cement production	$PM_{2.5}$	IE	0.0043	2%	100%	100.02%	0.000000	0.00000	0.02781	0.00000	0.00079	0.00000
2A2	Lime production	$PM_{2.5}$	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00029	0.00000	0.00001	0.00000
2A5a	Quarrying and mining of minerals other than coal	$PM_{2.5}$	NA	0.0092	2%	100%	100.02%	0.000001	0.00000	0.05988	0.00000	0.00169	0.00000
2A5b	Construction and demolition	$PM_{2.5}$	0.0496	0.1753	2%	100%	100.02%	0.000367	0.95104	1.14417	0.95104	0.03236	0.00906
2A6	Other mineral products	$PM_{2.5}$	0.0726	0.0021	2%	100%	100.02%	0.000000	-0.26949	0.01339	-0.26949	0.00038	0.00073
2B10a	Chemical industry: Other	$PM_{2.5}$	0.0892	0.0007	2%	20%	20.10%	0.000000	-0.34324	0.00446	-0.06865	0.00013	0.00005
2B10b	Storage, handling and transport of chemical products	$PM_{2.5}$	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00059	0.00000	0.00002	0.00000
2C1	Iron and steel production	$PM_{2.5}$	NA	0.0002	2%	20%	20.10%	0.000000	0.00000	0.00100	0.00000	0.00003	0.00000
2C3	Aluminium production	$PM_{2.5}$	NA	0.0023	2%	20%	20.10%	0.000000	0.00000	0.01501	0.00000	0.00042	0.00000
2C5	Lead production	$PM_{2.5}$	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00018	0.00000	0.00000	0.00000
2C6	Zinc production	$PM_{2.5}$	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00040	0.00000	0.00001	0.00000
2C7a	Copper production	$PM_{2.5}$	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00006	0.00000	0.00000	0.00000
2C7c	Other metal production	$PM_{2.5}$	0.0140	0.0260	2%	20%	20.10%	0.000000	0.11497	0.16956	0.02299	0.00480	0.00001
2D3b	Road paving with asphalt	$PM_{2.5}$	0.0007	0.0015	2%	100%	100.02%	0.000000	0.00687	0.00948	0.00687	0.00027	0.00000
2G	Other product use	$PM_{2.5}$	0.0562	0.0690	5%	50%	50.25%	0.000014	0.23106	0.45007	0.11553	0.03182	0.00014
2H1	Pulp and paper industry	$PM_{2.5}$	0.0840	0.0524	2%	100%	100.02%	0.000033	0.01441	0.34172	0.01441	0.00967	0.00000
2H2	Food and beverages industry	$PM_{2.5}$	0.0011	0.0051	2%	100%	100.02%	0.000000	0.02913	0.03342	0.02913	0.00095	0.00001
2I	Wood processing	$PM_{2.5}$	NA	0.0246	2%	100%	100.02%	0.000007	0.00000	0.16055	0.00000	0.00454	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	$PM_{2.5}$	NA	0.0092	2%	100%	100.02%	0.000001	0.00000	0.06021	0.00000	0.00170	0.00000
3B1a	Manure management - Dairy cattle	$PM_{2.5}$	0.0537	0.0474	2%	100%	100.02%	0.000027	0.10027	0.30956	0.10027	0.00876	0.00010
3B1b	Manure management - Non-dairy cattle	$PM_{2.5}$	0.0170	0.0197	2%	100%	100.02%	0.000005	0.06195	0.12835	0.06195	0.00363	0.00004

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
3B2	Manure management - Sheep	$PM_{2.5}$	0.0007	0.0017	2%	100%	100.02%	0.000000	0.00861	0.01122	0.00861	0.00032	0.00000
3B3	Manure management - Swine	$PM_{2.5}$	0.0016	0.0016	2%	100%	100.02%	0.000000	0.00372	0.01011	0.00372	0.00029	0.00000
3B4d	Manure management - Goats	$PM_{2.5}$	0.0001	0.0001					0.00000	0.00000	0.00000	0.00000	0.00000
3B4e	Manure management - Horses	$PM_{2.5}$	0.0006	0.0009	2%	100%	100.02%	0.000000	0.00351	0.00581	0.00351	0.00016	0.00000
3B4gi	Manure management - Laying hens	$PM_{2.5}$	0.0022	0.0025	2%	100%	100.02%	0.000000	0.00769	0.01615	0.00769	0.00046	0.00000
3B4gii	Manure management - Broilers	$PM_{2.5}$	0.0012	0.0028	2%	100%	100.02%	0.000000	0.01317	0.01797	0.01317	0.00051	0.00000
3B4giv	Manure management - Other poultry	$PM_{2.5}$	0.0063	0.0095	2%	100%	100.02%	0.000001	0.03764	0.06207	0.03764	0.00176	0.00001
3B4h	Manure management - Other animals	$PM_{2.5}$	0.0002	0.0005	2%	100%	100.02%	0.000000	0.00229	0.00307	0.00229	0.00009	0.00000
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	$PM_{2.5}$	0.0272	0.0306	2%	100%	100.02%	0.000011	0.09400	0.19980	0.09400	0.00565	0.00009
5A	Biological treatment of waste - Solid waste disposal on land	$PM_{2.5}$	0.0000	0.0000	2%	100%	100.02%	0.000000	-0.00005	0.00002	-0.00005	0.00000	0.00000
5C1bi	Industrial waste incineration	$PM_{2.5}$	NA	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00021	0.00000	0.00001	0.00000
5C1bv	Cremation	$PM_{2.5}$	0.0001	0.0003	2%	100%	100.02%	0.000000	0.00134	0.00176	0.00134	0.00005	0.00000
5C2	Open burning of waste	$PM_{2.5}$	0.1050	0.0292	10%	100%	100.50%	0.000010	-0.21851	0.19056	-0.21851	0.02695	0.00048
5E	Other waste	$PM_{2.5}$	0.1995	0.0651	2%	100%	100.02%	0.000051	-0.35258	0.42490	-0.35258	0.01202	0.00124
TOTAL			15.325	9.151				0.009249					0.18705
						Uncertainty in total inventory:		9.62%				Trend uncertainty:	4.32%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	172.7800	4.5403	2%	20%	20.10%	0.001879	-3.02521	1.62693	-0.60504	0.04602	0.00368
1A1c	Manufacture of solid fuels and other energy industries	TSP	0.4900	0.3437	2%	20%	20.10%	0.000011	0.10991	0.07167	0.02198	0.00203	0.00000
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	TSP	IE	0.0045	2%	20%	20.10%	0.000000	0.00000	0.07167	0.00000	0.00203	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	TSP	IE	0.0006	2%	20%	20.10%	0.000000	0.00000	0.07167	0.00000	0.00203	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	TSP	IE	0.0008	2%	20%	20.10%	0.000000	0.00000	0.07167	0.00000	0.00203	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	TSP	IE	0.2120	2%	20%	20.10%	0.000004	0.00000	0.07167	0.00000	0.00203	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	TSP	IE	0.0830	2%	20%	20.10%	0.000001	0.00000	0.07167	0.00000	0.00203	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	TSP	IE	0.0810	2%	20%	20.10%	0.000001	0.00000	0.07167	0.00000	0.00203	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	TSP	0.3379	0.0708	2%	50%	50.04%	0.000003	0.01624	0.02538	0.00812	0.00072	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	TSP	89.7900	3.0179	2%	20%	20.10%	0.000830	-1.34161	1.08142	-0.26832	0.03059	0.00073
1A3ai(i)	International aviation LTO (civil)	TSP	0.0004	0.0005	2%	30%	30.07%	0.000000	0.00016	0.00017	0.00005	0.00000	0.00000
1A3aii(i)	Domestic aviation LTO (civil)	TSP	0.0000	0.0000	2%	30%	30.07%	0.000000	0.00001	0.00001	0.00000	0.00000	0.00000
1A3bi	Road transport: Passenger cars	TSP	0.1314	0.1548	2%	20%	20.10%	0.000002	0.05191	0.05547	0.01038	0.00157	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3bii	Road transport: Light duty vehicles	TSP	0.1422	0.0338	2%	20%	20.10%	0.000000	0.00827	0.01212	0.00165	0.00034	0.00000
1A3biii	Road transport: Heavy duty vehicles and buses	TSP	0.2742	0.0746	2%	20%	20.10%	0.000001	0.01933	0.02674	0.00387	0.00076	0.00000
1A3biv	Road transport: Mopeds & motorcycles	TSP	0.0063	0.0010	2%	20%	20.10%	0.000000	0.00017	0.00034	0.00003	0.00001	0.00000
1A3bvi	Road transport: Automobile tyre and brake wear	TSP	0.2473	0.2303	2%	20%	20.10%	0.000005	0.07583	0.08252	0.01517	0.00233	0.00000
1A3bvii	Road transport: Automobile road abrasion	TSP	0.2166	0.1940	2%	20%	20.10%	0.000003	0.06364	0.06950	0.01273	0.00197	0.00000
1A3c	Railways	TSP	0.0847	0.0289	2%	20%	20.10%	0.000000	0.00806	0.01035	0.00161	0.00029	0.00000
1A3dii	National navigation (shipping)	TSP	0.0322	0.0596	2%	20%	20.10%	0.000000	0.02049	0.02136	0.00410	0.00060	0.00000
1A4ai	Commercial/institutional: Stationary	TSP	0.6500	0.3862	2%	20%	20.10%	0.000014	0.12082	0.13839	0.02416	0.00391	0.00001
1A4aii	Commercial/institutional: Mobile	TSP	0.0326	0.0173	2%	50%	50.04%	0.000000	0.00533	0.00621	0.00267	0.00018	0.00000
1A4bi	Residential: Stationary, liquid fuels	TSP	0.0033	0.0003	3%	20%	20.22%	0.000000	0.00001	0.00010	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	TSP	1.3580	0.0693	2%	20%	20.10%	0.000000	-0.01189	0.02482	-0.00238	0.00070	0.00000
1A4bi	Residential: Stationary, gaseous fuels	TSP	0.0037	0.0036	2%	20%	20.10%	0.000000	0.00120	0.00130	0.00024	0.00004	0.00000
1A4bi	Residential: Stationary, biomass	TSP	1.5239	1.9696	5%	20%	20.62%	0.000372	0.66454	0.70577	0.13291	0.04991	0.00020
1A4bi	Residential: Stationary, waste	TSP	0.3752	0.4702	50%	50%	70.71%	0.000249	0.15836	0.16850	0.07918	0.11915	0.00020
1A4bii	Residential: Household and gardening (mobile)	TSP	0.0018	0.0100	2%	50%	50.04%	0.000000	0.00353	0.00358	0.00176	0.00010	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	TSP	0.7400	0.1335	2%	20%	20.10%	0.000002	0.02784	0.04784	0.00557	0.00135	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	TSP	0.2138	0.1666	2%	50%	50.04%	0.000016	0.05392	0.05970	0.02696	0.00169	0.00001
1A4ciii	Agriculture/Forestry/Fishing: National fishing	TSP	IE	0.0010	2%	50%	50.04%	0.000000	0.00000	0.00038	0.00000	0.00001	0.00000
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	TSP	NE	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
1B1c	Other fugitive emissions from solid fuels	TSP	NR	0.1430	2%	100%	100.02%	0.000046	0.00000	0.05122	0.00000	0.00145	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1B2aiv	Fugitive emissions oil: Refining / storage	TSP	NA	0.0370	2%	100%	100.02%	0.000003	0.00000	0.01325	0.00000	0.00037	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	TSP	NO	0.0007	2%	100%	100.02%	0.000000	0.00000	0.00026	0.00000	0.00001	0.00000
2A1	Cement production	TSP	IE	0.0086	2%	100%	100.02%	0.000000	0.00000	0.00308	0.00000	0.00009	0.00000
2A2	Lime production	TSP	IE	0.0006	2%	100%	100.02%	0.000000	0.00000	0.00021	0.00000	0.00001	0.00000
2A5a	Quarrying and mining of minerals other than coal	TSP	NA	0.1873	2%	100%	100.02%	0.000079	0.00000	0.06713	0.00000	0.00190	0.00000
2A5b	Construction and demolition	TSP	4.9751	5.7897	2%	100%	100.02%	0.075652	1.93979	2.07463	1.93979	0.05868	0.03766
2A6	Other mineral products	TSP	NA	0.0187	2%	100%	100.02%	0.000001	0.00000	0.00669	0.00000	0.00019	0.00000
2B10a	Chemical industry: Other	TSP	0.9400	0.0062	2%	20%	20.10%	0.000000	-0.02319	0.00222	-0.00464	0.00006	0.00000
2B10b	Storage, handling and transport of chemical products	TSP	NA	0.0008	2%	20%	20.10%	0.000000	0.00000	0.00029	0.00000	0.00001	0.00000
2C1	Iron and steel production	TSP	NA	0.0002	2%	20%	20.10%	0.000000	0.00000	0.00008	0.00000	0.00000	0.00000
2C3	Aluminium production	TSP	NA	0.0034	2%	20%	20.10%	0.000000	0.00000	0.00124	0.00000	0.00003	0.00000
2C5	Lead production	TSP	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
2C6	Zinc production	TSP	NA	0.0001	2%	20%	20.10%	0.000000	0.00000	0.00003	0.00000	0.00000	0.00000
2C7a	Copper production	TSP	NA	0.0000	2%	20%	20.10%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
2C7c	Other metal production	TSP	NA	0.0567	2%	20%	20.10%	0.000000	0.00000	0.02031	0.00000	0.00057	0.00000
2D3b	Road paving with asphalt	TSP	0.2567	0.2180	2%	100%	100.02%	0.000107	0.07116	0.07810	0.07116	0.00221	0.00005
2D3d	Coating applications	TSP	NA	0.0008	2%	100%	100.02%	0.000000	0.00000	0.00030	0.00000	0.00001	0.00000
2D3g	Chemical products	TSP	NE	0.0026	2%	100%	100.02%	0.000000	0.00000	0.00093	0.00000	0.00003	0.00000
2D3h	Printing	TSP	NA	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2D3i	Other solvent use	TSP	NA	0.0099	2%	100%	100.02%	0.000000	0.00000	0.00353	0.00000	0.00010	0.00000
2G	Other product use	TSP	0.1127	0.0902	5%	50%	50.25%	0.000005	0.02929	0.03234	0.01464	0.00229	0.00000
2H1	Pulp and paper industry	TSP	0.0000	0.0873	2%	100%	100.02%	0.000017	0.03128	0.03128	0.03128	0.00088	0.00001
2H2	Food and beverages industry	TSP	0.0000	0.0466	2%	100%	100.02%	0.000005	0.01668	0.01668	0.01668	0.00047	0.00000
2I	Wood processing	TSP	NA	0.2261	2%	100%	100.02%	0.000115	0.00000	0.08102	0.00000	0.00229	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
2L	Other production, consumption, storage, transportation or handling of bulk products	TSP	NA	0.0840	2%	100%	100.02%	0.000016	0.00000	0.03011	0.00000	0.00085	0.00000
3B1a	Manure management - Dairy cattle	TSP	0.3874	0.1597	2%	100%	100.02%	0.000058	0.04674	0.05722	0.04674	0.00162	0.00002
3B1b	Manure management - Non-dairy cattle	TSP	0.2185	0.0653	2%	100%	100.02%	0.000010	0.01750	0.02341	0.01750	0.00066	0.00000
3B2	Manure management - Sheep	TSP	0.0222	0.0120	2%	100%	100.02%	0.000000	0.00371	0.00431	0.00371	0.00012	0.00000
3B3	Manure management - Swine	TSP	0.6647	0.2335	2%	100%	100.02%	0.000123	0.06570	0.08367	0.06570	0.00237	0.00004
3B4d	Manure management - Goats	TSP	0.0003	0.0007	2%	100%	100.02%	0.000000	0.00024	0.00025	0.00024	0.00001	0.00000
3B4e	Manure management - Horses	TSP	0.0041	0.0030	2%	100%	100.02%	0.000000	0.00097	0.00109	0.00097	0.00003	0.00000
3B4gi	Manure management - Laying hens	TSP	0.4226	0.1568	2%	100%	100.02%	0.000055	0.04474	0.05617	0.04474	0.00159	0.00002
3B4gii	Manure management - Broilers	TSP	0.0781	0.0551	2%	100%	100.02%	0.000007	0.01762	0.01974	0.01762	0.00056	0.00000
3B4giv	Manure management - Other poultry	TSP	0.1763	0.0666	2%	100%	100.02%	0.000010	0.01909	0.02386	0.01909	0.00067	0.00000
3B4h	Manure management - Other animals	TSP	0.0042	0.0021	2%	100%	100.02%	0.000000	0.00064	0.00075	0.00064	0.00002	0.00000
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	1.2313	0.7961	2%	100%	100.02%	0.001430	0.25197	0.28527	0.25197	0.00807	0.00064
5A	Farm-level agricultural operations including storage, handling and transport of agricultural products	TSP	0.0004	0.0009	2%	100%	100.02%	0.000000	0.00033	0.00034	0.00033	0.00001	0.00000
5B2	Biological treatment of waste - Solid waste disposal on land	TSP	NA	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
5C1bi	Industrial waste incineration	TSP	NA	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00003	0.00000	0.00000	0.00000
5C1bv	Cremation	TSP	NA	0.0003	2%	100%	100.02%	0.000000	0.00000	0.00011	0.00000	0.00000	0.00000
5C2	Open burning of waste	TSP	0.1399	0.0581	10%	100%	100.50%	0.000008	0.01703	0.02082	0.01703	0.00294	0.00000
5E	Other waste	TSP	NA	0.0651	10%	100%	100.50%	0.000010	0.00000	0.02333	0.00000	0.00330	0.00000
TOTAL			279.070	21.054				0.081150					0.04330
						Uncertainty in total inventory:		28.49%				Trend uncertainty:	2.08%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	CO	11.5300	5.4523	2%	20%	20.10%	0.000073	-0.65854	2.53595	-0.13171	0.07173	0.00022
1A1c	Manufacture of solid fuels and other energy industries	CO	6.4900	28.6748	2%	20%	20.10%	0.002025	11.53522	13.33701	2.30704	0.37723	0.05465
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	CO	IE	0.0289	2%	20%	20.10%	0.000000	0.00000	0.01344	0.00000	0.00038	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	CO	IE	0.0068	2%	20%	20.10%	0.000000	0.00000	0.00315	0.00000	0.00009	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	CO	IE	0.0026	2%	20%	20.10%	0.000000	0.00000	0.00123	0.00000	0.00003	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	CO	IE	0.2124	2%	20%	20.10%	0.000000	0.00000	0.09877	0.00000	0.00279	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	CO	IE	0.1527	2%	20%	20.10%	0.000000	0.00000	0.07103	0.00000	0.00201	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	CO	IE	0.3329	2%	20%	20.10%	0.000000	0.00000	0.15483	0.00000	0.00438	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	CO	1.7416	0.3645	2%	50%	50.04%	0.000002	-0.31303	0.16952	-0.15651	0.00479	0.00025
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	CO	6.1800	6.6811	2%	20%	20.10%	0.000110	1.39463	3.10744	0.27893	0.08789	0.00086
1A3ai(i)	International aviation LTO (civil)	CO	0.0907	0.1309	2%	30%	30.07%	0.000000	0.03574	0.06088	0.01072	0.00172	0.00000

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3aii(i)	Domestic aviation LTO (civil)	CO	0.0296	0.0432	2%	30%	30.07%	0.000000	0.01189	0.02010	0.00357	0.00057	0.00000
1A3bi	Road transport: Passenger cars	CO	102.5953	10.2389	2%	20%	20.10%	0.000258	-23.55340	4.76226	-4.71068	0.13470	0.22209
1A3bii	Road transport: Light duty vehicles	CO	8.9405	0.6084	2%	20%	20.10%	0.000001	-2.19343	0.28296	-0.43869	0.00800	0.00193
1A3biii	Road transport: Heavy duty vehicles and buses	CO	4.1119	1.0617	2%	20%	20.10%	0.000003	-0.64544	0.49380	-0.12909	0.01397	0.00017
1A3biv	Road transport: Mopeds & motorcycles	CO	6.4087	0.5084	2%	20%	20.10%	0.000001	-1.53885	0.23646	-0.30777	0.00669	0.00095
1A3c	Railways	CO	0.6030	0.2033	2%	100%	100.02%	0.000003	-0.07252	0.09456	-0.07252	0.00267	0.00005
1A3dii	National navigation (shipping)	CO	0.1386	0.3440	2%	100%	100.02%	0.000007	0.12157	0.15998	0.12157	0.00452	0.00015
1A4ai	Commercial/institutional: Stationary	CO	0.7000	0.8701	2%	20%	20.10%	0.000002	0.21074	0.40471	0.04215	0.01145	0.00002
1A4aii	Commercial/institutional: Mobile	CO	1.3703	0.4019	2%	50%	50.04%	0.000002	-0.19275	0.18691	-0.09638	0.00529	0.00009
1A4bi	Residential: Stationary, liquid fuels	CO	0.0082	0.0007	3%	20%	20.22%	0.000000	-0.00194	0.00033	-0.00039	0.00001	0.00000
1A4bi	Residential: Stationary, solid fuels	CO	17.3189	0.8010	2%	20%	20.10%	0.000002	-4.42274	0.37258	-0.88455	0.01054	0.00783
1A4bi	Residential: Stationary, gaseous fuels	CO	0.0596	0.0585	2%	20%	20.10%	0.000000	0.01073	0.02723	0.00215	0.00077	0.00000
1A4bi	Residential: Stationary, biomass	CO	42.7493	65.2214	5%	20%	20.62%	0.011020	18.45325	30.33530	3.69065	2.14503	0.18222
1A4bi	Residential: Stationary, waste	CO	0.8982	1.1257	50%	20%	53.85%	0.000022	0.27468	0.52356	0.05494	0.37022	0.00140
1A4bii	Residential: Household and gardening (mobile)	CO	0.5848	2.4780	2%	50%	50.04%	0.000094	0.99048	1.15255	0.49524	0.03260	0.00246
1A4ci	Agriculture/Forestry/Fishing: Stationary	CO	0.5100	0.2229	2%	20%	20.10%	0.000000	-0.03765	0.10366	-0.00753	0.00293	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	CO	1.3640	1.0488	2%	50%	50.04%	0.000017	0.10985	0.48780	0.05493	0.01380	0.00003
1A4ciii	Agriculture/Forestry/Fishing: National fishing	CO	IE	0.0057	2%	50%	50.04%	0.000000	0.00000	0.00265	0.00000	0.00008	0.00000
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	CO	NE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00001	0.00000	0.00000	0.00000
1B1c	Other fugitive emissions from solid fuels	CO	NE	0.1700	2%	100%	100.02%	0.000002	0.00000	0.07905	0.00000	0.00224	0.00000
1B2aiv	Fugitive emissions oil: Refining / storage	CO	NA	0.0123	2%	100%	100.02%	0.000000	0.00000	0.00570	0.00000	0.00016	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1B2c	Venting and flaring (oil, gas, combined oil and gas)	CO	NO	0.0007	2%	100%	100.02%	0.000000	0.00000	0.00034	0.00000	0.00001	0.00000
2A5a	Quarrying and mining of minerals other than coal	CO	NA	0.0057	2%	100%	100.02%	0.000000	0.00000	0.00263	0.00000	0.00007	0.00000
2B10a	Chemical industry: Other	CO	0.3400	0.3528	2%	50%	50.04%	0.000002	0.06986	0.16407	0.03493	0.00464	0.00001
2C1	Iron and steel production	CO	NA	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00007	0.00000	0.00000	0.00000
2C7c	Other metal production	CO	NA	0.0269	2%	50%	50.04%	0.000000	0.00000	0.01249	0.00000	0.00035	0.00000
2D3g	Chemical products	CO	0.0000	0.0021	2%	50%	50.04%	0.000000	0.00097	0.00097	0.00049	0.00003	0.00000
2G	Other product use	CO	0.2295	0.1044	5%	50%	50.25%	0.000000	-0.01501	0.04858	-0.00751	0.00343	0.00000
2H1	Pulp and paper industry	CO	0.0000	0.0052	2%	50%	50.04%	0.000000	0.00240	0.00240	0.00120	0.00007	0.00000
2H2	Food and beverages industry	CO	NA	0.0003	2%	50%	50.04%	0.000000	0.00000	0.00015	0.00000	0.00000	0.00000
2L	Other production, consumption, storage, transportation or handling of bulk products	CO	NA	0.0146	2%	50%	50.04%	0.000000	0.00000	0.00677	0.00000	0.00019	0.00000
5B1	Biological treatment of waste - Composting	CO	0.0038	0.0966	2%	50%	50.04%	0.000000	0.04390	0.04495	0.02195	0.00127	0.00000
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	CO	NA	0.0077	2%	50%	50.04%	0.000000	0.00000	0.00357	0.00000	0.00010	0.00000
5C1bi	Industrial waste incineration	CO	NA	0.0014	2%	50%	50.04%	0.000000	0.00000	0.00067	0.00000	0.00002	0.00000
5C1bv	Cremation	CO	NA	0.0011	2%	50%	50.04%	0.000000	0.00000	0.00051	0.00000	0.00001	0.00000
5C2	Open burning of waste	CO	0.0054	0.0022	10%	50%	50.99%	0.000000	-0.00045	0.00103	-0.00022	0.00015	0.00000
TOTAL			215.002	128.086				0.013645					0.47538
						Uncertainty in total inventory:		11.68%				Trend uncertainty:	6.89%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	63.1200	26.1381	2%	200%	200.01%	3.380749	8.43338	12.68826	16.86677	0.35888	2.84617
1A1c	Manufacture of solid fuels and other energy industries	Pb	NA	0.0024	2%	200%	200.01%	0.000000	0.00000	0.00116	0.00000	0.00003	0.00000
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Pb	IE	0.0002	2%	100%	100.02%	0.000000	0.00000	0.00010	0.00000	0.00000	0.00000
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Pb	IE	0.0231	2%	100%	100.02%	0.000001	0.00000	0.01121	0.00000	0.00032	0.00000
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Pb	IE	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00007	0.00000	0.00000	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Pb	IE	0.0338	2%	100%	100.02%	0.000001	0.00000	0.01643	0.00000	0.00046	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Pb	IE	0.0237	2%	100%	100.02%	0.000001	0.00000	0.01149	0.00000	0.00033	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Pb	IE	0.0586	2%	100%	100.02%	0.000004	0.00000	0.02843	0.00000	0.00080	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	Pb	0.9000	0.0030	2%	50%	50.04%	0.000000	-0.05885	0.00144	-0.02943	0.00004	0.00001
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Pb	62.4600	0.6696	2%	100%	100.02%	0.000555	-3.84810	0.32505	-3.84810	0.00919	0.14808
1A3bi	Road transport: Passenger cars	Pb	49.9695	0.0195	2%	20%	20.10%	0.000000	-3.33043	0.00945	-0.66609	0.00027	0.00444
1A3bii	Road transport: Light duty vehicles	Pb	4.3994	0.0029	2%	20%	20.10%	0.000000	-0.29327	0.00143	-0.05865	0.00004	0.00003
1A3biii	Road transport: Heavy duty vehicles and buses	Pb	17.4005	0.0100	2%	20%	20.10%	0.000000	-1.15999	0.00486	-0.23200	0.00014	0.00054
1A3biv	Road transport: Mopeds & motorcycles	Pb	1.7546	0.0001	2%	20%	20.10%	0.000000	-0.11752	0.00003	-0.02350	0.00000	0.00001

	A	B	C	D	E	F	G	H	I	J	K	L	M
	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A3bvi	Road transport: Automobile tyre and brake wear	Pb	0.2611	0.2442	2%	30%	30.07%	0.000007	0.10105	0.11855	0.03032	0.00335	0.00001
1A3c	Railways	Pb	0.0159	NA	2%	50%	50.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4ai	Commercial/institutional: Stationary	Pb	0.1400	0.0871	2%	100%	100.02%	0.000009	0.03291	0.04229	0.03291	0.00120	0.00001
1A4aii	Commercial/institutional: Mobile	Pb	0.3000	0.0026	2%	50%	50.04%	0.000000	-0.01883	0.00127	-0.00942	0.00004	0.00000
1A4bi	Residential: Stationary, liquid fuels	Pb	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	Pb	0.4343	0.0282	2%	100%	100.02%	0.000001	-0.01543	0.01367	-0.01543	0.00039	0.00000
1A4bi	Residential: Stationary, gaseous fuels	Pb	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	Pb	0.1443	0.4086	5%	100%	100.12%	0.000207	0.18867	0.19834	0.18867	0.01402	0.00036
1A4bii	Residential: Household and gardening (mobile)	Pb	0.1260	0.0178	2%	50%	50.04%	0.000000	0.00019	0.00864	0.00010	0.00024	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	Pb	0.1800	0.0288	2%	100%	100.02%	0.000001	0.00194	0.01400	0.00194	0.00040	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Pb	3.6000	0.0014	2%	50%	50.04%	0.000000	-0.24047	0.00069	-0.12023	0.00002	0.00014
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Pb	IE	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Pb	NO	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2C5	Lead production	Pb	NA	0.0098	2%	50%	50.04%	0.000000	0.00000	0.00476	0.00000	0.00013	0.00000
2C7c	Other metal production	Pb	NA	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00004	0.00000	0.00000	0.00000
2D3d	Coating applications	Pb	NA	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00002	0.00000	0.00000	0.00000
2D3e	Degreasing	Pb	NA	0.0001	2%	50%	50.04%	0.000000	0.00000	0.00003	0.00000	0.00000	0.00000
2D3i	Other solvent use	Pb	NE	0.0002	2%	50%	50.04%	0.000000	0.00000	0.00010	0.00000	0.00000	0.00000
2G	Other product use	Pb	0.0020	0.2880	5%	50%	50.25%	0.000026	0.13969	0.13982	0.06984	0.00989	0.00005
5C1bv	Cremation	Pb	NA	0.0002	5%	50%	50.25%	0.000000	0.00000	0.00011	0.00000	0.00001	0.00000
5C2	Open burning of waste	Pb	0.7949	0.3301	10%	100%	100.50%	0.000136	0.10699	0.16025	0.10699	0.02266	0.00012
5E	Other waste	Pb	NE	0.0002	10%	100%	100.50%	0.000000	0.00000	0.00009	0.00000	0.00001	0.00000
TOTAL			206.003	28.433				3.381698					2.99996
							Uncertainty in total inventory:	183.89%				Trend uncertainty:	17.32%

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	0.4922	2%	200%	200.01%	1.736681	6.74989	10.92603	13.49978	0.30903	1.82339
1A1c	Manufacture of solid fuels and other energy industries	Cd	NA	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00007	0.00000	0.00000	0.00000
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Cd	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00024	0.00000	0.00001	0.00000
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Cd	IE	0.0008	2%	100%	100.02%	0.000001	0.00000	0.01873	0.00000	0.00053	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Cd	IE	0.0005	2%	100%	100.02%	0.000001	0.00000	0.01185	0.00000	0.00034	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Cd	IE	0.0034	2%	100%	100.02%	0.000020	0.00000	0.07478	0.00000	0.00212	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	Cd	0.0016	0.0003	2%	50%	50.04%	0.000000	0.00158	0.00755	0.00079	0.00021	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Cd	3.2300	0.0176	2%	100%	100.02%	0.000555	-11.41623	0.39063	-11.41623	0.01105	1.30331
1A3bi	Road transport: Passenger cars	Cd	0.0038	0.0044	2%	20%	20.10%	0.000001	0.08411	0.09813	0.01682	0.00278	0.00000
1A3bii	Road transport: Light duty vehicles	Cd	0.0005	0.0005	2%	20%	20.10%	0.000000	0.00987	0.01187	0.00197	0.00034	0.00000
1A3biii	Road transport: Heavy duty vehicles and buses	Cd	0.0028	0.0017	2%	20%	20.10%	0.000000	0.02706	0.03722	0.00541	0.00105	0.00000
1A3biv	Road transport: Mopeds & motorcycles	Cd	0.0001	0.0000	2%	20%	20.10%	0.000000	0.00005	0.00051	0.00001	0.00001	0.00000
1A3bvi	Road transport: Automobile tyre and brake wear	Cd	0.0012	0.0011	2%	30%	30.07%	0.000000	0.02086	0.02521	0.00626	0.00071	0.00000
1A3c	Railways	Cd	0.0007	0.0002	2%	50%	50.04%	0.000000	0.00174	0.00422	0.00087	0.00012	0.00000
1A3dii	National navigation (shipping)	Cd	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00249	0.00275	0.00125	0.00008	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A4ai	Commercial/institutional: Stationary	Cd	0.0000	0.0026	2%	100%	100.02%	0.000012	0.05704	0.05704	0.05704	0.00161	0.00003
1A4aii	Commercial/institutional: Mobile	Cd	0.0001	0.0001	2%	50%	50.04%	0.000000	0.00124	0.00175	0.00062	0.00005	0.00000
1A4bi	Residential: Stationary, liquid fuels	Cd	0.0000	0.0000	3%	100%	100.04%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4bi	Residential: Stationary, solid fuels	Cd	0.0052	0.0003	2%	100%	100.02%	0.000000	-0.01156	0.00741	-0.01156	0.00021	0.00000
1A4bi	Residential: Stationary, gaseous fuels	Cd	0.0000	0.0000	2%	100%	100.02%	0.000000	0.00001	0.00001	0.00001	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	Cd	0.0695	0.1967	5%	100%	100.12%	0.069514	4.11029	4.36663	4.11029	0.30877	0.16990
1A4bii	Residential: Household and gardening (mobile)	Cd	0.0000	0.0000	2%	50%	50.04%	0.000000	0.00074	0.00078	0.00037	0.00002	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	Cd	0.0100	0.0016	2%	100%	100.02%	0.000005	-0.00145	0.03536	-0.00145	0.00100	0.00000
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Cd	0.0012	0.0010	2%	50%	50.04%	0.000000	0.01676	0.02129	0.00838	0.00060	0.00000
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Cd	IE	0.0000	2%	50%	50.04%	0.000000	0.00000	0.00016	0.00000	0.00000	0.00000
2G	Other product use	Cd	0.0225	0.0105	5%	50%	50.25%	0.000050	0.15075	0.23355	0.07537	0.01651	0.00006
5C1bv	Cremation	Cd	NA	0.0000	5%	50%	50.25%	0.000000	0.00000	0.00087	0.00000	0.00006	0.00000
5C2	Open burning of waste	Cd	0.0260	0.0108	10%	100%	100.50%	0.000211	0.14391	0.23956	0.14391	0.03388	0.00022
5E	Other waste	Cd	NE	0.0004	10%	100%	100.50%	0.000000	0.00000	0.00843	0.00000	0.00119	0.00000
TOTAL			4.505	0.747				1.807052					3.29691
							Uncertainty in total inventory:	134.43%				Trend uncertainty:	18.16%

A		B	C	D	E	F	G	H	I	J	K	L	M
	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	1.0100	0.4937	2%	200%	200.01%	3.320931	1.68204	42.76626	3.36407	1.20961	0.12780
1A1c	Manufacture of solid fuels and other energy industries	Hg	NA	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00009	0.00000	0.00000	0.00000
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Hg	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00043	0.00000	0.00001	0.00000
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Hg	IE	0.0003	2%	100%	100.02%	0.000000	0.00000	0.02244	0.00000	0.00063	0.00000
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Hg	IE	0.0001	2%	100%	100.02%	0.000000	0.00000	0.00641	0.00000	0.00018	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	Hg	0.0800	0.0037	2%	100%	100.02%	0.000047	-2.93081	0.32019	-2.93081	0.00906	0.08590
1A3c	Railways	Hg	0.0009	0.0000	2%	50%	50.04%	0.000000	-0.03822	0.00000	-0.01911	0.00000	0.00000
1A4ai	Commercial/institutional: Stationary	Hg	0.0000	0.0006	2%	100%	100.02%	0.000001	0.04895	0.04895	0.04895	0.00138	0.00002
1A4bi	Residential: Stationary, liquid fuels	Hg	0.0003	0.0000	3%	100%	100.04%	0.000000	-0.00881	0.00198	-0.00881	0.00008	0.00000
1A4bi	Residential: Stationary, solid fuels	Hg	0.0185	0.0012	2%	100%	100.02%	0.000005	-0.64704	0.10378	-0.64704	0.00294	0.00419
1A4bi	Residential: Stationary, gaseous fuels	Hg	0.0002	0.0002	2%	100%	100.02%	0.000000	0.00941	0.01801	0.00941	0.00051	0.00000
1A4bi	Residential: Stationary, biomass	Hg	0.0030	0.0085	5%	100%	100.12%	0.000245	0.61245	0.73416	0.61245	0.05191	0.00378
1A4ci	Agriculture/Forestry/Fishing: Stationary	Hg	0.0000	0.0004	2%	100%	100.02%	0.000001	0.03794	0.03794	0.03794	0.00107	0.00001
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Hg	IE	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00182	0.00000	0.00005	0.00000
2C7c	Other metal production	Hg	NA	0.0000	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
2D3a	Domestic solvent use including fungicides	Hg	0.0088	0.0074	2%	20%	20.10%	0.000007	0.27944	0.63709	0.05589	0.01802	0.00003

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
2G	Other product use	Hg	0.0112	0.0050	5%	50%	50.25%	0.000022	-0.02323	0.43402	-0.01161	0.03069	0.00001
5C1bv	Cremation	Hg	NA	0.0116	5%	50%	50.25%	0.000115	0.00000	1.00137	0.00000	0.07081	0.00000
5C2	Open burning of waste	Hg	0.0214	0.0089	10%	100%	100.50%	0.000272	-0.10019	0.76998	-0.10019	0.10889	0.00022
5E	Other waste	Hg	NA	0.0004	10%	100%	100.50%	0.000000	0.00000	0.03292	0.00000	0.00466	0.00000
TOTAL			1.154	0.542				3.321646					0.22197
						Uncertainty in total inventory:		182.25%				Trend uncertainty:	4.71%

	A	B	C	D	E	F	G	H	I	J	K	L	M
	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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/PCDF	2.3300	1.0121	2%	250%	250.01%	0.374869	-2.24001	12.54339	-5.60002	0.35478	0.31486
1A1c	Manufacture of solid fuels and other energy industries	PCDD/PCDF	NA	0.0106	2%	250%	250.01%	0.000041	0.00000	0.13194	0.00000	0.00373	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PCDD/PCDF	1.4400	0.3139	2%	250%	250.01%	0.036054	-5.24115	3.89002	-13.10287	0.11003	1.71697
1A3bi	Road transport: Passenger cars	PCDD/PCDF	0.1896	0.2333	2%	250%	250.01%	0.019925	1.68816	2.89184	4.22041	0.08179	0.17819
1A3bii	Road transport: Light duty vehicles	PCDD/PCDF	0.0312	0.0299	2%	250%	250.01%	0.000328	0.17336	0.37114	0.43341	0.01050	0.00188
1A3biii	Road transport: Heavy duty vehicles and buses	PCDD/PCDF	0.0998	0.0461	2%	250%	250.01%	0.000777	-0.06264	0.57091	-0.15661	0.01615	0.00025
1A3biv	Road transport: Mopeds & motorcycles	PCDD/PCDF	0.0100	0.0012	2%	250%	250.01%	0.000001	-0.04865	0.01476	-0.12161	0.00042	0.00015
1A3c	Railways	PCDD/PCDF	0.0242	0.0000	2%	250%	250.01%		-0.15333	0.00000	-0.38333	0.00000	0.00000
1A4ai	Commercial/institutional: Stationary	PCDD/PCDF	0.0200	0.0462	2%	250%	250.01%	0.000783	0.44613	0.57309	1.11533	0.01621	0.01244
1A4bi	Residential: Stationary, liquid fuels	PCDD/PCDF	0.0040	0.0003	3%	250%	250.02%	0.000000	-0.02102	0.00424	-0.05256	0.00018	0.00003
1A4bi	Residential: Stationary, solid fuels	PCDD/PCDF	2.4316	0.1309	2%	250%	250.01%	0.006266	-13.77174	1.62169	-34.42936	0.04587	11.85383
1A4bi	Residential: Stationary, gaseous fuels	PCDD/PCDF	0.0032	0.0031	2%	250%	250.01%	0.000004	0.01852	0.03865	0.04629	0.00109	0.00002
1A4bi	Residential: Stationary, biomass	PCDD/PCDF	0.6717	0.7665	5%	100%	100.12%	0.034481	5.23092	9.49901	5.23092	0.67168	0.27814
1A4bi	Residential: Stationary, waste	PCDD/PCDF	0.0177	0.0222	50%	100%	111.80%	0.000036	0.16270	0.27515	0.16270	0.19456	0.00064
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCDD/PCDF	0.0200	0.0041	2%	250%	250.01%	0.000006	-0.07661	0.05034	-0.19152	0.00142	0.00037
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCDD/PCDF	IE	0.0001	2%	250%	250.01%	0.000000	0.00000	0.00112	0.00000	0.00003	0.00000
1B2c	Venting and flaring (oil. gas. combined oil and gas)	PCDD/PCDF	NO	0.0000	2%	250%	250.01%	0.000000	0.00000	0.00005	0.00000	0.00000	0.00000
2G	Other product use	PCDD/PCDF	0.0004	0.0002	5%	250%	250.05%	0.000000	-0.00035	0.00229	-0.00087	0.00016	0.00000
5C1bi	Industrial waste incineration	PCDD/PCDF	NA	0.6382	5%	250%	250.05%	0.149089	0.00000	7.90906	0.00000	0.55925	0.00000
5C1biii	Clinical waste incineration	PCDD/PCDF	0.4700	0.0848	2%	250%	300.00%	0.003788	-1.93148	1.05076	-4.82870	0.02972	0.23317
5C1bv	Cremation	PCDD/PCDF	NA	0.0002	2%	250%	300.00%	0.000000	0.00000	0.00259	0.00000	0.00007	0.00000

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
5C2	Open burning of waste	PCDD/PCDF	0.3057	0.1270	2%	250%	250.01%	0.005900	-0.36687	1.57358	-0.91717	0.04451	0.00843
5E	Other waste	PCDD/PCDF	NE	0.6619	2%	250%	250.01%	0.160328	0.00000	8.20313	0.00000	0.23202	0.00000
TOTAL			8.069	4.133				0.792675					14.59937
							Uncertainty in total inventory:	89.03%				Trend uncertainty:	38.21%

A		B	C	D	E		F	G	H	I	J	K	L	M
	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	0.7725	2%	200%	200.01%	0.579702	10.15608	32.63180	20.31216	0.92297	4.13436
1A1c	Manufacture of solid fuels and other energy industries	B(a)p	NA	0.0003	2%	200%	200.01%	0.000000	0.00000	0.01381	0.00000	0.00039	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(a)p	0.0049	0.0010	2%	200%	200.01%	0.000001	-0.13293	0.04304	-0.26586	0.00122	0.00071
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(a)p	0.2262	0.3503	2%	200%	200.01%	0.119174	6.60016	14.79547	13.20033	0.41848	1.74424
1A3bi	Road transport: Passenger cars	B(a)p	0.0032	0.0080	2%	200%	200.01%	0.000062	0.21875	0.33639	0.43750	0.00951	0.00191
1A3bii	Road transport: Light duty vehicles	B(a)p	0.0007	0.0013	2%	200%	200.01%	0.000002	0.02640	0.05305	0.05281	0.00150	0.00003
1A3biii	Road transport: Heavy duty vehicles and buses	B(a)p	0.0014	0.0008	2%	200%	200.01%	0.000001	-0.01645	0.03519	-0.03289	0.00100	0.00001
1A3biv	Road transport: Mopeds & motorcycles	B(a)p	0.0002	0.0000	2%	200%	200.01%	0.000000	-0.00466	0.00084	-0.00932	0.00002	0.00000
1A3c	Railways	B(a)p	0.0068	0.0006	2%	200%	200.01%	0.000000	-0.22195	0.02408	-0.44390	0.00068	0.00197
1A3dii	National navigation (shipping)	B(a)p	0.0002	0.0004	2%	200%	200.01%	0.000000	0.00811	0.01571	0.01622	0.00044	0.00000
1A4ai	Commercial/institutional: Stationary	B(a)p	0.0300	0.0515	2%	200%	200.01%	0.002574	1.08805	2.17444	2.17611	0.06150	0.04739
1A4aii	Commercial/institutional: Mobile	B(a)p	0.0004	0.0002	2%	200%	200.01%	0.000000	-0.00571	0.01022	-0.01142	0.00029	0.00000
1A4bi	Residential: Stationary, liquid fuels	B(a)p	0.0002	0.0000	3%	200%	200.02%	0.000000	-0.00576	0.00064	-0.01152	0.00003	0.00000
1A4bi	Residential: Stationary, solid fuels	B(a)p	0.6937	0.0423	2%	200%	200.01%	0.001738	-23.26318	1.78697	-46.52636	0.05054	21.64705
1A4bi	Residential: Stationary, gaseous fuels	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00001	0.00005	0.00001	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	B(a)p	0.7420	0.7849	5%	100%	100.12%	0.149949	6.26798	33.15276	6.26798	2.34425	0.44783
1A4bi	Residential: Stationary, waste	B(a)p	0.0034	0.0042	50%	100%	111.80%	0.000005	0.05607	0.17740	0.05607	0.12544	0.00019
1A4bii	Residential: Household and gardening (mobile)	B(a)p	0.0000	0.0001	2%	200%	200.01%	0.000000	0.00473	0.00600	0.00946	0.00017	0.00000

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(a)p	0.0300	0.0078	2%	200%	200.01%	0.000060	-0.75470	0.33145	-1.50940	0.00937	0.02278
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(a)p	0.0037	0.0029	2%	200%	200.01%	0.000008	-0.01216	0.12148	-0.02433	0.00344	0.00001
1B2c	Venting and flaring (oil. gas. combined oil and gas)	B(a)p	NO	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00161	0.00000	0.00005	0.00000
2G	Other product use	B(a)p	0.0005	0.0002	5%	200%	200.06%	0.000000	-0.00807	0.00866	-0.01614	0.00061	0.00000
5C1bv	Cremation	B(a)p	NA	0.0000	5%	200%	200.06%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C2	Open burning of waste	B(a)p	0.0000	0.0000	2%	200%	200.01%	0.000000	-0.00061	0.00055	-0.00122	0.00002	0.00000
TOTAL			2.367	2.029				0.853275					28.04848
						Uncertainty in total inventory:		92.37%				Trend uncertainty:	52.96%

A		B	C	D	E	F	G	H	I	J	K	L	M
NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty in trend in national emissions introduced into the trend in total national emissions
			kt	kt	%	%	%		%	%	%	%	%
1A1a	Public electricity and heat production	B(b)f	0.7400	1.0299	2%	200%	200.01%	0.783392	14.63524	37.46382	29.27048	1.05964	8.57884
1A1c	Manufacture of solid fuels and other energy industries	B(b)f	NA	0.0004	2%	200%	200.01%	0.000000	0.00000	0.01473	0.00000	0.00042	0.00000
1A2gvii	Mobile Combustion in manufacturing industries and construction	B(b)f	0.0081	0.0017	2%	200%	200.01%	0.000002	-0.18768	0.06177	-0.37535	0.00175	0.00141
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(b)f	0.2766	0.4661	2%	200%	200.01%	0.160487	8.43011	16.95673	16.86022	0.47961	2.84497
1A3bi	Road transport: Passenger cars	B(b)f	0.0054	0.0090	2%	200%	200.01%	0.000060	0.16068	0.32714	0.32136	0.00925	0.00103
1A3bii	Road transport: Light duty vehicles	B(b)f	0.0010	0.0014	2%	200%	200.01%	0.000001	0.02200	0.05125	0.04400	0.00145	0.00002
1A3biii	Road transport: Heavy duty vehicles and buses	B(b)f	0.0086	0.0050	2%	200%	200.01%	0.000019	-0.08237	0.18356	-0.16473	0.00519	0.00027
1A3biv	Road transport: Mopeds & motorcycles	B(b)f	0.0003	0.0000	2%	200%	200.01%	0.000000	-0.00757	0.00102	-0.01515	0.00003	0.00000
1A3c	Railways	B(b)f	0.0093	0.0010	2%	200%	200.01%	0.000001	-0.25212	0.03456	-0.50423	0.00098	0.00254
1A3dii	National navigation (shipping)	B(b)f	0.0004	0.0006	2%	200%	200.01%	0.000000	0.01177	0.02255	0.02355	0.00064	0.00001
1A4ai	Commercial/institutional: Stationary	B(b)f	0.0400	0.0682	2%	200%	200.01%	0.003431	1.24715	2.47918	2.49430	0.07012	0.06226
1A4aii	Commercial/institutional: Mobile	B(b)f	0.0007	0.0004	2%	200%	200.01%	0.000000	-0.00679	0.01415	-0.01358	0.00040	0.00000
1A4bi	Residential: Stationary, liquid fuels	B(b)f	0.0001	0.0000	3%	200%	200.02%	0.000000	-0.00245	0.00028	-0.00489	0.00001	0.00000
1A4bi	Residential: Stationary, solid fuels	B(b)f	0.9722	0.0518	2%	200%	200.01%	0.001980	-27.95777	1.88343	-55.91555	0.05327	31.26551
1A4bi	Residential: Stationary, gaseous fuels	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00001	0.00006	0.00002	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	B(b)f	0.6366	0.6723	5%	100%	100.12%	0.083662	4.83970	24.45664	4.83970	1.72935	0.26413
1A4bi	Residential: Stationary, waste	B(b)f	0.0034	0.0043	50%	100%	111.80%	0.000004	0.05019	0.15467	0.05019	0.10937	0.00014
1A4bii	Residential: Household and gardening (mobile)	B(b)f	0.0000	0.0001	2%	200%	200.01%	0.000000	0.00406	0.00517	0.00811	0.00015	0.00000

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	%	%	%		%	%	%	%	%
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(b)f	0.0400	0.0101	2%	200%	200.01%	0.000076	-0.86261	0.36911	-1.72522	0.01044	0.02976
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	B(b)f	0.0062	0.0048	2%	200%	200.01%	0.000017	-0.01507	0.17435	-0.03015	0.00493	0.00001
1B2c	Venting and flaring (oil. gas. combined oil and gas)	B(b)f	NO	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00164	0.00000	0.00005	0.00000
2G	Other product use	B(b)f	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00274	0.00302	-0.00548	0.00021	0.00000
5C1bv	Cremation	B(b)f	NA	0.0000	5%	200%	200.06%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C2	Open burning of waste	B(b)f	0.0000	0.0000	2%	200%	200.01%	0.000000	-0.00038	0.00036	-0.00075	0.00001	0.00000
TOTAL			2.749	2.327				1.033132					43.05093
							Uncertainty in total inventory:	101.64%				Trend uncertainty:	65.61%

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	0.3960	2%	200%	200.01%	0.452991	6.59363	26.23061	13.18726	0.74191	1.74454
1A1c	Manufacture of solid fuels and other energy industries	B(k)f	NA	0.0002	2%	200%	200.01%	0.000000	0.00000	0.01537	0.00000	0.00043	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	B(k)f	0.1455	0.1766	2%	200%	200.01%	0.090061	4.18069	11.69582	8.36139	0.33081	0.70022
1A3bi	Road transport: Passenger cars	B(k)f	0.0022	0.0069	2%	200%	200.01%	0.000138	0.34260	0.45764	0.68520	0.01294	0.00470
1A3bii	Road transport: Light duty vehicles	B(k)f	0.0006	0.0011	2%	200%	200.01%	0.000004	0.04186	0.07299	0.08372	0.00206	0.00007
1A3biii	Road transport: Heavy duty vehicles and buses	B(k)f	0.0096	0.0056	2%	200%	200.01%	0.000092	-0.12463	0.37352	-0.24925	0.01056	0.00062
1A3biv	Road transport: Mopeds & motorcycles	B(k)f	0.0001	0.0000	2%	200%	200.01%	0.000000	-0.00398	0.00093	-0.00796	0.00003	0.00000
1A3c	Railways	B(k)f	0.0044	0.0007	2%	200%	200.01%	0.000001	-0.18401	0.04332	-0.36803	0.00123	0.00135
1A4ai	Commercial/institutional: Stationary	B(k)f	0.0200	0.0261	2%	200%	200.01%	0.001963	0.69402	1.72676	1.38804	0.04884	0.01929
1A4bi	Residential: Stationary, liquid fuels	B(k)f	0.0002	0.0000	3%	200%	200.02%	0.000000	-0.00711	0.00088	-0.01422	0.00004	0.00000
1A4bi	Residential: Stationary, solid fuels	B(k)f	0.4197	0.0245	2%	200%	200.01%	0.001739	-19.99007	1.62519	-39.98014	0.04597	15.98414
1A4bi	Residential: Stationary, gaseous fuels	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00002	0.00012	0.00005	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	B(k)f	0.5057	0.5330	5%	100%	100.12%	0.205664	9.16467	35.30627	9.16467	2.49653	0.90224
1A4bi	Residential: Stationary, waste	B(k)f	0.0015	0.0018	50%	100%	111.80%	0.000003	0.04605	0.12181	0.04605	0.08613	0.00010
1A4ci	Agriculture/Forestry/Fishing: Stationary	B(k)f	0.0200	0.0041	2%	200%	200.01%	0.000048	-0.76203	0.27052	-1.52407	0.00765	0.02323
1B2c	Venting and flaring (oil. gas. combined oil and gas)	B(k)f	NO	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00192	0.00000	0.00005	0.00000
2G	Other product use	B(k)f	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00416	0.00550	-0.00832	0.00039	0.00000
5C1bv	Cremation	B(k)f	NA	0.0000	5%	200%	200.06%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
5C2	Open burning of waste	B(k)f	0.0000	0.0000	2%	200%	200.01%	0.000000	-0.00058	0.00066	-0.00115	0.00002	0.00000
TOTAL			1.510	1.177				0.752703					19.38050
						Uncertainty in total inventory:		86.76%				Trend uncertainty:	44.02%

	A	B	C	D	E	F	G	H	I	J	K	L	M
	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	0.3842	2%	200%	200.01%	0.265465	8.71327	24.51427	17.42654	0.69337	3.04165
1A1c	Manufacture of solid fuels and other energy industries	I(1.2.3-cd)p	NA	0.0001	2%	200%	200.01%	0.000000	0.00000	0.00893	0.00000	0.00025	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	I(1.2.3-cd)p	0.0930	0.1746	2%	200%	200.01%	0.054791	5.48844	11.13703	10.97688	0.31500	1.20591
1A3bi	Road transport: Passenger cars	I(1.2.3-cd)p	0.0060	0.0078	2%	200%	200.01%	0.000110	0.13320	0.49946	0.26641	0.01413	0.00071
1A3bii	Road transport: Light duty vehicles	I(1.2.3-cd)p	0.0009	0.0012	2%	200%	200.01%	0.000003	0.02083	0.07535	0.04166	0.00213	0.00002
1A3biii	Road transport: Heavy duty vehicles and buses	I(1.2.3-cd)p	0.0022	0.0013	2%	200%	200.01%	0.000003	-0.05198	0.08269	-0.10396	0.00234	0.00011
1A3biv	Road transport: Mopeds & motorcycles	I(1.2.3-cd)p	0.0003	0.0000	2%	200%	200.01%	0.000000	-0.01781	0.00204	-0.03563	0.00006	0.00001
1A3c	Railways	I(1.2.3-cd)p	0.0026	0.0002	2%	200%	200.01%	0.000000	-0.14617	0.00957	-0.29233	0.00027	0.00085
1A4ai	Commercial/institutional: Stationary	I(1.2.3-cd)p	0.0200	0.0255	2%	200%	200.01%	0.001167	0.41106	1.62547	0.82213	0.04598	0.00678
1A4bi	Residential: Stationary, liquid fuels	I(1.2.3-cd)p	0.0004	0.0000	3%	200%	200.02%	0.000000	-0.01954	0.00194	-0.03908	0.00008	0.00002
1A4bi	Residential: Stationary, solid fuels	I(1.2.3-cd)p	0.3439	0.0202	2%	200%	200.01%	0.000731	-19.55134	1.28597	-39.10267	0.03637	15.29020
1A4bi	Residential: Stationary, gaseous fuels	I(1.2.3-cd)p	0.0000	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00011	0.00001	0.00000	0.00000
1A4bi	Residential: Stationary, biomass	I(1.2.3-cd)p	0.8260	0.8703	5%	100%	100.12%	0.341348	5.34613	55.52947	5.34613	3.92653	0.43999
1A4bi	Residential: Stationary, waste	I(1.2.3-cd)p	0.0018	0.0023	50%	100%	111.80%	0.000003	0.03487	0.14485	0.03487	0.10242	0.00012
1A4ci	Agriculture/Forestry/Fishing: Stationary	I(1.2.3-cd)p	0.0100	0.0038	2%	200%	200.01%	0.000025	-0.36789	0.23926	-0.73577	0.00677	0.00541
1B2c	Venting and flaring (oil. gas. combined oil and gas)	I(1.2.3-cd)p	NO	0.0000	2%	200%	200.01%	0.000000	0.00000	0.00102	0.00000	0.00003	0.00000
2G	Other product use	I(1.2.3-cd)p	0.0002	0.0001	5%	200%	200.06%	0.000000	-0.00606	0.00530	-0.01212	0.00037	0.00000
5C1bv	Cremation	I(1.2.3-cd)p	NA	0.0000	5%	200%	200.06%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL			1.567	1.491				0.663646					19.99179
						Uncertainty in total inventory:		81.46%				Trend uncertainty:	44.71%

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	NFR sectors	Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	0.0731	2%	250%	250.01%	0.428616	22.87966	37.95404	57.19916	1.07350	32.72896
1A1c	Manufacture of solid fuels and other energy industries	HCB	NA	0.0000	2%	250%	250.01%	0.000000	0.00000	0.00519	0.00000	0.00015	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	HCB	0.0636	0.0349	2%	250%	250.01%	0.097964	-29.61219	18.14498	-74.03049	0.51322	54.80776
1A3bi	Road transport: Passenger cars	HCB	0.0002	0.0003	2%	250%	250.01%	0.000007	0.00220	0.15421	0.00549	0.00436	0.00000
1A3c	Railways	HCB	0.0001	NA	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4ai	Commercial/institutional: Stationary	HCB	NA	0.0042	2%	100%	100.02%	0.000231	0.00000	2.20251	0.00000	0.06230	0.00000
1A4bi	Residential: Stationary, solid fuels	HCB	0.0022	0.0001	2%	250%	250.01%	0.000002	-1.57356	0.07372	-3.93390	0.00209	0.15476
1A4bi	Residential: Stationary, biomass	HCB	0.0797	0.1439	5%	100%	100.12%	0.266407	14.67343	74.71504	14.67343	5.28315	2.43221
1A4bi	Residential: Stationary, waste	HCB	0.0115	0.0145	50%	100%	111.80%	0.003361	-1.17503	7.51598	-1.17503	5.31460	0.29626
1A4ci	Agriculture/Forestry/Fishing: Stationary	HCB	NA	0.0005	50%	100%	111.80%	0.000003	0.00000	0.24143	0.00000	0.17072	0.00000
1A4ciii	Agriculture/Forestry/Fishing: National fishing	HCB	NA	0.0001	50%	100%	111.80%	0.000000	0.00000	0.02856	0.00000	0.02019	0.00000
5C1bv	Cremation	HCB	NA	0.0012	50%	100%	111.80%	0.000022	0.00000	0.60437	0.00000	0.42735	0.00000
5C2	Open burning of waste	HCB	0.0153	0.0063	2%	250%	250.01%	0.003233	-8.20019	3.29649	-20.50047	0.09324	4.20278
TOTAL			0.193	0.279				0.799846					94.62273
							Uncertainty in total inventory:	89.43%				Trend uncertainty:	97.27%

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NFR sectors		Pollutant	1990 emissions	2015 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance by Category in Year 2015	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	2.8121	2%	150%	150.01%	0.993513	1.92565	33.57658	2.88847	0.94969	0.09245
1A1c	Manufacture of solid fuels and other energy industries	PCB	NA	0.0044	2%	150%	150.01%	0.000002	0.00000	0.05310	0.00000	0.00150	0.00000
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	PCB	2.0000	1.1446	2%	100%	100.02%	0.073175	1.59581	13.66699	1.59581	0.38656	0.02696
1A4ai	Commercial/institutional: Stationary	PCB	0.2500	0.1782	2%	150%	150.01%	0.003991	0.61949	2.12810	0.92924	0.06019	0.00867
1A4bi	Residential: Stationary, solid fuels	PCB	0.6003	0.0389	2%	150%	150.01%	0.000190	-3.15476	0.46482	-4.73213	0.01315	0.22393
1A4bi	Residential: Stationary, biomass	PCB	0.0003	0.0004	5%	150%	150.08%	0.000000	0.00284	0.00474	0.00426	0.00034	0.00000
1A4ci	Agriculture/Forestry/Fishing: Stationary	PCB	0.2200	0.0332	2%	150%	150.01%	0.000138	-0.93076	0.39641	-1.39614	0.01121	0.01949
1A3bi	Road transport: Passenger cars	PCB	0.0002	0.0001	2%	100%	100.02%	0.000000	-0.00044	0.00078	-0.00044	0.00002	0.00000
1A3c	Railways	PCB	0.0202	NA	2%	100%	100.02%	0.000000	0.00000	0.00000	0.00000	0.00000	0.00000
1A4ciii	Agriculture/Forestry/Fishing: National fishing	PCB	NA	0.0003	2%	150%	150.01%	0.000000	0.00000	0.00314	0.00000	0.00009	0.00000
5C1bv	Cremation	PCB	NA	0.0032	2%	150%	150.01%	0.000001	0.00000	0.03798	0.00000	0.00107	0.00000
5C2	Open burning of waste	PCB	0.0405	0.0168	2%	150%	150.01%	0.000036	-0.04353	0.20088	-0.06530	0.00568	0.00004
TOTAL			8.375	4.232				1.071047					0.37155
						Uncertainty in total inventory:		103.49%				Trend uncertainty:	6.10%

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