REPUBLIC OF ESTONIA
ENVIRONMENT AGENCY

Estonian Informative Inventory Report 1990-2015

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 (2011) *"Thermonuclear Fusion in the Bog"*

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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 4	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.

Forest in the evening light (photo by Kristjan Klementi)

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 1990-2015 together with projections were submitted on 14th February 2017. 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 2014. The reasons for the recalculations are specified in Table 0.1 below:

Table 0.1 The status of recalculations in the 2017 submission

NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A1c	Manufacture of solid fuels and other energy industries	Emissions are reallocated from NFR 1A1b to NFR 1A1c as more appropriate subcategory for reporting emissions from the some technology equipment of oil shale oil production.	NO_x, NMVOC, CO	2008-2014
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	Emissions are reallocated from NFRs 1A2a-e to NFR 1Agviii	SO_x	2000-2001, 2003, 2008-2009
			NO_x	2001-2004, 2006, 2008-2009
			NMVOC	2003, 2006, 2008-2009
			$PM_{2.5}$, PM_{10}, TSP, BC, CO	2000-2009
			Pb	2001-2002, 2006, 2008-2009
			Cd, Hg	2008
			As, Cu	2008-2009
			Cr, Ni	2001-2009
			Zn	2004-2009
			PCDD/F, PAHs Total, HCB, PCB	2009
1A3ai(i)	International aviation LTO (civil)	Correction of f-BC calculations	BC	2000-2008, 2011
1A3ai(ii)	International aviation cruise (civil)	Correction of f-BC calculations	BC	2014
1A3aii(i)	Domestic aviation LTO (civil)	Correction of f-BC calculations	BC	2000-2008, 2011
1A3aii(ii)	Domestic aviation cruise (civil)	Correction of f-BC calculations	BC	2014
1A3bi	Road transport: Passenger cars	Correction of sulphur content in fuel. Other pollutants (NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, CO) emissions changed also because sulphur content is related to correction functions in emission calculations for gasoline fuel.	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, CO	2014
1A3bii	Road transport: Light duty vehicles	Correction of sulphur content in fuel. Other pollutants ($PM_{2.5}$, PM_{10}, TSP, CO) emissions changed also because sulphur content is related to correction functions in emission calculations for gasoline fuel.	SO_x, $PM_{2.5}$, PM_{10}, TSP, CO	2014

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NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
1A3biii	Road transport: Heavy duty vehicles and buses	Correction of sulphur content in fuel. Other pollutants ($PM_{2.5}$, PM_{10} and TSP) emissions changed also because sulphur content is related to correction functions in emission calculations for gasoline fuel.	SO_x, $PM_{2.5}$, PM_{10}, TSP	2014
1A3biv	Road transport: Mopeds & motorcycles	Correction of sulphur content in fuel. Other pollutants (CO) emissions changed also because sulphur content is related to correction functions in emission calculations for gasoline fuel.	CO	2014
1A3di(i)	International maritime navigation	Correction of PCB emission factors for marine diesel oil and gas oil.	PCBs	1990-2014
1A3di(ii)	National navigation (shipping)	Corrections of activity data	NO_x, NMVOC, SO_x, NH_3, TSP, CO, Cd, Cr, Cu, Ni, Se, Zn	1993
1A4bi	Residential: Stationary	Corrections of activity data	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, I(1,2,3-cd)p, PAHs Total, HCB, PCB	2014
		Correction of emission factor for the liquid fuels	B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total	1990-2014
1A4ci	Agriculture/Forestry/Fishing: Stationary	Correction of emission factor	PCB	1993
1B1c	Other fugitive emissions from solid fuels	Emissions are reallocated from NFR 1B1a to NFR 1B1c as more appropriate subcategory for reporting fugitive emissions from oil shale mining.	NO_x, NMVOC, SO_x, $PM_{2.5}$, PM_{10}, TSP, CO	2000-2014
			NH_3	2004-2014
2A5b	Construction and demolition	New emission factor in EMEP/EEA Guidebook 2016 is used. Corrections of activity data.	$PM_{2.5}$, PM_{10}	2000-2014
			TSP	1990-2014
2D3d	Coating application	Corrections in statistical data from Statistics Estonia	NMVOC	2014
2D3e	Degreasing	Corrections in statistical data from Statistics Estonia	NMVOC	2014
2D3h	Printing	Corrections in statistical data from Statistics Estonia	NMVOC	2014
2D3i	Other solvent use	Corrections in statistical data from Statistics Estonia	NMVOC	2014
2G	Other product use	Corrections in statistical data from Statistics Estonia	NMVOC	2013-2014
3B1a	Manure management - Dairy cattle	More detailed calculation method for NMVOC calculation is used. New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B1b	Manure management - Non-dairy cattle	More detailed calculation method is used. New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B2	Manure management - Sheep	New emissions factors from EMEP/EEA Guidebook 2016 is used. Sheep and goats emission is calculated separately first time.	NO_x, NH_3, NMVOC, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B3	Manure management - Swine	Corrections in statistical data. More detailed calculation method were used for NO_x and NH_3.	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, TSP	1990-2014

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NFR14 code	NFR name	Recalculation reasons	Pollutant	Recalculation period
3B4d	Manure management - Goats	New emissions factors from EMEP/EEA Guidebook 2016 is used. Sheep and goats emission is calculated separately first time.	NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B4e	Manure management - Horses	New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, NMVOC, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B4gii	Manure management - Broilers	New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B4gi	Manure management - Laying hens	New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, PM_{10}, $PM_{2.5}$, TSP	1990-2014
3B4giv	Manure management - Other poultry	New emissions factors from EMEP/EEA Guidebook 2016 is used.	PM_{10}, $PM_{2.5}$, TSP	1990-2014
3Da1	Inorganic N-fertilizers (includes also urea application)	More detailed allocation between 3Da1, 3Dc and 3De sector. New emissions factors from EMEP/EEA Guidebook 2016 is used.	NO_x, NH_3	1990-2014
3Da2a	Animal manure applied to soils	More detailed allocation between 3B1a, 3B1b and 3D sector.	NH_3	1990-2014
3Da2b	Sewage sludge applied to soils	Additionally calculated	NO_x, NH_3	1990-2014
3Da2c	Other organic fertilisers applied to soils (including compost)	Additionally calculated	NO_x, NH_3	1990-2014
3Da3	Urine and dung deposited by grazing animals	More detailed allocation between 3B1a, 3B1b and 3D sector.	NH_3	1990-2014
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	More detailed allocation between 3Da1, 3Dc and 3De sector. New emissions factors from EMEP/EEA Guidebook 2016 is used.	PM_{10}, $PM_{2.5}$, TSP	1990-2014
3De	Cultivated crops	More detailed allocation between 3Da1, 3Dc and 3De sector. New emissions factors from EMEP/EEA Guidebook 2016 is used.	NMVOC	1990-2014
5A	Biological treatment of waste – Solid waste disposal on land	Correction of calculated emissions	NMVOC	2003, 2009, 2013-2014
		Additionally calculated	NH_3	2007-2008
		Correction of calculated emissions	$PM_{2.5}$, PM_{10}	2008
5B2	Biological treatment on waste – Anaerobic digestion at biogas facilities	Additionally calculated	NO_x, NMVOC, SO_x, TSP, CO	2011-2012
		Additionally calculated	NH_3	2011-2014
5C2	Open burning of waste	Corrections of activity data	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	2014
5D2	Industrial wastewater handling	Correction of calculated emissions	NMVOC	2014
5E	Other waste	Correction of calculated emissions	$PM_{2.5}$, PM_{10}, TSP, PCDD/F	2014
		Correction of calculated emissions	As, Cr	1998-2014
		Correction of calculated emissions	Cu	2012-2014

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

The differences in total emissions between the 2016 and 2017 submissions are presented in Table 0.2.

Table 0.2 Difference between the 2016 and 2017 submissions (%)

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
1990	1.34	-2.50	0	-19.59	NR	NR	1.69	NR	0	0	0
1991	1.18	-2.53	0	-20.64	NR	NR	1.19	NR	0	0	0
1992	1.83	-2.09	0	-21.42	NR	NR	1.02	NR	0	0	0
1993	-1.92	-3.66	-0.21	-26.46	NR	NR	0.59	NR	-0.52	0	-0.01
1994	0.83	-3.24	0	-13.95	NR	NR	0.68	NR	0	0	0
1995	0.60	-2.72	0	-11.67	NR	NR	0.61	NR	0	0	0
1996	0.47	-2.26	0	-13.03	NR	NR	0.93	NR	0	0	0
1997	0.60	-1.88	0	-13.30	NR	NR	1.21	NR	0	0	0
1998	0.79	-1.92	0	-14.53	NR	NR	2.27	NR	0	0	0
1999	0.67	-1.56	0	-10.99	NR	NR	1.74	NR	0	0	0
2000	0.76	-1.64	0	-14.67	0.19	0.96	2.26	-0.00	0	0	0
2001	0.64	-1.84	0	-13.62	0.12	0.84	2.36	-0.00	0	0	0
2002	0.54	-1.63	0	-11.46	0.23	1.62	4.73	-0.00	0	0	0
2003	0.81	-1.51	0	-10.82	0.36	2.45	6.26	-0.00	0	0	0
2004	0.91	-1.17	0	-11.65	0.61	4.20	10.53	-0.00	0	0	0
2005	0.87	-0.80	0	-9.42	0.63	4.42	12.58	-0.00	0	0	0
2006	1.00	-0.66	0	-10.45	1.08	7.21	19.64	-0.00	0	0	0
2007	1.14	-0.62	0	-9.33	0.76	4.78	15.30	-0.00	0	0	0
2008	1.55	-1.04	0	-13.08	1.07	7.49	22.19	-0.00	-0.00	0	0
2009	1.52	-1.27	0	-11.93	0.78	5.67	18.16	0	-0.02	0	0
2010	1.32	-1.08	0	-12.24	0.30	2.19	8.44	0	0	0	0
2011	1.31	-0.85	0.00	-12.81	0.22	1.37	5.48	-0.00	0.00	0	0
2012	1.58	-0.60	0.00	-13.77	0.46	3.71	17.75	0	0.00	0	0
2013	1.79	-0.29	-0.01	-13.72	0.66	4.81	17.34	-0.00	-0.01	0	-0.01
2014	2.26	0.16	-0.01	-14.56	1.63	5.67	17.72	1.71	1.35	-0.05	-0.07

Table 0.2 continues

Year	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	PAHs Total	HCB	PCBs
1990	0	0	0	0	0	0	0	0	-8.62	0	0
1991	0	0	0	0	0	0	0	0	-5.98	0	0
1992	0	0	0	0	0	0	0	0	-1.75	0	0
1993	0	0	-0.02	-1.00	-0.02	-4.32	-0.05	0	-1.15	0	-42.69
1994	0	0	0	0	0	0	0	0	-0.30	0	0
1995	0	0	0	0	0	0	0	0	-0.18	0	0
1996	0	0	0	0	0	0	0	0	-1.02	0	0
1997	0	0	0	0	0	0	0	0	-0.85	0	0
1998	0	0.00	0.00	0	0	0	0	0	-1.33	0	0
1999	0	0.00	0.00	0	0	0	0	0	-2.32	0	0
2000	0	0.00	0.00	0	0	0	0	0	-2.25	0	0
2001	0	0.00	0.00	0	0	0	0	0	-1.05	0	0
2002	0	0.00	0.00	0	0	0	0	0	-2.22	0	0
2003	0	0.00	0.00	0	0	0	0	0	-1.87	0	0
2004	0	0.00	0.00	0	0	0	0	0	-1.10	0	0
2005	0	0.00	0.00	0	0	0	0	0	-1.16	0	0
2006	0	0.00	0.00	0	0	0	0	0	-1.40	0	0
2007	0	0.00	0.00	0	0	0	0	0	-1.18	0	0
2008	0	0.00	0.00	0	0	0	0	0	-1.47	0	0
2009	0	0.00	0.00	0	0	-0.27	0	0	-0.99	0	0
2010	0	0.00	0.00	0	0	0	0	0	-0.70	0	0
2011	0	0.00	0.00	0	0	0	0	0	-1.10	0	0
2012	0	0.00	0.00	-0.00	0	0	0	-0.00	-0.95	0	0
2013	-0.00	-0.00	0.00	-0.00	0	0	0	-0.00	-0.84	0	0
2014	0	-0.00	0.00	0.00	-0.00	0	-0.00	2.80	1.27	0.74	-0.02

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 particulates. The main reason for the ammonia emission change is a transition from Tier 1 calculation method to Tier 2 calculation method in the agriculture sector. The main reason for the particulates emissions change is a updating of emission factors for construction and demolition sector in new EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and correcting of activities data.

The inventory improvements made during 2016:

- Recalculation of particulates for construction and demolition sector;
- Recalculations done in the agriculture sector are due to the updating of emission factors for new EMEP/EEA Guidebook 2016. Emissions from sewage sludge and compost application are reported, for the first time. In addition, emissions from the sheep and goats category are calculated separately for the first time;
- Additionally calculated emission from forest fires.

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.

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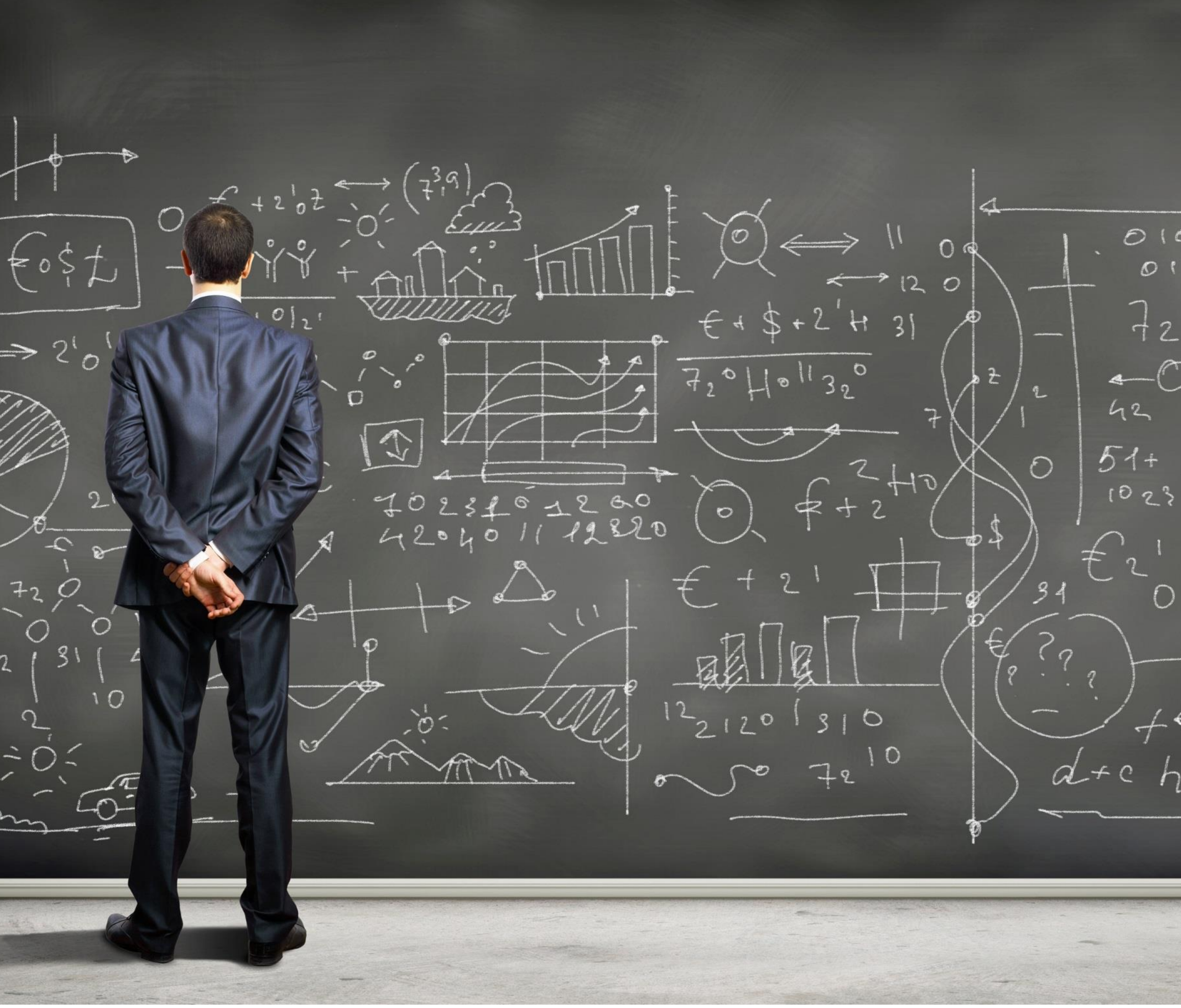

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1. INTRODUCTION

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 2016. The report contains information on Estonian emission inventory from 1990 to 2014. 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 1990 reports in 2015) 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 2013.

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.

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, the Estonian Rescue Board, the Estonian Defence Forces, the Estonian Road Administration, the 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.

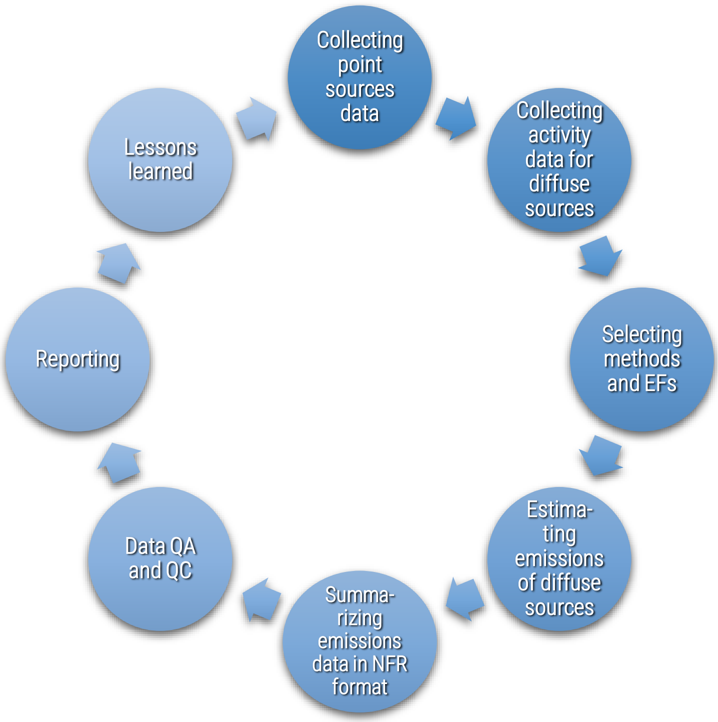

Figure 1.1 The main activities of inventory preparation

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 2015 the number had increased to 1.990.

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 Ministry of the Environment (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 Ambient Air 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).

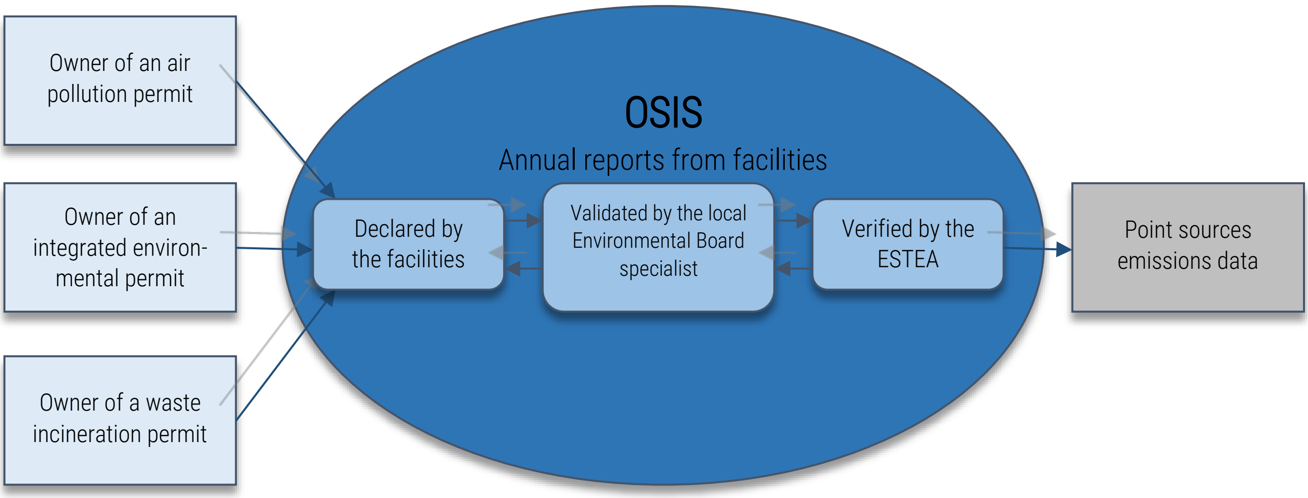

Figure 1.2 Validation of Estonian point sources data

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.

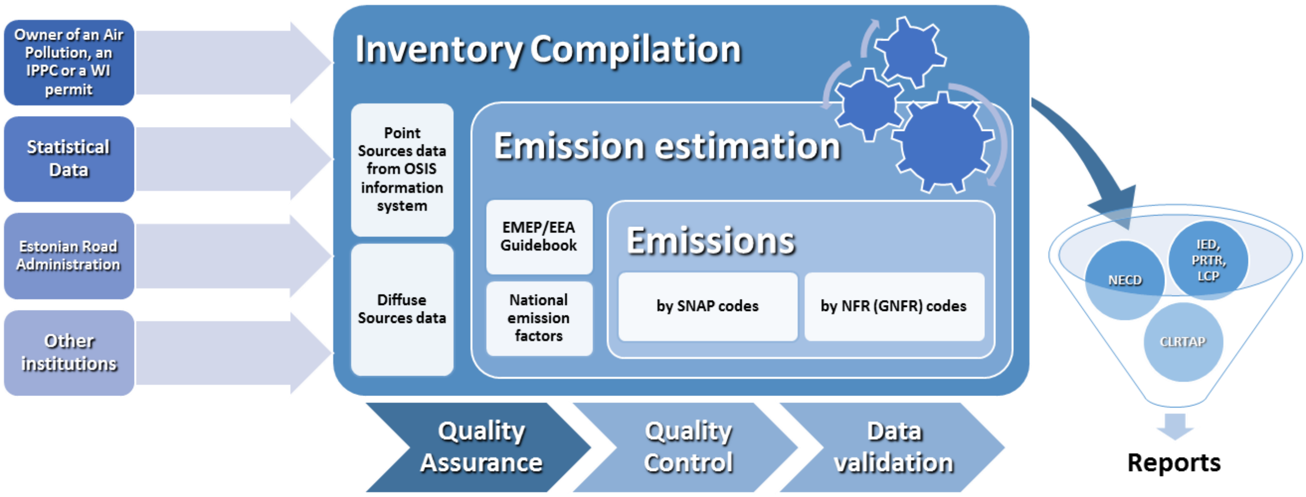

Figure 1.3 Air pollution inventory structure

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 4 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 Estonian Weather Service 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 2015, only the level assessment was chosen.

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

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

Combustion in residential plants (1A4bi) is also a main source of NMVOC (14.7%). Additionally, road transport (1A3bi) decorative coating application (2D3d), domestic solvent use (2D3a), 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 2015 from the energy sector are responsible for 78.2% of SO_2 emissions in 2015. 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) 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. Also 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, 52.5% 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													92.2
	78.2%	14.1%													
NO_x	1A1a	1A4bi	1A3biii	1A4cii	1A3bi	3Da1									80.6
	24.7%	15.9%	13.7%	10.9%	10.7%	4.7%									
NH_3	3Da2a	3B1a	3Da1	3Da3	3B3	3B4giv	3B4gi								81.0
	25.6%	16.3%	15.4%	9.1%	7.5%	3.9%	3.4%								
NMVOC	1A4bi	2D3d	3B1a	2D3a	3B1b	1A3bi	2D3e	1B2av	1A2gviii	1A1c	2D3i	2H2	1A1a	2D3h	80.5
	14.7%	14.2%	9.1%	6.9%	5.5%	4.7%	4.4%	4.3%	3.5%	3.3%	2.9%	2.9%	2.1%	2.1%	
CO	1A4bi	1A1c	1A3bi												82.9
	52.5%	22.4%	8.0%												
TSP	2A5b	1A1a	1A2gviii	1A4bi	3Dc	1A4ai									81.0
	27.5%	21.6%	14.3%	11.9%	3.8%	1.8%									
PM_{10}	1A1a	1A2gviii	1A4bi	2A5b	3Dc										82.5
	28.7%	19.2%	16.5%	12.5%	5.7%										
$PM_{2.5}$	1A2gviii	1A1a	1A4bi	1A4ai											81.9
	27.6%	26.9%	24.4%	3.1%											
Pb	1A1a														91.9
	91.9%														
Hg	1A1a														91.1
	91.1%														
Cd	1A1a	1A4bi													92.3
	65.9%	26.4%													
DIOX	1A1a	1A4bi	5E	5C1bi	1A2gviii										85.9
	24.5%	22.3%	16.0%	15.4%	7.6%										
PAH	1A4bi	1A1a	1A2gviii												96.3
	42.9%	36.8%	16.6%												
HCB	1A4bi	1A1a													83.0
	56.8%	26.2%													

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1.6. QA/QC and Verification Methods

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

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

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

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

- **Stakeholder engagement (stakeholders = e.g. suppliers of data, reviewers, recipients, other inventory compiling institutes):** The Estonian inventory was reviewed under the stage 3 review in 2016 summer by the EMEP emission centre CEIP acting as the review secretariat. The results are available at CEIP home page (http://www.ceip.at/review-process/centralised-review-stage-3/).
- **Data collection:** Data collection includes both point sources emissions and diffuse sources activity. Prior to using activity data, common statistical quality checking related to the assessment of trends is carried out.
  ESTEA uses only point sources data which are checked and validated by local environmental departments.
- **Data manipulation:** Common statistical quality checking is carried out.
- **Inventory compilation:** Before submitting data to CEIP/EEA NFR, formats have to be checked with RepDab.
- **Reporting**
- **Archiving**

1.7. General Uncertainty Evaluation

Uncertainty analysis has been carried out for the 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 hydrocarbons (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 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 infosystem
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 infosystem
5D1	2	National statistics; operators data
5D2	2	National statistics; operators data
5D3	2	National statistics; operators data
5E	2	National statistics; operators data

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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											
2D3f		B											

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NFR sector	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	CO	Heavy metals	Dioxin	PAHs	HCB	PCB
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.

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: 1990–2015;
- PM_{10} and $PM_{2.5}$: 2000–2015;
- BC: 2000–2015;
- All heavy metals: 1990–2015;
- POPs: 1990–2015.

Table 2.1 Main pollutant emissions in the period of 1990-2015 (kt)

Year	NO_x	NMVOC	SO_2	NH_3	CO	$PM_{2.5}$	PM_{10}	BC	TSP
1990	77.270	65.404	272.392	21.744	215.002	NR	NR	NR	279.070
1991	71.211	62.717	250.097	19.286	215.150	NR	NR	NR	277.738
1992	46.263	42.874	190.995	16.312	120.695	NR	NR	NR	249.312
1993	40.732	34.828	155.223	11.978	121.827	NR	NR	NR	195.381
1994	46.187	37.303	150.048	11.527	157.647	NR	NR	NR	169.948
1995	47.198	42.219	115.736	10.773	212.389	NR	NR	NR	127.407
1996	51.612	42.867	124.705	9.583	235.815	NR	NR	NR	115.292
1997	50.673	45.278	115.933	9.771	248.316	NR	NR	NR	92.256
1998	45.567	39.236	104.158	9.662	195.739	NR	NR	NR	84.150
1999	43.527	38.984	97.779	8.830	203.911	NR	NR	NR	82.540
2000	44.400	37.971	97.108	8.574	194.893	15.325	32.069	3.418	70.145
2001	46.329	37.387	90.705	8.835	197.129	16.246	31.978	3.703	68.344
2002	46.997	36.641	87.029	8.812	186.495	16.635	28.053	3.890	48.481
2003	47.847	35.249	100.320	9.746	176.586	14.285	24.329	3.660	44.468
2004	44.863	34.968	88.175	9.859	169.493	15.427	24.889	3.780	43.125
2005	41.256	32.936	76.246	9.624	153.430	14.193	22.468	3.440	35.705
2006	39.859	31.322	69.900	9.765	138.767	9.761	16.303	2.486	27.209
2007	44.228	29.077	88.034	10.158	154.685	12.683	22.776	2.988	32.833
2008	41.486	26.876	69.477	10.879	155.010	11.928	19.031	3.072	28.441
2009	35.934	24.278	54.876	10.366	153.917	9.620	15.496	2.542	22.600
2010	42.298	23.956	83.273	10.613	154.769	13.894	23.359	3.147	30.141
2011	40.424	23.576	72.768	10.695	130.282	18.170	34.383	3.468	42.649
2012	37.141	23.324	40.626	11.037	140.411	8.164	13.013	2.136	19.582
2013	34.461	22.807	36.528	11.087	133.616	10.786	17.497	2.500	23.409
2014	34.087	22.573	40.835	11.143	128.226	7.904	13.204	1.970	19.600
2015	30.737	22.917	31.807	11.645	128.086	9.151	14.006	2.482	21.054
Trend 1990-2015, %	-60.2	-65.0	-88.3	-46.4	-40.4	-40.3	-56.3	-27.4	-92.5
Trend 2005-2015, %	-25.5	-30.4	-58.3	21.0	-16.5	-35.5	-37.7	-27.9	-41

2.1. Sulphur Dioxide

During the period of 1990–2015, the emissions of sulphur dioxide had decreased by about 88%, 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 161 PJ in 2015) (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.

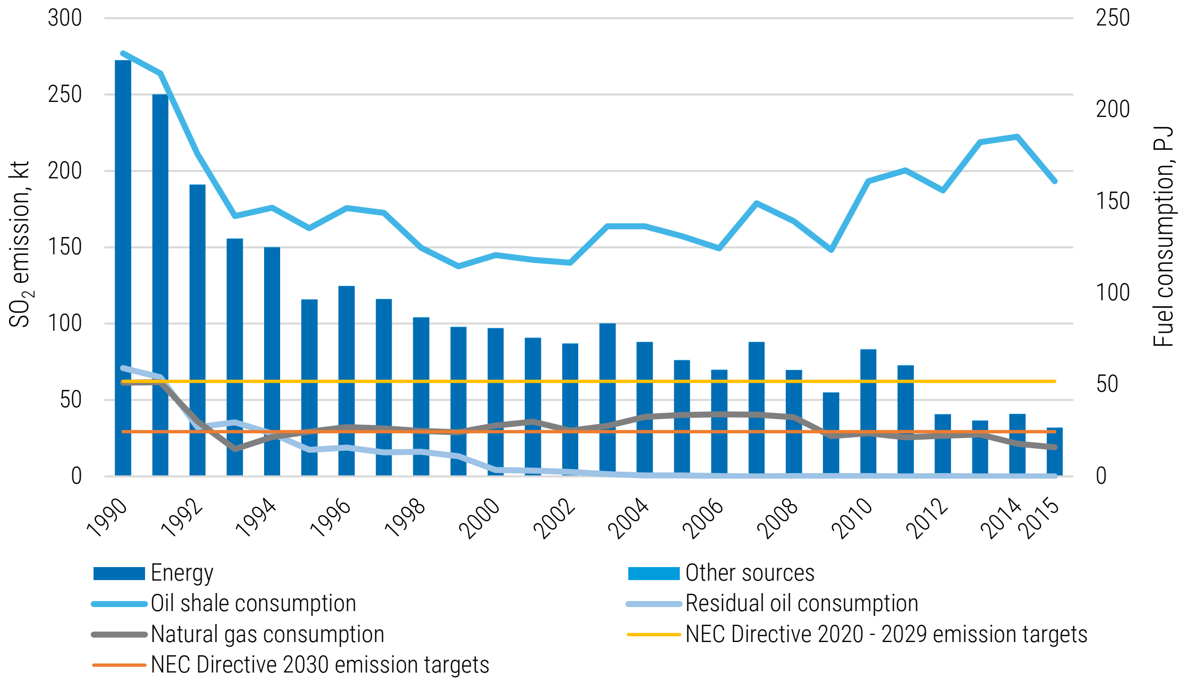

Figure 2.1 SO_2 emissions in the period of 1990–2015 and NEC Directive 2016/2284 targets

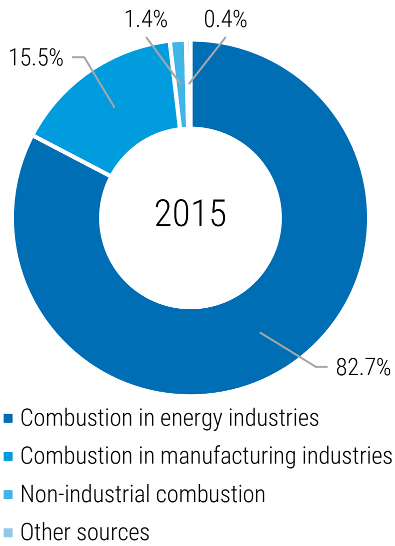

Figure 2.2 SO_2 emissions by sources of pollution in 2015

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

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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 2015, SO_2 emissions had decreased about 22% compared to 2014. The main reason is the decrease of electricity production by 16.3% at the same period. Another reason is that alongside oil shale, biomass is used in the newer units of the Narva power stations to produce electricity. In the Auvere Power Plant, it is possible to replace as much as 50% of oil shale with biomass. This way, Narva Power Plants use less oil shale in the electricity production and also generate less oil shale ash.

The share of energy sector, including mobile sources, in total SO_2 emission is 99.9%; the combustion in energy industry (NFR 1.A.1.a-c) is responsible for about 82.7% of total emissions in 2015 (Figure 2.2). The share of SO_2 emissions from the two large oil shale plants – Narva PP (Eesti and Balti) – accounts for approximately 54% of total emissions (the same indicator in 2005 was 71.5%).

According to the new NEC Directive 2016/2284, the Member States should comply with the emission reduction commitments set out in this directive. Estonia fulfilled the requirements of the directive and the Gothenburg Protocol of LRTAP Convention, which provided for the reduction of sulphur dioxide emissions by 32% relative to 2005 baseline emissions by 2020, already in 2015. SO_2 emissions decreased by 58% in 2015 compared to 2005.

2.2. Nitrogen Oxides

Emissions of nitrogen oxides have decreased by 60.2% 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% and 25% respectively. The share of other mobile sources was 21% and non-industrial combustion – 17% in 2015 (Figure 2.4).

In 2015, NO_x emissions decreased by 9.8% 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. 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*).

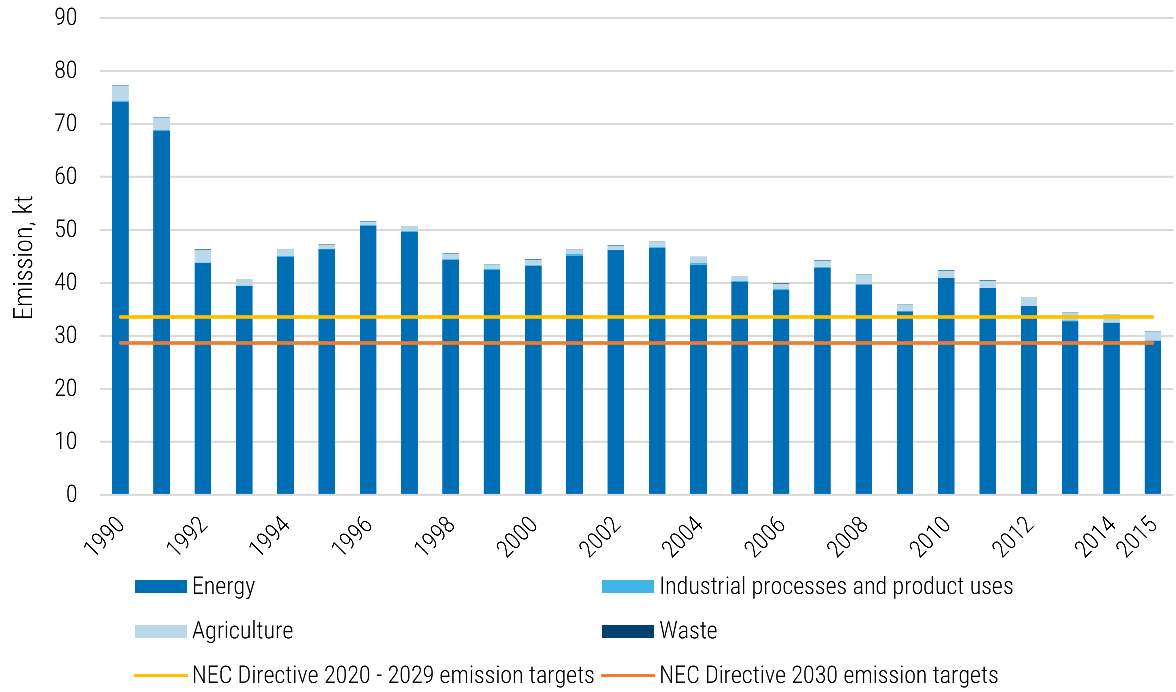

Figure 2.3 NO_x emissions in the period of 1990-2015 and NEC Directive 2016/2284 targets

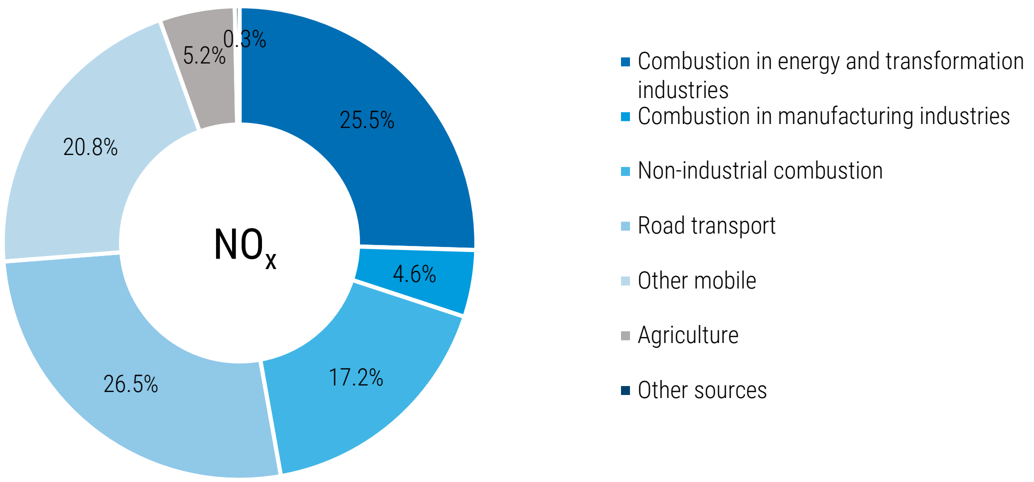

Figure 2.4 NO_x emissions by sources of pollution in 2015

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 25.5% in 2015 compared to 2005.

2.3. Non-Methane Volatile Compounds

In 2015, NMVOC emissions increased by 1.5% compared to 2014, mainly due to an increase in biomass combustion in industrial combustion plants. The decrease in emissions for the same period was observed in the road transport and fugitive emissions from fuel distribution (5.4% and 13.2% respectively) (Figure 2.6).

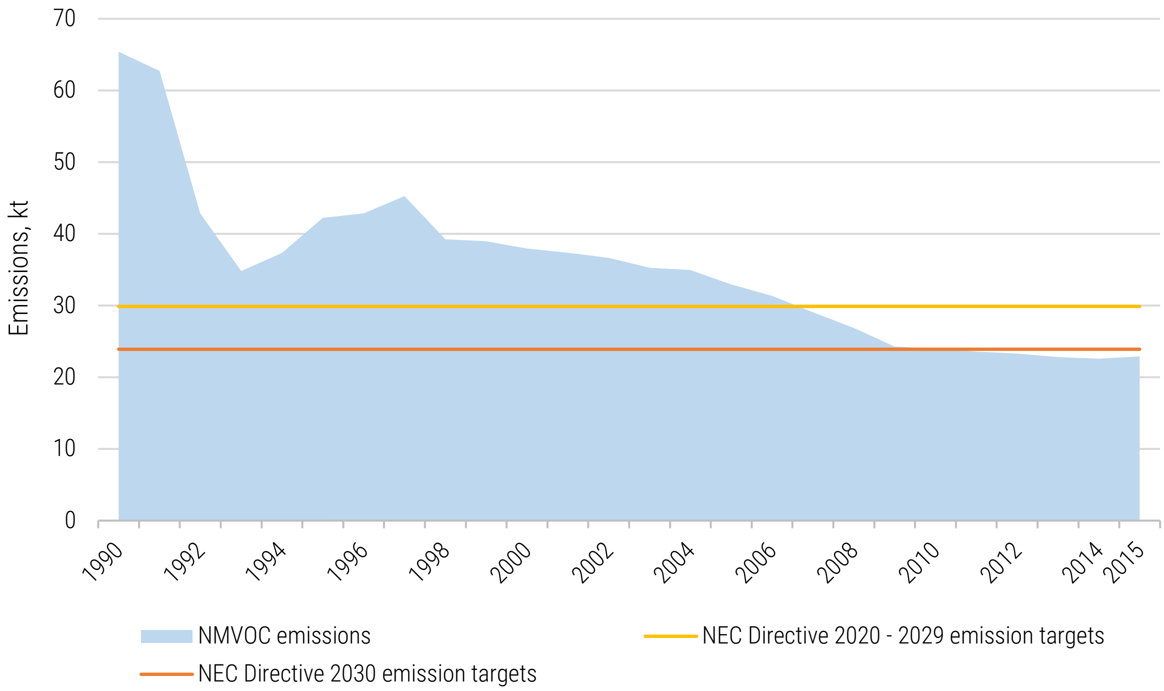

Figure 2.5 Emissions of non-methane volatile organic compounds in the period of 1990-2015 and NEC Directive 2016/2284 targets

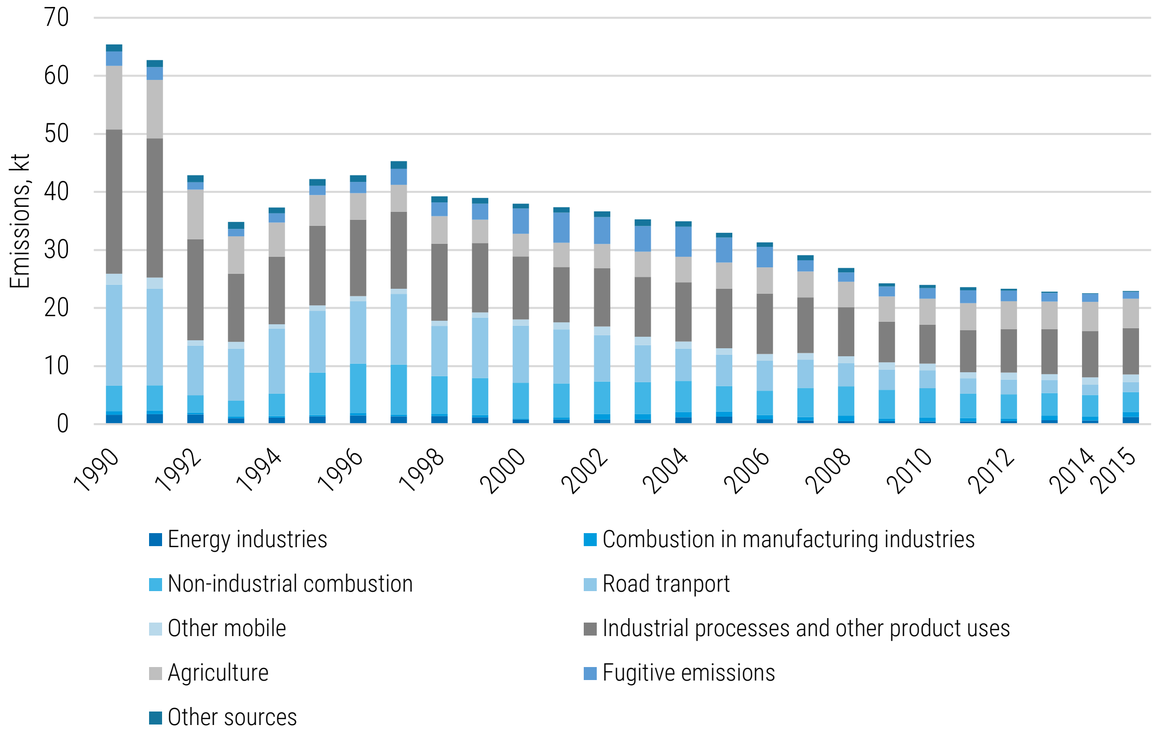

Figure 2.6 Emissions of non-methane volatile organic compounds in the period of 1990-2015

The total emissions of non-methane volatile organic compounds decreased by 65% between 1990 and 2015 (Table 2.1, Figure 2.5). In 1990, the main polluters of NMVOC were industrial processes and product uses (38%) and road transport (26%). In 2015, the dominant source was the same – industrial processes and product uses sector (35%), but share of non-industrial combustion has increased from 7% to 15% and share of road transport has decreased from 26%

to 7.5% (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 1990–2015, 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).

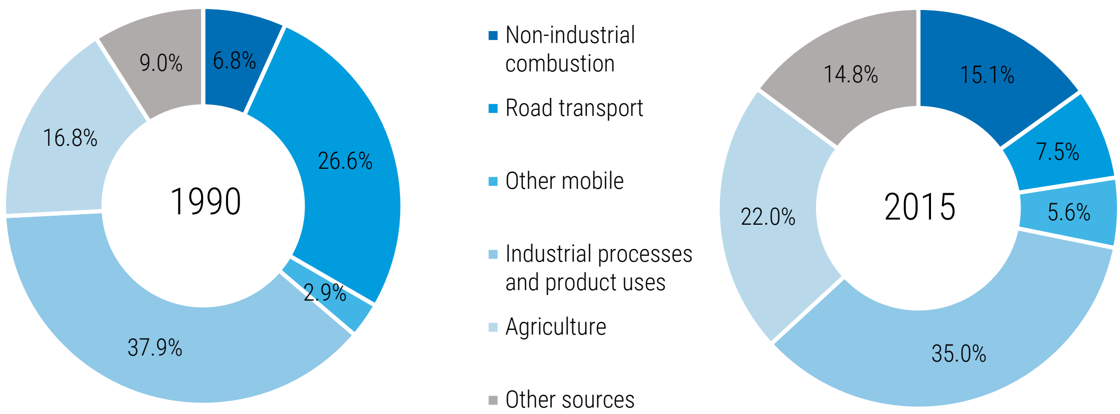

Figure 2.7 NMVOC emissions by sources of pollution in 1990 and 2015

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. NO_x emissions decreased by 30% in 2015 compared to 2005.

2.4. Ammonia

Total NH_3 emissions decreased by 46.4% between the years 1990 to 2015 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 90.8%). The non-industrial combustion sector is responsible for the 2.8% of total emissions, fugitive emissions from solid fuels (oil shale open cast mining, mainly explosive works) account for approximately 1.7% and road transport makes up 1.3%. The ammonia emissions from road transport have increased in recent years due to a growth in the use of new cars. All other sectors (manufacturing industry, waste, energy industry) account for approximately 2.7% of total ammonia emissions (Figure 2.9).

In 2015, the emissions of NH_3 increased by 4.5% compared to 2014, mainly due to the increase in the categories of dairy cattle and laying hens.

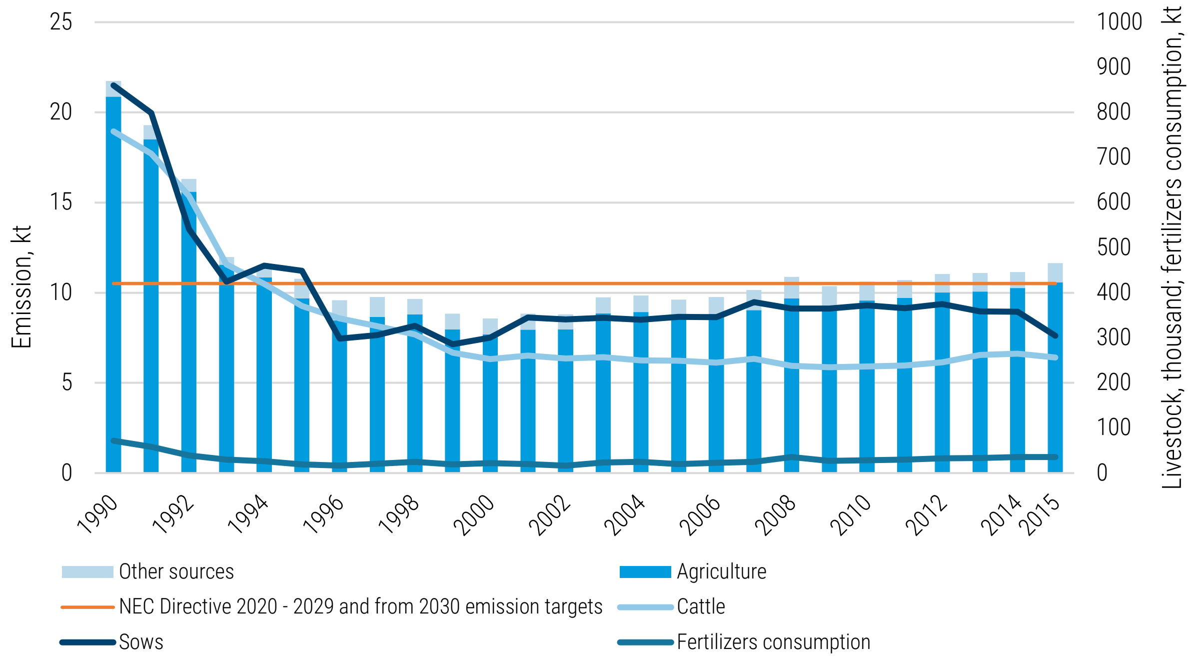

Figure 2.8 Emissions of ammonia in the period of 1990-2015 and NEC Directive 2016/2284 targets

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 2015, there was an increase in emissions of 24% compared to 2005.

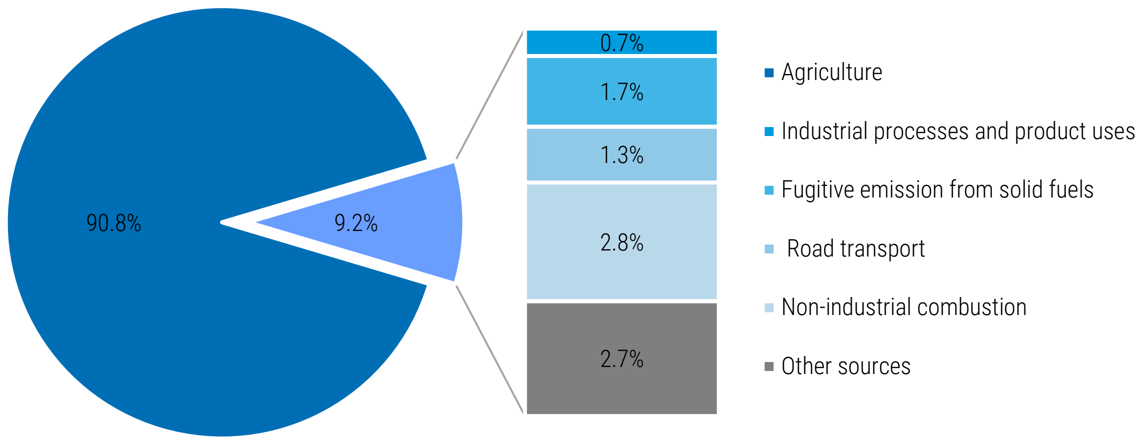

Figure 2.9 Ammonia emissions by sources of pollution in 2015

2.5. Carbon Monoxide

In the period of 1990–2015, the emissions of carbon monoxide decreased by 40.4%. That was, among other things, caused by the reduction in the use of vehicle fuels (especially from 1990 to 1992), and in recent years, by a decrease in the number of cars driving on petrol. The 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 (56.8%), while in 2015, the dominant source was non-industrial combustion (53.3%) (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 8.4% to 26.6%, mainly due to an increase in shale oil production in Eesti Energia Õlitööstus plc (Eesti Energia Oil Industry) plant.

In 2015, the biggest polluters of CO were combustion in the non-industrial sector (about 53%, from which a large part is wood combustion in the domestic sector), combustion in the energy industry (26.6%, mainly from shale oil production industry) and road transport – 9.7% (Figure 2.11).

Emissions in 2015 remained practically at the level of 2014, at the same time emission in manufacture of solid fuels and other energy industries sector has increased by 11%, but emissions in energy industries and residential sectors were reduced.

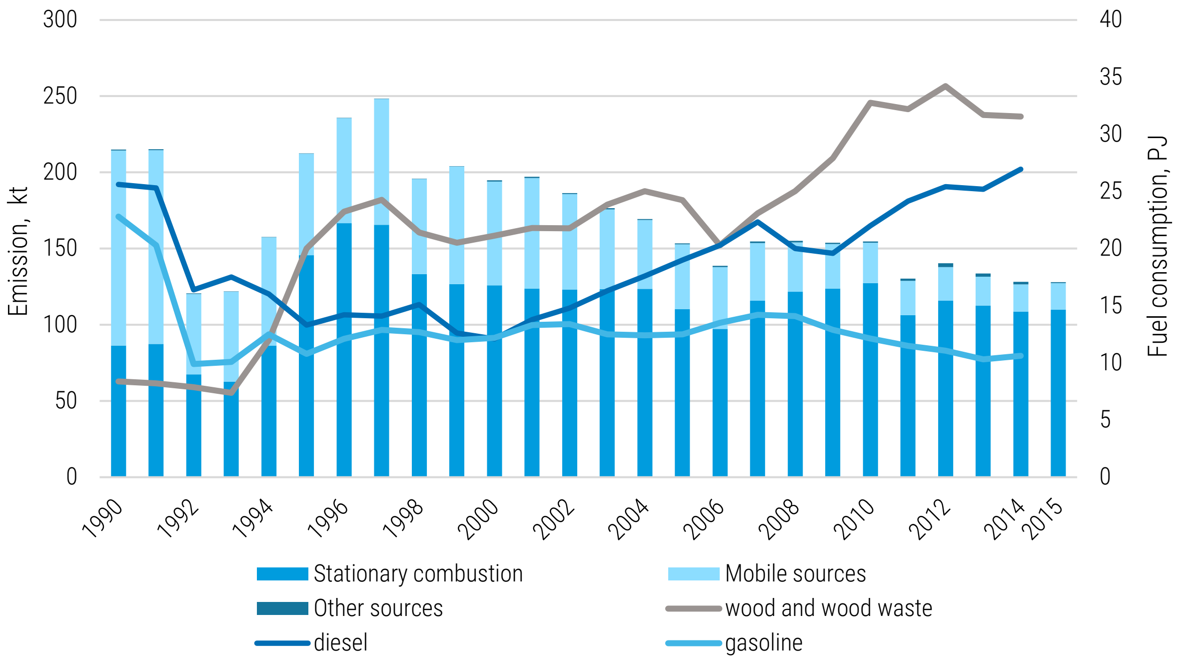

Figure 2.10 Emissions of carbon monoxide in the period of 1990-2015

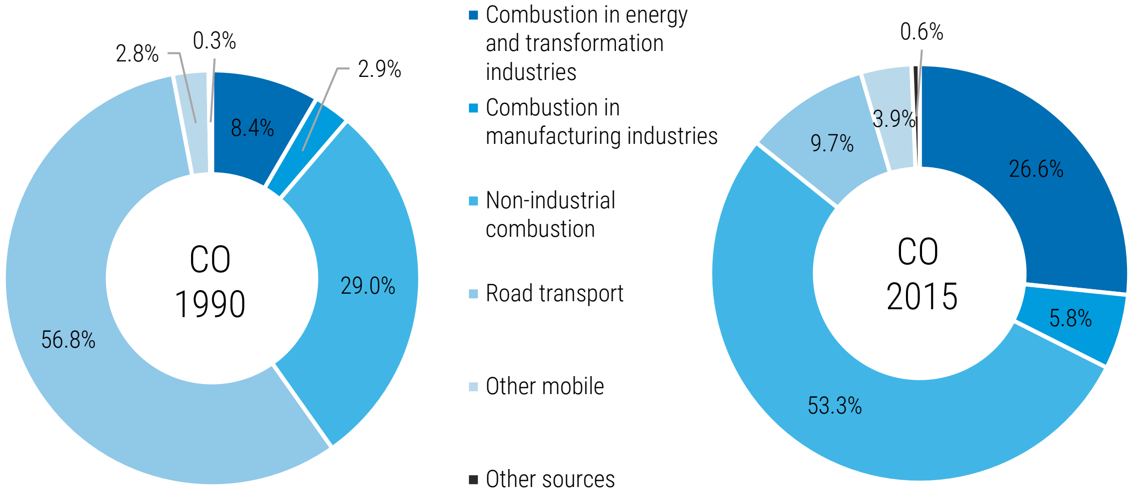

Figure 2.11 CO emissions by sources of pollution in 1990 and 2015

2.6. Particulates

The main source of particulate is the energy sector – 59.6%. The emissions of TSP by sectors of pollution are shown in Figure 2.13.

In 1990–2015, TSP emissions dropped signify-cantly – by 92.5% (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 plc) and it is a result of bad operation of electric precipitators on two power units of this power plant.

In 2015, particulate emissions increased by 7.4% compared to 2014, mainly due to the increase of emissions in combustion in manufacturing industries (the amount of the burned wood and wood waste has increased) and construction / demolition sectors.

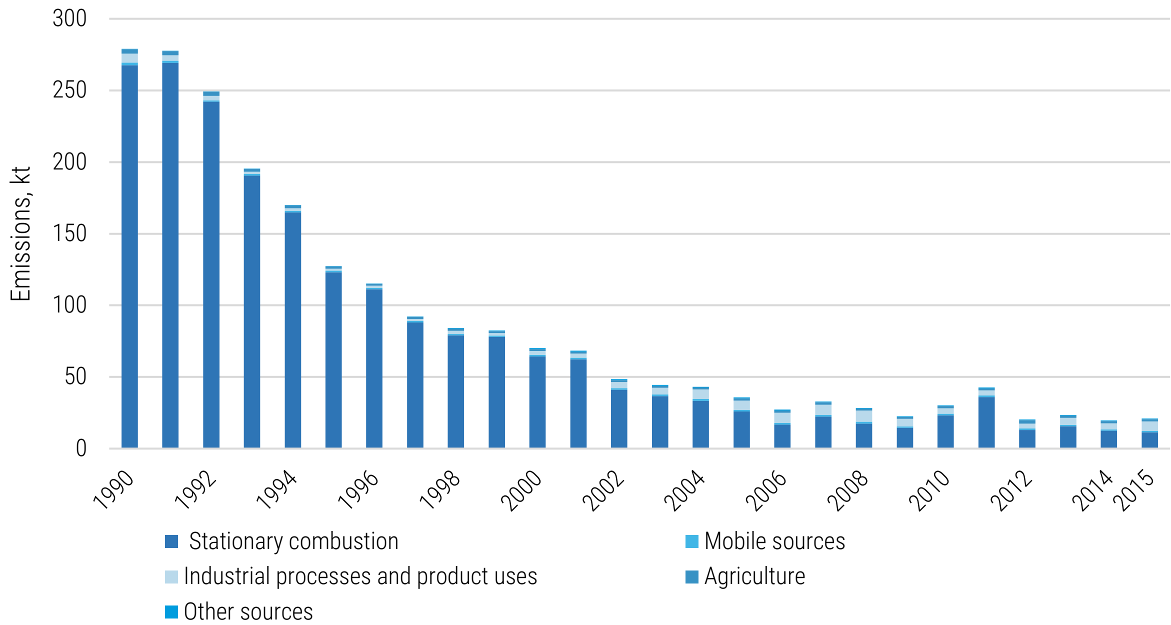

Figure 2.12 TSP emission in the period of 1990-2015

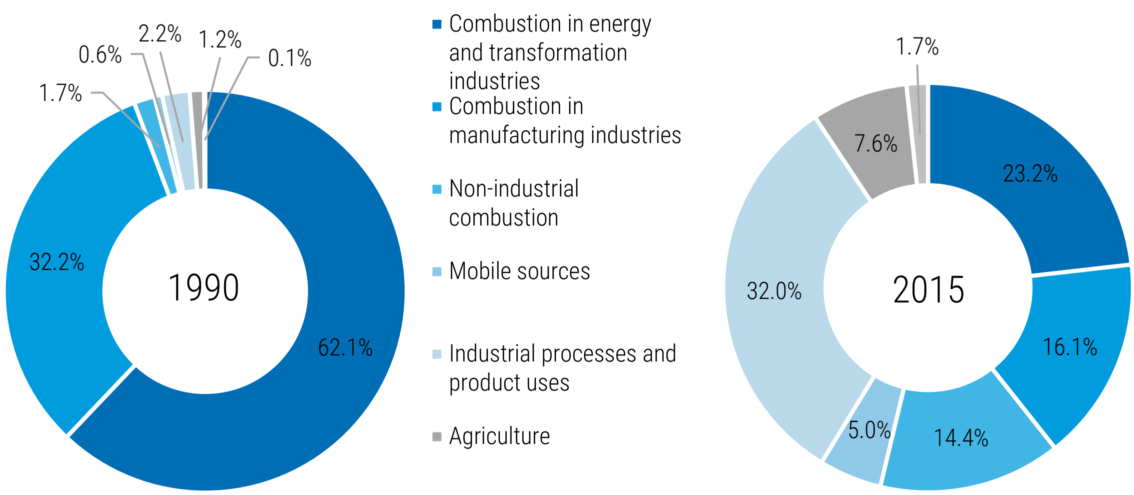

Figure 2.13 TSP emissions by sources of pollution in 1990 and 2015

In 1990, the main polluters of TSP were the energy industry (62%) and combustion in manufacturing industries (32%). In 2015, the share of combustion in energy industries dropped to 23% and dominant source was industrial processes and product uses (more precisely, construction and demolition) (32%). The share of industrial combustion has decreased by 16%, while the share of non-industrial combustion, agriculture, and mobile sources had increased by 12%, 6.5% and 4.4% 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 one of the oil shale power plants. Other sources contribute to 2% of the total emissions.

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

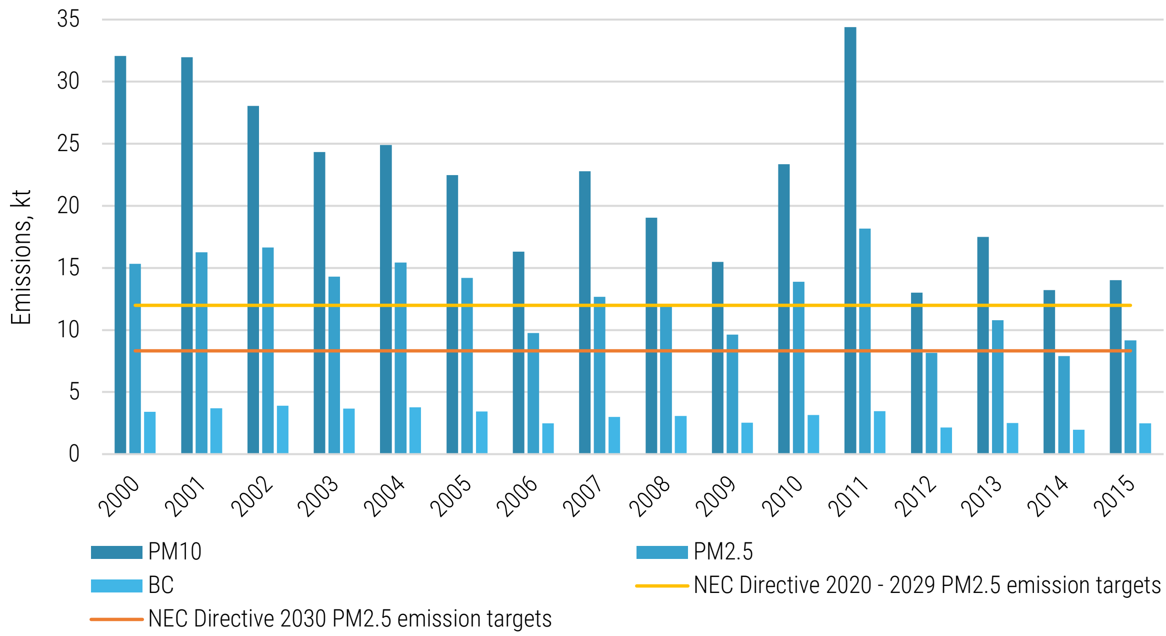

Figure 2.14 PM_{10}, $PM_{2.5}$ and BC emissions in the period of 2000–2015 and NEC directive 2016/2284 $PM_{2.5}$ targets

Emission of black carbon for all activities was calculated in this submission for 2000–2015. In the process of making the calculations, the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 methodology was applied.

In the period of 2000–2015, the emissions of PM_{10}, $PM_{2.5}$ and BC increased by 56.3%, 40.3% and 27.4% respectively, despite the increase in electricity production at the same period.

The increase in the PM_{10}, $PM_{2.5}$ and BC emissions in 2015 compared to 2014 (6.1%, 15.8% and 26% respectively) was the result of increasing the amount of wood burned in industrial boiler.

The primary sources of fine particulates (PM_{10}) emission in 2015 were combustion in energy and transformation industries (28.7%, mainly oil shale combustion), combustion in manufacturing industries (20.7%), and non-industrial combustion (19.4%, mainly wood combustion) (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 14.4% of the total emissions, then share in emissions of BC is significantly higher and makes up 37%.

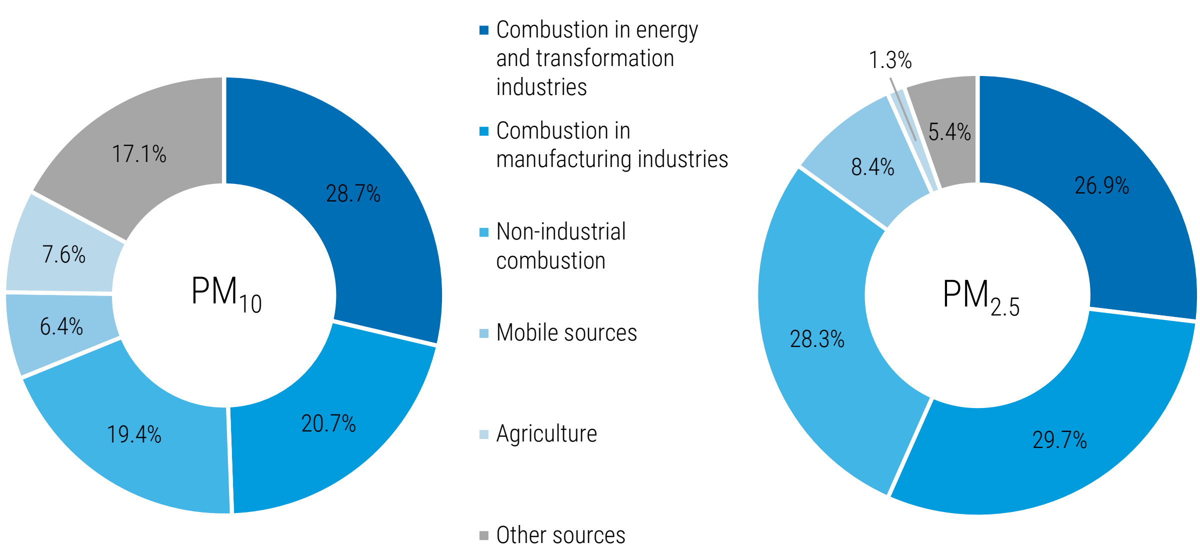

Figure 2.15 PM_{10} and $PM_{2.5}$ emissions by activities in 2015

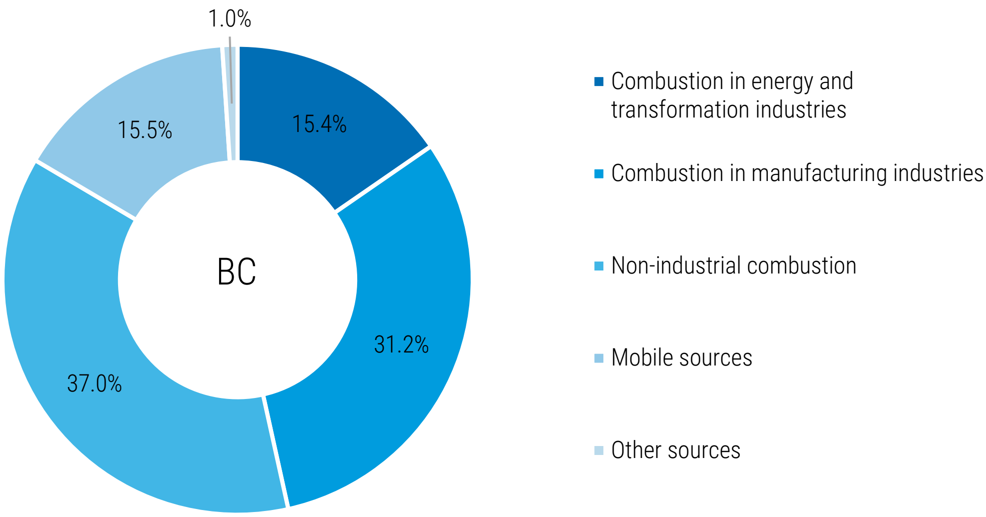

Figure 2.16 Black Carbon emission by activities in 2015

The primary sources of black carbon emission in 2015 were non-industrial combustion (37%), combustion in manufacturing industry (31%), mobile sources (15.5%), combustion in energy and transformation industries (15.4%, 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 25.5% in 2015 compared to 2005.

2.7. Heavy Metals

In 1990–2015, 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 1990-2015 (kt)

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
1990	206.003	4.505	1.154	18.867	18.395	10.059	27.325	106.843
1991	188.693	4.297	1.044	16.467	16.025	9.326	25.543	97.860
1992	124.688	3.089	0.857	14.048	13.798	6.658	16.953	79.791
1993	103.094	2.311	0.674	10.856	10.469	5.381	14.311	62.381
1994	123.334	2.975	0.676	10.698	10.324	5.934	12.835	65.582
1995	86.266	2.180	0.637	10.083	9.956	5.042	10.460	63.989
1996	66.746	1.306	0.633	10.376	10.225	4.593	10.824	62.499
1997	47.443	1.345	0.639	10.221	9.968	4.589	9.718	62.504
1998	40.115	1.223	0.572	9.166	8.905	4.184	8.765	55.719
1999	40.133	1.158	0.547	8.728	8.502	4.060	7.481	53.551
2000	36.944	0.774	0.550	8.607	8.354	3.728	6.448	49.900
2001	37.024	0.745	0.535	8.399	8.231	4.011	6.397	49.730
2002	36.351	0.771	0.539	8.372	8.351	4.172	6.163	49.124
2003	38.451	0.841	0.619	9.998	9.820	4.503	6.768	57.547
2004	36.770	0.786	0.569	9.794	9.386	4.549	6.650	57.766
2005	35.624	0.762	0.548	9.234	9.093	4.606	6.430	53.497
2006	32.127	0.729	0.550	8.603	8.464	4.517	5.749	49.057
2007	40.487	0.901	0.679	11.085	10.791	5.232	6.724	62.157
2008	35.363	0.829	0.598	9.416	9.329	4.741	5.902	55.386
2009	28.448	0.709	0.468	7.610	7.543	4.025	4.829	46.523
2010	39.030	0.897	0.653	10.971	10.594	4.966	6.587	62.733
2011	38.485	0.859	0.657	10.889	10.418	4.894	6.415	60.717
2012	33.979	0.793	0.579	9.605	9.178	4.724	5.637	55.047
2013	39.453	0.966	0.689	11.244	10.583	5.015	6.496	62.561
2014	36.528	0.897	0.680	10.253	9.850	5.048	6.023	57.481
2015	28.433	0.747	0.542	7.752	7.599	4.454	4.648	46.920
Trend 1990-2015, %	-86.2	-83.4	-53.1	-58.9	-58.7	-55.7	-83.0	-56.1

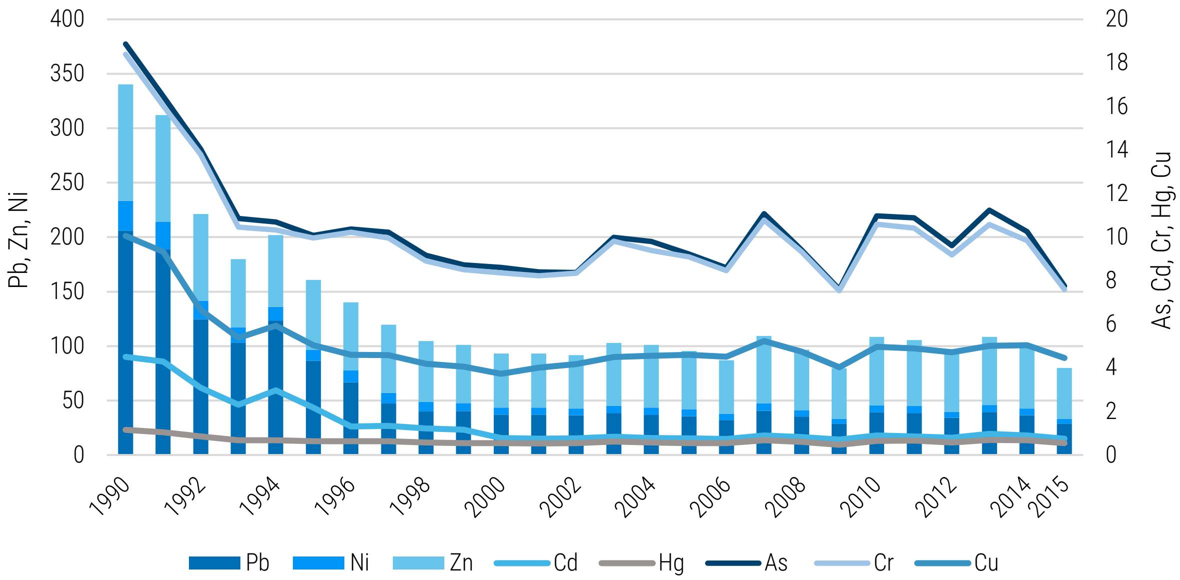

Figure 2.17 Heavy metals emissions in the period of 1990-2015 (kt)

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The emissions of lead by sources of pollution in 1990 and 2015 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 2015 the main source of pollution by all heavy metals was the energy industry (mainly oil shale power plants).

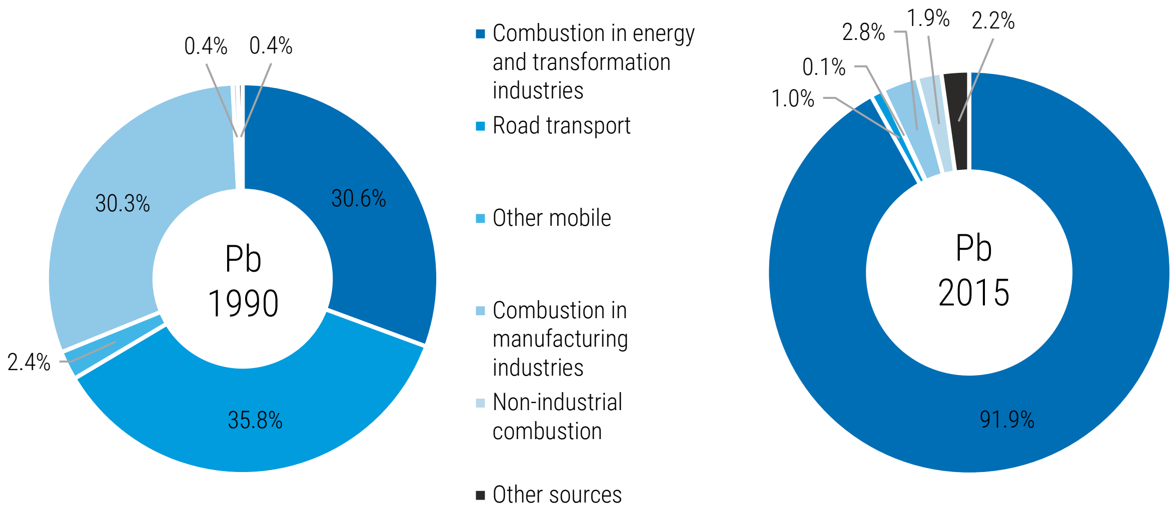

Figure 2.18 Lead emission by sources of pollution in 1990 and 2015

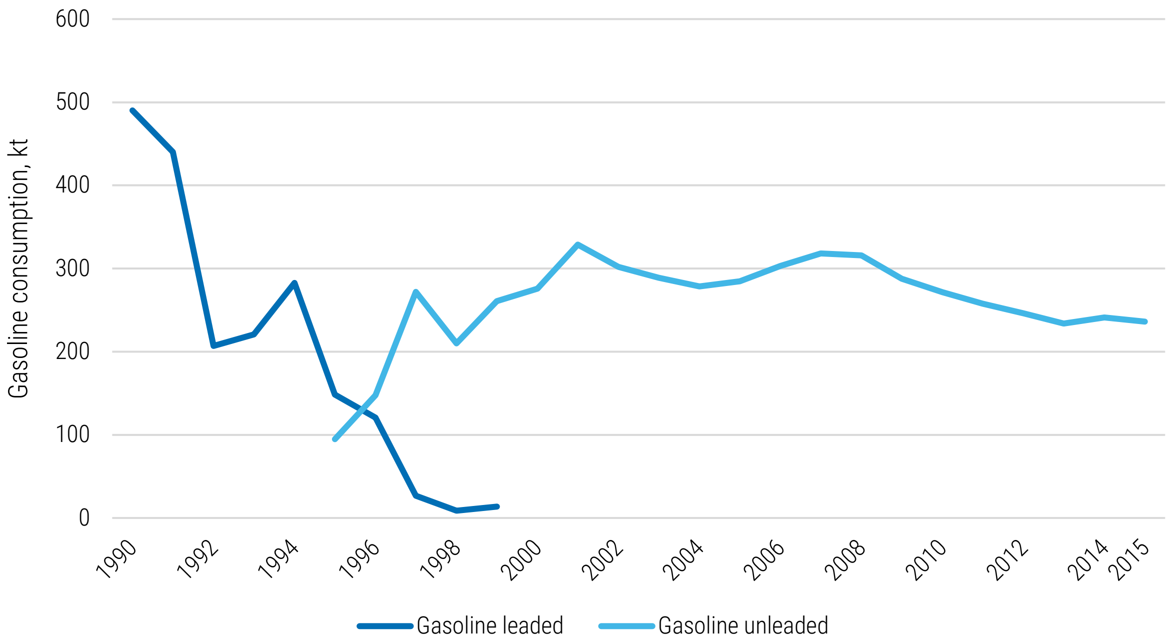

Figure 2.19 Gasoline consumption in 1990-2015

2.8. Persistent Organic Pollutants

In the period of 1990–2015, dioxin, PAHs total and PCB emissions decreased by approximately 49%, 14% and 49% respectively. Only HCB emissions increased for the same period by 44.9%, but decreased from 1995 to 2015 by 16.2%.

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

Table 2.3 POPs emissions in the period of 1990-2015

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	8.069	2.367	2.749	1.510	1.567	8.193	0.193	8.375
1991	7.958	2.349	2.772	1.498	1.540	8.158	0.187	8.539
1992	5.334	1.628	1.796	1.020	1.160	5.605	0.164	5.609
1993	4.235	1.384	1.483	0.887	1.060	4.815	0.143	5.048
1994	4.199	1.744	1.776	1.124	1.502	6.146	0.214	5.149
1995	5.593	2.821	2.756	1.826	2.611	10.013	0.333	4.122
1996	6.303	3.226	3.200	2.106	2.996	11.528	0.370	4.725
1997	6.289	3.223	3.189	2.106	3.014	11.533	0.382	4.317
1998	7.082	2.619	2.649	1.688	2.364	9.320	0.330	4.350
1999	7.096	2.549	2.629	1.638	2.259	9.075	0.315	3.773
2000	6.737	2.401	2.455	1.531	2.151	8.539	0.317	2.620
2001	6.556	2.331	2.439	1.488	2.058	8.316	0.322	4.197
2002	6.885	2.298	2.405	1.465	2.011	8.179	0.305	4.002
2003	6.876	2.309	2.435	1.444	1.995	8.182	0.312	4.756
2004	6.177	2.416	2.590	1.494	1.987	8.487	0.341	3.711
2005	5.731	2.211	2.432	1.339	1.735	7.717	0.289	3.725
2006	5.041	2.214	2.052	1.166	1.430	6.862	0.257	3.046
2007	6.669	1.901	1.978	1.222	1.705	6.806	0.316	1.807
2008	6.704	2.015	2.100	1.254	1.753	7.121	0.333	2.803
2009	6.094	2.136	2.250	1.314	1.821	7.521	0.307	3.058
2010	6.410	2.386	2.601	1.431	1.928	8.346	0.347	4.176
2011	6.302	2.022	2.231	1.210	1.600	7.062	0.314	3.619
2012	4.733	2.039	2.247	1.229	1.620	7.136	0.329	3.480
2013	3.666	2.090	2.210	1.274	1.566	7.140	0.335	3.939
2014	4.042	2.049	2.326	1.199	1.530	7.104	0.280	4.222
2015	4.133	2.029	2.327	1.177	1.491	7.025	0.279	4.232
Trend 1990-2015, %	-48.8	-14.3	-15.3	-22.1	-4.8	-14.3	44.9	-49.5

The main sources of dioxin emission are the waste sector (29%, mainly industrial and clinical waste incineration), combustion in energy industries (25%, includes also waste combustion as fuel), non-industrial combustion sector (24%), combustion in the manufacturing industry (8%), includes also waste combustion as fuel, mainly in the cement manufacturing industry) and road transport (7%) (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 residential sector (45.7% and 58.5% respectively, mainly wood combustion) (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.

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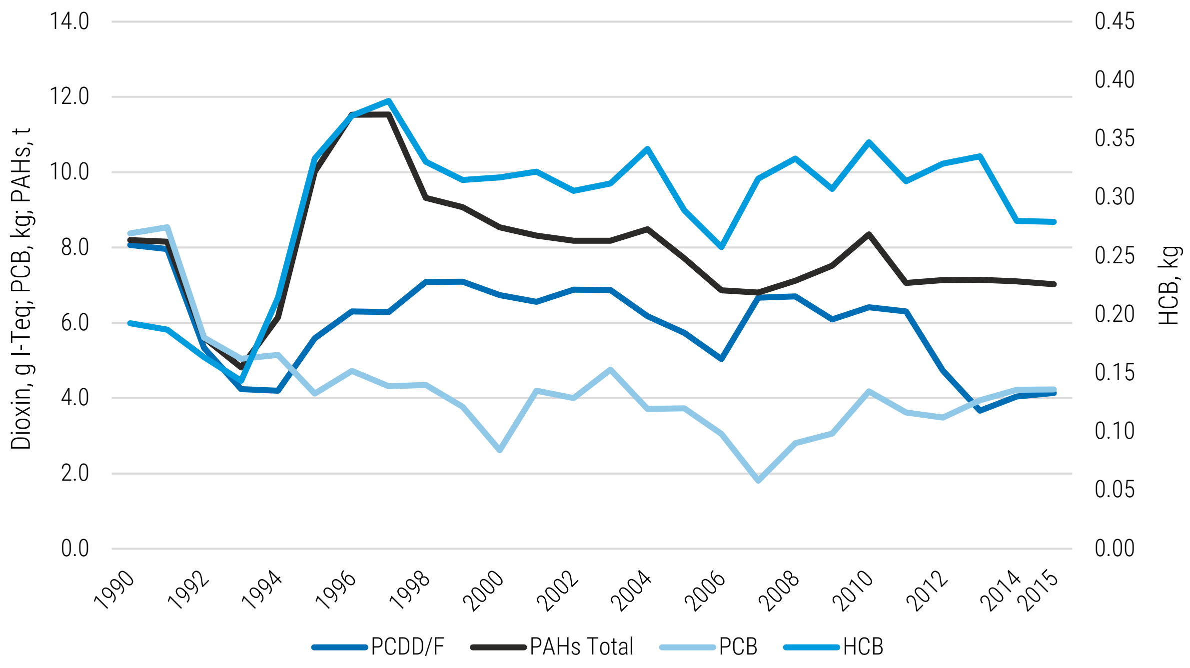

Figure 2.20 POPs emissions in the period of 1990-2015

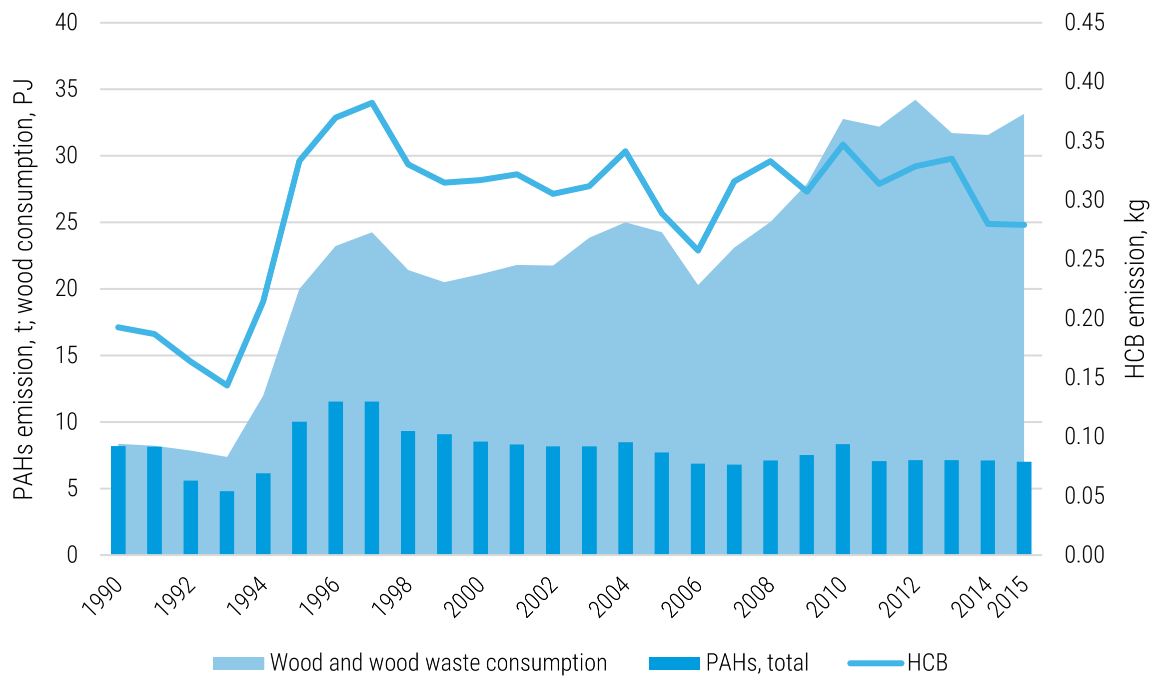

Figure 2.21 PAHs and HCB emissions and wood consumption in 1990-2015

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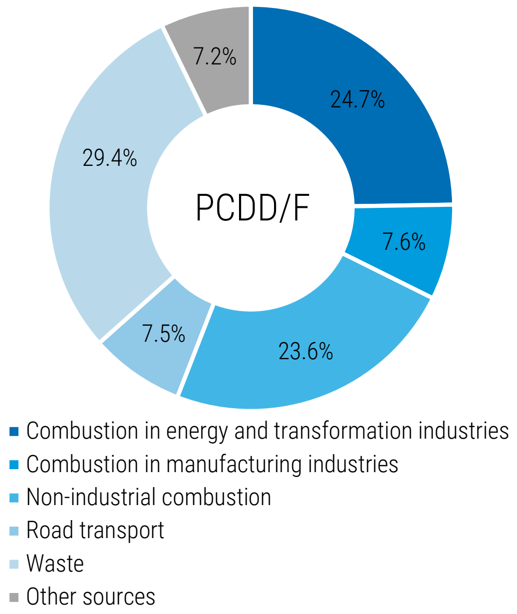


Figure 2.22 Dioxin (PCDD/PCDF) emissions by activities in 2015

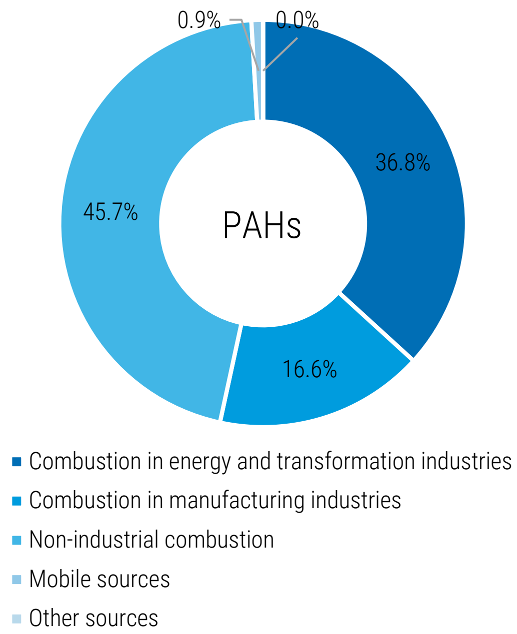


Figure 2.23 PAHs emissions by activities in 2015

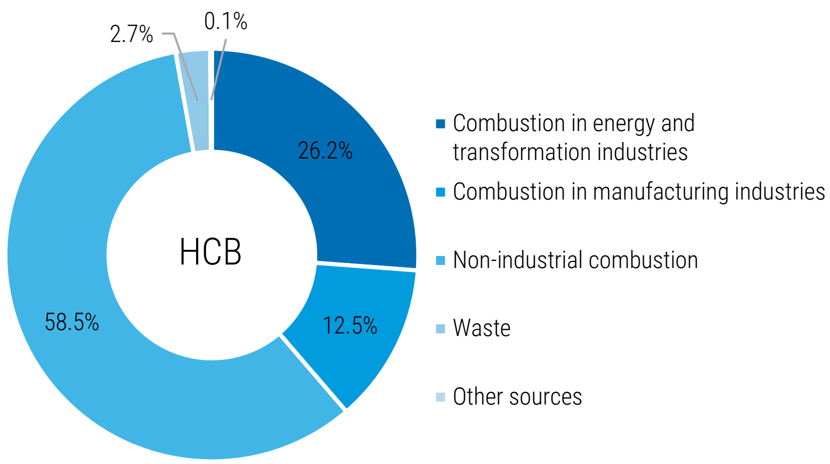
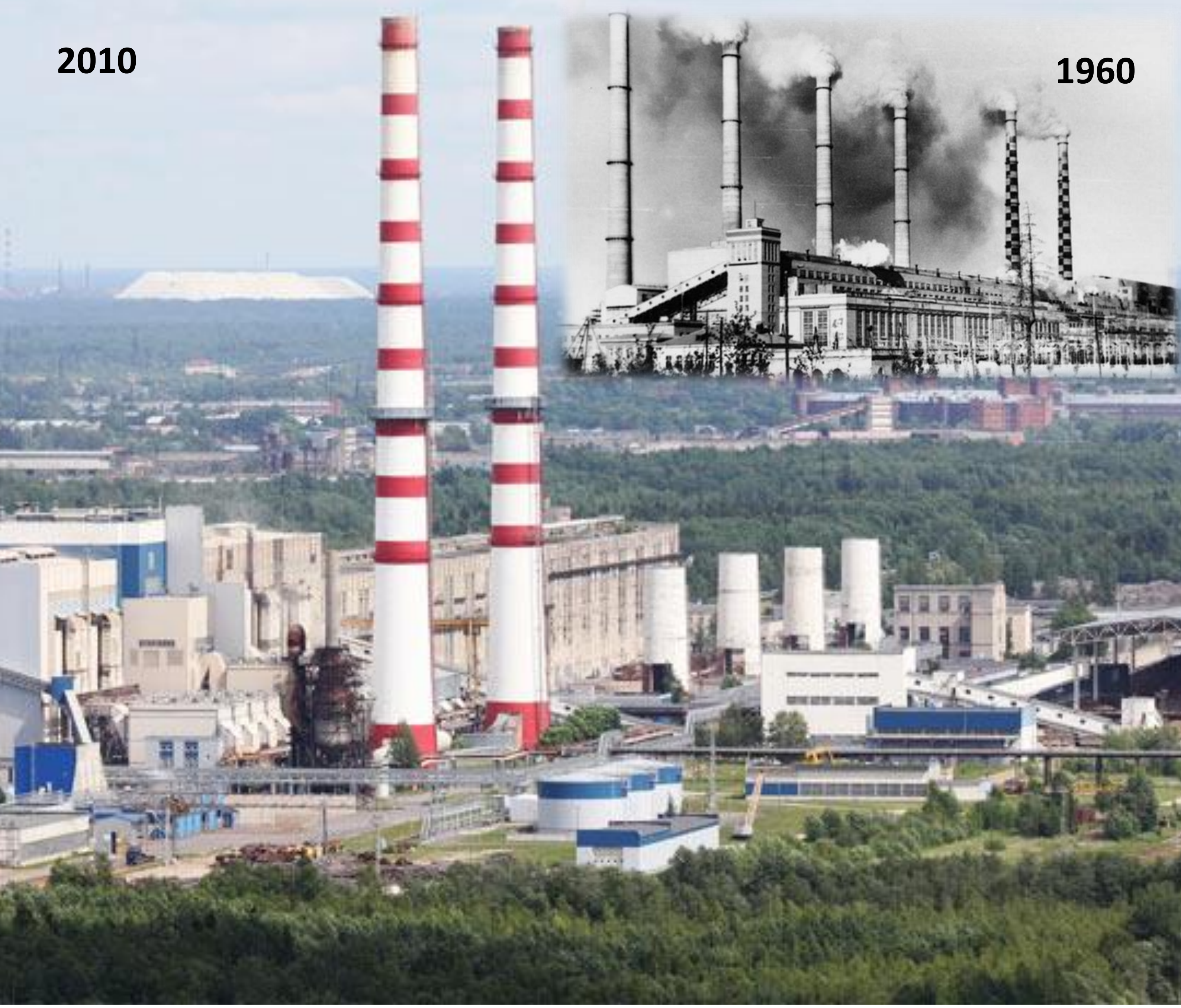


Figure 2.24 HCB emission by activities in 2015



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, mobile sources, and fugitive fuel emissions.

The energy sector is the main source of SO_2, NO_x, CO, particulates, HM and POPs in Estonia. In 2015, the energy sector contributed 99.9% of total SO_2 emissions, 94.6% of total NO_x emissions, 75.9% of PM_{10} emissions, 57.5% of total NMVOC emissions, 99.5% of total CO emissions, and 97.8% of Pb emissions (Figures 3.5, 3.6 and Table 3.1).

During the period of 1990–2015, the emissions of sulphur dioxide from the energy sector decreased by approximately 88% 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 161 PJ in 2015) (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 Desulphurisation) technology in the Eesti Energia Narva Elektrijaamad pcl (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).

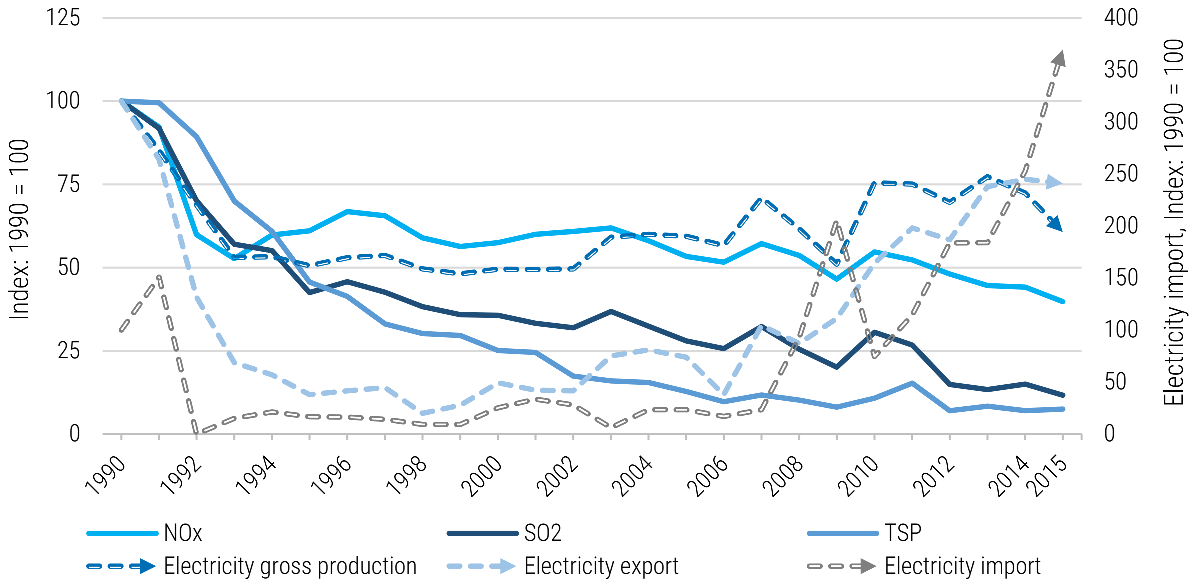


Figure 3.1 Pollutant emissions, electricity production, and export in the period of 1990–2015

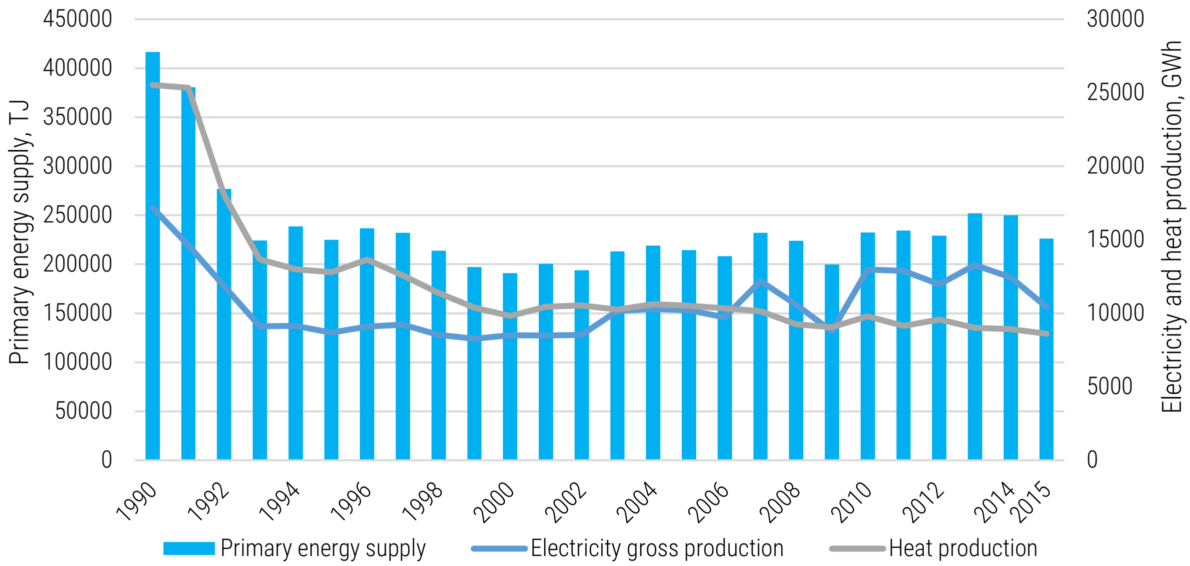


Figure 3.2 Total energy supply, electricity and heat production in the period of 1990–2015
(Source: Statistics Estonia)

Electricity sales volume decreased by 21% compared to 2014. This is attributable to the historically low market price on the Nord Pool power exchange. In addition, prices on the power exchange were highly volatile, sometimes oscillating more than ten-fold during a day. In 2015, energy prices continued to slide relative to previous years. Due to globalisation, the Estonian energy markets are affected by the same factors that influence energy markets across the world. Oil prices remain low because the markets are oversupplied. The prices on the Nord Pool power exchange declined compared to 2014, mainly in connection with strong hydropower output in the Nordic countries, but also due to above average air temperatures.[2]

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 plc "Environmental Report 2014")

The TSP emissions decreased in 2015 by 7.9% compared to 2014. The PM_{10} and $PM_{2.5}$ emissions increased in the same period by 0.5% and 16.2% respectively, which was mainly the result of increasing the amount of wood 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 (Table 3.1). During the same period, insignificant decrease in emissions in residential sector took place.

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 2015, the share of domestic fuels – oil shale, wood and peat – accounted for approximately 86.5% (from which oil shale is about 71.2%) of the primary energy supply. Coal, natural gas and liquid fuels were imported to

[2] Eesti Energia plc „Annual Report 2015" https://www.energia.ee/-/doc/8457332/ettevottest/investorile/pdf/annual_report_2015_eng.pdf

Estonia in 2015. Imports of natural gas decreased by about 11% compared to 2014. The imports of motor gasoline decreased by 2.3%, while imports of diesel increased by about 3.9% compared to the previous year. The imports of coal decreased by about 62% compared to 2014. Imported fuels (natural gas, fuel oils, coal, and motor fuels) made up 11.5% (Figure 3.3).

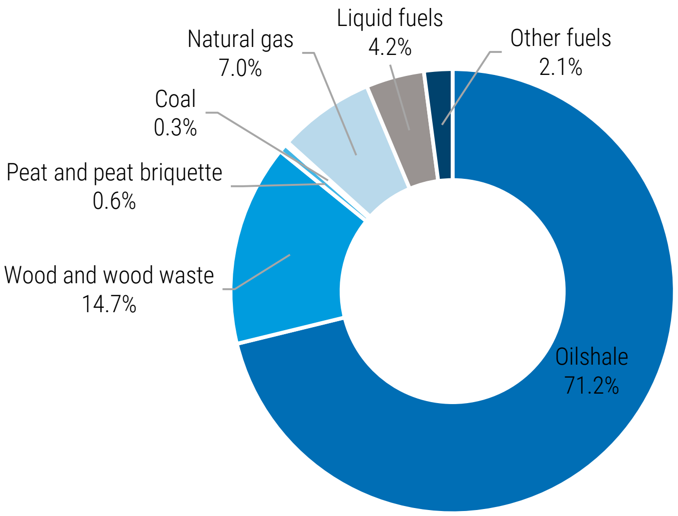


Figure 3.3 Structure of primary energy supply in Estonia in 2015

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 Ltd 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.

Renewables formed 13.4% of the gross inland consumption in 2013, with wood fuel prevailing. 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% compared to 2014. The generation of hydro energy has been stable over the past three years. In 2005, electricity generated from renewable energy sources was only 1.1%, but in 2015, it accounted for 17.2%. 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.

Domestic fuels have a large share in Estonia's total energy resources, and in the balance of primary energy, they are mainly based on oil shale. In 2015, about 17.3 million tonnes of oil shale were produced, which is 12.8% less than in 2014. The approximately 35% of oil shale is consumed as a raw material for shale oil production. The demand for shale oil in Estonia and in external markets increased the production of shale oil by about 5%. Nearly 87% of the

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production was exported in 2014, which is about 11.4% more than in 2013. More than one third (34%) of this amount was exported to the Netherlands, followed by Belgium and Denmark. The production of peat fuels remained approximately at the level of the 2013. Compared to 2013, peat briquettes production increased by about 11%.

In terms of the efficiency of electricity generation, the renovation of two units in the Narva PP of Eesti Energia plc 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 plc decreased as a result of shutting down the older boilers: in May 2005, Narva Elektrijaamad plc 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.

Table 3.1 Pollutant emissions from the energy sector in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb
	kt									t
1990	74.090	28.400	272.380	0.320	NR	NR	NR	269.440	214.420	205.210
1991	68.660	27.480	250.080	0.290	NR	NR	NR	270.740	214.640	187.890
1992	43.740	15.740	190.980	0.270	NR	NR	NR	243.070	120.290	123.780
1993	39.400	15.450	155.530	0.280	NR	NR	NR	191.640	121.660	102.310
1994	44.870	18.770	150.030	0.450	NR	NR	NR	166.010	157.470	122.340
1995	46.300	22.080	115.720	0.830	NR	NR	NR	124.140	212.250	85.160
1996	50.730	23.980	124.690	0.950	NR	NR	NR	112.230	235.690	65.550
1997	49.620	26.020	115.910	0.970	NR	NR	NR	89.150	248.110	46.160
1998	44.360	20.200	104.140	0.740	NR	NR	NR	80.020	195.600	38.890
1999	42.470	21.990	97.760	0.710	NR	NR	NR	78.940	203.780	38.870
2000	43.230	22.380	97.050	0.740	14.540	29.690	3.390	65.520	194.240	35.690
2001	45.130	22.700	90.610	0.730	15.480	29.680	3.670	63.510	196.490	36.120
2002	46.120	21.460	86.850	0.720	15.670	25.230	3.850	42.420	186.060	35.370
2003	46.640	19.480	100.140	0.720	13.400	21.460	3.620	38.020	176.100	37.410
2004	43.400	19.440	87.990	0.760	14.400	21.280	3.740	34.680	168.960	35.890
2005	40.150	17.350	76.090	0.690	13.190	18.780	3.400	27.320	152.870	34.610
2006	38.560	15.610	69.770	0.700	8.730	12.370	2.450	18.070	138.200	31.120
2007	42.780	14.190	87.990	0.860	11.720	18.900	2.940	23.740	153.920	39.690
2008	39.580	13.280	69.440	0.860	10.890	15.000	3.040	18.890	154.320	34.730
2009	34.570	12.340	54.830	0.830	8.920	12.540	2.510	15.750	153.210	28.020
2010	40.910	12.250	83.230	0.830	13.280	20.840	3.130	24.550	154.100	38.500
2011	39.000	11.130	72.730	0.780	17.640	31.960	3.440	37.320	129.650	37.940
2012	35.600	10.700	40.570	0.810	7.670	10.620	2.110	14.290	139.880	33.370
2013	32.710	10.070	36.480	0.730	10.140	14.590	2.470	16.750	133.010	38.790
2014	32.460	9.420	40.820	0.740	7.370	10.570	1.950	13.610	127.610	35.790
2015	29.080	9.730	31.770	0.890	8.560	10.630	2.460	12.540	127.470	27.800
Trend 1990-2015, %	-60.8	-65.7	-88.3	181.6	-41.2	-64.2	-27.4	-95.3	-40.6	-86.5

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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	4.460	1.110	18.840	18.390	10.030	27.320	106.840	8.190	7.290	0.180	8.330
1991	4.250	1.000	16.440	16.020	9.300	25.540	97.850	8.160	7.180	0.170	8.500
1992	3.050	0.820	14.020	13.800	6.640	16.950	79.780	5.600	4.530	0.150	5.560
1993	2.270	0.640	10.830	10.470	5.360	14.310	62.370	4.810	3.490	0.130	5.010
1994	2.930	0.630	10.670	10.320	5.910	12.830	65.570	6.150	3.380	0.200	5.100
1995	2.130	0.590	10.050	9.950	5.020	10.460	63.970	10.010	4.750	0.310	4.070
1996	1.260	0.590	10.350	10.220	4.570	10.820	62.480	11.530	5.420	0.350	4.660
1997	1.290	0.590	10.190	9.960	4.540	9.710	62.480	11.530	5.190	0.360	4.250
1998	1.170	0.520	9.130	8.900	4.130	8.760	55.690	9.320	3.970	0.310	4.290
1999	1.110	0.500	8.700	8.500	3.990	7.480	53.510	9.070	4.250	0.290	3.710
2000	0.720	0.500	8.580	8.340	3.670	6.440	49.850	8.540	3.870	0.290	2.560
2001	0.710	0.490	8.380	8.210	3.960	6.380	49.670	8.320	3.840	0.310	4.150
2002	0.730	0.490	8.350	8.310	4.090	6.120	48.950	8.180	3.830	0.290	3.950
2003	0.800	0.570	9.970	9.810	4.420	6.750	57.390	8.180	4.060	0.290	4.700
2004	0.760	0.530	9.780	9.380	4.450	6.640	57.710	8.490	3.700	0.330	3.680
2005	0.730	0.510	9.210	9.020	4.420	6.390	53.390	7.720	3.190	0.280	3.700
2006	0.700	0.510	8.580	8.400	4.310	5.720	48.940	6.860	3.060	0.250	3.020
2007	0.870	0.640	11.060	10.720	4.980	6.690	62.010	6.810	4.670	0.310	1.780
2008	0.810	0.570	9.400	9.250	4.580	5.850	55.300	7.120	4.700	0.320	2.780
2009	0.680	0.440	7.600	7.500	3.930	4.820	46.480	7.520	4.090	0.300	3.040
2010	0.880	0.620	10.960	10.510	4.820	6.570	62.660	8.350	4.970	0.340	4.160
2011	0.840	0.630	10.880	10.320	4.730	6.390	60.640	7.060	4.900	0.310	3.600
2012	0.770	0.550	9.590	9.160	4.520	5.620	54.940	7.140	3.490	0.320	3.460
2013	0.940	0.660	11.230	10.560	4.790	6.480	62.440	7.140	2.550	0.330	3.920
2014	0.880	0.650	10.240	9.830	4.800	6.000	57.330	7.100	2.750	0.270	4.200
2015	0.730	0.510	7.740	7.590	4.270	4.630	46.800	7.020	2.620	0.270	4.210
Trend 1990-2015, %	-83.7	-54.3	-58.9	-58.7	-57.4	-83.1	-56.2	-14.3	-64.1	53.2	-49.5

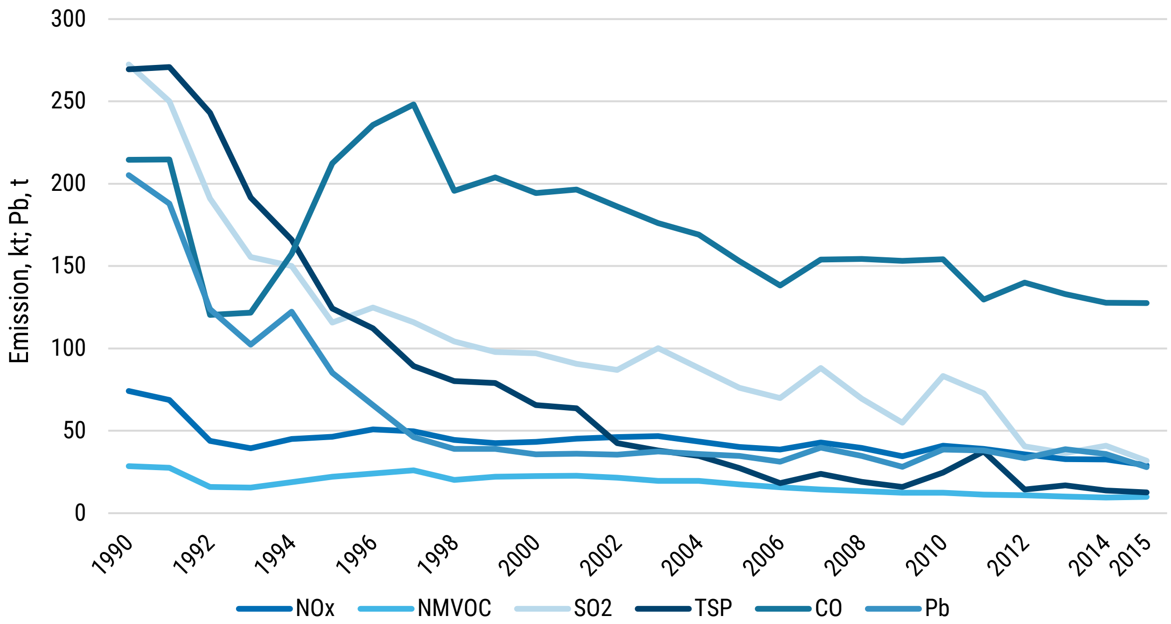

Figure 3.4 Pollutant emissions from the energy industry in the period of 1990-2015

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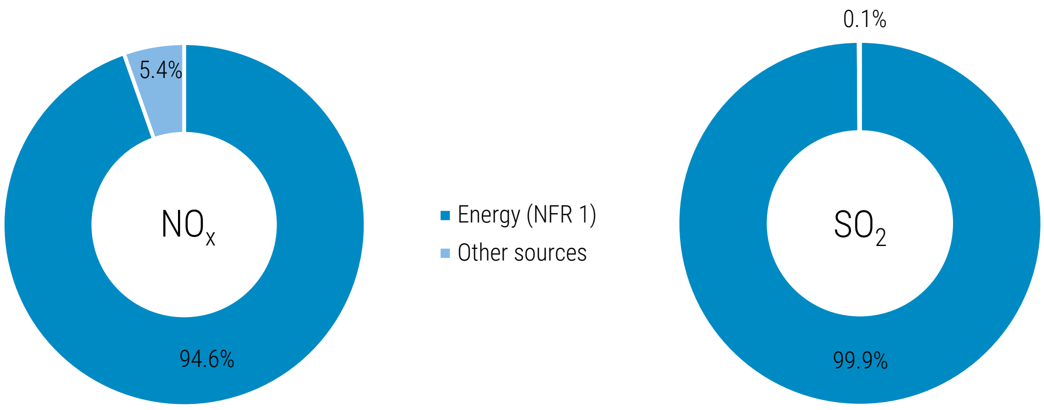

Figure 3.5 Share of SO_2 and NO_x emissions from the energy sector in total emissions in 2015

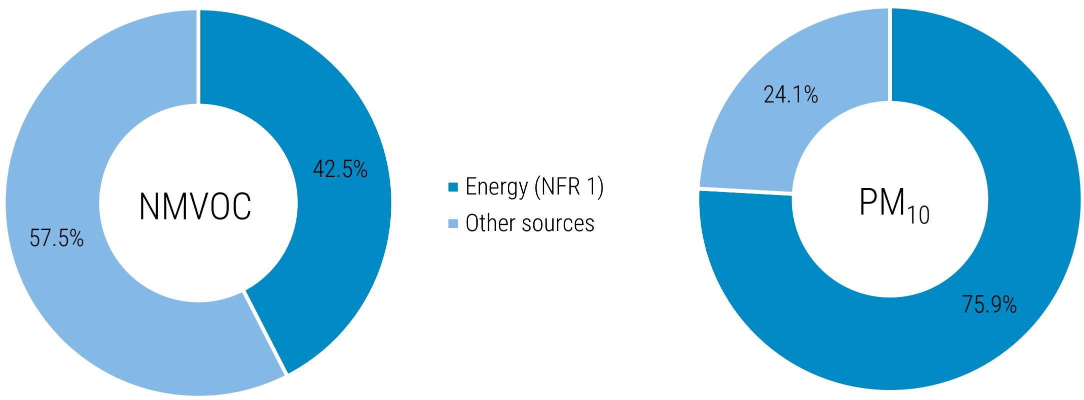

Figure 3.6 Share of NMVOC and PM_{10} emissions from the energy sector in total emissions in 2015

3.2. Stationary Fuel Combustion

This chapter gives an overview of stationary fuel combustion, which includes energy industries (NFR 1A1), stationary combustion in manufacturing industries (NFR 1A2) and non-industrial combustion plants (NFR 1A4). Energy related activities (excluding transport) are the most significant contributors to SO_2 emissions – 99.5% in 2015. The share of mobile sources of the total emissions is very small – 0.5% (Figure 3.8 and 3.9, includes in other sources).

3.2.1. 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
	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 8 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 14 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 60 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 26 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 plants	Includes emissions from boilers and other equipment in the residential sector. Only diffuse sources data.	NO_x, SO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, CO, 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

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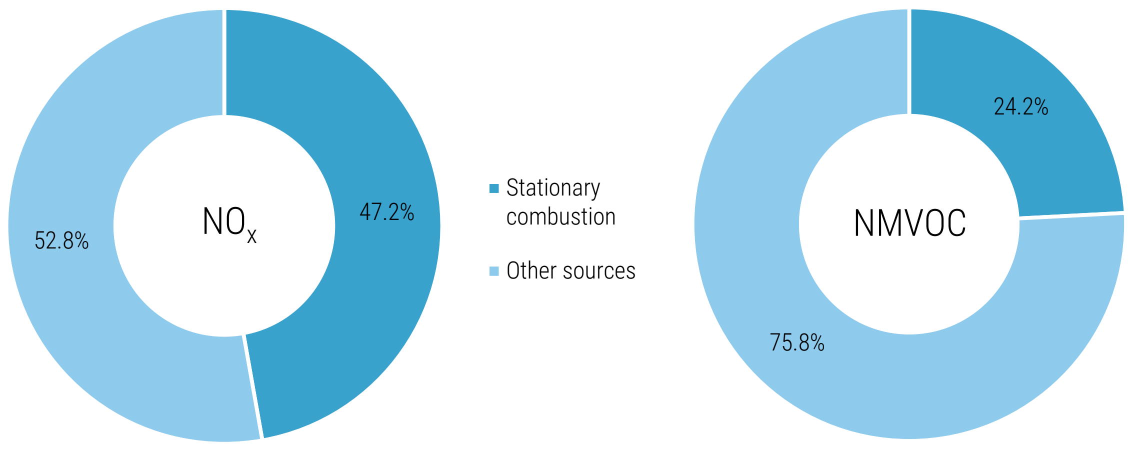

Figure 3.7 NO_x and NMVOC emissions from stationary fuel combustion and other sources in 2015

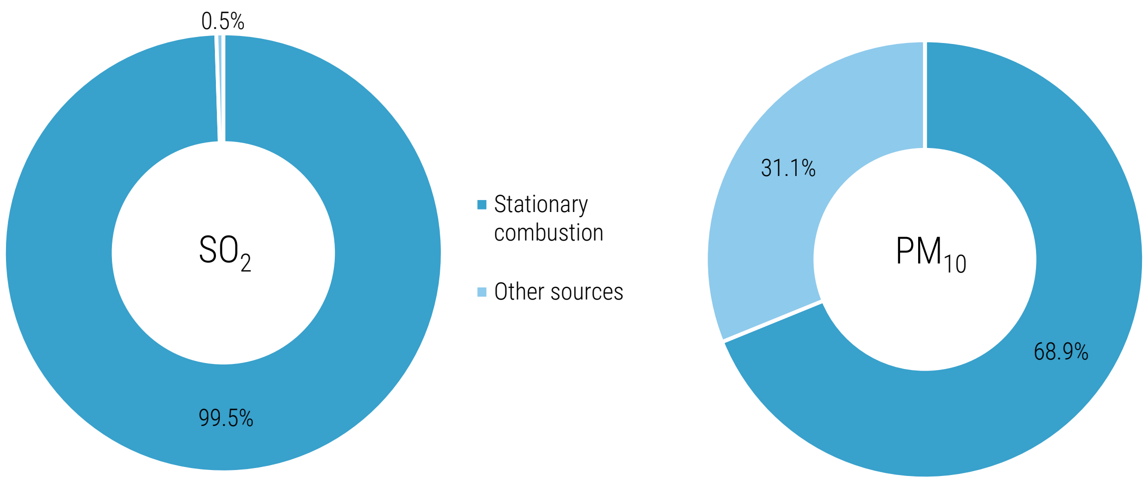

Figure 3.8 SO_2 and PM_{10} emissions from stationary fuel combustion and other sources in 2015

Table 3.3 Pollutant emissions from stationary fuel combustion in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb	Cd
	kt									t	
1990	36.060	6.650	265.480	0.300	NR	NR	NR	267.710	86.440	126.480	4.440
1991	32.970	6.690	243.460	0.280	NR	NR	NR	269.080	87.480	118.200	4.240
1992	24.110	4.950	187.040	0.260	NR	NR	NR	242.120	67.410	89.460	3.040
1993	19.380	4.060	151.240	0.270	NR	NR	NR	190.620	62.690	67.220	2.270
1994	22.450	5.240	145.960	0.430	NR	NR	NR	164.920	86.280	79.320	2.920
1995	26.430	8.860	112.070	0.800	NR	NR	NR	123.130	145.680	60.380	2.130
1996	29.140	10.400	120.820	0.910	NR	NR	NR	111.220	166.630	43.840	1.250
1997	27.730	10.250	112.030	0.920	NR	NR	NR	88.090	165.530	36.310	1.280
1998	24.080	8.260	100.150	0.690	NR	NR	NR	79.000	133.170	32.820	1.170
1999	22.820	7.970	94.240	0.650	NR	NR	NR	77.990	126.690	31.320	1.100
2000	23.680	7.100	93.890	0.630	13.630	28.650	2.940	64.300	125.790	30.670	0.720
2001	24.270	7.020	89.700	0.590	14.680	28.710	3.300	62.310	123.750	30.130	0.700
2002	23.430	7.350	85.740	0.570	14.690	24.070	3.370	41.040	123.170	29.820	0.720

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	BC	TSP	CO	Pb	Cd
	kt									t	
2003	25.830	7.210	99.430	0.560	12.460	20.330	3.150	36.660	123.430	35.140	0.790
2004	23.760	7.430	87.370	0.530	13.410	20.130	3.240	33.320	123.660	33.780	0.750
2005	20.680	6.590	75.700	0.420	12.240	17.650	2.920	25.960	110.370	32.470	0.720
2006	18.940	5.730	69.430	0.400	7.780	11.200	1.960	16.650	97.360	29.650	0.690
2007	23.540	6.260	87.670	0.510	10.750	17.730	2.440	22.330	115.780	38.140	0.860
2008	21.900	6.510	69.160	0.500	10.000	13.890	2.590	17.520	121.600	33.140	0.800
2009	19.320	5.920	54.660	0.510	8.160	11.550	2.130	14.500	123.710	26.620	0.680
2010	24.320	6.170	83.080	0.500	12.470	19.770	2.720	23.200	127.340	37.980	0.870
2011	23.690	5.270	72.520	0.400	16.890	30.940	3.070	35.990	106.270	37.460	0.830
2012	20.380	5.120	40.420	0.410	6.890	9.580	1.730	12.950	115.790	32.880	0.760
2013	18.820	5.350	36.350	0.370	9.440	13.680	2.110	15.610	112.700	38.340	0.940
2014	17.960	5.000	40.700	0.390	6.600	9.610	1.560	12.410	108.580	35.490	0.870
2015	14.510	5.540	31.640	0.540	7.770	9.640	2.070	11.320	109.840	27.500	0.720
Trend 1990-2015, %	-59.8	-16.7	-88.1	81.2	-43.0	-66.3	-29.6	-95.8	27.1	-78.3	-83.9

Table 3.3 continues

Year	Hg	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F	HCB	PCB
	t							g I-Teq	kg	
1990	1.110	18.840	18.260	7.280	27.270	104.240	8.100	6.940	0.180	8.310
1991	1.000	16.440	15.910	6.810	25.490	95.480	8.070	6.850	0.170	8.470
1992	0.820	14.020	13.730	5.270	16.920	78.540	5.560	4.370	0.150	5.550
1993	0.640	10.830	10.400	3.930	14.280	61.050	4.770	3.380	0.130	5.000
1994	0.630	10.670	10.240	4.280	12.810	63.980	6.090	3.140	0.200	5.090
1995	0.590	10.050	9.880	3.590	10.440	62.510	9.970	4.520	0.310	4.060
1996	0.590	10.350	10.140	3.030	10.800	60.920	11.480	5.190	0.350	4.650
1997	0.590	10.190	9.880	2.930	9.690	60.810	11.490	4.950	0.360	4.250
1998	0.520	9.130	8.830	2.650	8.740	54.220	9.280	3.770	0.310	4.290
1999	0.500	8.700	8.420	2.500	7.460	51.980	9.040	4.030	0.290	3.710
2000	0.500	8.580	8.260	2.140	6.420	48.300	8.500	3.640	0.290	2.560
2001	0.490	8.370	8.110	2.120	6.360	47.800	8.270	3.560	0.310	4.150
2002	0.490	8.350	8.210	2.090	6.090	46.970	8.130	3.530	0.290	3.950
2003	0.570	9.970	9.710	2.490	6.720	55.450	8.130	3.770	0.290	4.700
2004	0.530	9.780	9.280	2.480	6.610	55.740	8.440	3.400	0.330	3.680
2005	0.510	9.210	8.910	2.410	6.360	51.340	7.670	2.880	0.280	3.700
2006	0.510	8.580	8.290	2.150	5.680	46.740	6.810	2.720	0.250	3.020
2007	0.640	11.060	10.600	2.700	6.660	59.690	6.750	4.300	0.310	1.780
2008	0.570	9.400	9.130	2.340	5.810	53.030	7.070	4.360	0.320	2.780
2009	0.440	7.600	7.390	1.920	4.780	44.440	7.470	3.770	0.300	3.040
2010	0.620	10.960	10.400	2.670	6.530	60.520	8.290	4.650	0.340	4.160
2011	0.630	10.880	10.210	2.610	6.360	58.520	7.010	4.580	0.310	3.600
2012	0.550	9.590	9.050	2.310	5.590	52.740	7.080	3.160	0.320	3.460
2013	0.660	11.230	10.450	2.650	6.450	60.290	7.080	2.240	0.330	3.920
2014	0.650	10.240	9.710	2.550	5.970	55.100	7.040	2.450	0.270	4.200
2015	0.510	7.740	7.470	1.980	4.590	44.530	6.960	2.310	0.270	4.210
Trend 1990-2015, %	-54.3	-58.9	-59.1	-72.8	-83.2	-57.3	-14.1	-66.7	53.2	-49.3

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 plc portfolio and in overall electricity production in Estonia. Each year, the new power block produces 130–140 GWh of renewable energy, enough to cover 2% of annual electricity consumption in Estonia. Renewable energy from biofuel produced in the Narva PP provides enough electricity to cover the annual consumption of 50,000 Estonian families.

The oil shale power plants contribute about 54% to the total SO_2 emissions. The Narva PP is investing in scrubbers to reduce sulphurous and nitrous wastes from flue gas in order to make energy production from oil shale cleaner and to ensure that the current production capacity can be maintained after the environmental requirements become stricter in 2012 and 2016.

Photo by Lembit Michelson: Eesti Power Plant

In 2012, the desulphurisation equipment was finally installed in four blocks of Eesti PP. Eesti Energia plc 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.

2015 was the third 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 2014, 221.4 tonnes of mixed municipal waste was used to produce 248.1 GWh of heat and 111.8 GWh of 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]

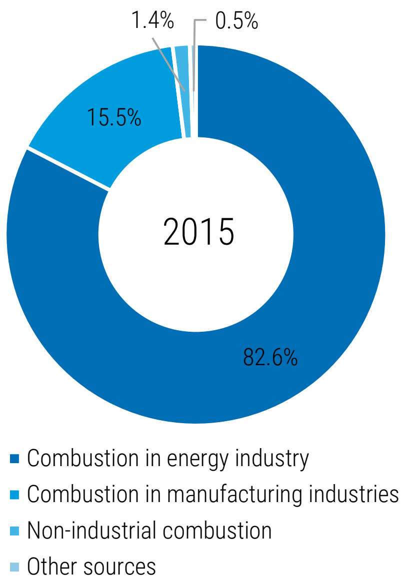

Figure 3.9 SO_2 emissions by sources of pollution in 2015

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

Non-industrial combustion is responsible for about 62% of the total NMVOC and CO emissions in stationary combustion, for approximately 1.5% of SO_2 and 27% of TSP emissions (Figures 3.10–3.14). Combustion in energy and transformation industries accounts for 83% of SO_2, for 43% of TSP and for the 31% of CO emissions in stationary combustion (thus the main part of carbon monoxide is emitted from Narva shale oil production plant, which increased during the last year as a result of growing shale oil production) (Figures 3.10, 3.12, 3.13, 3.14).

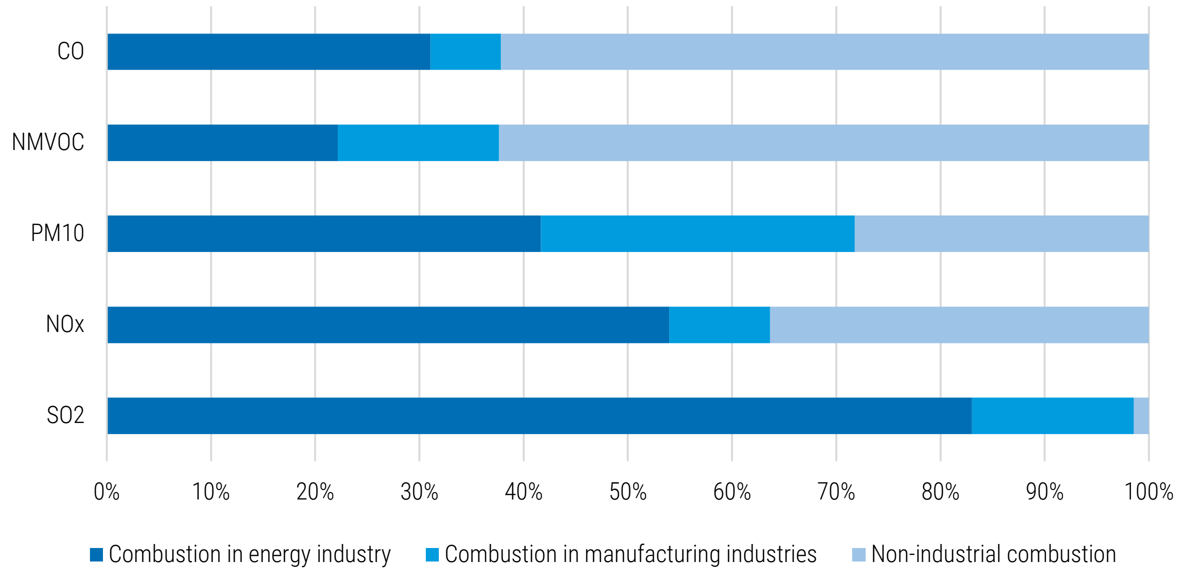

Figure 3.10 Distribution of pollutant emissions by sector in stationary combustion in 2015

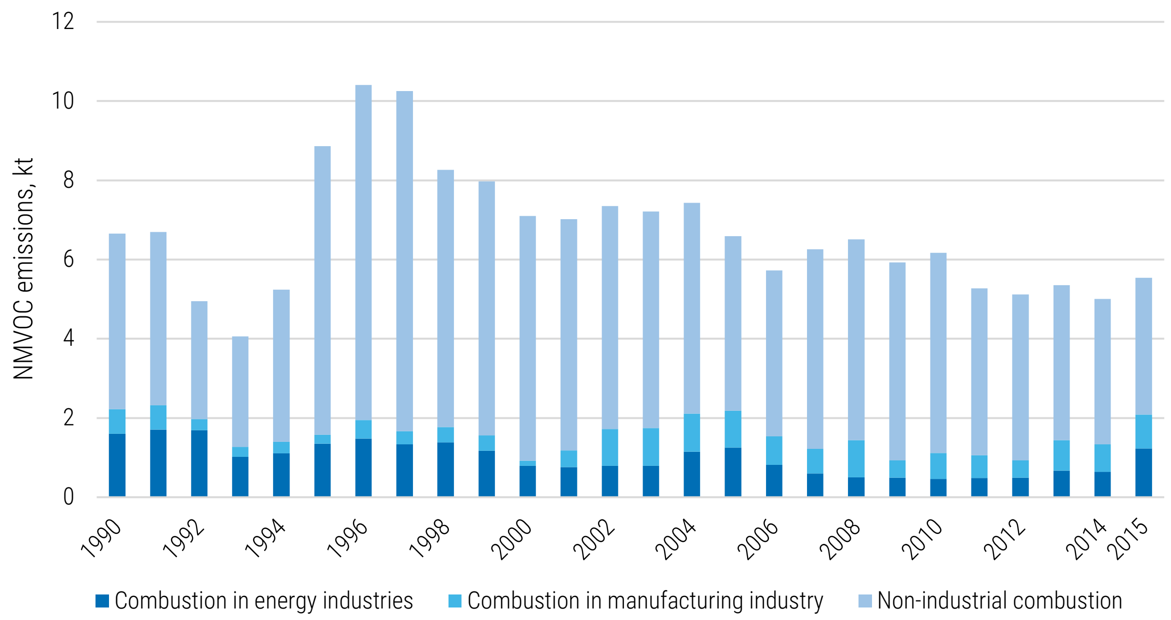

Figure 3.11 Distribution of NMVOC emissions by sector in stationary combustion in the period of 1990–2015

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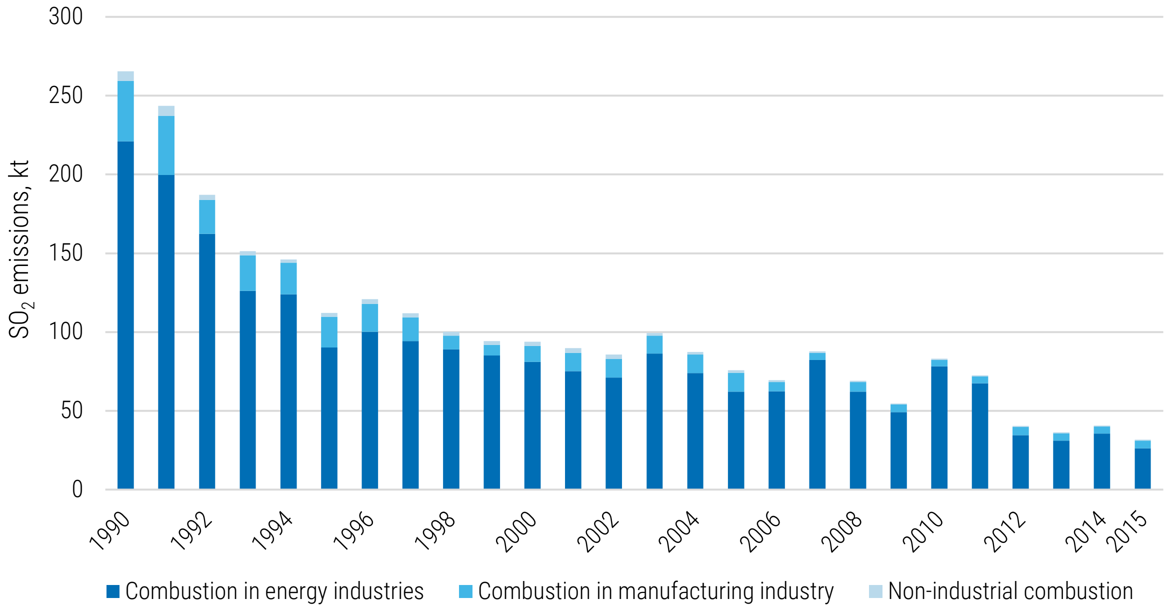

Figure 3.12 Distribution of SO_2 emissions by sector in stationary combustion in the period of 1990–2015

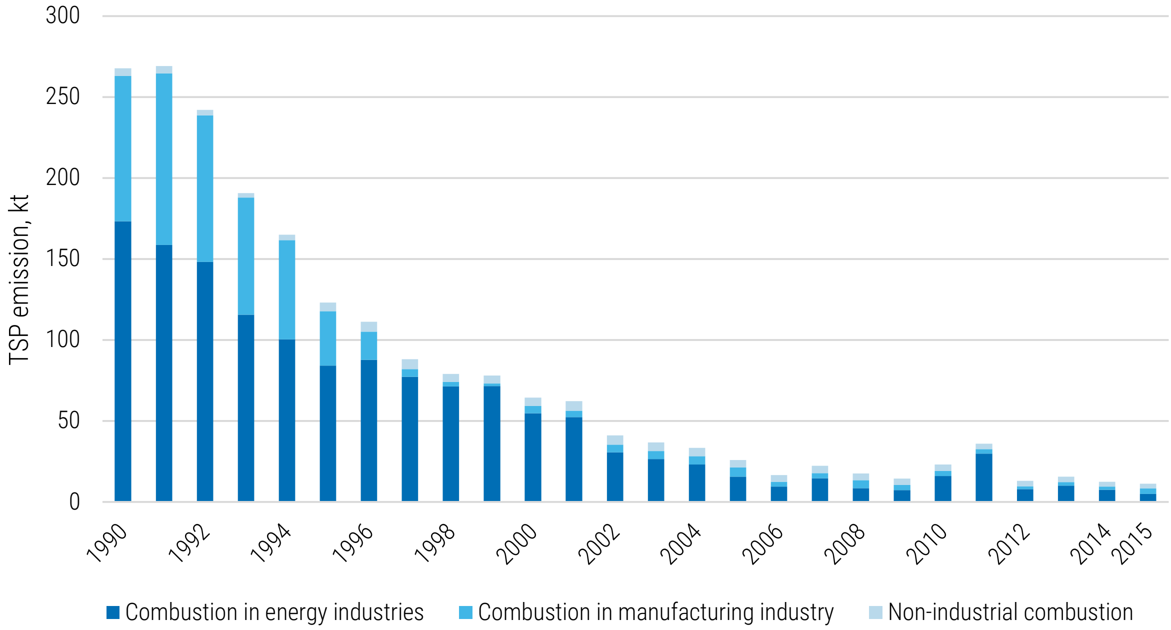

Figure 3.13 Distribution of TSP emissions by sector in stationary combustion in the period of 1990–2015

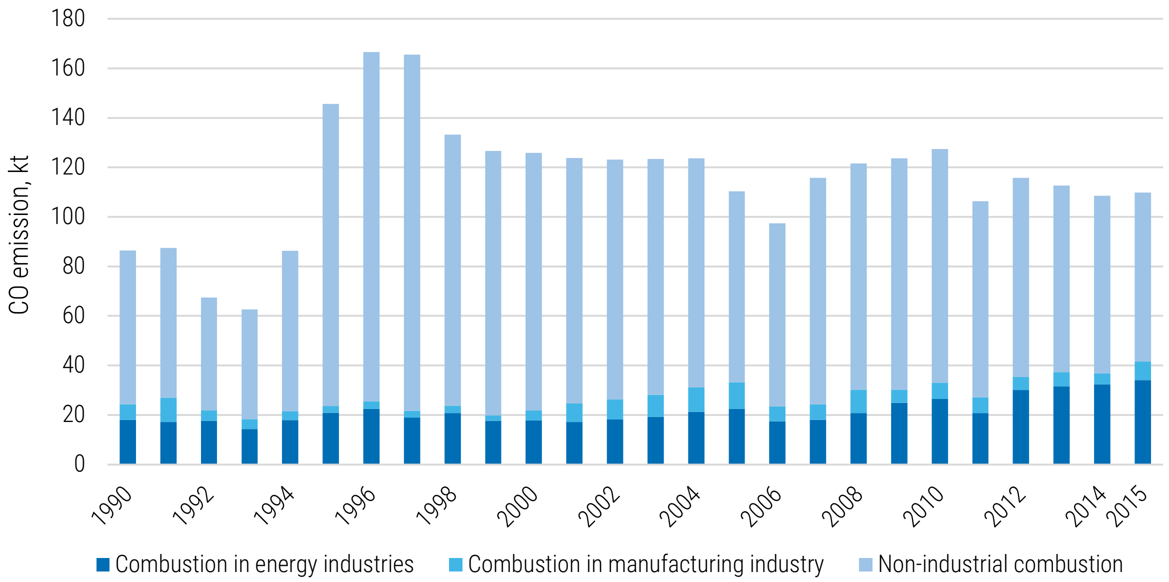

Figure 3.14 Distribution of CO emissions by sector in stationary combustion in the period of 1990–2015

3.2.2. Methodological Issues

NFR 1A1a Public electricity and heat production, NFR 1A2f Stationary combustion in manufacturing industries and construction: Non-metallic minerals, NFR 1A2gviii Stationary combustion in manufacturing industries and construction: Other, and NFR 1A4ai, 1A4ci Non-industrial combustion plants (stationary combustion related to commercial and agriculture) 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, national emission factors 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 (TUT). Below is given the explanation of the University, according to which Estonian Oil Shale (EOS) is a solid fossil fuel that has low heating value and high ash content. Oil shale burned in power plants has the following proximate characteristics: W_i^r = 9–13%, A^r = 45–57%, CO_2 = 16–19%, and Q_i^r = 7–11 MJ/kg. The molar ratio of Ca/S of 8–10 in oil shale exceeds by over 2–3 times the ratio of Ca/S sufficient to capture SO_2 completely. Oil shale contains a lot of carbonate minerals. Due to decomposition of the carbonate minerals, the CO_2 footprint is bigger than in typical coal firing power plant, but during the calcite decomposition, free lime is formed that binds the Sulphur during combustion process. In 2004, a novel Circulating Fluidized Bed Combustion (CFBC) was introduced for EOS. For EOS CFBC, no sand is needed for bed material since ash is the material that is forming the bed. The circulating ash contains free lime that is one of the key parameters for almost 100% sulphur binding and the second key parameter is low combustion temperature – around 800 °C. Low combustion temperature and low fuel nitrogen content (below 0.1%) mean that NO_x emissions are also below the limit values (below 200 mg/Nm^3) (Table 3.4).

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Table 3.4 Block Nº 8 of the Eesti PP and old PF Blocks. CFBC unit parameters*)**)

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

*)*Double data sets (x/y): the first set is the data obtained on the basis of the Elektrowatt-EKONO performance test results, and the second set is the average data for Block Nº 8 of the Eesti PP in 2004.*
**)*Hotta et. al*[4]

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 one has to bear in mind that for coal it is a matter of economics. No power company is willing to put additional/excess lime into the CFBC for Sulphur binding. They insert only the amount of free CaO that is needed to achieve the 200 or 400 mg/Nm^3 for SO_2 emissions. For EOS, the free CaO is already present in the fuel. Initially, of course, in the form of limestone, but during combustion process, it decomposes to CO_2 and CaO. So, this is the key element for officials to understand. We have more than enough CaO for efficient Sulphur binding.

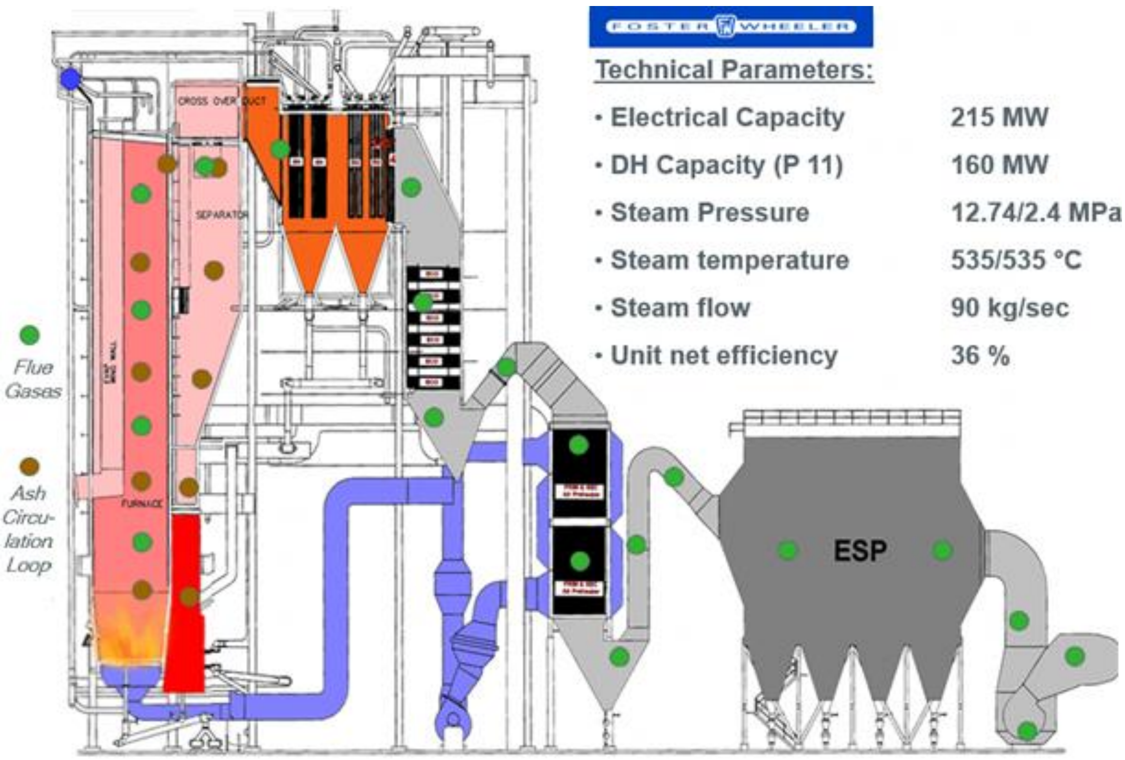

Figure 3.15 Existing EOS CFBC boiler drawing

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.

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.

TUT has conducted a lot of laboratory and *in situ* experiments in the Oil Shale Firing Power Plants. TUT has an accredited Laboratory that has competence according to CEN/TS 15675:2007 and their flue gas measurements have validated the results given by CEMS monitoring. Also, TUT has published a lot of research papers regarding EOS firing and emission and ash formation. Some of the results can be seen in Table 3.5 (Konist et. al[5], Plamus et. al[6]) that validate the SO_2 numbers given so far.

Table 3.5 Concentration of main pollutants in flue gas before ESP (6% O_2)

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 or the combined method for emission estimations.

The production of shale oil in Estonia is carried out at three factories: Eesti Energia Õlitööstus AS (Narva Oil Plant plc), Kiviõli Keemiatööstuse OÜ (Kiviõli Oil Shale Processing & Chemicals Plant), 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

[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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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 and VKG Oil plants, both these technologies are used.

Eesti Energia Õlitööstus plc 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.

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

Eesti Energia Õlitööstus produces liquid fuels and retort gas, which is used in electricity production in the Narva Power Plants. The oil Industry produces about one million barrels of liquid fuels per year. Currently, about one fifth of the oil shale mined in Estonia is used in the production of fuel oil and chemicals. In 2009, Eesti Energia started building a new oil plant with Enefit-280 technology, which is cleaner, more reliable, and more efficient. This new generation of technology has been developed jointly by Eesti Energia and the international engineering company Outotec. Having produced its first oil in December 2012, the new Enefit-280 (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.

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

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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 Air Pollutant Emission Inventory Guidebook. For cement production, the HCB and PAHs emissions are for the first time 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 Air Pollutant Emission Inventory Guidebook.

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

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

According to national legislation, all operators with boiler capacity from 0.3 MW_{th} must prepare an annual report. The report for the energy-related activities contains data about the type and capacity of boilers, fuel characteristics and consumption, pollutant emissions and so on.

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

Diffuse sources Fuel = EB fuel – PS fuel

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

Emissions from PS have been calculated according to national emission factors and fuel consumption or on the basis of measurements. According to national legislation, all large combustion plants >100 MW_{th} are obliged to carry out continuous monitoring. For other sources, the frequency of measurements is regulated by emission permits. National emission factors for the calculation of emissions from boilers were adopted by a Regulation of the Minister of the Environment in 2004 (Tables 3.6–3.10).

Table 3.6 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		

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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
Peat							
- no control		1,000	2,000				
- cyclone		220	230	700			700
- cyclone + multicyclone				80			
- electrostatic precipitator							80
Wood							
- no control			1,000	1,000	1000		1,000
- cyclone		240	240	500		70	
- electrostatic precipitator						70	80
Heavy fuel oil	100				100		
Oil shale oil	100				100		
Light fuel oil	100				100		

Table 3.7 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 3.8 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 3.9 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 3.10 Heavy metal emission factors for boilers (mg/GJ)

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

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.

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 3.11.

Table 3.11 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

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 Air Pollutant Emission Inventory Guidebook 2016 for NFR 1A1, 1A2, 1A4ai and 1A4ci sectors this year. Most probably, the national methodology will be used next year.

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 3.12. For the calculation of heavy metals, emissions from wood combustion and POPs and HM from other fuels were used as emission factors for the new EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and these are presented in the Tables 3.12 and 3.13.

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 3.14). 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 3.17). It might be considered that growing awareness and continuous notification concerning the quantities of waste incinerated will assist in its downward trend.

The emission factors for the main substances will be defined and emissions are calculated according to the next period of the reporting.

Table 3.12 Main pollutant 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	60	79	0.3	0.3
NH_3	g/GJ	2.5	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				

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

Table 3.13 HM and PCB emission factor 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 3.14 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	0.833	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

Table 3.15 National POPs 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

Activity Data

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).

Table 3.16 Fuel consumption in stationary fuel combustion in the period of 1990–2015 (PJ)

Year	Liquid fuels	Solid fuels	Biomass	Gas
1990	68.14	242.83	8.37	40.61
1991	64.99	226.34	8.21	42.36
1992	36.07	188.36	7.86	23.42
1993	34.97	148.61	7.38	11.79
1994	32.27	147.05	12.00	14.89
1995	22.62	142.65	20.01	17.32
1996	23.08	149.43	23.22	19.90
1997	20.67	147.28	24.27	19.24
1998	19.75	125.48	21.42	17.86
1999	18.26	115.40	20.50	17.44
2000	10.69	123.02	20.63	21.78
2001	11.28	119.11	21.94	23.33
2002	9.67	123.45	21.77	23.32
2003	9.13	138.39	23.85	24.05
2004	9.53	142.88	25.01	23.53
2005	8.26	138.48	24.22	23.55
2006	6.31	134.29	20.05	23.35
2007	5.46	164.07	22.85	26.13
2008	5.22	141.09	25.02	27.41
2009	4.75	132.00	27.42	20.67
2010	5.94	167.58	32.79	23.48
2011	6.01	174.75	31.24	21.17
2012	5.69	151.42	34.22	21.38
2013	5.08	174.52	31.64	18.58
2014	3.88	171.98	32.44	17.80
2015	6.00	151.37	33.15	15.30

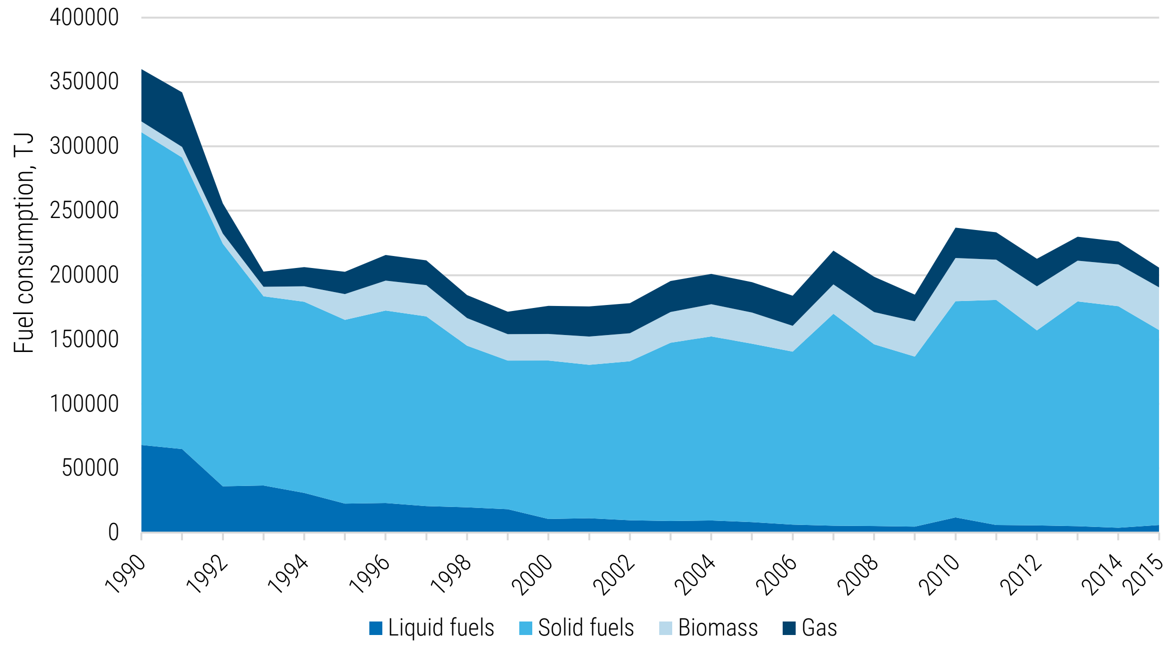

Figure 3.16 Fuel consumption by stationary combustion in the period of 1990–2015

Table 3.17 Amount of waste incinerated in domestic stoves (tonnes)

Year	Amount of waste
1990	16,757.789
1991	18,337.391
1992	19,785.172
1993	20,779.755
1994	21,824.939
1995	22,886.049
1996	23,105.193
1997	23,366.963
1998	23,716.474
1999	24,042.975
2000	24,996.018
2001	23,891.434
2002	22,793.789
2003	21,796.037
2004	20,760.928
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

3.2.3. 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 3.18.

Table 3.18 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%

3.2.4. 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.

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

3.2.5. Planned Source-Specific Improvements

- Improve the QA/QC procedure.

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

Table 3.19 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, Cr, Cu, Ni, Se, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs
1A3bv	Road transport: Gasoline evaporation	Gasoline 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, Pb, Cd, Cr, Cu, Ni, Se, Zn,
1A3bvii	Road transport: Automobile road abrasion	PM emissions from road abrasion	Tier 1	$PM_{2.5}$, PM_{10}, TSP

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NFR	Source	Description	Method	Emissions
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, 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
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 1 A 5 b 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, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs
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, NH_3, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p, PAHs Total, HCB, PCBs

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 3.17). The share of mobile sources in total national emissions in 2015 was the following: NO_x – 47.3%, BC – 15.5%, CO – 13.6% and NMVOC – 13.1%. 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 61.7%, 84.4% and 86.4% respectively. The trend of the emissions of these categories is given in Figure 3.18 and Table 3.20.

Some recalculations have been made for the following sectors: road transport and national navigation. The main reasons for recalculations were the correction of statistical fuel consumption and emission factors. Recalculations led to a change in total emissions. A detailed overview is given in each transport subsector and Chapter 8.

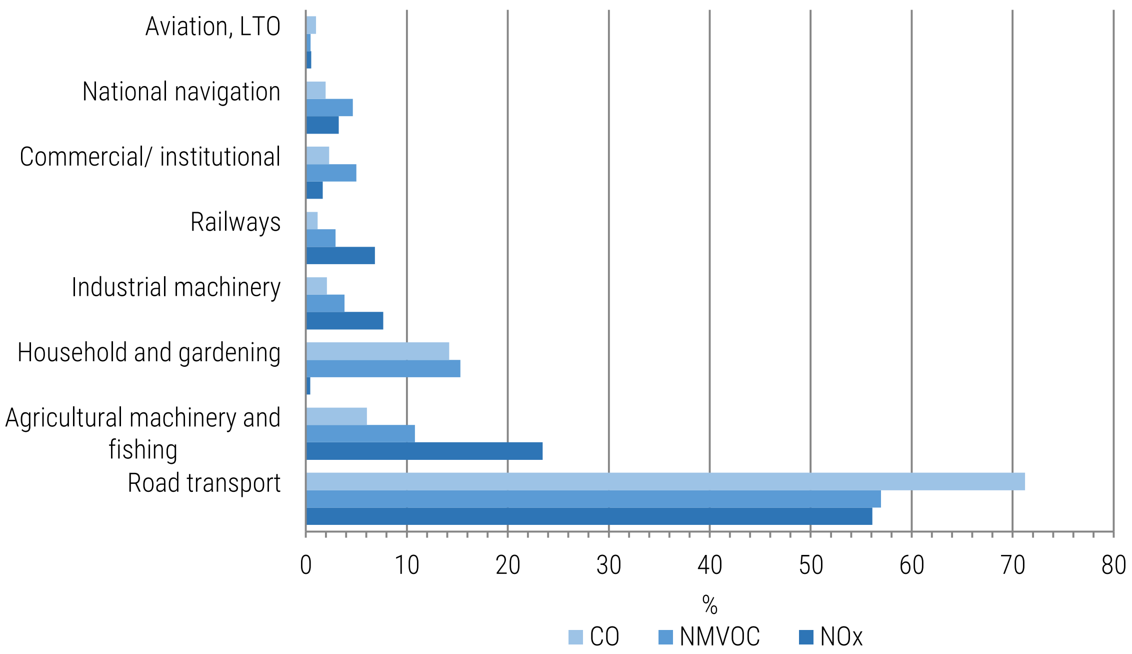

Figure 3.17 NO_x, NMVOC and CO emission shares in the transport sectors in 2015

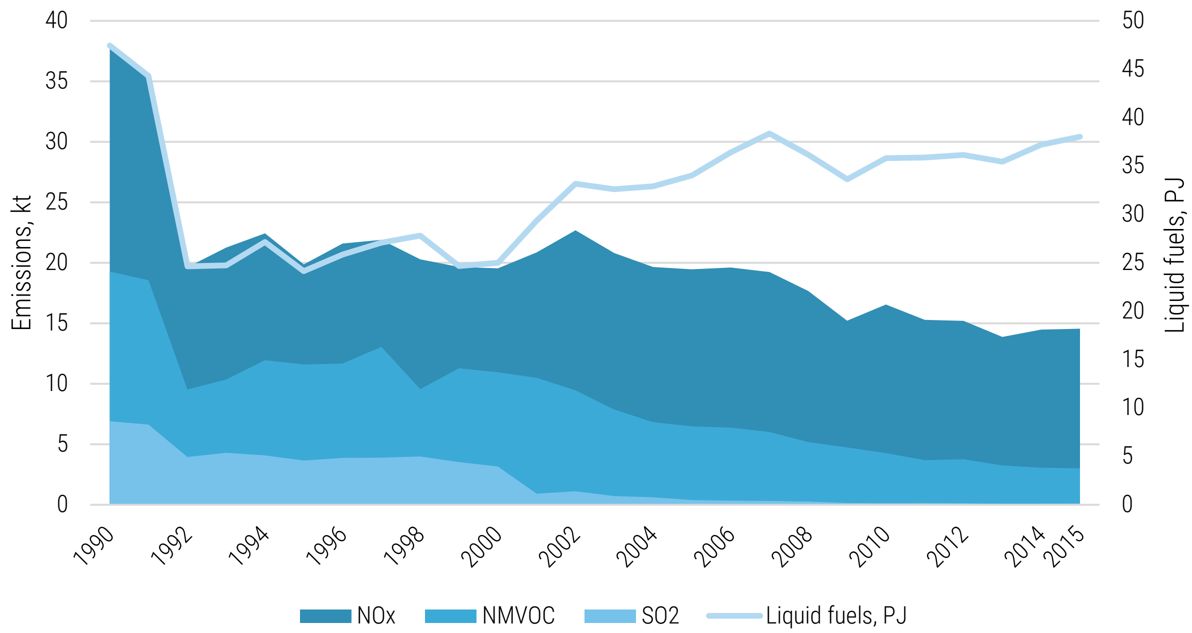

Figure 3.18 NO_x, NMVOC and CO emissions from the transport sector in the period of 1990-2015

Table 3.20 Total emissions from the transport sector in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	38.030	19.275	6.899	0.019	NR	NR	1.721	NR	127.979
1991	35.699	18.552	6.620	0.018	NR	NR	1.653	NR	127.167
1992	19.630	9.523	3.942	0.009	NR	NR	0.955	NR	52.872
1993	20.025	10.111	4.287	0.013	NR	NR	1.011	NR	58.973
1994	22.429	11.946	4.075	0.024	NR	NR	1.093	NR	71.187
1995	19.860	11.592	3.647	0.030	NR	NR	1.013	NR	66.579
1996	21.588	11.669	3.869	0.040	NR	NR	1.014	NR	69.060
1997	21.892	13.047	3.885	0.051	NR	NR	1.058	NR	82.587

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1998	20.281	9.555	3.985	0.048	NR	NR	1.024	NR	62.426
1999	19.652	11.278	3.518	0.063	NR	NR	0.947	NR	77.094
2000	19.537	10.950	3.157	0.112	0.904	0.994	1.107	0.443	68.250
2001	20.853	10.489	0.908	0.141	0.781	0.890	1.025	0.373	72.556
2002	22.683	9.457	1.109	0.147	0.970	1.083	1.222	0.486	62.625
2003	20.801	7.863	0.711	0.161	0.923	1.032	1.162	0.472	52.325
2004	19.648	6.824	0.615	0.224	0.976	1.088	1.221	0.499	45.040
2005	19.455	6.479	0.382	0.214	0.932	1.047	1.180	0.479	42.331
2006	19.604	6.370	0.335	0.241	0.936	1.060	1.202	0.484	40.587
2007	19.232	6.009	0.309	0.256	0.951	1.081	1.230	0.493	37.918
2008	17.660	5.174	0.262	0.254	0.883	1.011	1.162	0.454	32.438
2009	15.206	4.733	0.139	0.228	0.732	0.848	0.982	0.380	29.337
2010	16.548	4.266	0.128	0.215	0.772	0.895	1.040	0.407	26.564
2011	15.279	3.684	0.134	0.206	0.711	0.833	0.979	0.367	22.563
2012	15.197	3.758	0.113	0.193	0.731	0.858	1.010	0.381	22.071
2013	13.866	3.249	0.081	0.168	0.683	0.807	0.953	0.357	18.962
2014	14.474	3.056	0.082	0.160	0.743	0.869	1.016	0.384	18.001
2015	14.547	3.005	0.098	0.157	0.765	0.894	1.043	0.384	17.438
Trend 1990-2015, %	-61.7	-84.4	-98.6	717.8	-15.4	-10.0	-39.4	-13.4	-86.4

Table 3.20 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg		t				
1990	78.727	0.012	0.940	0.476	0.131	2.754	0.050	0.006	2.591
1991	69.698	0.011	1.130	0.572	0.118	2.491	0.048	0.006	2.376
1992	34.327	0.006	0.387	0.196	0.064	1.380	0.027	0.003	1.237
1993	35.089	0.007	0.419	0.212	0.068	1.437	0.027	0.003	1.324
1994	43.019	0.007	0.435	0.220	0.080	1.637	0.027	0.003	1.593
1995	24.788	0.006	0.308	0.156	0.073	1.433	0.022	0.002	1.468
1996	21.707	0.007	0.466	0.236	0.077	1.537	0.024	0.003	1.561
1997	9.841	0.007	0.292	0.148	0.081	1.615	0.024	0.003	1.660
1998	6.064	0.006	0.111	0.056	0.074	1.480	0.023	0.002	1.462
1999	7.552	0.006	0.024	0.012	0.075	1.490	0.021	0.002	1.535
2000	5.027	0.007	0.047	0.024	0.077	1.531	0.022	0.002	1.549
2001	5.984	0.008	0.063	0.032	0.093	1.841	0.026	0.003	1.875
2002	5.542	0.008	0.008	0.004	0.100	1.998	0.030	0.003	1.985
2003	2.270	0.008	0.200	0.267	0.096	1.929	0.036	0.004	1.933
2004	2.108	0.008	0.141	0.188	0.099	1.972	0.034	0.004	1.974
2005	2.136	0.009	0.126	0.168	0.102	2.015	0.034	0.004	2.050
2006	1.470	0.009	0.064	0.085	0.109	2.159	0.034	0.004	2.201
2007	1.544	0.010	0.063	0.084	0.116	2.274	0.035	0.004	2.326
2008	1.592	0.009	0.131	0.174	0.114	2.246	0.037	0.004	2.271
2009	1.402	0.009	0.170	0.227	0.102	2.003	0.035	0.004	2.044
2010	0.516	0.009	0.103	0.137	0.108	2.143	0.035	0.004	2.135
2011	0.482	0.009	0.054	0.071	0.108	2.126	0.032	0.004	2.114
2012	0.486	0.009	0.057	0.076	0.114	2.215	0.033	0.004	2.203
2013	0.446	0.009	0.033	0.044	0.111	2.141	0.031	0.003	2.152
2014	0.298	0.009	0.016	0.022	0.114	2.243	0.033	0.004	2.230
2015	0.302	0.010	0.021	0.028	0.117	2.294	0.034	0.004	2.270
Trend 1990-2015, %	-99.6	-17.8	-97.8	-94.1	-10.5	-16.7	-31.7	-30.8	-12.4

Table 3.20 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs Total	HCB	PCBs
	g I-Teq	t					g	
1990	0.355	0.022	0.040	0.017	0.012	0.091	0.276	20.432
1991	0.333	0.022	0.039	0.015	0.012	0.088	0.283	24.504
1992	0.162	0.012	0.022	0.008	0.005	0.047	0.116	8.416
1993	0.104	0.013	0.023	0.009	0.006	0.051	0.128	9.102
1994	0.236	0.012	0.021	0.010	0.008	0.050	0.168	9.477
1995	0.223	0.009	0.017	0.010	0.007	0.042	0.149	6.744
1996	0.233	0.010	0.019	0.010	0.008	0.047	0.180	10.157
1997	0.244	0.009	0.018	0.010	0.007	0.045	0.177	6.423
1998	0.202	0.008	0.016	0.010	0.006	0.040	0.128	2.477
1999	0.222	0.007	0.014	0.009	0.006	0.037	0.148	0.626
2000	0.225	0.007	0.014	0.009	0.006	0.037	0.167	1.125
2001	0.285	0.008	0.017	0.011	0.008	0.043	0.228	1.486
2002	0.292	0.011	0.020	0.012	0.008	0.050	0.229	0.282
2003	0.289	0.011	0.019	0.011	0.007	0.048	0.772	2.640
2004	0.302	0.011	0.019	0.012	0.008	0.049	0.614	1.883
2005	0.314	0.011	0.019	0.012	0.008	0.050	0.590	1.689
2006	0.345	0.012	0.021	0.013	0.009	0.055	0.466	0.908
2007	0.366	0.013	0.022	0.013	0.009	0.057	0.493	0.898
2008	0.347	0.012	0.021	0.013	0.009	0.055	0.663	1.744
2009	0.319	0.011	0.019	0.012	0.008	0.050	0.750	2.232
2010	0.327	0.013	0.021	0.013	0.009	0.056	0.582	1.380
2011	0.323	0.012	0.021	0.013	0.009	0.055	0.450	0.753
2012	0.332	0.013	0.022	0.014	0.010	0.059	0.469	0.798
2013	0.315	0.013	0.021	0.014	0.010	0.057	0.389	0.109
2014	0.302	0.014	0.023	0.014	0.010	0.061	0.333	0.271
2015	0.311	0.015	0.024	0.014	0.011	0.064	0.352	0.328
Trend 1990-2015, %	-12.3	-30.5	-39.8	-17.5	-8.6	-29.3	27.5	-98.4

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.ii (i) Civil aviation (Domestic, LTO);
1.A.3.a.i (i) International aviation (LTO);
1.A.3.a.ii (ii) Civil aviation (Domestic, Cruise);
1.A.3.a.i (ii) International aviation (Cruise).

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

The aviation sector has quite a minor share in total emissions. The total contribution of aircraft LTO emissions to the emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide in the transport sector in 2015 was 0.5%, 0.5%, and 1.0% 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 1990–2015, the emission of NO_x, NMVOC, and CO from the LTO phase increased by 51.4%, 21.8%, and 44.7% respectively (Figure 3.19, Table 3.21), mainly due to changes in fuel consumption, which increased by 39.8% (Table 3.25) and the number of landing and take-off operations (Figure 3.21). This is roughly in line with the trends in the number of air passengers and freight transported over the same period. Figure 3.20 illustrate the importance of the international aviation sector, which contributes the majority of the emissions from the aviation sector.

In 2015, the emissions of NO_x and CO increased by 4.7 and 2.9% respectively compared to 2014. NMVOC emissions decreased by 1.7%. At the same time, the number of landing and take-off operations and fuel consumption increased by 7.8% and 5.2% respectively. Therefore, the increase in emissions occurred due to higher fuel consumption in 2015. The decrease in NMVOC emissions has mainly been caused by the fact that the share of different aircraft types varies and therefore the average emission factor (Table 3.23) changes from year to year in the LTO phase in the aviation sector.

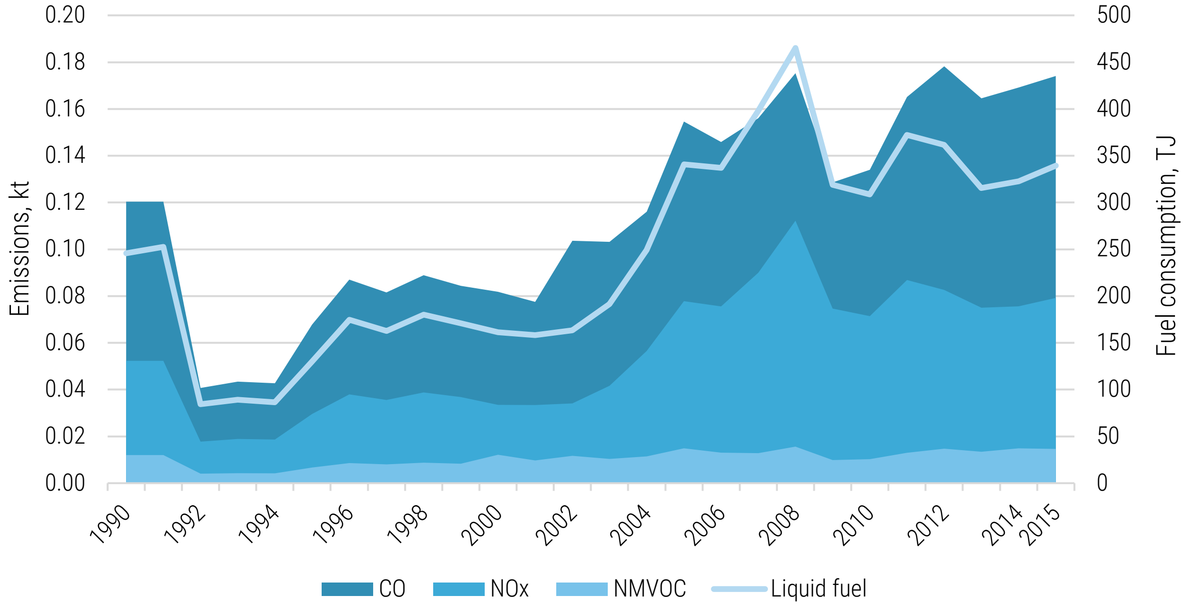

Figure 3.19 NO_x, NMVOC and CO emissions from the LTO cycle in aviation sector in the period of 1990-2015

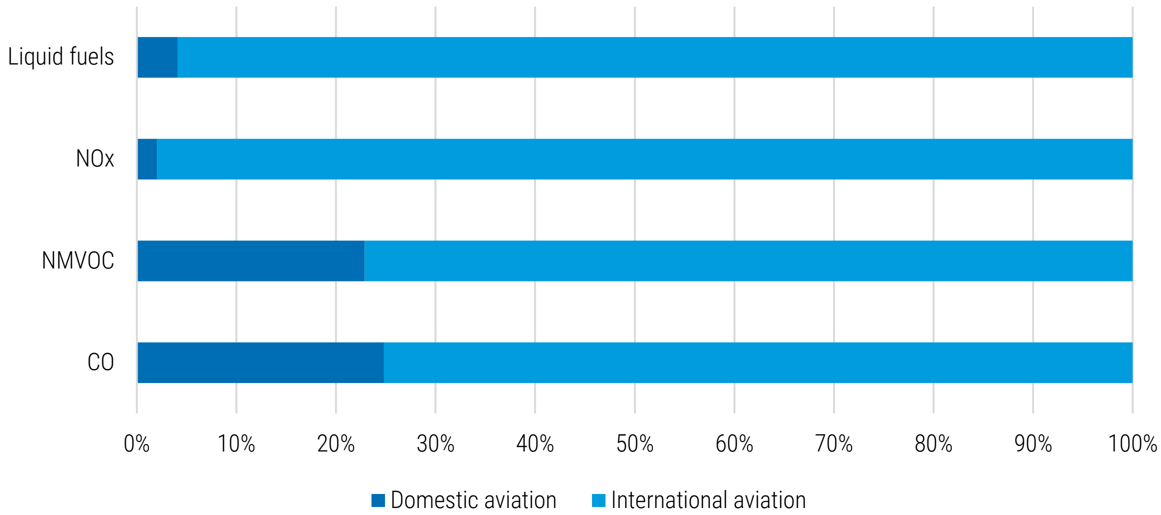

Figure 3.20 The share of pollutant emissions from the LTO cycle in aviation sector in 2015

Table 3.21 Emissions from the LTO cycle in the aviation sector in the period of 1990–2015

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
1991	0.052	0.012	0.006	NR	NR	0.392	NR	0.120
1992	0.018	0.004	0.002	NR	NR	0.133	NR	0.041
1993	0.019	0.004	0.002	NR	NR	0.141	NR	0.043
1994	0.019	0.004	0.002	NR	NR	0.139	NR	0.043
1995	0.030	0.007	0.003	NR	NR	0.221	NR	0.068
1996	0.038	0.009	0.004	NR	NR	0.283	NR	0.087
1997	0.036	0.008	0.004	NR	NR	0.265	NR	0.082
1998	0.039	0.009	0.004	NR	NR	0.289	NR	0.089
1999	0.037	0.008	0.004	NR	NR	0.275	NR	0.084
2000	0.033	0.012	0.004	0.314	0.314	0.314	0.152	0.082
2001	0.033	0.010	0.004	0.282	0.282	0.282	0.137	0.078
2002	0.034	0.012	0.004	0.272	0.272	0.272	0.132	0.104
2003	0.042	0.010	0.004	0.330	0.330	0.330	0.160	0.103
2004	0.057	0.011	0.006	0.441	0.441	0.441	0.213	0.116
2005	0.078	0.015	0.008	0.652	0.652	0.652	0.314	0.155
2006	0.076	0.013	0.008	0.642	0.642	0.642	0.310	0.146
2007	0.090	0.013	0.009	0.780	0.780	0.780	0.376	0.156
2008	0.112	0.016	0.010	0.941	0.941	0.941	0.453	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	0.307	0.165
2012	0.083	0.015	0.008	0.465	0.465	0.465	0.223	0.178
2013	0.075	0.013	0.007	0.463	0.463	0.463	0.221	0.165
2014	0.076	0.015	0.007	0.482	0.482	0.482	0.231	0.169
2015	0.079	0.015	0.007	0.501	0.501	0.501	0.240	0.174
Trend 1990-2015, %	51.4	21.8	32.1	59.5	59.5	27.7	57.4	44.7

Table 3.22 Emissions from the cruise phase in the aviation sector in the period of 1990–2015 (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
1991	0.385	0.015	0.030	NR	NR	0.006	NR	0.035
1992	0.128	0.005	0.010	NR	NR	0.002	NR	0.012
1993	0.206	0.008	0.016	NR	NR	0.003	NR	0.019
1994	0.165	0.006	0.013	NR	NR	0.003	NR	0.015
1995	0.190	0.007	0.015	NR	NR	0.003	NR	0.017
1996	0.153	0.006	0.012	NR	NR	0.002	NR	0.014
1997	0.237	0.009	0.019	NR	NR	0.004	NR	0.021
1998	0.147	0.006	0.012	NR	NR	0.002	NR	0.013
1999	0.230	0.009	0.018	NR	NR	0.004	NR	0.021
2000	0.224	0.009	0.018	0.004	0.004	0.004	0.002	0.020
2001	0.158	0.006	0.012	0.002	0.002	0.002	0.001	0.014
2002	0.187	0.007	0.015	0.003	0.003	0.003	0.001	0.017
2003	0.177	0.007	0.014	0.003	0.003	0.003	0.001	0.016
2004	0.298	0.011	0.023	0.005	0.005	0.005	0.002	0.027
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

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO
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	0.001	0.036
2015	0.208	0.008	0.016	0.003	0.003	0.003	0.000	0.018
Trend 1990-2015, %	-45.9	-44.4	-46.4	-7.6	-7.6	-45.8	-71.1	-48.3

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 (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013).

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 3.23) 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 3.25). Fuel-based cruise emission factors are taken from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013 as a single set for an average aircraft (Table 3.22). 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 3.23). 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 2015. Extrapolation has been done for 1990 and 1991.

Table 3.23 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

	NO_x	NMVOC	SO_2	$PM_{2.5}$	CO	Fuel consumption
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, 1000-2000 sph/engine	1.51	0	0.20	0	2.24	200.0
turboprop, >2000sph/engine	1.82	0.26	0.20	0	2.33	200.0
Piston engine						
microlight aircraft	0.03	0.04	0	0	0.94	1.4
4 seat single engine (<180hp)	0.01	0.06	0	0	3.93	3.9
singe engine high performance (180-360hp)	0.02	0.16	0	0	7.33	7.5
twin engine high performance (2x235hp)	0.05	0.22	0.01	0	19.33	21.6
Helicopters						
A109	0.13	0.89	0.02	0.01	1.31	32.8
A139	0.38	0.68	0.03	0.01	0.97	60.3
ALO3	0.11	0.28	0.01	0.00	0.40	21.4
AS32	0.65	0.49	0.04	0.02	0.68	77.4
AS35	0.18	0.22	0.01	0.01	0.32	27.5
AS50	0.15	0.24	0.01	0.01	0.35	25.2
AS55	0.15	0.82	0.02	0.01	1.20	34.8
H269	0.01	0.09	0	0	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	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	0.48	18.6
MI8	0.53	0.55	0.04	0.02	0.78	70.0
R22	0.01	0.09	0	0	6.21	6.2
R44	0.02	0.11	0	0	8.79	8.8
S76	0.29	0.59	0.02	0.01	0.85	48.2

Table 3.24 Emission factors for the cruise phase (kg/t)

	NO_x	NMVOC	SO_2	$PM_{2.5}$	BC	CO
Domestic aviation	10.3	0.1	1.0	0.2	0.096	2.0
International aviation	12.8	0.5	1.0	0.2	0.096	1.1

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Table 3.25 Fuel consumption in the aviation sector (kt)

Year	Domestic LTO	Domestic cruise	International LTO	International cruise	Total
1990	0.285	1.515	5.358	28.842	36.000
1991	0.285	1.515	5.358	28.842	36.000
1992	0.095	0.505	1.821	9.579	12.000
1993	0.096	1.124	1.943	15.157	18.320
1994	0.095	0.725	1.917	12.333	15.070
1995	0.150	0.971	3.041	14.059	18.221
1996	0.194	0.817	3.902	11.298	16.211
1997	0.181	0.952	3.657	17.750	22.540
1998	0.198	0.616	3.987	10.987	15.788
1999	0.188	0.672	3.784	17.418	22.062
2000	0.153	0.638	3.596	16.982	21.369
2001	0.170	0.608	3.562	11.871	16.211
2002	0.322	0.480	3.480	14.253	18.535
2003	0.333	0.415	4.142	13.478	18.368
2004	0.273	0.792	5.640	22.651	29.356
2005	0.308	0.239	7.568	38.987	47.102
2006	0.314	0.090	7.523	23.436	31.363
2007	0.291	0.126	8.966	39.791	49.174
2008	0.321	0.402	10.560	16.539	27.822
2009	0.284	0.267	7.134	24.901	32.586
2010	0.287	0.277	6.893	29.138	36.595
2011	0.339	0.532	8.319	24.536	33.726
2012	0.360	0.731	8.046	28.216	37.353
2013	0.313	0.072	7.060	20.966	28.411
2014	0.320	0.075	7.181	32.352	39.928
2015	0.322	0.075	7.570	16.198	24.165

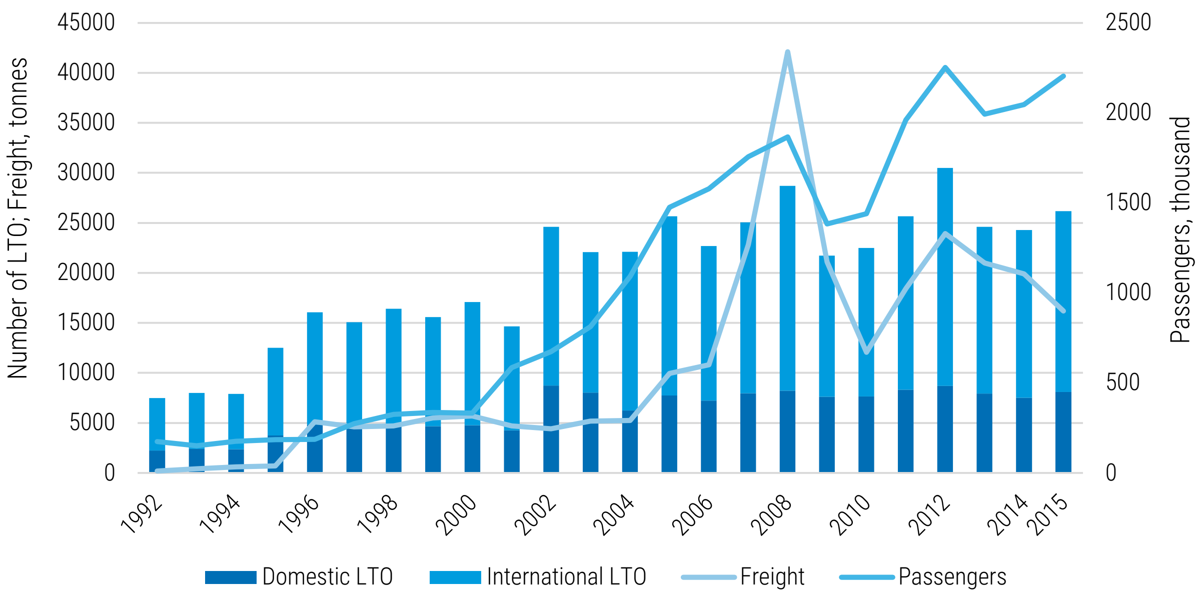

Figure 3.21 The number of LTO cycles, passengers carried and freight transported

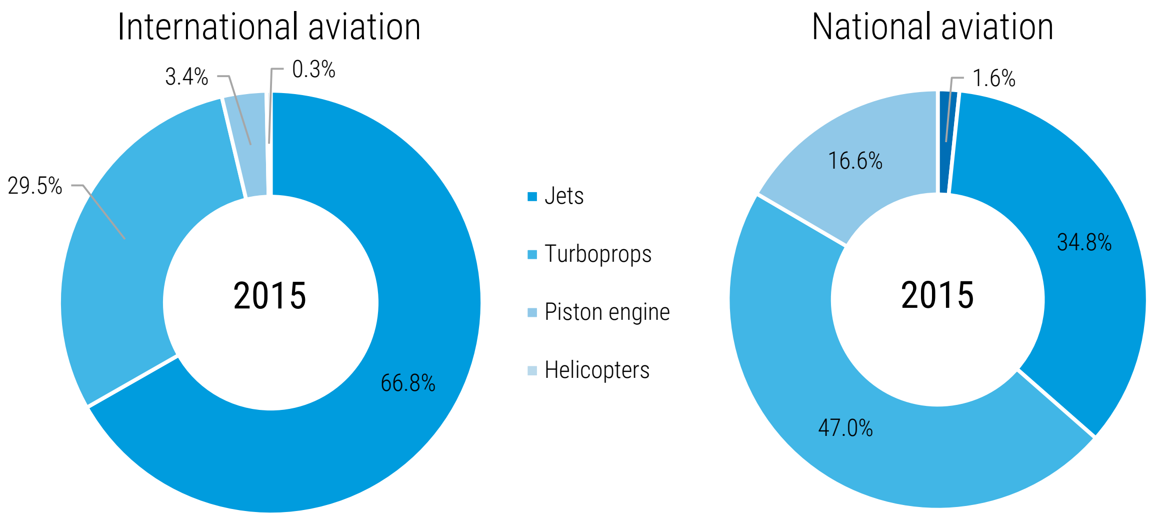

Figure 3.22 The share of different aircraft types in domestic and international civil aviation

3.3.2.3. Uncertainty

An uncertainty analysis was carried out for the 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 3.26. No uncertainty estimation for cruise phase has been carried out.

Table 3.26 Uncertainties in 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, road abrasion, tyre and brake wear, and NMVOC emissions from gasoline evaporation.

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

In 2015, road transport contributed to the total national emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide by 26.5%, 7.5%, and 9.7% respectively, and in the transport sector, 56.1%, 57.0%, and 71.2% respectively (Figure 3.16). 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 has mainly been caused by the stricter emission standards for road vehicles.

The lead emissions from road transport have decreased by about 99.6% since 1990 (Figure 3.22). The reduction of emissions is related to the prohibition on leaded gasoline in 2000. The share of road transport in the total Pb emissions was 1.0% in 2015.

The reduction of sulphur content in fuels has led to a substantial decrease in SO_2 emissions in the road transport sector (Figure 3.23). In 2001, the sulphur content was reduced from 5,000 ppm (diesel) and 1,000 ppm (gasoline) to 500 ppm and since then, sulphur content in fuel has been gradually reduced even more. Currently, all road transport fuels are sulphur free (sulphur content less than 10 ppm). Therefore, SO_2 emissions have decreased by 99.7% between 1990 and 2015. Since the beginning of 2010, the country-specific average sulphur content is used for SO_2 emission calculations. Average sulphur content in fuel (Table 3.28) 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).

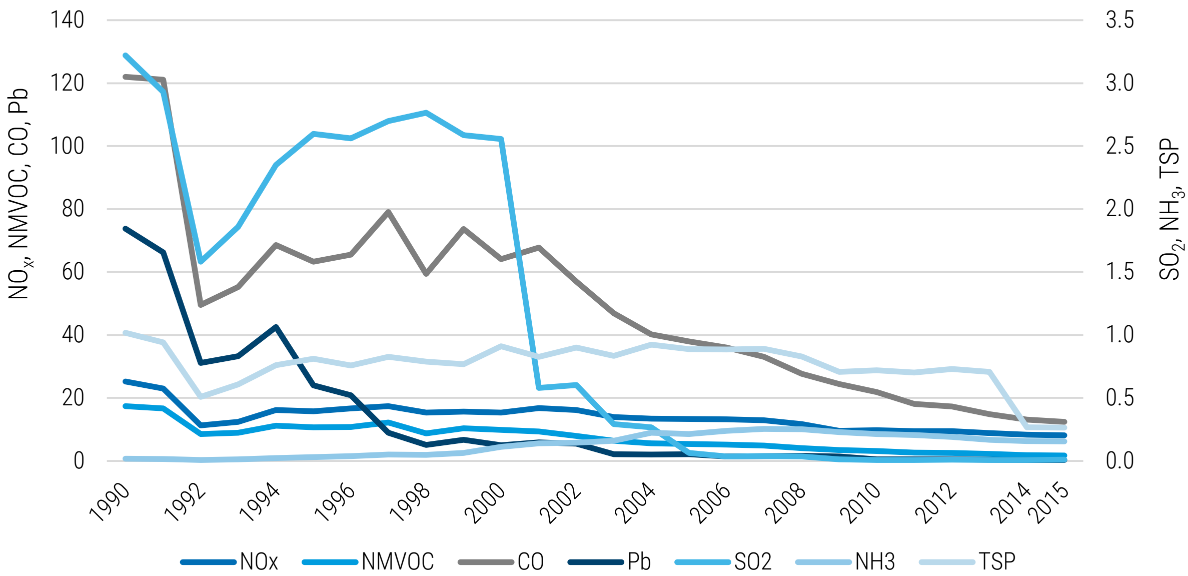

Figure 3.23 Pollutant emissions from road transport (kt)

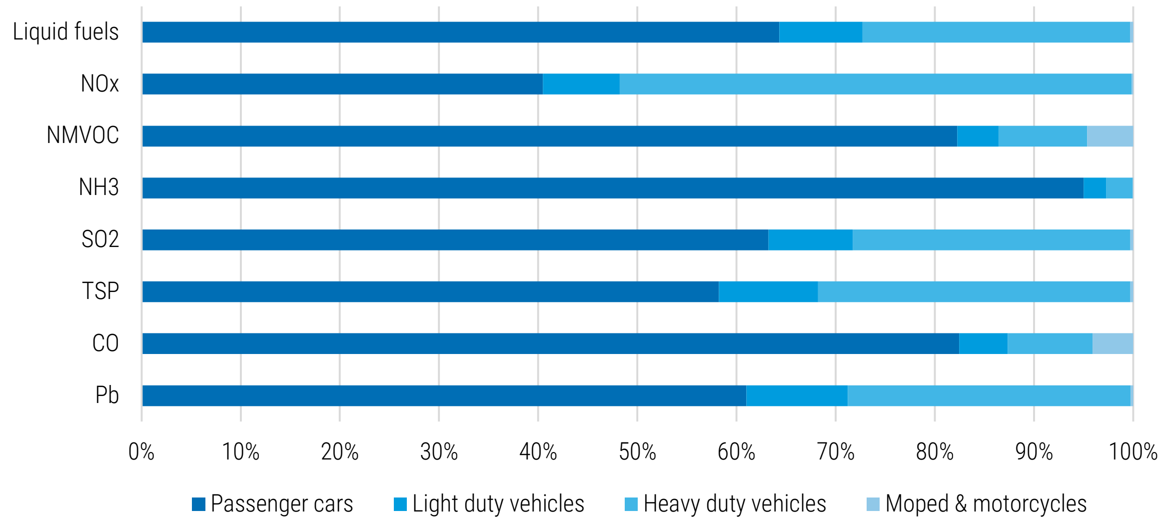

Figure 3.24 The share of pollutant emissions in the road transport sector in 2015

Fuel consumption has changed over the decades in the road transport sector. In the 1990s, gasoline consumption dominated but from 2003, we can see the continuous growth in diesel consumption in road transport (Figure 3.25). This trend can be explained by the fact that the popularity of vehicles with gasoline engines has declined in recent years, and diesel engines dominate due to their greater fuel efficiency and torque compared to gasoline engines. Since 1990, the number of gasoline passenger cars and light duty vehicles equipped with catalytic converters has increased, resulting in relatively decreasing emissions of, for example, NO_x and NMVOC by 91% and 94% between 1990 and 2015. 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 53% decrease in gasoline consumption during the period of 1990–2015 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, 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 0.03% in 2005 and increased to 0.57% in 2015 (Table 3.33).

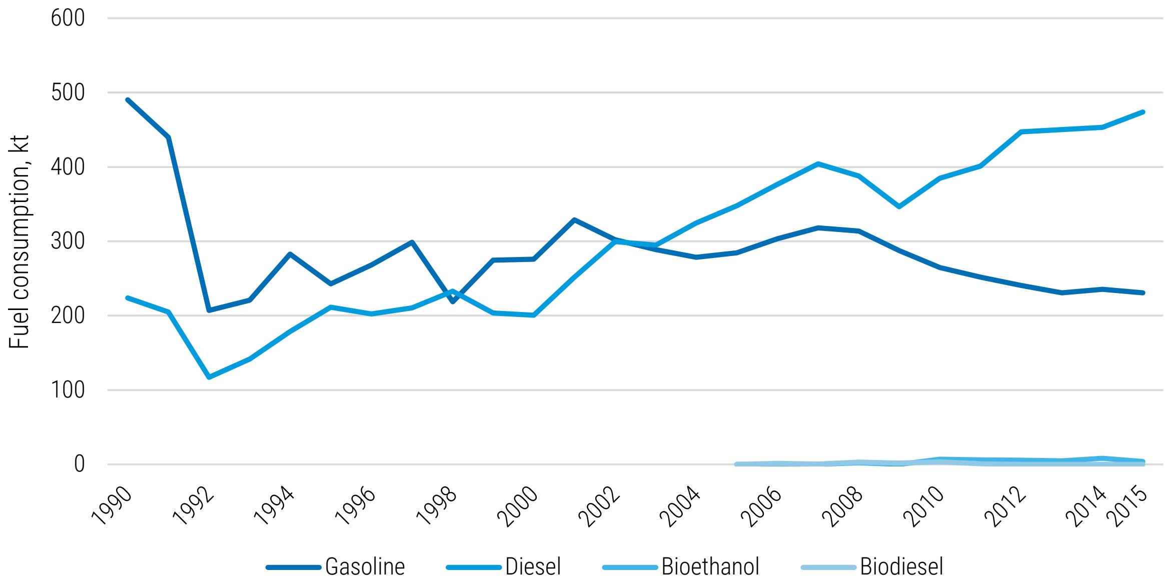

Figure 3.25 Gasoline and diesel consumption in the road transport sector

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The emission trend in recent years has been impacted by the improved fuel efficiency and minimised emissions of new vehicles. In 2015, statistics showed that the number of vehicles continued to increase (13.9%) compared to 2014. Therefore, the total mileage driven by vehicles and the amount of fuel consumed also increased by 3.7% and 1.7% respectively. Although there has been an increase in the number of vehicles, vehicle-kilometres, and fuel consumption, the main pollutant emissions from road transport decreased compared to 2014: nitrogen oxides emissions by 1.8%, non-methane volatile organic compounds by 5.4%, sulphur dioxide by 2.7%, and carbon monoxide by 5.0%.

In the Figures 3.23-24, a detailed overview of NO_x, NMVOC, NH_3, SO_x,, TSP, CO and Pb emission sources in the road transport sector is provided. All the emission trends are presented in Table 3.27.

Passenger cars (1A3bi)

Passenger cars contributed the majority of emissions within the road transport sector: 40.5% of NO_x, 62.9% of NMVOC, 63.2% of SO_2, 95.0% of NH_3, 22.5% of TSP, 82.5% of CO in 2015.

The passenger car fleet has grown over the last decades from 241 thousand vehicles to 537 thousand between 1990 and 2015. Cars with petrol engines make up a majority of registered passenger cars – 88% in 1990 and 60% in 2015 (Figure 3.26). This trend reflects that the number of diesel cars has grown fast during the same period (Figure 3.27). Significant changes have also taken place in annual mileage – annual mileage driven by diesel cars increased nine times (445 to 3,917 million km) and annual mileage per gasoline cars decreased by 32% (5,156 to 3,497 million km). Overall fuel consumption in this subsector decreased by 0.2% between 1990 and 2015. In detail, fuel consumed by diesel cars increased approximately ten times and gasoline fuel amount decreased by 33% during the same period.

During the period of 1990–2015, the pollutant emissions decreased significantly: 74.8% of NO_x, 89.6% of NMVOC, 99.4% of SO_2, and 90.0% of CO, although all the activity data increased in the same time. Therefore, the main pollutant emissions from passenger cars have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicles categories.

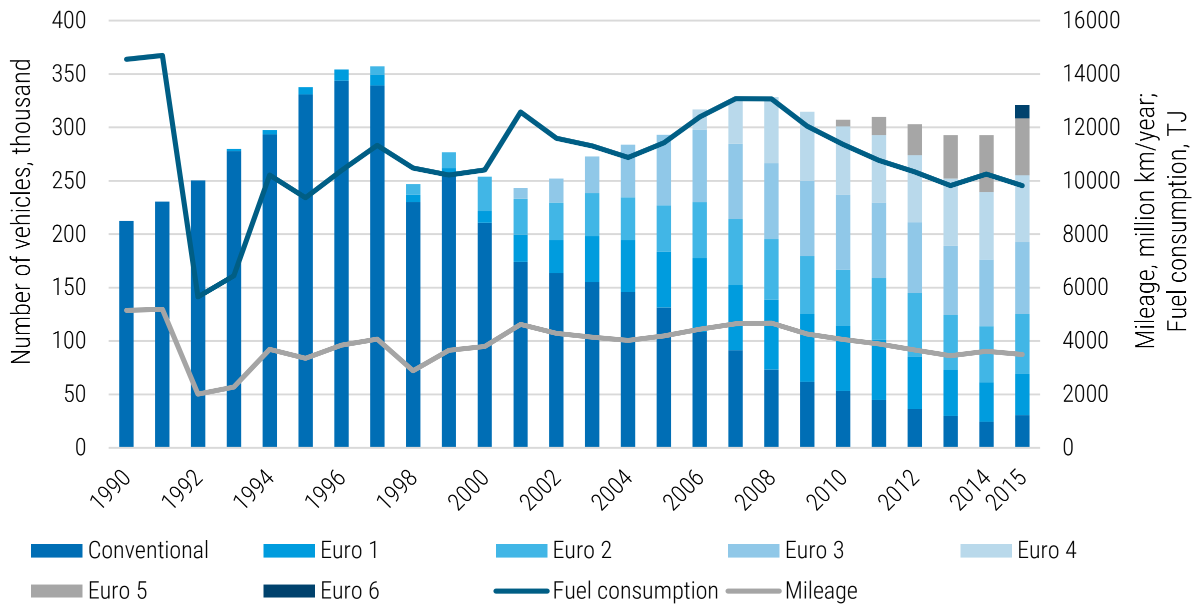

Figure 3.26 Gasoline passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

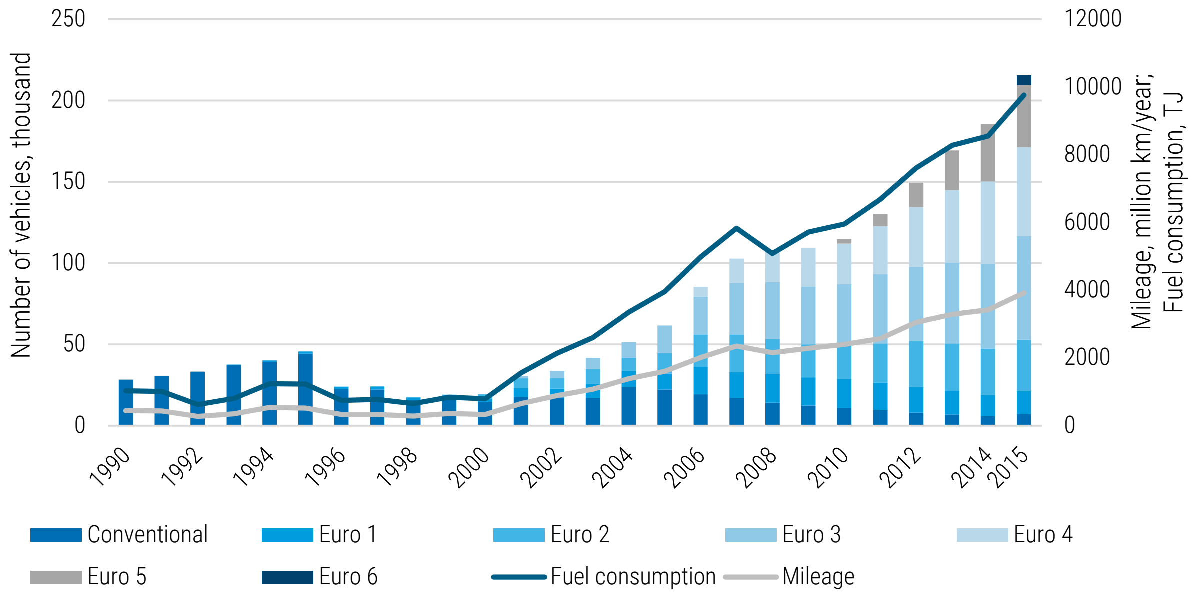

Figure 3.27 Diesel passenger cars: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

Light duty vehicles (1A3bii)

Light duty vehicles contributed about 7.8% of NO_x, 3.7% of NMVOC, 8.5% of SO_2, 2.3% of NH_3, 8.2% $PM_{2.5}$, 6.3% of PM_{10}, 4.9% of TSP and 4.9% of CO in the total road transport sector in 2015.

The light duty vehicle fleet has grown over the last decades from 31 thousand vehicles to 43 thousand between 1990 and 2015. Vehicles with diesel engines dominated during the entire period. The number of diesel light duty vehicles was 18 thousand in 1990 and increased by 95% to 35 thousand vehicles in 2015 (Figure 3.29). The gasoline light duty vehicle fleet decreased by 44% over the same period from 13 thousand to 7 thousand vehicles (Figure 3.28). A similar trend can be seen in the annual mileage and fuel consumption – mileage and fuel consumption increased by 16% and 7% respectively in this subsector. As expected, annual mileage driven by gasoline vehicles declined by 74% and the total annual kilometres driven by diesel vehicles increased more than twice. In addition, gasoline fuel consumption decreased by 72% and diesel fuel consumption increased by 96% in this subsector during the same period.

The pollutant emissions decreased significantly: 59.9% of NO_x, 92.0% of NMVOC, 99.8% of SO_2, and 93.2% of CO, although all the activity data increased in the period of 1990–2015. 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.

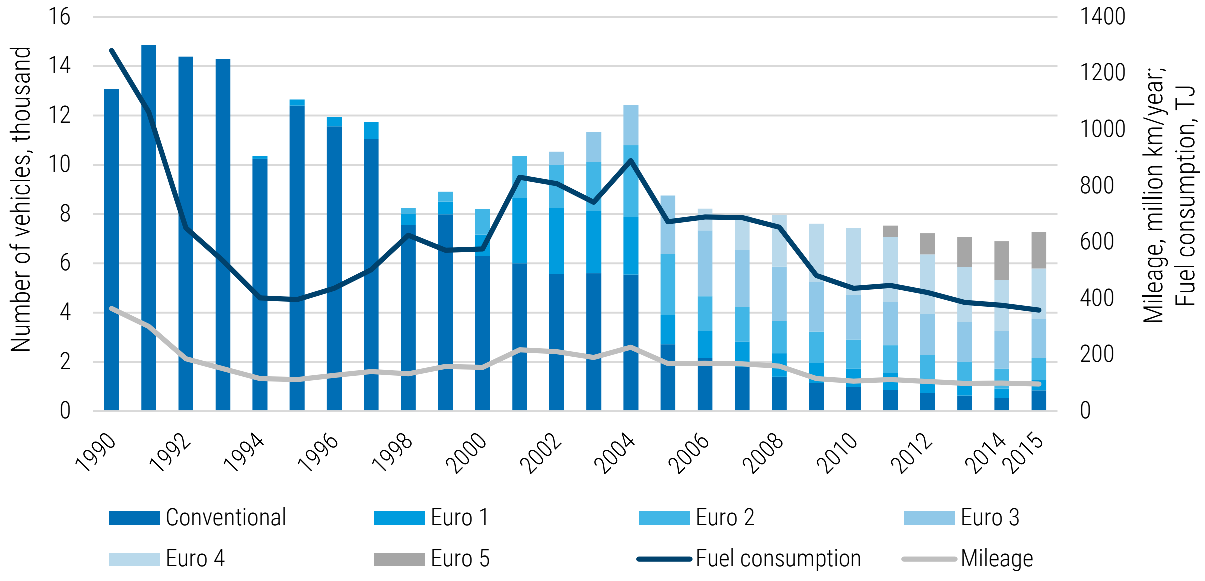

Figure 3.28 Gasoline light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

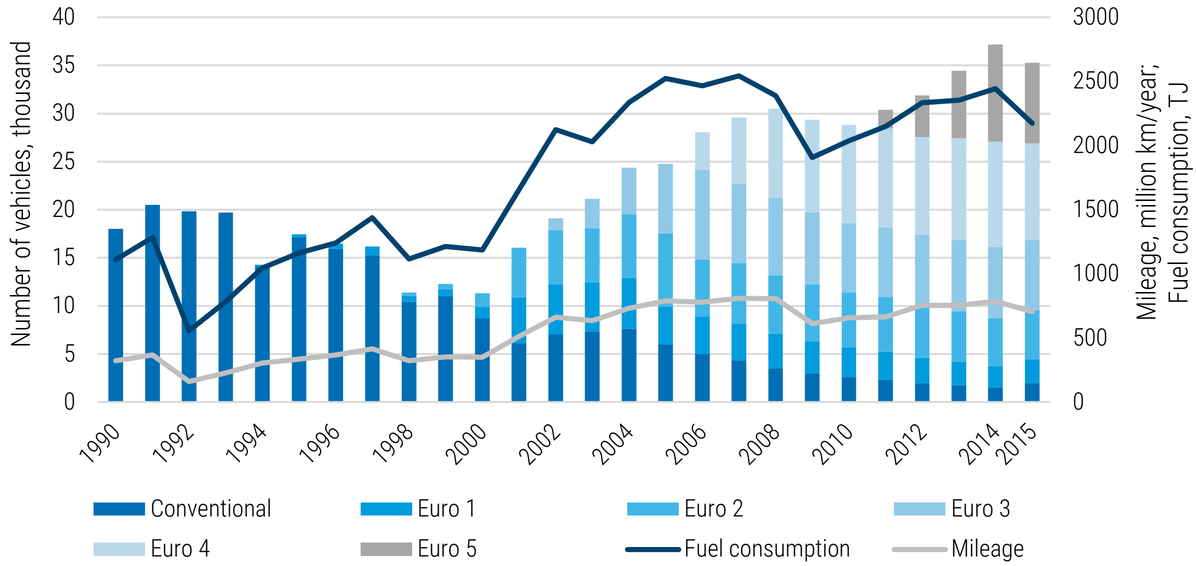

Figure 3.29 Diesel light duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

Heavy duty vehicles and buses (1A3biii)

Heavy duty vehicles contributed about 51.6% of NO_x, 8.9% of NMVOC, 28.0% of SO_2, 2.6% of NH_3, 18.1% $PM_{2.5}$, 13.8% of PM_{10}, 10.8% of TSP and 8.5% of CO in the total road transport sector in 2015.

The heavy duty vehicle fleet has declined over the last decades from 45 thousand vehicles to 29 thousand between 1990 and 2015. Heavy duty vehicles with diesel engines make up the majority of registered vehicles – 60% in 1990 and 93% in 2015. The number of diesel and gasoline vehicles has declined – 13% and 89% respectively. Total annual mileage and fuel consumption decreased by 42% and 33% respectively during this period. In detail, mileage driven and fuel consumed by gasoline vehicles decreased by 99% (Figure 3.30). However, the same indicators for diesel powered heavy duty vehicles increased by 15% and 11% respectively (Figure 3.31).

During the period of 1990–2015, the pollutant emissions decreased significantly: 59.8% of NO_x, 93.9% of NMVOC, 99.9% of SO_2, and 74.2% of CO, although all the activity data increased in the same time. Therefore, the main pollutant emissions from heavy duty vehicles have been reduced by improving the quality of fuels and by setting increasingly stringent emission limits for new vehicle categories.

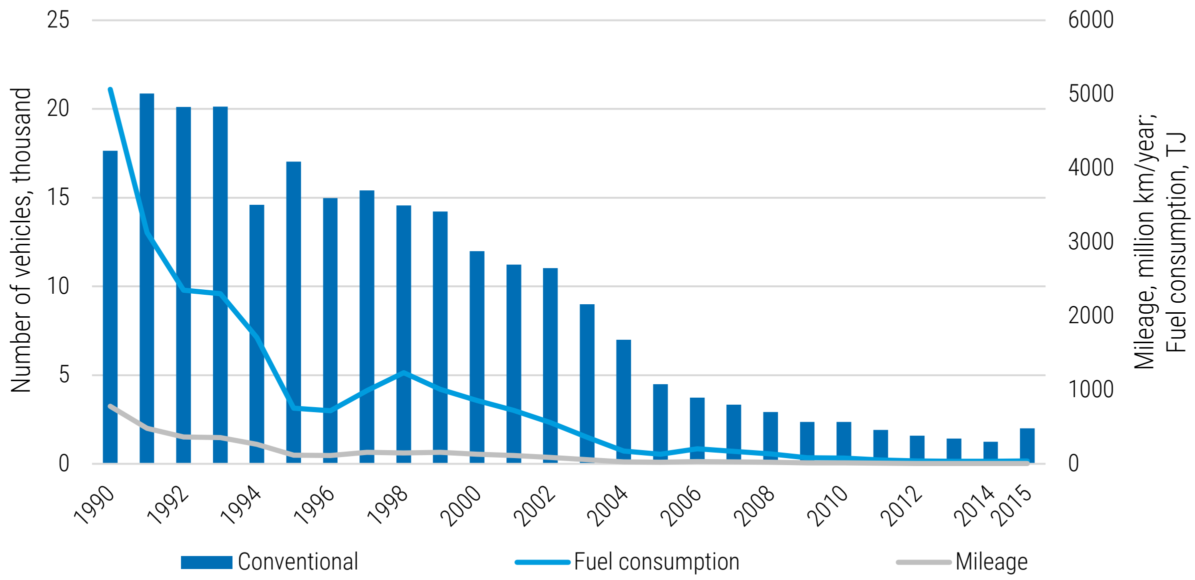

Figure 3.30 Gasoline heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

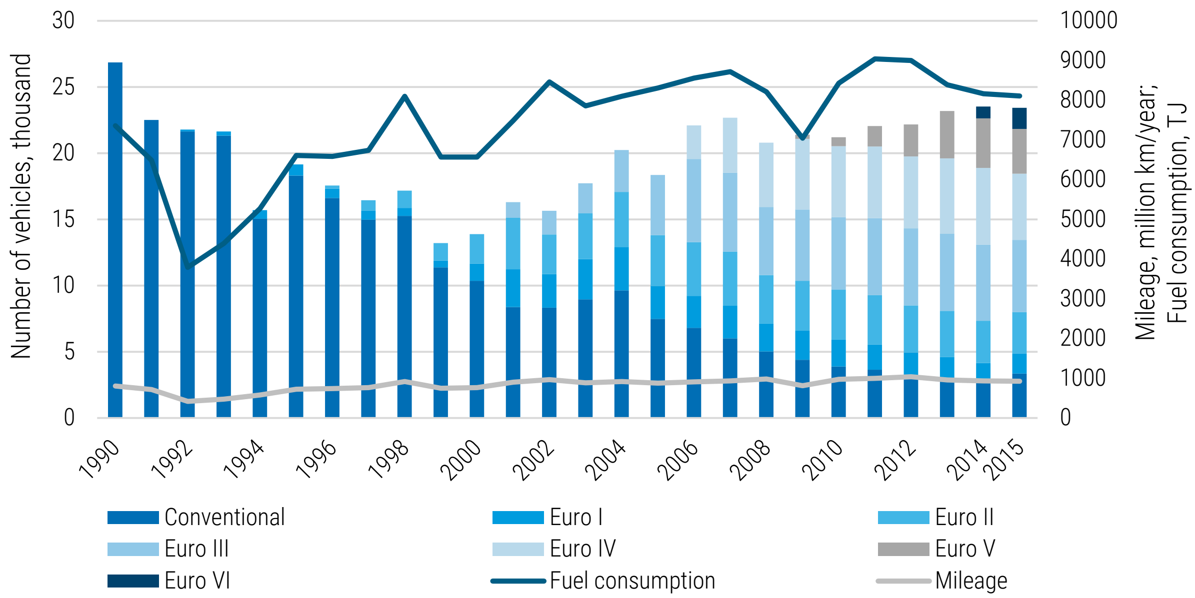

Figure 3.31 Diesel heavy duty vehicles: number of vehicles, annual mileage, and fuel consumption in the period of 1990–2015

Motorcycles and mopeds (1A3biv)

This subsector contributes only a marginal share of the total road transport sector emissions: 0.2% of NO_x, 3.3% of NMVOC, 0.3% of SO_2, 0.1% of NH_3, 0.2% of $PM_{2.5}$, 0.1% of PM_{10}, 0.1% of TSP and 4.1% of CO in 2015.

The number of motorcycles, annual mileage, and fuel consumption decreased by 70.8%, 79.6%, and 81.5% respectively between 1990 and 2015. During this period, NO_x emissions decreased by 89.0%, NMVOC emissions by 88.0%, SO_2 emissions by 99.9% and CO emissions by 92.1%.

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Recalculations

SO_x emissions from the road transport sector have been recalculated for the year 2014. Recalculations entailed using corrected sulphur content in fuels. In addition, other pollutants emissions also changed because sulphur content is related to correction functions in emission calculations for gasoline fuel in the COPERT 4 programme. The pollutants most affected by this recalculation have been NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP and CO. An overview of the updated data is given in Chapter 8.

Table 3.27 Emissions from road transport in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	25.250	17.389	3.220	0.016	NR	NR	1.018	NR	122.056
1991	22.949	16.651	2.930	0.015	NR	NR	0.942	NR	121.144
1992	11.294	8.554	1.583	0.007	NR	NR	0.509	NR	49.562
1993	12.446	8.965	1.859	0.011	NR	NR	0.608	NR	55.237
1994	16.147	11.181	2.350	0.022	NR	NR	0.759	NR	68.550
1995	15.786	10.678	2.598	0.029	NR	NR	0.812	NR	63.319
1996	16.632	10.785	2.561	0.039	NR	NR	0.759	NR	65.492
1997	17.350	12.184	2.700	0.050	NR	NR	0.825	NR	79.040
1998	15.387	8.686	2.765	0.047	NR	NR	0.790	NR	59.370
1999	15.632	10.382	2.587	0.062	NR	NR	0.767	NR	73.653
2000	15.350	9.905	2.558	0.111	0.713	0.800	0.910	0.334	64.102
2001	16.780	9.332	0.581	0.140	0.587	0.694	0.826	0.263	67.794
2002	16.150	7.964	0.602	0.146	0.657	0.767	0.901	0.307	57.005
2003	13.905	6.440	0.293	0.160	0.603	0.708	0.835	0.287	46.869
2004	13.453	5.571	0.267	0.223	0.683	0.792	0.923	0.331	40.176
2005	13.283	5.387	0.063	0.213	0.646	0.758	0.888	0.313	37.946
2006	13.212	5.220	0.036	0.240	0.626	0.746	0.885	0.303	35.965
2007	12.858	4.821	0.037	0.255	0.617	0.744	0.890	0.301	33.096
2008	11.672	4.009	0.036	0.253	0.554	0.680	0.829	0.266	27.628
2009	9.536	3.481	0.012	0.227	0.464	0.576	0.707	0.226	24.403
2010	9.754	3.110	0.006	0.213	0.459	0.578	0.719	0.223	21.915
2011	9.454	2.597	0.008	0.205	0.438	0.558	0.701	0.211	18.101
2012	9.471	2.573	0.009	0.192	0.456	0.581	0.731	0.223	17.285
2013	8.871	2.271	0.008	0.167	0.441	0.563	0.707	0.218	14.844
2014	8.309	1.809	0.008	0.159	0.414	0.539	0.684	0.198	13.065
2015	8.160	1.712	0.009	0.154	0.413	0.541	0.688	0.195	12.417
Trend 1990-2015, %	-67.7	-90.2	-99.7	839.9	-49.4	-44.5	-74.1	-41.6	-89.8

Table 3.27 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t								
1990	73.785	0.008	NE	NE	0.112	2.152	0.024	0.002	2.214
1991	66.237	0.008	NE	NE	0.098	1.887	0.021	0.002	1.994
1992	31.167	0.004	NE	NE	0.051	0.991	0.011	0.001	0.999
1993	33.265	0.004	NE	NE	0.057	1.087	0.012	0.001	1.108
1994	42.559	0.005	NE	NE	0.071	1.351	0.015	0.001	1.414
1995	24.026	0.005	NE	NE	0.067	1.258	0.014	0.001	1.357
1996	20.813	0.005	NE	NE	0.070	1.320	0.015	0.001	1.422
1997	8.922	0.006	NE	NE	0.075	1.416	0.016	0.001	1.536
1998	5.104	0.005	NE	NE	0.068	1.273	0.014	0.001	1.338
1999	6.743	0.005	NE	NE	0.070	1.329	0.015	0.001	1.440
2000	4.944	0.005	NE	NE	0.072	1.359	0.015	0.001	1.446
2001	5.902	0.007	NE	NE	0.088	1.669	0.018	0.002	1.773
2002	5.445	0.007	NE	NE	0.091	1.717	0.019	0.002	1.819

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
					t				
2003	2.127	0.007	NE	NE	0.088	1.644	0.018	0.002	1.761
2004	2.065	0.007	NE	NE	0.092	1.712	0.019	0.002	1.818
2005	2.112	0.007	NE	NE	0.094	1.758	0.019	0.002	1.896
2006	1.444	0.008	NE	NE	0.101	1.887	0.021	0.002	2.040
2007	1.516	0.008	NE	NE	0.107	1.998	0.022	0.002	2.162
2008	1.569	0.008	NE	NE	0.107	1.988	0.022	0.002	2.116
2009	1.372	0.007	NE	NE	0.095	1.770	0.019	0.002	1.904
2010	0.490	0.007	NE	NE	0.100	1.861	0.020	0.002	1.967
2011	0.459	0.007	NE	NE	0.101	1.875	0.020	0.002	1.966
2012	0.459	0.008	NE	NE	0.106	1.965	0.021	0.002	2.055
2013	0.424	0.008	NE	NE	0.104	1.922	0.021	0.002	2.023
2014	0.271	0.008	NE	NE	0.106	1.959	0.021	0.002	2.063
2015	0.277	0.008	NE	NE	0.108	2.000	0.022	0.002	2.096
Trend 1990-2015, %	-99.6	-7.5	NE	NE	-2.8	-7.1	-8.3	-0.7	-5.3

Table 3.27 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	0.331	0.006	0.015	0.013	0.009	0.043	0.202	0.202
1991	0.304	0.005	0.013	0.010	0.009	0.037	0.194	0.194
1992	0.152	0.003	0.007	0.006	0.004	0.020	0.086	0.086
1993	0.171	0.003	0.008	0.007	0.005	0.022	0.095	0.092
1994	0.225	0.004	0.010	0.008	0.006	0.027	0.134	0.127
1995	0.215	0.004	0.009	0.007	0.006	0.027	0.125	0.114
1996	0.222	0.004	0.009	0.007	0.006	0.027	0.143	0.127
1997	0.237	0.004	0.010	0.008	0.007	0.029	0.154	0.133
1998	0.199	0.003	0.009	0.008	0.005	0.026	0.119	0.097
1999	0.221	0.004	0.009	0.008	0.006	0.027	0.146	0.116
2000	0.224	0.004	0.009	0.008	0.006	0.026	0.163	0.105
2001	0.283	0.005	0.011	0.009	0.007	0.032	0.223	0.126
2002	0.292	0.005	0.012	0.010	0.007	0.034	0.228	0.112
2003	0.288	0.006	0.011	0.010	0.007	0.033	0.237	0.101
2004	0.302	0.006	0.012	0.010	0.007	0.035	0.237	0.092
2005	0.313	0.007	0.012	0.010	0.008	0.037	0.254	0.094
2006	0.344	0.007	0.013	0.011	0.009	0.040	0.296	0.099
2007	0.366	0.008	0.014	0.012	0.009	0.043	0.325	0.100
2008	0.346	0.008	0.013	0.012	0.009	0.042	0.315	0.089
2009	0.318	0.007	0.012	0.011	0.008	0.038	0.297	0.080
2010	0.326	0.008	0.013	0.012	0.008	0.041	0.308	0.078
2011	0.323	0.008	0.013	0.012	0.009	0.042	0.307	0.074
2012	0.331	0.009	0.015	0.013	0.009	0.046	0.316	0.072
2013	0.315	0.009	0.015	0.013	0.009	0.046	0.301	0.067
2014	0.301	0.009	0.015	0.013	0.010	0.047	0.289	0.064
2015	0.311	0.010	0.015	0.014	0.010	0.050	0.297	0.065
Trend 1990-2015, %	-6.0	81.0	1.4	8.7	9.1	15.6	47.0	-67.8

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 4 programme (Computer Programme to calculate Emissions from Road Transport, Copert 4 Version 11.3), 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 3.31) and the number of vehicles (Table 3.32), 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 2016, 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 3.33) by emission factors (Table 3.28–3.30). 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. 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 3.28 Sulphur content in fuel (ppm)

Fuel	Gasoline	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	5.1	4.8
2011	5.5	6.2
2012	6.5	7.1
2013	6.0	6.1
2014	6.016	5.350
2015	6.102	6.552

- Pb emissions are estimated according to the calculation that 75% of lead contained in gasoline is emitted into the air. Equation:

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

where

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

Table 3.29 Lead content in gasoline (g/l)

Fuel	Leaded gasoline	Unleaded gasoline
1990	0.15	0.013
2003	-	0.005
2006	-	0.003
2010	-	0.0001

- 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

$E_{Heavy\ metal}$ – heavy metal emission;
k – weight-related content of heavy metal in fuel (kg/kg);
FC – fuel consumption.

Table 3.30 Heavy metals content in fuel (mg/kg)

Fuel	Gasoline/ Bioethanol	Diesel/ Biodiesel
Cd	0.0108	0.0087
Cu	0.0418	0.0212
Cr	0.0159	0.0300
Ni	0.0130	0.0088
Se	0.0002	0.0001
Zn	2.1640	1.7380

Table 3.31 Average annual mileage in the road transport sector (million km per year)

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
1990	5601.3	687.2	1584.3	317.1	8189.9
1991	5612.3	668.1	1195.8	230.5	7706.7
1992	2278.0	346.9	783.4	230.0	3638.3
1993	2619.9	377.9	831.4	223.3	4052.6
1994	4224.7	421.8	843.9	5.1	5495.4
1995	3880.1	446.8	842.7	7.7	5177.3
1996	4172.4	494.9	850.3	10.0	5527.6
1997	4396.3	555.4	923.7	12.8	5888.3
1998	3165.2	455.9	1064.4	10.5	4696.0
1999	4012.0	512.2	902.4	14.5	5441.1
2000	4125.7	505.5	899.8	15.9	5546.9
2001	5271.2	729.3	1011.3	16.2	7028.1
2002	5176.5	872.8	1053.0	17.3	7119.6
2003	5219.5	825.3	941.0	19.3	7005.1
2004	5419.8	958.5	942.1	32.8	7353.2
2005	5801.9	958.9	898.4	10.7	7669.8

Year	Passenger cars	Light duty vehicles	Heavy duty vehicles	Motorcycles	Total
2006	6451.1	950.0	939.1	19.2	8359.4
2007	6989.5	978.3	960.7	28.1	8956.6
2008	6829.0	965.6	995.8	29.8	8820.2
2009	6546.7	727.4	818.6	26.6	8119.3
2010	6455.7	763.6	981.5	28.0	8227.8
2011	6460.2	777.8	998.5	25.1	8261.7
2012	6714.8	859.8	1042.3	33.9	8650.8
2013	6737.3	852.5	962.4	44.0	8596.2
2014	7028.9	887.2	932.7	27.6	8876.5
2015	7413.1	799.9	925.9	64.8	9203.7

Table 3.32 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
1991	261.1	35.4	50.3	100.2	447.0
1992	283.5	34.2	48.8	100.0	466.5
1993	317.4	34.0	48.8	97.1	497.3
1994	337.8	24.7	35.4	2.2	400.1
1995	383.4	30.1	42.5	3.3	459.3
1996	378.3	28.4	37.9	4.2	448.8
1997	381.5	27.9	36.8	5.4	451.6
1998	264.8	19.6	36.3	4.4	325.1
1999	295.7	21.2	31.1	6.1	354.2
2000	273.1	19.5	29.1	6.7	328.5
2001	273.9	26.4	30.9	6.8	338.0
2002	285.8	29.6	29.9	7.3	352.5
2003	314.4	32.5	30.0	8.1	385.0
2004	335.1	36.8	30.5	9.1	411.5
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	9.8	560.8
2015	536.5	42.5	29.0	30.8	639.0

Table 3.33 Fuel consumption in the road transport sector (kt)

Year	Gasoline	Diesel	Bioethanol	Biodiesel
1990	490.16	223.95	-	-
1991	440.05	205.00	-	-
1992	206.98	116.86	-	-
1993	220.89	141.70	-	-
1994	282.63	178.45	-	-
1995	242.96	211.25	-	-
1996	268.09	202.46	-	-
1997	298.91	210.25	-	-
1998	218.62	232.76	-	-
1999	274.61	203.74	-	-
2000	275.70	200.65	-	-
2001	328.79	251.76	-	-
2002	302.07	299.76	-	-
2003	288.95	294.77	-	-
2004	278.49	324.74	-	-
2005	284.61	347.73	0	0.17
2006	303.29	376.55	0	1.23
2007	317.94	404.25	0.02	0.57
2008	313.76	387.96	2.15	3.15
2009	287.71	346.47	0.15	1.82
2010	264.64	384.63	6.86	3.57
2011	251.77	401.07	5.93	0.72

Year	Gasoline	Diesel	Bioethanol	Biodiesel
2012	240.55	447.38	5.63	0
2013	230.50	450.07	4.78	0
2014	235.51	453.08	7.98	0
2015	230.68	473.83	3.99	0

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.

$PM_{2.5}$ and PM_{10} emissions from automobile tyre and brake wear calculations are based on the Tier 2 method and use the COPERT model (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016). Nevertheless, TSP emissions from automobile tyre and brake wear and $PM_{2.5}$, PM_{10}, and TSP emissions from the road abrasion sector is not included in the COPERT model and therefore these emissions are calculated separately by using Tier 1 default emission factors from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 (Table 3.34).

Table 3.34 Emission factors for road abrasion, tyre and brake wear, g/km

Transport Category	Tyre and brake wear			Road abrasion
	$PM_{2.5}$	PM_{10}	TSP	TSP
Passenger cars	0.0074	0.0138	0.0182	0.0150
Light duty vehicles	0.0117	0.0216	0.0286	0.0150
Heavy duty vehicles	0.0316	0.0590	0.0777	0.0760
Motorcycles	0.0034	0.0064	0.0083	0.0060

3) Gasoline evaporation

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

Gasoline evaporation calculations are based on the Tier 3 method and use the COPERT model (EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016).

3.3.3.3. Uncertainty

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 3.35.

Table 3.35 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/F	0.311	g I-TEQ	7.51	14.50	4.25

Pollutant	Emissions, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
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

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

Use an improved new edition of the COPERT 5 programme for emission calculations. Also, include more detailed vehicle subsectors in calculations: mopeds, hybrid and LPG/CNG vehicles. Specify activity data and recalculate, if necessary.

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.

The total contribution to the emissions of nitrogen oxides, non-methane volatile compounds and carbon monoxide were 6.8%, 2.9% and 1.2% respectively, in the transport sector in 2015.

The emissions of NO_x, NMVOC and CO have decreased compared to 1990 by 59.0%, 60.6% and 66.3% respectively. The trend of all the emissions is given in Table 3.36.

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

Emissions from rail originate primarily from the combustion of diesel and light fuel oil by locomotives. Since emissions from railway sector are calculated by Tier 1 method which takes into account the amount of fuel consumed and default emission factors, the deviations of time series can be explained by statistical fuel consumption deviations in the railway sector. As shown in Figure 3.31 freight turnover shows similar changes in trend and therefore all the emissions are directly influenced by freight rail activity.

Fuel consumption decreased 2.7% in 2015 compared to 2014 and therefore insignificant decrease in emissions for this period is observed.

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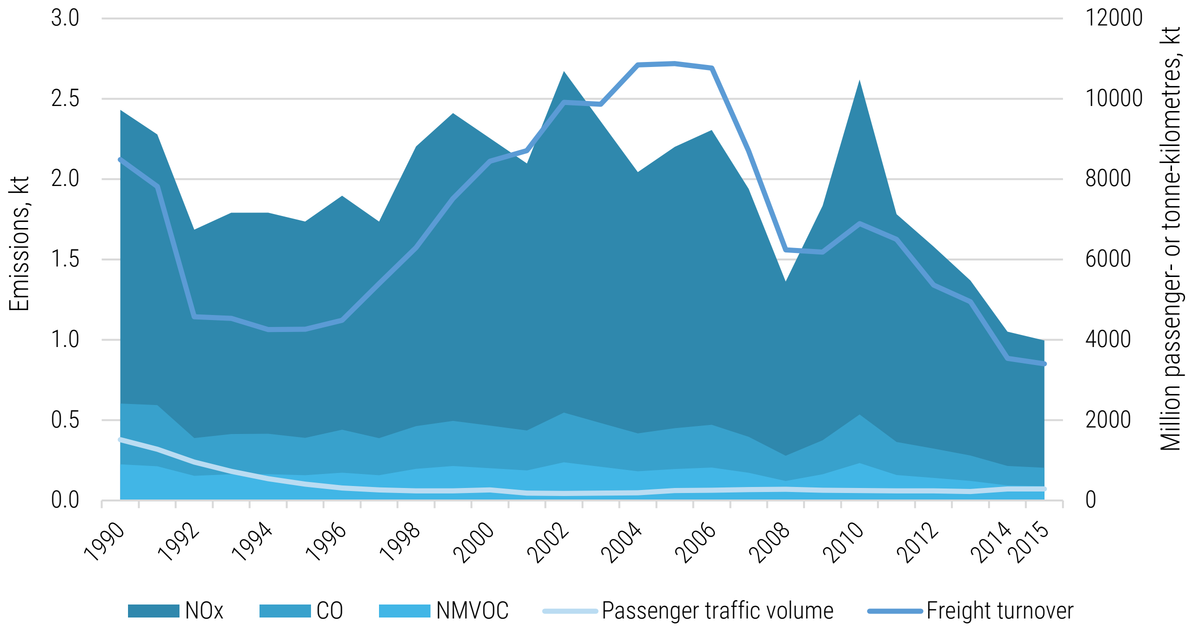

Figure 3.32 NO_x, NMVOC and CO emissions from the railway sector

Table 3.36 Emissions from railway transport in the period of 1990-2015

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
1991	2.278	0.213	0.559	0.301	NR	NR	0.083	NR	0.593
1992	1.685	0.153	0.364	0.224	NR	NR	0.055	NR	0.388
1993	1.791	0.163	0.388	0.238	NR	NR	0.058	NR	0.413
1994	1.791	0.163	0.390	0.238	NR	NR	0.059	NR	0.415
1995	1.736	0.157	0.365	0.231	NR	NR	0.055	NR	0.389
1996	1.897	0.173	0.413	0.252	NR	NR	0.062	NR	0.440
1997	1.736	0.157	0.363	0.231	NR	NR	0.055	NR	0.388
1998	2.203	0.197	0.433	0.294	NR	NR	0.066	NR	0.462
1999	2.411	0.214	0.463	0.322	NR	NR	0.070	NR	0.495
2000	2.254	0.200	0.177	0.301	0.060	0.063	0.066	0.038	0.466
2001	2.097	0.187	0.167	0.280	0.056	0.059	0.062	0.036	0.435
2002	2.673	0.237	0.199	0.357	0.070	0.074	0.078	0.045	0.547
2003	2.358	0.209	0.170	0.315	0.062	0.065	0.068	0.040	0.482
2004	2.044	0.181	0.153	0.273	0.053	0.056	0.059	0.035	0.417
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	0.068	0.238	0.047	0.049	0.052	0.030	0.364
2012	1.581	0.140	0.060	0.211	0.041	0.043	0.046	0.027	0.323
2013	1.368	0.121	0.052	0.183	0.036	0.038	0.040	0.023	0.279
2014	1.050	0.093	0.040	0.140	0.027	0.029	0.030	0.018	0.215
2015	0.996	0.088	0.038	0.113	0.026	0.027	0.029	0.017	0.203
Trend 1990-2015, %	-59.0	-60.6	-93.3	-64.9	-56.3	-56.3	-65.9	-55.8	-66.3

Table 3.36 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
1991	0.019	0.687	1.130	0.572	0.004	0.076	0.005	0.687	0.072
1992	0.007	0.408	0.387	0.196	0.002	0.055	0.003	0.408	0.042
1993	0.007	0.435	0.419	0.212	0.002	0.059	0.003	0.435	0.045
1994	0.007	0.439	0.435	0.220	0.002	0.059	0.003	0.439	0.045
1995	0.005	0.400	0.308	0.156	0.002	0.057	0.003	0.400	0.041
1996	0.008	0.466	0.466	0.236	0.003	0.062	0.003	0.466	0.048
1997	0.005	0.397	0.292	0.148	0.002	0.057	0.003	0.397	0.040
1998	0.002	0.445	0.111	0.056	0.002	0.072	0.003	0.445	0.045
1999	0.000	0.465	0.024	0.012	0.002	0.078	0.003	0.465	0.047
2000	0.001	0.441	0.047	0.024	0.002	0.073	0.003	0.441	0.044
2001	0.001	0.414	0.063	0.032	0.002	0.068	0.003	0.414	0.042
2002	0.000	0.512	0.008	0.004	0.003	0.087	0.004	0.512	0.051
2003	0.000	0.450	0.000	0.000	0.002	0.077	0.003	0.450	0.045
2004	0.000	0.390	0.000	0.000	0.002	0.066	0.003	0.390	0.039
2005	0.000	0.420	0.000	0.000	0.002	0.071	0.003	0.420	0.042
2006	0.000	0.440	0.000	0.000	0.002	0.075	0.003	0.440	0.044
2007	0.000	0.370	0.000	0.000	0.002	0.063	0.003	0.370	0.037
2008	0.000	0.260	0.000	0.000	0.001	0.044	0.002	0.260	0.026
2009	0.000	0.350	0.000	0.000	0.002	0.060	0.002	0.350	0.035
2010	0.000	0.500	0.000	0.000	0.003	0.085	0.004	0.500	0.050
2011	0.000	0.340	0.000	0.000	0.002	0.058	0.002	0.340	0.034
2012	0.000	0.302	0.000	0.000	0.002	0.051	0.002	0.302	0.030
2013	0.000	0.261	0.000	0.000	0.001	0.044	0.002	0.261	0.026
2014	0.000	0.200	0.000	0.000	0.001	0.034	0.001	0.200	0.020
2015	0.000	0.190	0.000	0.000	0.001	0.032	0.001	0.19	0.019
Trend 1990-2015, %	-100.0	-71.8	-100.0	-100.0	-75.7	-59.8	-72.1	-71.8	-72.8

Table 3.36 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs Total	HCB	PCBs
	g I-Teq	t					g	kg
1990	0.024	0.007	0.009	0.004	0.003	0.023	0.074	0.020
1991	0.029	0.008	0.011	0.005	0.003	0.026	0.089	0.024
1992	0.010	0.003	0.004	0.002	0.001	0.011	0.030	0.008
1993	0.011	0.003	0.005	0.002	0.001	0.012	0.033	0.009
1994	0.011	0.004	0.005	0.002	0.001	0.012	0.034	0.009
1995	0.008	0.003	0.004	0.002	0.001	0.010	0.024	0.007
1996	0.012	0.004	0.005	0.003	0.001	0.013	0.037	0.010
1997	0.008	0.003	0.004	0.002	0.001	0.009	0.023	0.006
1998	0.003	0.002	0.003	0.002	0.001	0.007	0.009	0.002
1999	0.001	0.002	0.002	0.002	0.000	0.006	0.002	0.001
2000	0.001	0.002	0.003	0.002	0.000	0.006	0.004	0.001
2001	0.002	0.002	0.002	0.002	0.000	0.006	0.005	0.001
2002	0.000	0.002	0.003	0.002	0.000	0.006	0.001	0.000
2003	0.000	0.001	0.002	0.002	0.000	0.006	0.000	0.000
2004	0.000	0.001	0.002	0.001	0.000	0.005	0.000	0.000
2005	0.000	0.001	0.002	0.001	0.000	0.005	0.000	0.000
2006	0.000	0.001	0.002	0.002	0.000	0.005	0.000	0.000
2007	0.000	0.001	0.002	0.001	0.000	0.005	0.000	0.000
2008	0.000	0.001	0.001	0.001	0.000	0.003	0.000	0.000
2009	0.000	0.001	0.002	0.001	0.000	0.004	0.000	0.000
2010	0.000	0.002	0.003	0.002	0.000	0.006	0.000	0.000
2011	0.000	0.001	0.002	0.001	0.000	0.004	0.000	0.000
2012	0.000	0.001	0.002	0.001	0.000	0.004	0.000	0.000

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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	0.000	0.001	0.001	0.001	0.000	0.003	0.000	0.000
2014	0.000	0.001	0.001	0.001	0.000	0.002	0.000	0.000
2015	0.000	0.001	0.001	0.001	0.000	0.002	0.000	0
Trend 1990-2015, %	-100.0	-91.6	-89.8	-85.2	-94.1	-89.9	-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 3.41) by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and are presented in Tables 3.37-40.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.41) by emission factors (Table 3.40). 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 3.37 Emission factors for railway transport

Pollutant	Fuel: Light fuel oil/Diesel	Fuel: Coal
Unit	**kg/t**	**g/GJ**
NO_x	52.4	173
NMVOC	4.65	88.8
SO_2	equation	900
NH_3	0.01	-
$PM_{2.5}$	1.37	108
PM_{10}	1.44	117
TSP	1.52	124
f-BC	6.4	6.4
CO	10.7	931

Table 3.38 Emission factors for heavy metals

Pollutant	Fuel: Light fuel oil/Diesel	Fuel: Coal
Unit	**g/t**	**mg/GJ**
Pb	-	134
Cd	0.01	1.8
Hg	-	7.9
As	-	4
Cu	1.7	17.5
Cr	0.05	13.5
Ni	0.07	13
Se	0.01	1.8
Zn	1	200

Table 3.39 Emission factors for POPs

Pollutant	Fuel: Light fuel oil/Diesel		Fuel: Coal	
PCDD/F	TEQµg /t	-	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	-	mg/GJ	23.7
I(1,2,3-cd)p	g/t	-	mg/GJ	18.5
HCB	mg/t	-	mg/GJ	0.00062
PCBs	mg/t	-	mg/GJ	0.17

Table 3.40 Sulphur content of fuel (by weight)

Fuel	Light fuel oil	Diesel
1990	0.5%	0.5%
2000	0.2%	0.5%
2001	0.2%	0.05%
2003	0.2%	0.035%
2004	0.2%	0.03%
2005	0.2%	0.005%
2006	0.2%	0.004%
2008	0.1%	0.004%
2009	0.1%	0.001%
2011	0.1%	0.1%

Table 3.41 Fuel consumption, passenger traffic volume and freight turnover in the railway sector

Year	Coal	Diesel	Light fuel oil	Passenger traffic volume	Freight turnover
	TJ	kt		million passenger kilometres	million tonne-kilometres
1990	119	0	46	1,510.0	6,977
1991	143	0	43	1,273.0	6,545
1992	49	0	32	952.8	3,618
1993	53	0	34	722.4	3,813
1994	55	0	34	537.2	3,717
1995	39	0	33	408.2	3,851
1996	59	0	36	308.7	4,177
1997	37	0	33	261.9	5,143
1998	14	0	42	236.3	6,058
1999	3	0	46	238.0	7,277
2000	6	0	43	260.5	8,186
2001	8	0	40	182.4	8,526
2002	1	2	49	177.0	9,736
2003	0	3	42	181.5	9,685
2004	0	1	38	192.5	10,648
2005	0	0	42	247.0	10,629
2006	0	2	42	255.9	10,504
2007	0	7	30	271.7	8,425
2008	0	1	25	274.4	5,961
2009	0	10	25	249.5	5,934
2010	0	15	35	247.7	6,642
2011	0	34	0	241.3	6,261
2012	0	30	0.163	235.8	5,126
2013	0	26	0.116	224.9	4,722
2014	0	20	0.047	281.9	3,256
2015	0	19	0	288.7	3,114

3.3.4.3. Uncertainty

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 3.54.

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 2015 was: NO_x – 3.3%, NMVOC – 4.7%, CO – 2.0%. Detailed emission data are provided in Table 3.42.

Deviations of time series can be explained by changing statistical fuel consumption in the national navigation sector (Figure 3.33). Fuel consumption increased 33.7% in 2015 compared to 2014, therefore all the emissions increased also in same extent.

Recalculations

All the emissions for the year 1993 are recalculated. Recalculations concern using corrected fuel consumption data. An overview of the updated data is given in Chapter 8.

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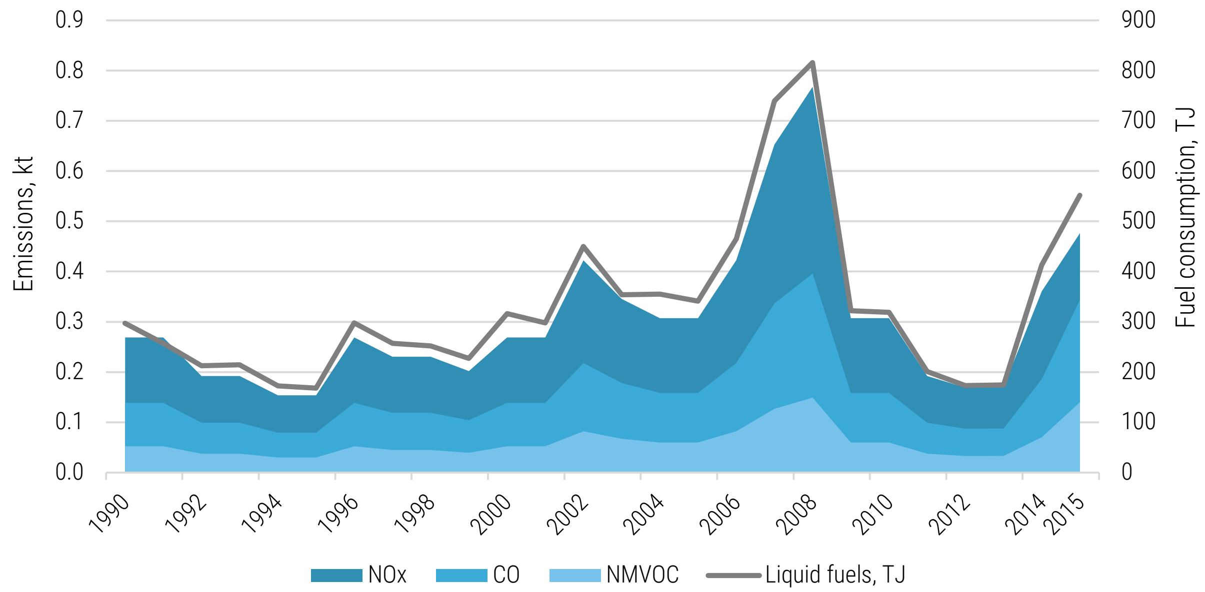

Figure 3.33 NO_x, NMVOC and CO emissions from the national navigation sector

Table 3.42 Emissions from national navigation in the period of 1990-2015

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
1991	0.269	0.052	0.070	0.049	NR	NR	0.032	NR	0.139
1992	0.192	0.037	0.050	0.035	NR	NR	0.023	NR	0.099
1993	0.192	0.037	0.050	0.035	NR	NR	0.023	NR	0.099
1994	0.154	0.030	0.040	0.028	NR	NR	0.018	NR	0.079
1995	0.154	0.030	0.040	0.028	NR	NR	0.018	NR	0.079
1996	0.269	0.052	0.070	0.049	NR	NR	0.032	NR	0.139
1997	0.230	0.045	0.060	0.042	NR	NR	0.028	NR	0.119
1998	0.230	0.045	0.060	0.042	NR	NR	0.028	NR	0.119
1999	0.202	0.039	0.053	0.037	NR	NR	0.024	NR	0.104
2000	0.269	0.052	0.028	0.049	0.032	0.032	0.032	0.018	0.139
2001	0.269	0.052	0.028	0.049	0.032	0.032	0.032	0.018	0.139
2002	0.422	0.082	0.044	0.077	0.051	0.051	0.051	0.028	0.218
2003	0.346	0.067	0.036	0.063	0.041	0.041	0.041	0.023	0.178
2004	0.307	0.060	0.032	0.056	0.037	0.037	0.037	0.020	0.158
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	0.029	0.087	0.060	0.060	0.060	0.031	0.344
Trend 1990-2015, %	77.3	168.6	-58.7	77.6	85.1	85.1	85.1	77.8	148.2

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Table 3.42 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
1991	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
1992	0.050	0.250	0.009	0.350	0.050	0.005	0.150	0.250	0.400
1993	0.050	0.250	0.009	0.350	0.050	0.005	0.150	0.250	0.400
1994	0.040	0.200	0.007	0.280	0.040	0.004	0.120	0.200	0.320
1995	0.040	0.200	0.007	0.280	0.040	0.004	0.120	0.200	0.320
1996	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
1997	0.060	0.300	0.010	0.420	0.060	0.006	0.180	0.300	0.480
1998	0.060	0.300	0.010	0.420	0.060	0.006	0.180	0.300	0.480
1999	0.053	0.263	0.009	0.368	0.053	0.005	0.158	0.263	0.420
2000	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
2001	0.070	0.350	0.012	0.490	0.070	0.007	0.210	0.350	0.560
2002	0.110	0.550	0.019	0.770	0.110	0.011	0.330	0.550	0.880
2003	0.090	0.450	0.015	0.630	0.090	0.009	0.270	0.450	0.720
2004	0.080	0.400	0.014	0.560	0.080	0.008	0.240	0.400	0.640
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
Trend 1990-2015, %	77.1	77.1	76.5	77.1	77.1	77.1	77.1	77.1	77.1

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 3.44) by respective emission factors. Default emission factors for the main pollutants are taken from EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 and are presented in Tables 3.43-45.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.46) by emission factors (Table 3.45). 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 3.43 Emission factors for national navigation transport (kg/t)

	Marine diesel oil/marine gas oil
NO_x	38.4
NMVOC	7.45
NH_3	0.007
$PM_{2.5}$	4.6
PM_{10}	4.6
TSP	4.6
f-BC	0.55
CO	19.8

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Table 3.44 Emission factors for heavy metals and PAHs

		Marine diesel oil/marine gas oil
Cd	g/t	0.01
Cr		0.05
Cu		1.7
Ni		0.07
Se		0.01
Zn		1
B(a)p	mg/t	0.03
B(b)f		0.05

Table 3.45 Sulphur content of fuel (by weight)

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

Table 3.46 Fuel consumption in the navigation sector in the period of 1990-2015 (kt)

Year	Marine gas oil	Marine diesel oil
1990	0	7
1991	0	7
1992	0	5
1993	0	5
1994	0	4
1995	0	4
1996	0	7
1997	0	6
1998	0	6
1999	0.256	5
2000	2	5
2001	2	5
2002	4	7
2003	2	7
2004	2	6
2005	0	8
2006	5	6
2007	12	5
2008	13	7
2009	2	6
2010	2	6
2011	0	5
2012	0.395	4
2013	0.419	4
2014	0.395	9
2015	0.395	12

3.3.5.3. Uncertainty

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 3.54.

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.

Photot: 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.

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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 gasoline 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 33.2%, 35.0% and 24.7% respectively, in the transport sector in 2015.

All the emissions have decreased in the period 1990 to 2015, but slightly increased in 2015 compared to 2014 due to small increase in fuel consumption that year. Deviations of time series can be explained by changing statistical fuel consumption in non-road machinery sector (Figures 3.33-35) and the share of some specific sector in total non-road machinery emissions. Detailed emission data are provided in Table 3.47.

The most important deployment of other non-road mobile machinery is the use in agricultural and industrial sector, which are responsible for about 90.5% of total energy use in this sector, where diesel is the dominant fuel type, with 95% of energy use in 2015.

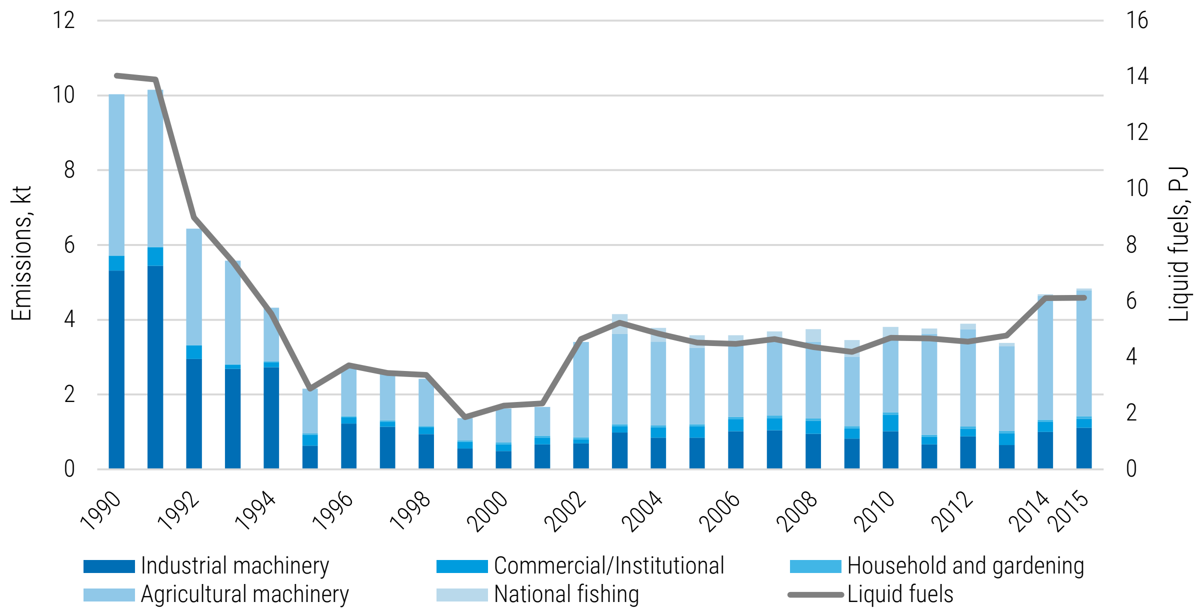

Figure 3.34 NO_x emissions from other non-road machinery

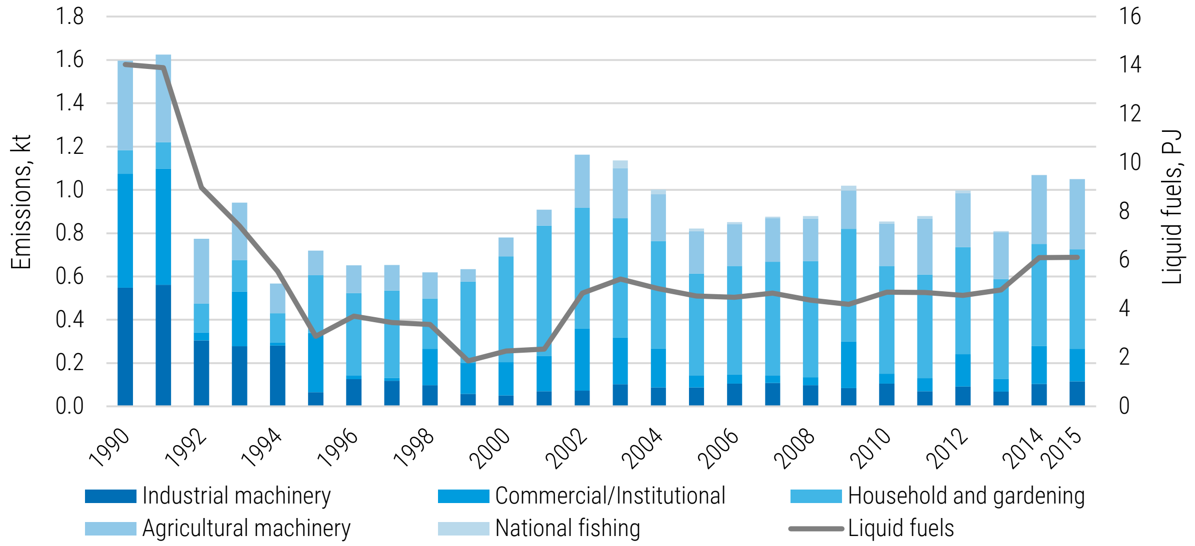

Figure 3.35 NMVOC emissions from other non-road machinery

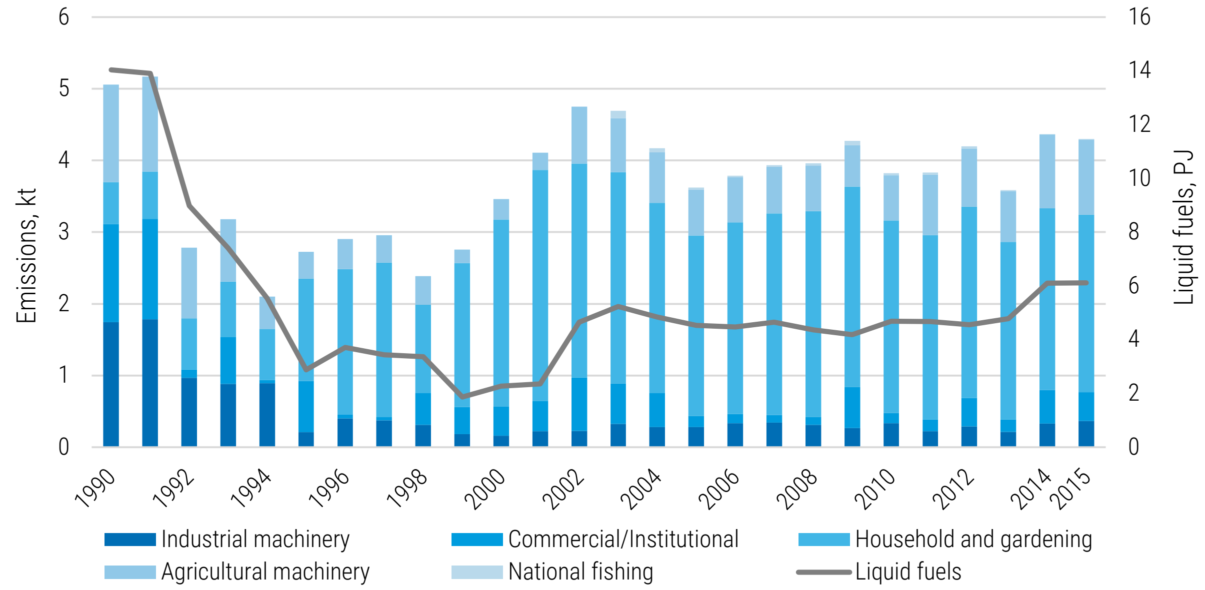

Figure 3.36 CO emissions from other non-road machinery

Table 3.47 Emissions from other non-road machinery in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
	kt								
1990	10.028	1.597	3.036	0.002	NR	NR	0.586	NR	5.061
1991	10.151	1.625	3.056	0.002	NR	NR	0.596	NR	5.171
1992	6.441	0.775	1.943	0.002	NR	NR	0.368	NR	2.783
1993	5.577	0.942	1.668	0.001	NR	NR	0.321	NR	3.180
1994	4.319	0.568	1.293	0.001	NR	NR	0.256	NR	2.100
1995	2.155	0.720	0.640	0.001	NR	NR	0.127	NR	2.724
1996	2.753	0.651	0.821	0.001	NR	NR	0.161	NR	2.902
1997	2.540	0.653	0.758	0.001	NR	NR	0.149	NR	2.959
1998	2.421	0.619	0.723	0.001	NR	NR	0.141	NR	2.385
1999	1.370	0.634	0.412	0.000	NR	NR	0.085	NR	2.758
2000	1.630	0.780	0.390	0.000	0.099	0.099	0.099	0.053	3.461
2001	1.673	0.909	0.129	0.000	0.105	0.105	0.105	0.056	4.110

Year	NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
					kt				
2002	3.404	1.162	0.261	0.001	0.192	0.192	0.192	0.105	4.752
2003	4.151	1.137	0.207	0.001	0.217	0.218	0.218	0.121	4.693
2004	3.787	1.001	0.157	0.001	0.201	0.202	0.202	0.113	4.172
2005	3.586	0.822	0.111	0.001	0.191	0.191	0.191	0.108	3.623
2006	3.588	0.850	0.079	0.001	0.199	0.199	0.199	0.113	3.787
2007	3.692	0.877	0.074	0.001	0.205	0.205	0.205	0.116	3.934
2008	3.745	0.879	0.086	0.001	0.201	0.201	0.201	0.114	3.960
2009	3.455	1.019	0.038	0.001	0.183	0.184	0.184	0.102	4.272
2010	3.809	0.854	0.028	0.001	0.208	0.208	0.208	0.118	3.822
2011	3.764	0.878	0.040	0.001	0.202	0.202	0.202	0.113	3.834
2012	3.894	0.997	0.027	0.001	0.213	0.213	0.213	0.119	4.198
2013	3.381	0.810	0.005	0.001	0.186	0.186	0.186	0.104	3.587
2014	4.678	1.069	0.008	0.001	0.258	0.258	0.258	0.145	4.367
2015	4.835	1.050	0.015	0.001	0.266	0.266	0.266	0.140	4.299
Trend 1990-2015, %	-51.8	-34.2	-99.5	-53.3	168.2	168.3	-54.6	163.3	-15.1

Table 3.47 continues

Year	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
	t		kg				t		
1990	4.926	0.003	0.000	0.000	0.015	0.510	0.021	0.003	0.300
1991	3.443	0.003	0.000	0.000	0.015	0.517	0.021	0.003	0.304
1992	3.153	0.002	0.000	0.000	0.010	0.325	0.013	0.002	0.191
1993	1.817	0.002	0.000	0.000	0.008	0.283	0.012	0.002	0.167
1994	0.453	0.001	0.000	0.000	0.006	0.221	0.009	0.001	0.130
1995	0.756	0.001	0.000	0.000	0.003	0.112	0.005	0.001	0.066
1996	0.887	0.001	0.000	0.000	0.004	0.142	0.006	0.001	0.084
1997	0.914	0.001	0.000	0.000	0.004	0.132	0.005	0.001	0.078
1998	0.958	0.001	0.000	0.000	0.004	0.125	0.005	0.001	0.073
1999	0.809	0.000	0.000	0.000	0.002	0.074	0.003	0.000	0.044
2000	0.082	0.001	0.000	0.000	0.003	0.088	0.004	0.001	0.052
2001	0.081	0.001	0.000	0.000	0.003	0.092	0.004	0.001	0.054
2002	0.096	0.001	0.000	0.000	0.005	0.176	0.007	0.001	0.104
2003	0.143	0.001	0.200	0.267	0.006	0.193	0.014	0.002	0.118
2004	0.043	0.001	0.141	0.188	0.005	0.180	0.012	0.002	0.109
2005	0.024	0.001	0.126	0.168	0.005	0.171	0.011	0.001	0.103
2006	0.026	0.001	0.064	0.085	0.005	0.178	0.009	0.001	0.106
2007	0.028	0.001	0.063	0.084	0.005	0.184	0.010	0.001	0.109
2008	0.023	0.001	0.131	0.174	0.005	0.179	0.012	0.001	0.109
2009	0.030	0.001	0.170	0.227	0.005	0.160	0.012	0.001	0.098
2010	0.026	0.001	0.103	0.137	0.005	0.183	0.011	0.001	0.110
2011	0.022	0.001	0.054	0.071	0.005	0.184	0.009	0.001	0.110
2012	0.028	0.001	0.057	0.076	0.006	0.191	0.010	0.001	0.114
2013	0.022	0.001	0.033	0.044	0.005	0.167	0.008	0.001	0.099
2014	0.027	0.001	0.016	0.022	0.007	0.234	0.010	0.001	0.138
2015	0.025	0.001	0.021	0.028	0.007	0.241	0.011	0.001	0.142
Trend 1990-2015, %	-99.5	-52.7	-89.6	-89.6	-52.7	-52.8	-49.6	-50.6	-52.6

Table 3.47 continues

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	mg I-Teq	t					g	
1990	0.000	0.009	0.015	NA	NA	0.024	0.000	0.000
1991	0.000	0.009	0.015	NA	NA	0.024	0.000	0.000
1992	0.000	0.006	0.010	NA	NA	0.015	0.000	0.000

Year	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	PAHs total	HCB	PCBs
	mg I-Teq	t					g	
1993	0.000	0.005	0.008	NA	NA	0.013	0.000	0.000
1994	0.000	0.004	0.006	NA	NA	0.010	0.000	0.000
1995	0.000	0.002	0.003	NA	NA	0.005	0.000	0.000
1996	0.000	0.003	0.004	NA	NA	0.007	0.000	0.000
1997	0.000	0.002	0.004	NA	NA	0.006	0.000	0.000
1998	0.000	0.002	0.004	NA	NA	0.006	0.000	0.000
1999	0.000	0.001	0.002	NA	NA	0.003	0.000	0.000
2000	0.000	0.002	0.003	NA	NA	0.004	0.000	0.000
2001	0.000	0.002	0.003	NA	NA	0.004	0.000	0.000
2002	0.000	0.003	0.005	NA	NA	0.008	0.000	0.000
2003	0.869	0.003	0.005	NA	NA	0.009	0.535	2.539
2004	0.613	0.003	0.005	NA	NA	0.008	0.377	1.791
2005	0.546	0.003	0.005	NA	NA	0.008	0.336	1.595
2006	0.277	0.003	0.005	NA	NA	0.008	0.170	0.809
2007	0.273	0.003	0.005	NA	NA	0.009	0.168	0.798
2008	0.566	0.003	0.005	NA	NA	0.008	0.348	1.655
2009	0.736	0.003	0.005	NA	NA	0.007	0.453	2.152
2010	0.445	0.003	0.005	NA	NA	0.008	0.274	1.302
2011	0.232	0.003	0.005	NA	NA	0.009	0.143	0.679
2012	0.248	0.003	0.006	NA	NA	0.009	0.153	0.726
2013	0.144	0.003	0.005	NA	NA	0.008	0.088	0.420
2014	0.071	0.004	0.007	NA	NA	0.011	0.044	0.207
2015	0.090	0.004	0.007	NA	NA	0.011	0.055	0.263
Trend 1990-2015, %	NA	-52.6	-53.1	NA	NA	-52.9	NA	NA

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 3.53) by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013 and are presented in Tables 3.48-52.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.53) by emission factors (Table 3.51). 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 – percentage sulphur content in fuel (%);
FC – fuel consumption.

Pb emissions are estimated by assuming that 75% of the lead contained in gasoline is emitted into the air. Equation:

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

Table 3.48 Emission factors for other mobile sources

NFR	Fuel	Unit	NO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	f-BC	CO
1A2gvii 1A4aii 1A4bii 1A4cii	Diesel	kg/t	32.792	3.385	0.008	2.086	2.086	2.086	0.57-0.62	10.722
	Gasoline: 2-stroke	kg/t	2.765	242.197	0.003	3.762	3.762	3.762	0.05	620.793
	Gasoline: 4-stroke	kg/t	7.117	17.602	0.004	0.157	0.157	0.157	0.05	770.368
1A4cii	Diesel/ Light fuel oil	kg/t	35.043	3.366	0.008	1.738	1.738	1.738	0.57	10.939
1A4ciii	Diesel/ Light fuel oil	kg/t	78.500	2.800	-	1.400	1.500	1.500	0.65	7.400
	Gasoline	kg/t	9.400	181.500	-	9.500	9.500	9.500	0.05	573.900

Table 3.49 Emission factors for heavy metals

NFR	Fuel	Unit	Cd	Hg	As	Cu	Cr	Ni	Se	Zn
1A2gvii 1A4aii 1A4bii 1A4cii	Gasoline	g/t	0.010	-	-	1.700	0.050	0.070	0.010	1.000
	Diesel/ Light fuel oil	g/t	0.010	-	-	1.700	0.050	0.070	0.010	1.000
1A4ciii	Diesel/ Light fuel oil	g/t	0.010	0.030	0.040	0.880	0.050	1.000	0.100	1.200

Table 3.50 Emission factors for POPs

NFR	Fuel	PCDD/F	B(a)p	B(b)f	B(k)f	I(1,2,3-cd)p	HCB	PCBs
		TEQµg /t	g/t				mg/t	
1A2gvii 1A4aii 1A4bii 1A4cii	Gasoline	-	0.040	0.040	-	-	-	-
	Diesel/ Light fuel oil	-	0.030	0.050	-	-	-	-
1A4ciii	Diesel/ Light fuel oil	0.130	-	-	-	-	0.080	0.038

Table 3.51 Sulphur content of fuel (by weight)

NFR	Fuel	1990	2000	2001	2003	2004	2005	2006	2009	2010
1A2gvii 1A4aii 1A4bii 1A4ciii 1A4cii	Gasoline	0.10%	0.10%	0.05%	0.015%	0.013%	0.005%	0.002%	0.002%	0.002%
	Diesel	0.50%	0.50%	0.05%	0.035%	0.030%	0.005%	0.004%	0.002%	0.002%
	Light fuel oil	0.50%	0.20%	0.20%	0.200%	0.200%	0.200%	0.200%	0.200%	0.100%

Table 3.52 Lead content in fuel

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

Table 3.53 Total fuel consumption in other mobile sectors for the period of 1990-2015 (kt)

Year	Diesel	Light fuel oil	Gasoline
1990	288.050	9.000	32.840
1991	293.000	8.000	22.950
1992	183.140	7.000	21.020
1993	158.300	6.104	12.110
1994	124.550	4.184	3.020
1995	59.750	3.255	5.040
1996	76.540	4.353	5.910
1997	70.750	3.840	6.090
1998	63.236	7.814	6.385
1999	32.264	7.881	5.393
2000	31.351	15.969	6.296
2001	24.243	24.519	6.214
2002	46.242	51.852	7.418
2003	78.235	33.564	11.040
2004	80.262	23.641	8.424
2005	77.266	21.672	4.694
2006	85.319	16.609	5.129
2007	89.271	15.682	5.556
2008	86.862	16.667	4.215
2009	88.019	5.139	5.880
2010	95.959	10.891	5.063
2011	89.773	16.425	4.457
2012	99.796	10.581	5.487
2013	96.185	0.407	4.339
2014	132.845	1.992	5.393
2015	133.654	5.679	4.937

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 3.54.

Table 3.54 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	20.520	12.070	2.540
NMVOC	1.279	kt	5.580	2.280	0.690
SO_x	0.082	kt	0.260	0.080	0.040
NH_3	0.001	kt	0.010	0.004	0.001
$PM_{2.5}$	0.351	kt	3.840	1.010	0.490
PM_{10}	0.353	kt	2.520	0.660	0.250
TSP	0.354	kt	1.680	0.440	0.030
CO	4.846	kt	3.780	1.120	0.550
Pb	0.025	t	0.090	0.030	0.120
Cd	0.002	t	0.230	0.070	0.010
Hg	0.000	t	0.004	0.002	0.020
PCDD/F	0.000	g I-TEQ	0.002	0.010	0.380
B(a)p	0.005	t	0.260	0.310	0.520
B(b)f	0.009	t	0.370	0.450	0.630
B(k)f	0.001	t	0.060	0.110	0.370
I(1,2,3-cd)p	0.000	t	0.010	0.020	0.290
HCB	0.000	kg	0.020	0.020	0.060
PCB	0.000	kg	0.010	0.010	0.120

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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

This source category covers 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

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 66.9% between 1990 and 2015. As of 2012, a significant increase in fuel consumption is apparent: fuel consumption is more than twice higher (193 to 411 kt) 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 the emissions depend on the amount of fuel used, emissions from the international maritime navigation sector show trends similar to fuel consumption. The emissions of nitrogen oxides, non-methane volatile compounds, and carbon monoxide have increased by approximately 57.5%, 70.0%, and 66.9% compared to 1990. Sulphur oxide emissions have decreased by 24.8% during the same period due to the reduction of sulphur content in marine fuels. Detailed emission data are provided in Table 3.55.

In 2015, emissions from the international maritime navigation sector have decreased compared to 2014. This decrease in emissions occurred due to lower fuel consumption in 2015 (–10.3%). The emissions of NO_x, NMVOC, SO_x and CO decreased by 11.2%, 9.7%, 25.7% and 10.3% respectively during the same period.

Recalculations

All the PCBs emissions are recalculated for the period of 1990–2014. Recalculations in the international maritime sector were made based on the correction of the emission factor presented in the EMEP/EEA Air Pollutant Emission Inventory Guidebook. An overview of the updated data is given in Chapter 8.

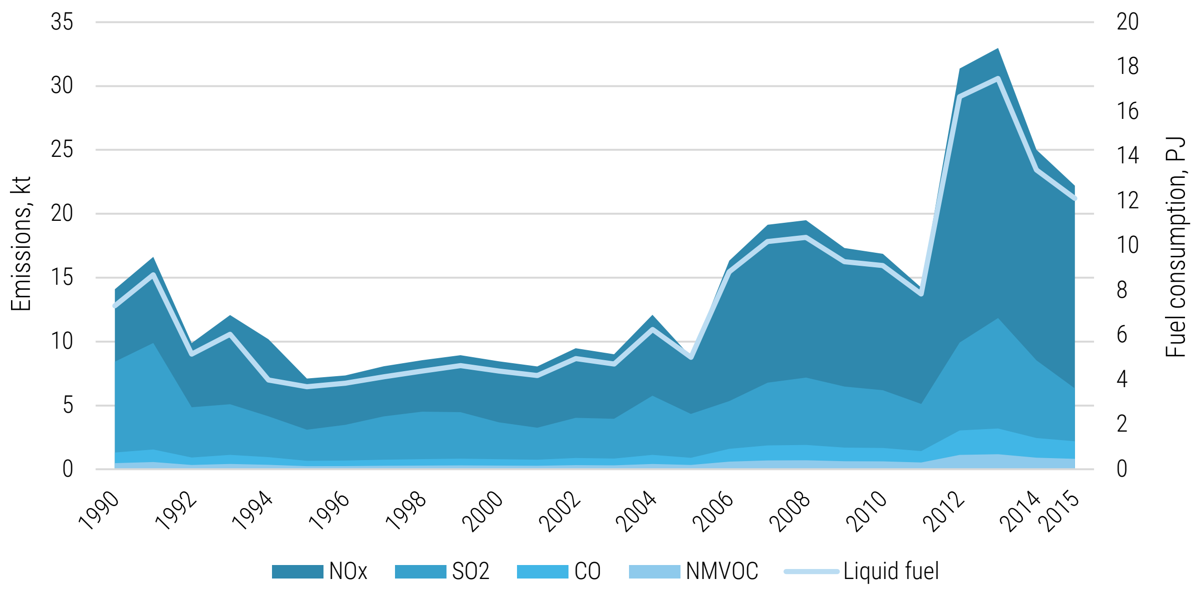

Figure 3.37 NO_x, NMVOC, SO_x and CO emissions from the international navigation sector

Table 3.55 Emissions from the international maritime navigation sector in the period of 1990-2015

Year	NO_x	NMVOC	SO_2	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd
	kt								t	
1990	14.094	0.483	8.424	NR	NR	0.977	NR	1.317	0.031	0.003
1991	16.627	0.570	9.888	NR	NR	1.147	NR	1.554	0.036	0.004
1992	9.878	0.342	4.858	NR	NR	0.573	NR	0.925	0.020	0.002
1993	12.075	0.420	5.094	NR	NR	0.610	NR	1.132	0.024	0.002
1994	10.179	0.355	4.150	NR	NR	0.499	NR	0.955	0.020	0.002
1995	7.105	0.247	3.100	NR	NR	0.370	NR	0.666	0.014	0.001
1996	7.347	0.255	3.482	NR	NR	0.412	NR	0.688	0.015	0.002
1997	8.064	0.279	4.144	NR	NR	0.487	NR	0.755	0.017	0.002
1998	8.540	0.295	4.512	NR	NR	0.529	NR	0.799	0.018	0.002
1999	8.931	0.309	4.474	NR	NR	0.527	NR	0.836	0.018	0.002
2000	8.452	0.293	3.678	0.423	0.466	0.466	0.062	0.792	0.017	0.002
2001	8.053	0.280	3.258	0.382	0.421	0.421	0.058	0.755	0.016	0.002
2002	9.477	0.329	4.030	0.466	0.514	0.514	0.069	0.888	0.019	0.002
2003	9.005	0.312	3.956	0.454	0.500	0.500	0.066	0.844	0.018	0.002
2004	12.093	0.418	5.762	0.647	0.714	0.714	0.091	1.132	0.025	0.003
2005	8.810	0.345	4.338	0.491	0.522	0.522	0.071	0.903	0.020	0.002
2006	16.330	0.602	5.340	1.023	1.110	1.110	0.135	1.606	0.037	0.004
2007	19.140	0.697	6.784	1.283	1.397	1.397	0.163	1.872	0.044	0.005
2008	19.496	0.708	7.180	1.355	1.477	1.477	0.168	1.909	0.045	0.005
2009	17.319	0.633	6.480	1.220	1.329	1.329	0.151	1.702	0.041	0.004
2010	16.864	0.623	6.192	1.173	1.274	1.274	0.147	1.672	0.040	0.004
2011	14.218	0.535	5.118	0.975	1.055	1.055	0.124	1.428	0.034	0.004
2012	31.365	1.130	9.922	1.934	2.112	2.112	0.256	3.041	0.070	0.007
2013	32.975	1.182	11.840	2.244	2.455	2.455	0.281	3.197	0.076	0.008
2014	25.009	0.910	8.530	1.637	1.783	1.783	0.210	2.449	0.057	0.006
2015	22.197	0.822	6.334	1.268	1.371	1.371	0.177	2.198	0.049	0.005
Trend 1990-2015, %	57.5	70.0	-24.8	199.9	194.3	40.4	186.4	66.9	59.2	52.6

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Table 3.55 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
1991	0.005	0.122	0.129	0.250	5.697	0.040	0.252	0.087	0.027	0.102
1992	0.003	0.057	0.061	0.140	2.667	0.022	0.150	0.044	0.015	0.048
1993	0.004	0.058	0.062	0.165	2.664	0.024	0.184	0.047	0.017	0.049
1994	0.003	0.047	0.050	0.138	2.144	0.020	0.155	0.039	0.014	0.039
1995	0.002	0.036	0.038	0.098	1.640	0.015	0.108	0.029	0.010	0.030
1996	0.002	0.041	0.044	0.103	1.891	0.016	0.112	0.032	0.011	0.034
1997	0.002	0.050	0.053	0.116	2.303	0.018	0.122	0.037	0.012	0.042
1998	0.002	0.054	0.058	0.124	2.526	0.019	0.130	0.041	0.013	0.046
1999	0.003	0.053	0.057	0.128	2.469	0.020	0.136	0.041	0.014	0.045
2000	0.003	0.046	0.049	0.118	2.122	0.018	0.128	0.036	0.012	0.039
2001	0.002	0.041	0.043	0.111	1.869	0.016	0.122	0.033	0.012	0.034
2002	0.003	0.050	0.054	0.132	2.321	0.020	0.144	0.040	0.014	0.042
2003	0.003	0.049	0.053	0.126	2.284	0.019	0.137	0.039	0.013	0.042
2004	0.004	0.072	0.077	0.173	3.346	0.027	0.184	0.055	0.018	0.061
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
Trend 1990-2015, %	79.1	37.9	38.3	58.7	36.9	51.8	66.9	45.4	54.8	38.2

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 3.59–60). 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 3.61) is multiplied by respective emission factors (Tables 3.56–3.58). Default emission factors for the main pollutants and heavy metals are taken from the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016.

SO_2 emissions are dependent on fuel consumption and fuel type. SO_2 emissions are calculated by multiplying statistical fuel use (Table 3.59) by emission factors (Table 3.56). 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 3.56 Emission factors for the international maritime navigation sector (kg/t)

	NO_x	NMVOC	$PM_{2.5}$	PM_{10}	TSP	f-BC	CO
Bunker fuel oil	79.3	2.7	5.6	6.2	6.2	0.12	7.4
Marine diesel oil	78.5	2.8	1.4	1.5	1.5	0.31	7.4

Table 3.57 Emission factors for heavy metals and PAHs

	Pb	Cd	Cu	Cr	As	Hg	Ni	Se	Zn	PCDD/F	HCB	PCB's
	g/t									TEQµg /t	mg/t	
Bunker fuel oil	0.18	0.02	1.25	0.72	0.68	0.02	32.00	0.21	1.20	0.47	0.14	0.57
Marine diesel oil	0.13	0.01	0.88	0.05	0.04	0.03	1.00	0.10	1.20	0.13	0.08	0.38

Table 3.58 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 3.59 Number of vessels visiting Estonian ports by type of vessel in the period of 2005–2015

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

Table 3.60 Gross tonnage of vessels visiting Estonian ports by type of vessel in the period of 2005–2015 (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

Table 3.61 Fuel consumption in the international maritime navigation sector in the period of 1990-2015 (kt)

Year	Bunker fuel oil	Marine diesel oil/ Marine gas oil	Total
1990	151	27	178
1991	177	33	210
1992	82	43	125
1993	81	72	153
1994	65	64	129
1995	50	40	90
1996	58	35	93
1997	71	31	102
1998	78	30	108
1999	76	37	113
2000	65	42	107
2001	57	45	102
2002	71	49	120
2003	70	44	114
2004	103	50	153
2005	77	45	122
2006	172	45	217
2007	222	31	253
2008	238	20	258
2009	215	15	230
2010	205	21	226
2011	169	24	193
2012	325	86	411
2013	392	40	432
2014	281	50	331
2015	205	92	297

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.portoftallin.com

Table 3.62 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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This year submission, emissions from oil shale mining sector are shown in category NFR 1B1c. In previous years, emissions were reported under NFR 1B1a, which is only suitable for coal mining industry.

NMVOC emissions from this sector contribute about 5% to total national emissions and have decreased by 52% up to 2015 compared to 1990 and by 13% compared to 2014 due to decreasing emissions from terminals (Figure 3.38 and Table 3.64). Emissions of other pollutants are very small compared to the emissions from the other sectors (Table 3.63).

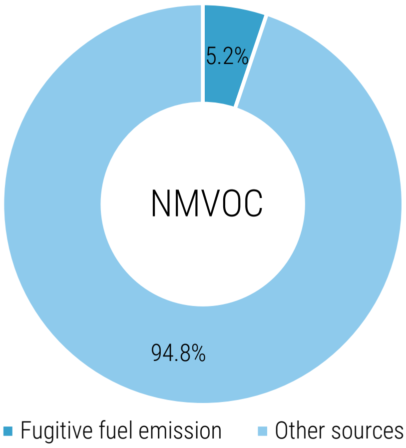

Figure 3.38 NMVOC emission distribution in 2015

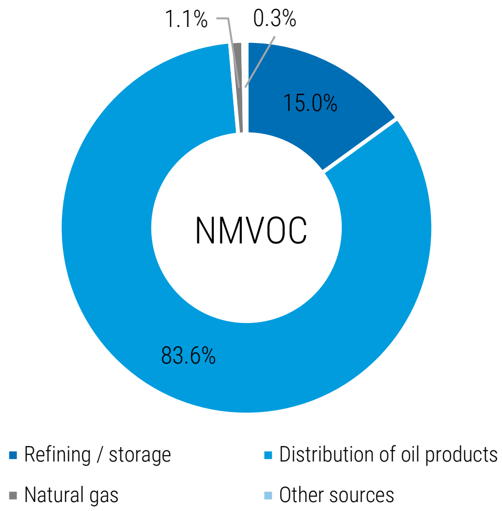

Figure 3.39 NMVOC emission distribution within the fuel fugitive emission sector in 2015

Figure 3.39 shows that the distribution of oil products is a main source of NMVOC emissions in the fuel fugitive emissions sector (83.6%).

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.

Table 3.63 Fugitive emission in the period of 1990-2015 (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
1991	2.239	NR	NR	NR	NR	NA	NA	NA	NA
1992	1.275	NR	NR	NR	NR	NA	NA	NA	NA
1993	1.275	NR	NR	NR	NR	NA	NA	NA	NA
1994	1.583	NR	NR	NR	NR	NA	NA	NA	NA
1995	1.632	NR	NR	NR	NR	NA	NA	NA	NA
1996	1.911	NR	NR	NR	NR	NA	NA	NA	NA
1997	2.721	NR	NR	NR	NR	NA	NA	NA	NA
1998	2.380	NR	NR	NR	NR	NA	NA	NA	NA
1999	2.740	NR	NR	NR	NR	NA	NA	NA	NA
2000	4.326	0.010	0.050	0.110	NA	0.010	0.200	NA	NA
2001	5.197	0.021	0.085	0.170	NA	0.010	0.180	NA	NA
2002	4.649	0.010	0.080	0.160	NA	0.010	0.270	NA	NA
2003	4.404	0.010	0.097	0.198	NA	0.010	0.350	NA	NA
2004	5.184	0.010	0.070	0.140	NA	0.000	0.260	0.010	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	0.141	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

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Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC	NO_x	CO	NH_3	SO_2
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	0.073	0.183	0.196	0.032
Trend 1990-2015. %	-52.1	76.0	80.8	64.3					

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 m³ per year[7]. That means only the smallest service stations are regarded as diffuse sources. Emissions from oil terminals are based on the facilities data. 16 terminals presented reports on emissions in 2015. In the table below. NMVOC emissions from gasoline distribution and terminals are presented.

Table 3.64 NMVOC emissions from liquid fuel distribution in the period of 1990-2015 (kt)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Gasoline distribution	2.055	1.820	0.896	0.924	1.124	0.971	1.100	1.199	1.159	1.100	1.108	1.122	0.856
Terminals	0.323	0.323	0.323	0.323	0.418	0.625	0.771	1.483	1.184	1.594	3.157	4.012	3.645
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gasoline distribution	0.657	0.628	0.467	0.482	0.514	0.508	0.467	0.447	0.478	0.511	0.460	0.427	0.397
Terminals	3.695	3.910	3.199	2.626	1.200	0.629	0.799	0.644	1.265	0.854	0.740	0.737	0.594

[7] 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

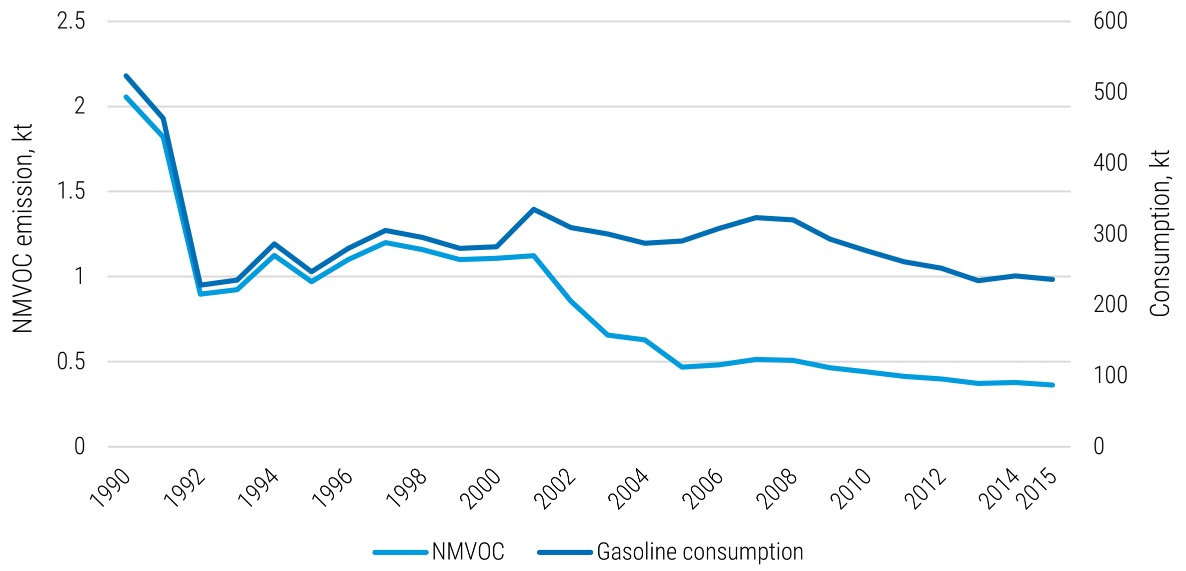

Figure 3.40 NMVOC emission and gasoline distribution in the period of 1990-2015

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 2005-2015, 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 2005-2015, the Tier 2 technology specific emission factors for Service Stations from the EMEP/EEA Air Pollutant Emission Inventory 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 3.65.

Table 3.65 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.

Table 3.66 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

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
	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 3.67).

Table 3.67 Consumption of motor gasoline in the period of 1990-2015 (kt)

Year	Gasoline consumption	Year	Gasoline consumption
1990	523	2003	300
1991	463	2004	287
1992	228	2005	290
1993	235	2006	308
1994	286	2007	323
1995	247	2008	320
1996	280	2009	293
1997	305	2010	276
1998	295	2011	261
1999	280	2012	252
2000	282	2013	234
2001	335	2014	241
2002	309	2015	236

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 3.41).

The Estonian gas transmission network was built between 1951 and 2006, and is part of the former Soviet Union's transmission network. The construction of the natural gas pipeline to the towns of Pärnu and Sindi was completed in 2006. The natural gas pipelines also reached customers in the county town of Rapla and the town of Püssi.[8]

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 Ltd, and operated by EG Võrguteenus, which provides transmission and distribution services, and operates the gas metering systems on the Estonian border. Eesti Gaas Ltd 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.[9] 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 3.41 Map of high-pressure gas distribution pipelines in Estonia

Table 3.68 NMVOC emissions from gas distribution in the period of 1990-2015 (kt)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NMVOC	0.096	0.096	0.056	0.028	0.041	0.036	0.040	0.039	0.037	0.036	0.031	0.033	0.028
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NMVOC	0.032	0.036	0.028	0.028	0.028	0.027	0.018	0.019	0.018	0.019	0.019	0.015	0.013

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

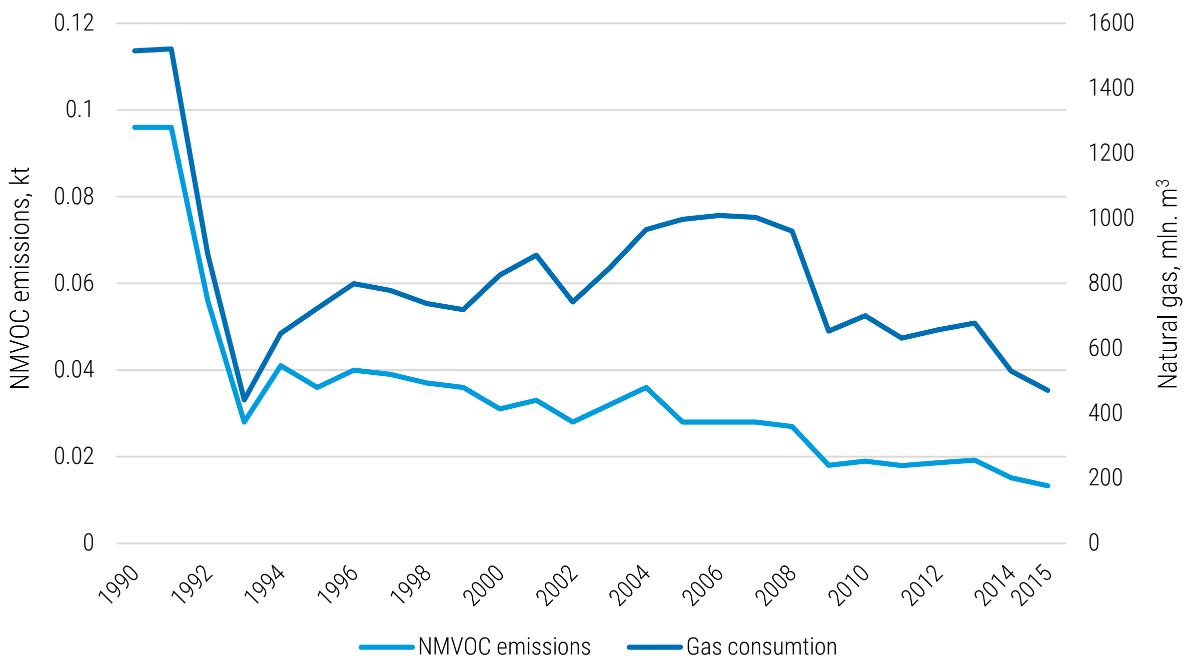

Figure 3.42 NMVOC emission from natural gas distribution in the period of 1990-2015

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 3.69-70. 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 3.69 Tier 1 NMVOC emission factors for fugitive emissions (including venting and flaring) from gas operations

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

Table 3.70 Tier 1 emission factors for fugitive emissions (including venting and flaring) from gas operations for different years

Category	Sub-category	Emission source	IPCC Code	1990	1995	2000	2005-2015	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 3.71).

Table 3.71 Gas consumption in the period 1990-2015 (mln m^3)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Gas consumption	1 516	1 521	890	441	646	723	799	778	738	719	826	887	743
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Gas consumption	847	966	997	1 009	1 003	961	653	701	632	657	678	530	471

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 3.72.

Table 3.72 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

There are currently no improvements planned for this sector.

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}, $PM_{2.5}$
	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

NFR		Source	Description	Emissions reported
	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 and paper production. Data reported by two 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 Air Pollutant Emission Inventory 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 (Tier 1 method). Emissions from Construction and demolition sector are recalculated due to the correction of the activity data and updated emission factors in new EMEP/EEA Guidebook 2016 (see Chapter 8).

BC emissions from industry are calculated for the period 2000–2015.

The share of industry sources in total emissions in 2015 was: NMVOC – 3.5%, $PM_{2.5}$ – 3.4%, PM_{10} – 15% and TSP about 32%. The shares of other pollutants were not so significant. The emissions of NMVOC, NH_3 and NO_x have decreased in comparison with 1990 by 94.7%, 87.7% and 76.5%, respectively. The emissions of NO_x, $PM_{2.5}$, PM_{10} and TSP increased in 2015 compared to 2014 by 41.4%, 0.6%, 106.7% and 9.1%. NO_x emissions has increase in pulp and paper industries. Growth in construction sector was the cause of increase in emissions of particulates.

The trend of NMVOC and PM emissions in these categories are given in Figure 4.1 and 4.4. The distribution of NMVOC and PM10 emissions by sources of pollution inside of manufacturing industry sector in 2015 are shown in Figures 4.2 and 4.3. The biggest polluter of NMVOC emissions were Pulp, paper and food industries – 87.3% (mainly food production), the chemistry industry is responsible for the 5.7% of emission and share of other activities are not significant. The main polluter of particulates emission is mineral industry (88%, 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 1990-2015

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2,5}$	PM_{10}	TSP	BC	CO	Pb
	kt									t
1990	0.190	15.335	NA	0.530	NR	NR	6.172	NR	0.340	NA
1991	0.100	13.894	NA	0.460	NR	NR	3.812	NR	0.300	NA
1992	0.090	9.600	NA	0.440	NR	NR	3.106	NR	0.300	NA
1993	0.050	4.405	NA	0.120	NR	NR	1.566	NR	0.010	NA
1994	0.190	3.513	NA	0.220	NR	NR	1.844	NR	0.040	NA
1995	0.070	4.377	NA	0.240	NR	NR	1.390	NR	0.000	NA
1996	0.150	3.191	NA	0.160	NR	NR	1.436	NR	0.000	NA
1997	0.150	3.142	NA	0.120	NR	NR	1.360	NR	0.010	NA
1998	0.140	2.400	NA	0.100	NR	NR	2.105	NR	0.020	NA
1999	0.190	1.457	NA	0.140	NR	NR	1.748	NR	0.000	NA
2000	0.200	2.080	0.040	0.120	0.311	1.023	2.766	0.005	0.530	0.010
2001	0.340	1.449	0.080	0.140	0.313	1.087	3.071	0.004	0.510	0.010
2002	0.130	1.513	0.160	0.110	0.488	1.537	4.248	0.008	0.280	0.010
2003	0.161	1.932	0.150	0.120	0.444	1.621	4.660	0.006	0.290	0.000
2004	0.360	1.846	0.130	0.120	0.640	2.395	6.719	0.010	0.360	0.000
2005	0.180	1.573	0.130	0.200	0.582	2.269	6.472	0.009	0.340	0.000
2006	0.270	1.303	0.120	0.157	0.619	2.486	7.213	0.009	0.380	0.001
2007	0.250	1.072	0.020	0.138	0.545	2.350	7.063	0.007	0.440	0.001
2008	0.298	0.959	0.022	0.181	0.699	2.784	7.825	0.012	0.481	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	0.029	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	0.0001	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
Trend 1990-2015, %	-76.5	-94.7		-87.7	0.6	106.7	9.1	-54.3	19.3	

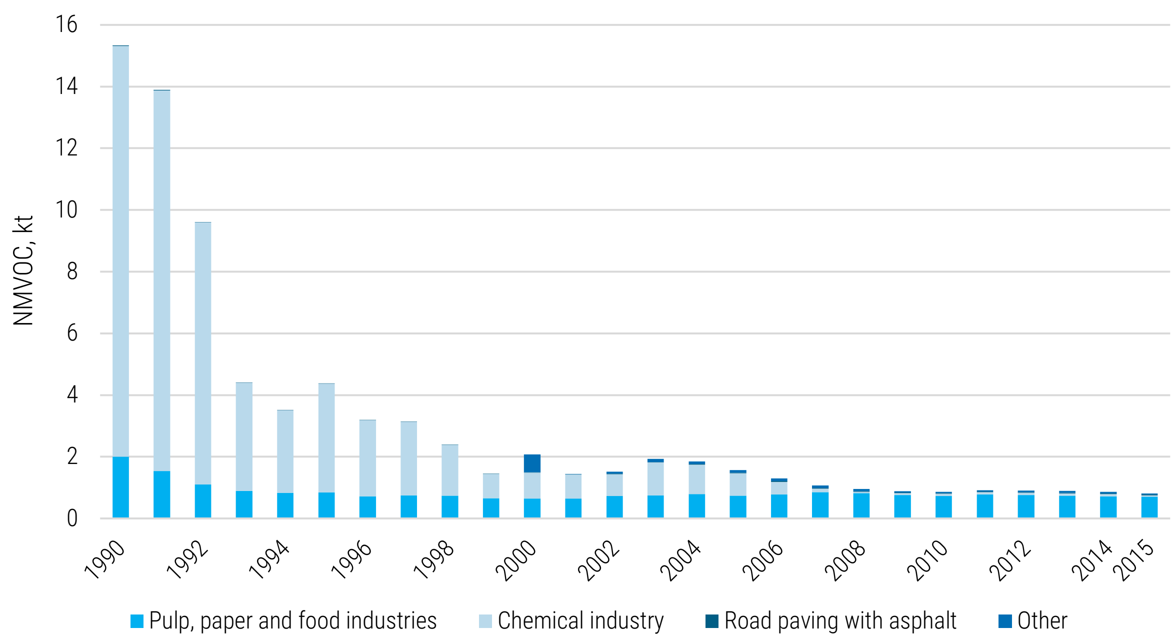

Figure 4.1 NMVOC emissions and oil shale production from the industrial sector in the period of 1990-2015

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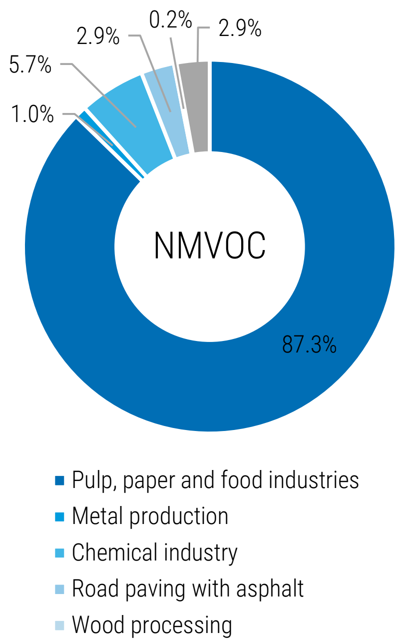

Figure 4.2 Distribution of NMVOC emissions by activities in industry in 2015

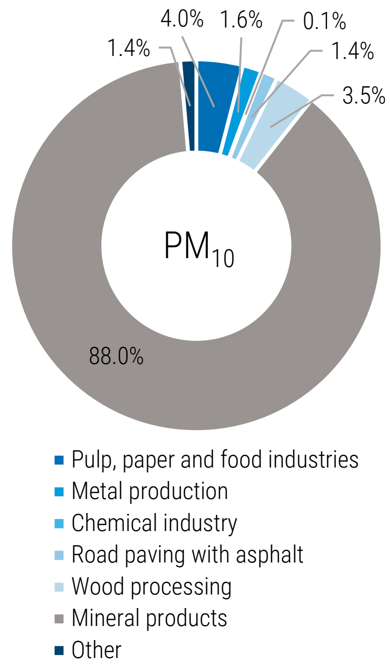

Figure 4.3 Distribution of PM_{10} emissions by activities in industry in 2015

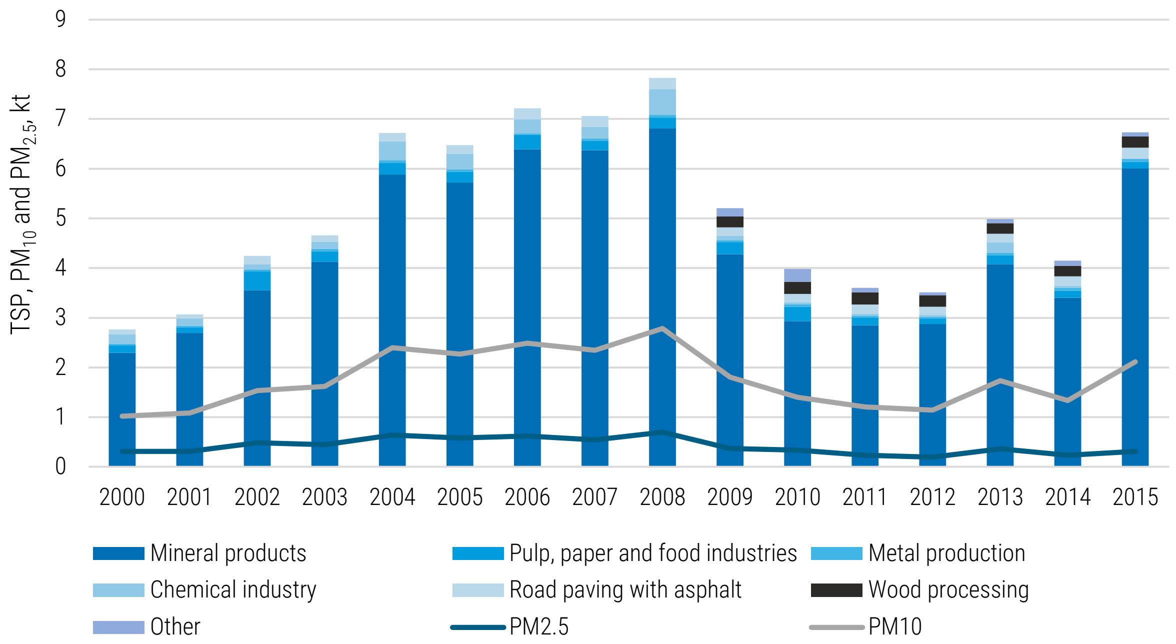

Figure 4.4 Particulates emissions from the industrial sector in the period of 2000-2015

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;

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- Other mineral products.

In Estonia, the only enterprise that produces cement is Kunda Nordic Tsement Ltd. 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 Ltd, 2007).

Photo by Ilmar Saabas: Limestone excavation in Väo quarry

There are two facilities for lime production, one of which presents an annual report on emissions (Nordkalk Ltd). 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.

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

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 2015, over 9,000 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 Astlanda Ehitus LLC, Fund Ehitus LLC, Maru Ehitus Ltd, YIT Ehitus Ltd and Ehitusfirma Rand Ltd and Tuulberg. In road construction, the greater contributions are made by Merko Ehitus Ltd, Nordecon Ltd, TREF Ltd, Teede REV 2 Ltd and Lemminkäinen Eesti Ltd.

The number of dwelling permits issued rose in all categories: in the accounting of one-family houses, two-family houses, row houses and apartment buildings. The largest increase took place in the number of authorizations issued for row houses and large apartment buildings (in both category 1.5 times), but even in the only category that dropped in the year 2014, one-family houses, saw a significant growth in 2015 – 1.4 times.[10]

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

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

Table 4.3 Pollutant emissions from mineral products in the period of 1990-2015 (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
1991	NA	NA	NA	NA	NR	NR	3.497		NA
1992	NA	NA	NA	NA	NR	NR	2.611		NA
1993	NA	NA	NA	NA	NR	NR	1.362		NA
1994	NA	NA	NA	NA	NR	NR	1.182		NA
1995	NA	NA	NA	NA	NR	NR	0.829		NA
1996	NA	NA	NA	NA	NR	NR	1.085		NA
1997	NA	NA	NA	NA	NR	NR	1.157		NA
1998	NA	NA	NA	NA	NR	NR	1.949		NA
1999	NA	NA	NA	NA	NR	NR	1.462		NA
2000	NA	0.570	NA	0.010	0.122	0.713	2.296	0.00000	0.040
2001	0.010	0.010	0.010	0.010	0.161	0.841	2.695	0.00000	0.040
2002	0.000	0.040	NA	0.010	0.198	1.105	3.548	0.00000	NA
2003	0.000	0.090	NA	0.010	0.229	1.284	4.122	0.00002	0.010
2004	0.010	0.070	NA	NA	0.298	1.832	5.883	0.00030	0.010
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

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%.

Construction and demolition sector is a key source of emissions of TSP (27.5% of total emission, Figure 4.5) and $PM_{2.5}$ (12.5% of total emission). Emissions have been recalculated, using new, more detailed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 methodology. New emission factors are highest compared with the EMEP/EEA Guidebook 2013 EFs.

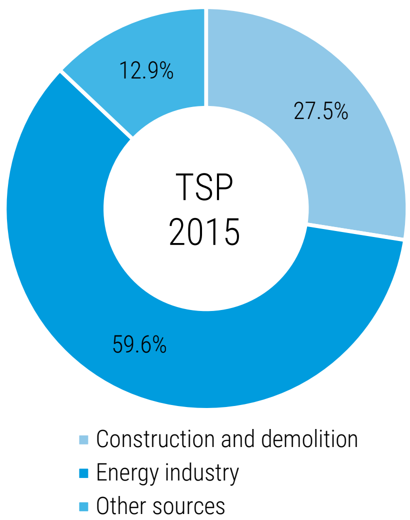

Figure 4.5 The share of construction and demolition sector in total TSP emissions

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.

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 cement 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	0.060	0.563	185.000	0.07	0.0130	541.401	0.2	0.108
1991	905.000	0.060	0.543	207.000	0.07	0.0140	592.206	0.2	0.118
1992	483.000	0.060	0.290	92.000	0.07	0.0060	350.444	0.2	0.071
1993	354.000	0.060	0.212	21.000	0.07	0.0010	139.217	0.2	0.028
1994	402.500	0.060	0.242	18.000	0.07	0.0010	128.283	0.2	0.026
1995	417.600	0.060	0.251	16.800	0.07	0.0010	81.343	0.2	0.016
1996	387.700	0.060	0.233	17.400	0.07	0.0010	68.009	0.2	0.014
1997	422.500	0.070	0.030	19.500	0.07	0.0010	62.674	0.2	0.013
1998	321.300	0.070	0.022	32.100	0.07	0.0020	54.674	0.2	0.011
1999	357.700	0.070	0.025	23.300	0.07	0.0020	46.139	0.2	0.009
2000	329.100	0.070	0.023	21.200	0.07	0.0010	45.072	0.2	0.009
2001	404.600	0.070	0.028	20.000	0.07	0.0010	54.140	0.2	0.011
2002	465.900	0.070	0.033	21.200	0.07	0.0010	61.608	0.2	0.012
2003	506.300	0.070	0.035	32.000	0.07	0.0020	63.741	0.2	0.013
2004	506.300	0.070	0.035	32.000	0.07	0.0020	63.741	0.2	0.013
2005	726.000	0.070	0.051	37.200	0.07	0.0020	69.342	0.2	0.014

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
2006	848.900	0.070	0.059	39.700	0.07	0.0027	82.667	0.2	0.016
2007	936.200	0.070	0.065	43.500	0.07	0.0030	143.485	0.2	0.029
2008	806.100	0.070	0.056	59.400	0.07	0.0041	113.081	0.2	0.023
2009	326.000	0.070	0.023	30.200	0.07	0.0021	38.938	0.2	0.007
2010	536.700	0.070	0.037	27.200	0.07	0.0019	56.500	0.2	0.011
2011	719.002	0.004	0.003	36.100	0.07	0.0025	84.544	0.2	0.017
2012	714.600	0.006	0.004	72.000	0.07	0.005	107.213	0.2	0.021
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

Emission calculations from construction and demolition (2A5b) sectors are based on the Tier 1 method from the renewed EMEP/EEA Air Pollutant Emission Inventory 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 2000-2015 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).

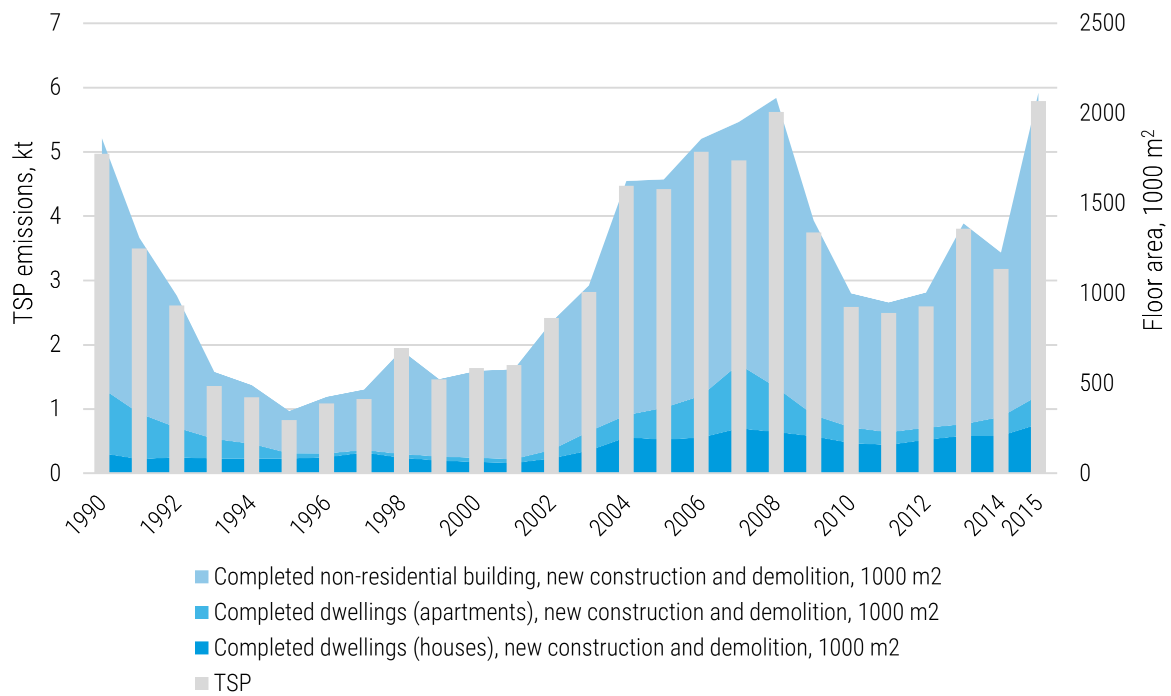

Figure 4.6 The completed dwelling and non-residential building, new construction and demolition and TSP emission in the period of 1990-2015

Table 4.7 Activity data for PM emission calculations from the construction sector in the period of 1990-2015 (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
1991	78.6	254.1	975.9
1992	89.3	164.1	733.6
1993	81.7	109.3	372.6
1994	82.2	81.7	326.2
1995	81.6	29.2	235.2
1996	88.9	21.3	314.6
1997	115.6	13.7	336.3
1998	85.8	21.0	576.6
1999	71.1	22.3	429.9
2000	62.4	23.2	483.2
2001	57.4	21.6	499.2
2002	82.5	47.0	711.1
2003	126.1	105.8	811.9
2004	199.7	123.1	1 300.7
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

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 Ltd, Kiviõli Keemiatööstuse LLC and Eesti Energia Õlitööstus plc (production of shale oil), Akzo Nobel Baltics Ltd, Tikkurila Ltd and Eskaro Ltd (paints and varnishes), Molycorp Silmet Ltd (rare metals), Novotrade Invest Ltd (recycling of petroleum products), Krimelte LLC and Henkel Makroflex Ltd (installation foam), Eastman Specialties Ltd (benzoic acid, sodium benzoate, plasticizers), Orica Eesti LLC (explosives), Takeda Pharma Ltd (pharmaceuticals) and Interchemie Werken De Adelaar Eesti Ltd (veterinary medicines and supplies).[11]

In 2015, production decreased in all branches of the chemical industry. 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 Ltd, 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 22% in 1990, and only 0.2% in 2015 (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.

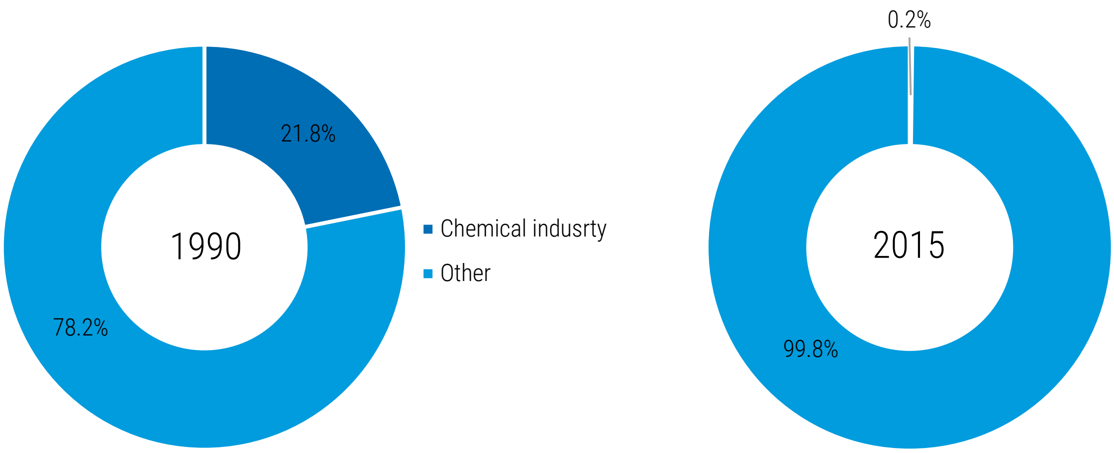

Figure 4.7 Distribution of NMVOC emissions by activities in 1990 and 2015

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

Table 4.8 Emissions from the chemical industry in the period of 1990-2015 (kt)

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	0.190	13.300	NA	0.370	NR	NR	0.940	NR	0.340
1991	0.100	12.330	NA	0.300	NR	NR	0.100	NR	0.300
1992	0.090	8.500	NA	0.280	NR	NR	0.470	NR	0.300
1993	0.050	3.500	NA	0.080	NR	NR	0.150	NR	0.010
1994	0.190	2.670	NA	0.140	NR	NR	0.610	NR	0.040
1995	0.070	3.530	NA	0.140	NR	NR	0.490	NR	NA
1996	0.150	2.460	NA	0.070	NR	NR	0.280	NR	NA
1997	0.150	2.390	NA	0.060	NR	NR	0.140	NR	0.010
1998	0.140	1.650	NA	0.060	NR	NR	0.080	NR	0.020
1999	0.190	0.790	NA	0.090	NR	NR	0.180	NR	NA
2000	0.190	0.840	NA	0.040	0.090	0.163	0.190	0.0027	0.340
2001	0.310	0.770	0.010	0.030	0.071	0.129	0.150	0.0021	0.320
2002	0.100	0.710	NA	0.020	0.043	0.079	0.100	0.0016	0.230
2003	0.130	1.065	0.010	0.030	0.067	0.122	0.146	0.0020	0.270
2004	0.320	0.960	0.010	0.040	0.179	0.326	0.380	0.0053	0.330
2005	0.160	0.720	0.0	0.080	0.146	0.266	0.310	0.0044	0.290
2006	0.230	0.410	NA	0.060	0.126	0.232	0.280	0.0037	0.330
2007	0.200	0.120	0.0	0.070	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	NA	0.071	0.000005	0.010	0.005	0.014	0.042	0.0001	0.405
2011	0.000	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	0.0002	0.046	0.000005	0.007	0.001	0.002	0.007	0.00001	0.353
Trend 1990-2015, %	-99.9	-99.7		-98.2	-91.1	-99.3	-96.04	-99.5	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 Air Pollutant Emission Inventory 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 Kohimo Ltd, Fortaco Estonia Ltd, Marketex Offshore Constructions LLC, Remeksi Keskus Ltd, E-Profiil Ltd (metal structures), Ruukki Products Ltd, Saku Metall Ltd (building structures), HANZA Mechanics Tartu Ltd, FAVOR Ltd, AQ Lasertool LLC, Metalliset Eesti Ltd (metalworking) and Metaprint Ltd (metal packaging manufacturing). In the long run, growth of production volume is expected to continue in the metals industry, fuelled mainly by exports.[12]

Machine-building plant of BLRT Masinaehtius LLC; source: www.masinaehitus.ee

The situation in the metal industry in 2015, could be assessed as satisfactory. Production grew marginally. In 2015, there was a slight increase in emissions compared to 2014.

Emissions from the metal industry are presented in Table 4.9.

Table 4.9 Emissions from the metal production sector in the period of 1990-2015 (kt)

Year	NO_x	SO_x	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
1990	NA	NA	NA	0.160	NR	NR	NA	NR	NA
1991	NA	NA	0,0	0.160	NR	NR	NA	NR	NA
1992	NA	NA	0,0	0.160	NR	NR	NA	NR	NA
1993	NA	NA	NA	0.040	NR	NR	NA	NR	NA
1994	NA	NA	NA	0.080	NR	NR	NA	NR	NA
1995	NA	NA	NA	0.100	NR	NR	NA	NR	NA
1996	NA	NA	0,0	0.090	NR	NR	NA	NR	NA
1997	NA	NA	NA	0.060	NR	NR	NA	NR	NA
1998	NA	NA	NA	0.040	NR	NR	NA	NR	NA
1999	NA	NA	NA	0.050	NR	NR	NA	NR	NA
2000	NA	NA	0.010	0.040	0.014	0.018	0.030	0.0001	0.010
2001	0.010	NA	0.010	0.080	0.014	0.018	0.030	0.0001	0.010
2002	0.010	NA	0.020	0.060	0.023	0.030	0.050	0.0001	0.010
2003	0.011	NA	0.015	0.050	0.022	0.029	0.048	0.0001	0.010
2004	0.010	NA	0.010	0.030	0.028	0.036	0.060	0.0001	0.020
2005	0.010	NA	0.010	0.060	0.023	0.030	0.050	0.0001	0.010
2006	0.030	NA	0.010	0.080	0.014	0.018	0.030	0.0001	0.020
2007	0.000	NA	0.010	0.060	0.005	0.006	0.050	0.0000	0.020
2008	0.000	0.0002	0.008	0.033	0.002	0.002	0.048	0.0001	0.023
2009	0.000	0.00002	0.004	0.0001	0.001	0.001	0.035	0.0001	0.012
2010	0.000	0.000	0.006	0.000	0.001	0.002	0.044	0.0001	0.009
2011	0.000	0.0001	0.008	0.070	0.001	0.002	0.033	0.0001	0.009
2012	0.001	0.0001	0.007	0.072	0.001	0.001	0.034	0.0001	0.009
2013	0.015	0.0001	0.008	0.074	0.019	0.025	0.045	0.0001	0.012
2014	0.020	0.0001	0.007	0.043	0.023	0.033	0.056	0.0001	0.021
2015	0.022	0.0001	0.008	0.058	0.028	0.035	0.061	0.0001	0.027

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.

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

BC emission have been calculated on the base EMEP/EEA Air Pollutant Emission Inventory 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 Air Pollutant Emission Inventory 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 1990-2015 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP	BC
1990	0.027	NR	NR	0.257	NR
1991	0.023	NR	NR	0.215	NR
1992	0.003	NR	NR	0.025	NR
1993	0.006	NR	NR	0.054	NR
1994	0.006	NR	NR	0.052	NR
1995	0.008	NR	NR	0.071	NR
1996	0.008	NR	NR	0.071	NR
1997	0.007	NR	NR	0.063	NR
1998	0.008	NR	NR	0.076	NR
1999	0.011	NR	NR	0.106	NR
2000	0.011	0.001	0.013	0.100	0.0003
2001	0.009	0.001	0.011	0.085	0.0003
2002	0.018	0.001	0.023	0.170	0.0006
2003	0.014	0.001	0.017	0.130	0.0004
2004	0.018	0.001	0.022	0.165	0.0006
2005	0.019	0.001	0.023	0.175	0.0006
2006	0.024	0.001	0.030	0.222	0.0008
2007	0.024	0.001	0.030	0.223	0.0008
2008	0.024	0.002	0.030	0.226	0.0008
2009	0.016	0.001	0.023	0.176	0.0006
2010	0.018	0.001	0.022	0.168	0.0006
2011	0.020	0.001	0.026	0.192	0.0006
2012	0.018	0.001	0.023	0.169	0.0006
2013	0.019	0.001	0.024	0.177	0.0006
2014	0.021	0.001	0.026	0.193	0.0007
2015	0.023	0.001	0.029	0.218	0.0007
Trend 1990-2015, %	-23.6	117.8	117.8	-15.1	117.8

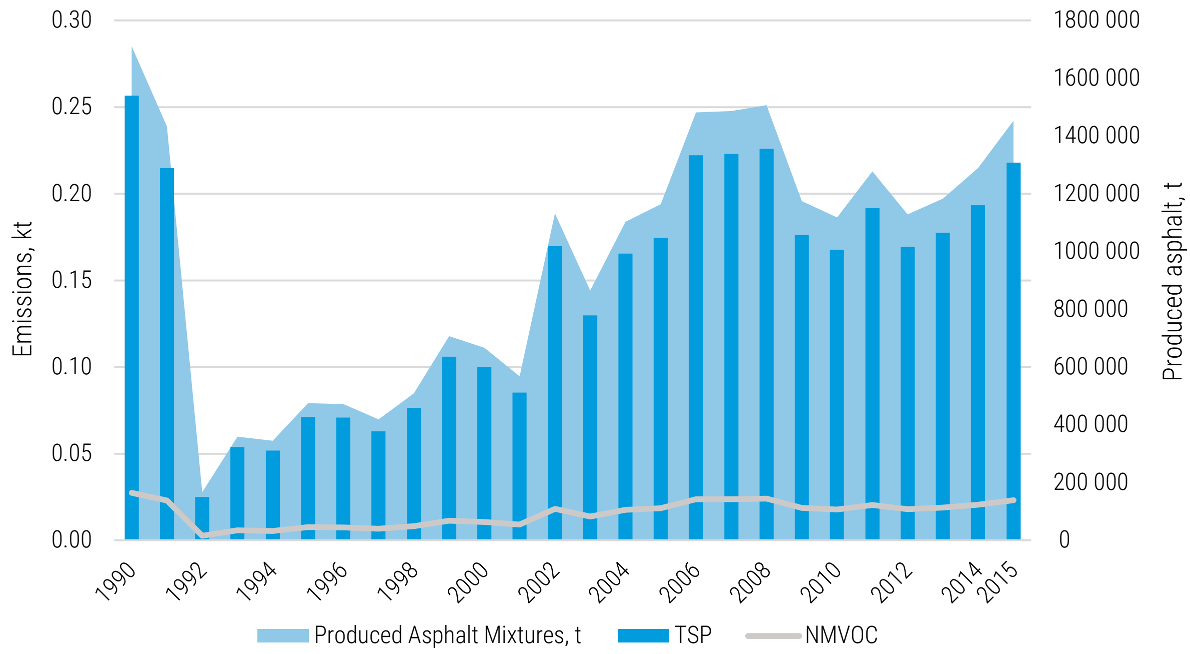

Figure 4.8 Emissions of NMVOC and TSP from road paving with asphalt and asphalt production in the period of 1990-2015

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 1990-2015 (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 1990-2015 (tonnes)

Year	Produced Asphalt Mixtures
1990	1,711.000
1991	1,433.000
1992	167.000
1993	359.000
1994	345.000
1995	475.000
1996	472.000
1997	419.000
1998	509.000
1999	707.000
2000	667.000
2001	568.000
2002	1,132.000
2003	865.000

Year	Produced Asphalt Mixtures
2004	1,103.000
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

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 and wood, furniture.

The pulp and paper industry in Estonia has a long tradition, having been established as far back as the 17th century. There are about 60 companies in Estonia that manufacture paper, pulp or paper products. Over 80% 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 which made 78 million euros of turnover in the year 2015 and the paper and cardboard producer Horizon Tselluloosi ja Paberi Ltd with a slightly smaller turnover. Together they provide more than two-thirds of the sector's revenue.[13]

In 2015, the paper industry continued to rise in sales volumes, increasing by 0.6%.

The paper industry is a heavily concentrated industry in Estonia. Horizon Tselluloosi ja Paberi Ltd 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 Ltd

Horizon only manufactures unbleached varieties. Estonian Cell Ltd, 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.

Nearly 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.[14]

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

[13] Overview of Economy 2015. The Ministry of Economic Affairs and Communications, the Ministry of Finance. Tallinn 2016
[14] Overview of Economy 2014. The Ministry of Economic Affairs and Communications, the Ministry of Finance 2015. Tallinn 2015

two major sectors: food production and beverage production. The year 2015 proved to be difficult for both sectors, which was mainly due to reduced demand in export markets. The restrictions on imports of food products imposed by Russia in the previous year and the resulting new market situation reached the farmers in its full capacity in 2015. The milk, meat, and fish sectors are most affected by Russia's ban on imports. In addition to Russia's restrictions, the industry was also affected by a number of other factors. The swine farming sector received an additional blow from the African swine fever virus which set export restrictions on the sector, and created additional problems in the realization of production.[15]

The emissions from sector NFR 2H are presented in Table 4.13.

Table 4.13 Pollutant emissions from the pulp, paper and food industries in the period of 1990-2015 (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
1991	NA	1.541	NA	NR	NR	NA	NR	NA
1992	NA	1.097	NA	NR	NR	NA	NR	NA
1993	NA	0.899	NA	NR	NR	NA	NR	NA
1994	NA	0.837	NA	NR	NR	NA	NR	NA
1995	NA	0.839	NA	NR	NR	NA	NR	NA
1996	NA	0.723	NA	NR	NR	NA	NR	NA
1997	NA	0.745	NA	NR	NR	NA	NR	NA
1998	NA	0.742	NA	NR	NR	NA	NR	NA
1999	NA	0.656	NA	NR	NR	NA	NR	NA
2000	0.010	0.649	0.040	0.085	0.115	0.150	0.002	0.140
2001	0.010	0.650	0.060	0.066	0.088	0.110	0.002	0.140
2002	0.020	0.725	0.160	0.223	0.299	0.380	0.006	0.040
2003	0.020	0.748	0.140	0.126	0.169	0.215	0.003	0.000
2004	0.020	0.788	0.120	0.133	0.179	0.230	0.003	0.000
2005	0.0	0.744	0.130	0.127	0.171	0.220	0.003	0.020
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	0.0	0.057	0.085	0.134	0.001	0.005

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

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

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 Air Pollutant Emission Inventory 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 Ltd and Spratfil Ltd 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 1990-2015 (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 1990-2015 (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
1991	149.4	10.4	151.8			5.6	631.6
1992	138.6	5.0	107.9	132.0		0	303.5
1993	111.7	4.2	83.7	133.0		0.6	200.7
1994	109.3	5.5	69.4	120.8		0.1	184.6
1995	99.7	5.0	67.7	132.0	3.6	0.1	162.8
1996	93.9	5.6	58.6	108.7	4.8	0.1	97.6
1997	86.8	5.2	53.4	123.9	7.0		131.3
1998	81.6	4.3	60.0	119.3	7.2		151.7
1999	77.3	4.6	61.1	111.9	3.5		131.8
2000	76.5	4.4	53.3	113.4	0.8		133.3
2001	76.3	6.0	57.3	103.4	0.9		150.2
2002	77.2	7.4	68.3	101.0	0.9		167.1
2003	72.4	7.9	67.5	79.4	1.0		199.5
2004	72.8	9.0	71.3	84.5	1.6		207.3
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	76.0	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	83.2	73.7	..	..	127.4

Table 4.17 Activity data for the drinks industries in the period of 1990-2015 (thousand hl)

Year	Wine of fruits and berries	Beer	Crude spirits	Distilled spirits
1990	37.0	769.0	82.0	147.0
1991	50.9	675.5	83.4	160.5
1992	20.5	425.7	70.7	120.9
1993	13.0	419.3	94.1	168.4
1994	12.8	476.9	76.1	123.0
1995	14.0	499.6	91.0	176.0
1996	22.0	459.0	79.0	96.0
1997	21.5	543.0	77.0	109.0
1998	31.0	744.0	59.0	102.0
1999	24.0	957.0	32.0	66.0
2000	32.6	950.1	20.4	86.4
2001	30.4	1,015.2	24.1	115.2
2002	34.3	1,044.1	33.1	142.4
2003	34.5	1,040.2	38.3	173.1
2004	60.7	1,202.8	40.0	187.9
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

Year	Wine of fruits and berries	Beer	Crude spirits	Distilled spirits
2013	106.6	1,472.7	1.8	157.7
2014	107.3	1,636.7	1.8	136.0
2015	107.6	1,446.9		137.6

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. Sources-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.

No major improvements are planned for the next submission.

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

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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: 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	Emissions from domestic solvent use	Tier 1	NMVOC, Hg
2D3d	Coating application	Includes emissions from domestic and industrial paint application	Tier 1 / Tier 3	NMVOC, PM_{10}, TSP, Pb, Cu, Zn
2D3e	Degreasing	Includes emissions from degreasing (vapour and cold cleaning), electronic components manufacturing and other industrial cleaning	Tier 1 / Tier 3	NMVOC, Pb
2D3f	Dry cleaning	Includes emissions from dry cleaning	Tier 1 / Tier 3	NMVOC
2D3g	Chemical products	Includes emissions from polyurethane, polystyrene foam and rubber processing, paints, inks and glues manufacturing, textile finishing, leather tanning and other use of solvents	Tier 3	NMVOC, NH_3, TSP, CO, Cr, Zn
2D3h	Printing	Emissions from solvents in printing houses	Tier 1 / Tier 3	NMVOC, TSP
2D3i	Other solvent use		Tier 2 / Tier 3	NMVOC, NH_3, TSP, Pb 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 2015, the solvent and other product use sector, which was the largest pollution source of NMVOC emissions in Estonia, accounted for 31.4% of total NMVOC emissions. The largest share was for coating application at 45.3%, with the others being domestic solvent use at 21.9%, degreasing 13.9%, other solvent use 9.3%, printing 6.6%, chemical products 2.5%, dry cleaning 0.4% and other product use 0.1% (Figure 4.9).

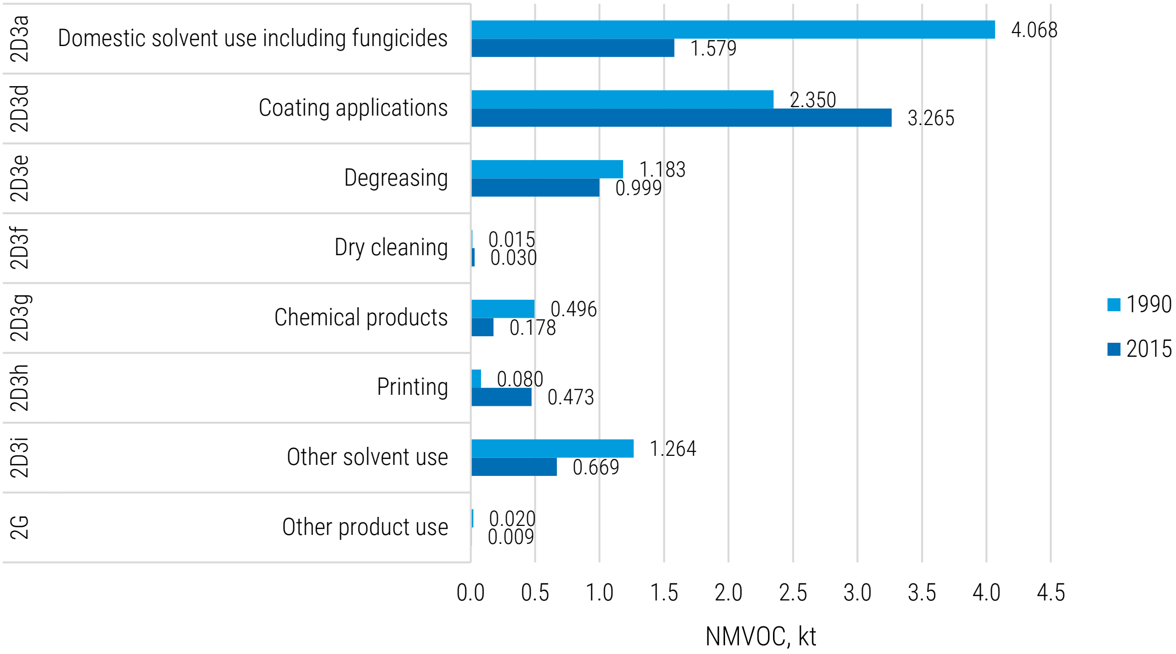

Figure 4.9 NMVOC emissions by sectors in 1990 and 2015

There has been a slight increase in trends in NMVOC emissions from solvent and other product use in recent years. Since 1990, NMVOC emissions have decreased in the solvent sector by 24% (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 1990-2015 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 Estonian Republic 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 36% in comparison with 2006 (Figure 4.11). In 2011 there was a slight increase in NMVOC emissions by 8.9%, which means that the bottom of the emissions was reached, and henceforward, the emissions have been started to rise again.

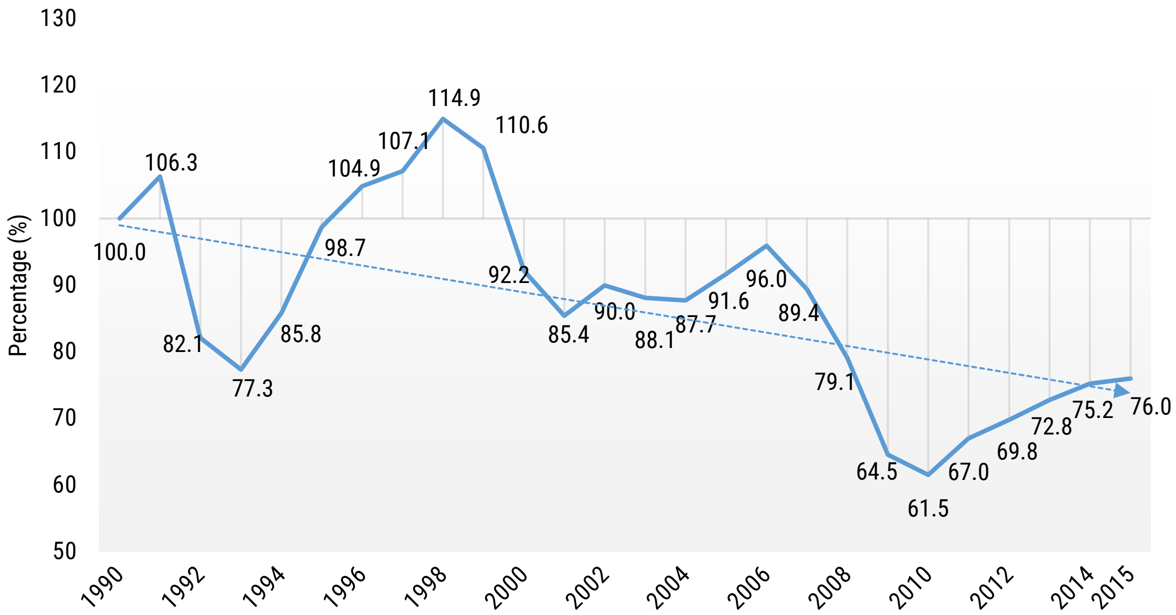

Figure 4.10 The dynamics of NMVOC emissions from the solvent and other product use sector in the period of 1990-2015 (base year is 1990)

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.

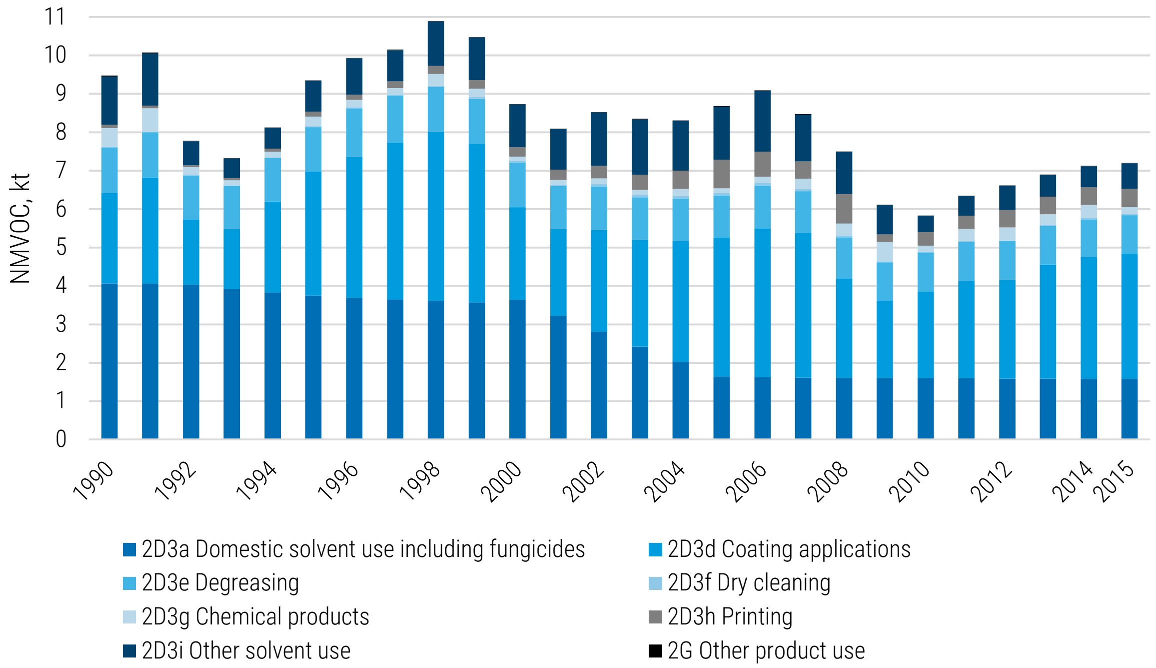

Figure 4.11 NMVOC emissions from the solvent and other product use sector in the period of 1990-2015

Table 4.20 NMVOC emissions from the solvent and other product use sector in the period of 1990-2015 (kt)

	2D3a	2D3d	2D3e	2D3f	2D3g	2D3h	2D3i	2G
1990	4.068	2.350	1.183	0.015	0.496	0.080	1.264	0.020
1991	4.060	2.768	1.169	0.012	0.615	0.066	1.365	0.017
1992	4.027	1.700	1.149	0.011	0.201	0.054	0.628	0.009
1993	3.914	1.568	1.124	0.012	0.135	0.058	0.505	0.013
1994	3.825	2.374	1.136	0.018	0.135	0.090	0.540	0.011
1995	3.751	3.225	1.157	0.025	0.250	0.126	0.810	0.011
1996	3.691	3.668	1.258	0.030	0.197	0.134	0.949	0.010
1997	3.642	4.094	1.223	0.005	0.192	0.172	0.808	0.015
1998	3.608	4.398	1.178	0.024	0.307	0.214	1.154	0.010
1999	3.572	4.124	1.173	0.050	0.217	0.223	1.111	0.010
2000	3.629	2.418	1.159	0.050	0.107	0.248	1.115	0.009
2001	3.217	2.264	1.115	0.047	0.113	0.273	1.055	0.009
2002	2.809	2.651	1.134	0.056	0.151	0.323	1.393	0.011
2003	2.420	2.778	1.110	0.064	0.127	0.392	1.446	0.011
2004	2.022	3.151	1.103	0.064	0.184	0.474	1.303	0.011
2005	1.631	3.624	1.101	0.062	0.125	0.744	1.384	0.013
2006	1.621	3.867	1.128	0.065	0.158	0.655	1.588	0.012
2007	1.612	3.764	1.095	0.054	0.265	0.452	1.216	0.017
2008	1.606	2.588	1.067	0.051	0.314	0.765	1.097	0.007
2009	1.603	2.012	1.003	0.022	0.497	0.204	0.764	0.012
2010	1.600	2.246	1.023	0.012	0.164	0.354	0.425	0.006
2011	1.596	2.526	1.026	0.018	0.313	0.344	0.517	0.009
2012	1.590	2.569	1.016	0.008	0.337	0.456	0.630	0.009
2013	1.584	2.974	1.000	0.039	0.268	0.461	0.562	0.009
2014	1.579	3.175	0.979	0.041	0.338	0.458	0.551	0.009
2015	1.579	3.265	0.999	0.030	0.178	0.473	0.669	0.009
Trend 1990-2015, %	**-61.2**	**38.9**	**-15.6**	**107.6**	**-64.0**	**493.2**	**-47.1**	**-55.6**

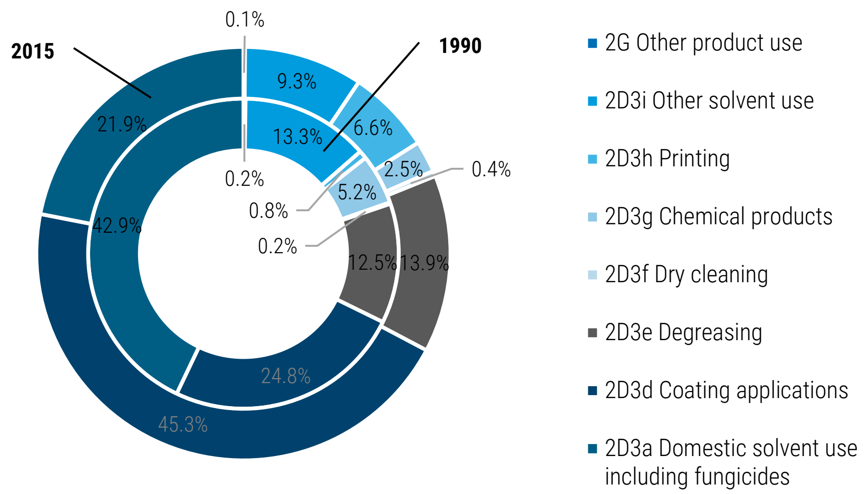

Figure 4.12 The share of NMVOC emissions in 1990 and 2015 by NFR solvent subcategory codes

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 from Statistics Estonia and Eurostat 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*

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); 1,2 kg/person/year (since 2005); EFs for the years 2001-2004 are interpolated
		060411	Domestic use of pharmaceutical products	Included under SNAP 060408	DS: 1.8% 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 (DS); reported by operators (PS, since 2000)	DS: 600 g/kg paint applied (1990-1999); 400 g/kg paint applied (2000-2015) PS: facility specific
		060103	Construction and buildings	Statistics Estonia / Eurostat and expert estimate	DS: 217 g/kg of paint (1990-1999); 150 g/kg of paint applied (2000-2015)
		060104	Domestic use	Statistics Estonia / Eurostat 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); 0.7 kg/person/year (cold)
		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 PS: facility specific

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
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 (since 2007)	PS: facility specific
		060309	Glues manufacturing	Reported by operators (since 2006)	PS: facility specific
		060310	Asphalt blowing	Not occurring	NO
		060311	Adhesive, magnetic tapes, films and photographs manufacturing	Not included	NA
		060312	Textile finishing	Reported by operators (since 2006)	PS: facility specific
		060313	Leather tanning	Reported by operators (since 2006)	PS: facility specific
		060314	Other	Reported by operators (since 2006)	PS: facility specific
2D3h	Printing ink and solvents in printing houses	060403	Printing industry	Statistics Estonia / Eurostat; reported by operators (since 2001)	DS: 500 g/kg ink; 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	Reported by operators (since 2002)	PS: facility specific
		060405	Application of glues and adhesives	Statistics Estonia / Eurostat; reported by operators (since 1990)	DS: 780 g/kg adhesives (1990-2000); 522 g/kg adhesive (since 2005); 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

NFR	Product group	SNAP	Activity where used	Activity data	NMVOC emission factors*
		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
		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 0.1 tonnes or more.

The data collected in the annual air emissions report for the solvent use are:

- Class – solvent, varnish, adhesive, paint or other preparation 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 EMTAK (Estonian classification of economic activities – not required since 2012) and SNAP codes where the reported chemical has been used;
- The annual consumption of solvent or solvent containing preparation in tonnes per year;
- Emissions of pollutants by the used solvent or solvent containing preparation – CAS number, name of the substance, maximum emissions 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, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	0.003	kt	0.011	0.01%	0.00%
NMVOC	7.203	kt	31.432	8.84%	2.19%
SO_x	0.001	kt	0.003	0.00%	0.00%
NH_3	0.011	kt	0.093	0.04%	0.01%
$PM_{2.5}$	0.069	kt	0.754	0.38%	0.12%
PM_{10}	0.087	kt	0.618	0.31%	0.10%
TSP	0.104	kt	0.492	0.22%	0.01%
CO	0.107	kt	0.083	0.04%	0.01%
Pb	0.288	t	1.014	0.51%	0.07%
Cd	0.011	t	1.408	0.71%	0.08%
Hg	0.012	t	2.282	0.54%	0.07%

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Pollutant	Emission, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
PCDD/PCDF	0.0002	g I-TEQ	0.004	0.01%	0.00%
B(a)p	0.0002	t	0.010	0.02%	0.02%
B(b)f	0.0001	t	0.004	0.01%	0.01%
B(k)f	0.0001	t	0.007	0.01%	0.01%
I(1,2,3-cd)p	0.0001	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 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 2015, 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 domestic solvent use;
$EF_{pollutant}$ = the emission factor for this pollutant.

Table 4.24 presents the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 default emission factors for NFR source category 2D3a for NMVOC and Hg, for EU-15 including Iceland, Norway and Switzerland. This table also presents additional information on Tier 1 emission factors for the four main subcategories: household products, car care products, cosmetics and toiletries, DIY/buildings in addition to pharmaceutical products and other various products.

Table 4.24 Tier 1 emission factors for NFR source category 2D3a domestic solvent use including fungicides

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

An IIASA Tier 1 NMVOC emission factor for western European Union Member States (EU-15 including Iceland, Norway and Switzerland) is 1,519 ± 559 g/person. An IIASA Tier 1 NMVOC emission factor for eastern EU countries (EU-12 and 12 EECCA countries) is 703 ± 273 g/person. This suggests that an emission factor for EU-12 can be derived from Table 4.24 by multiplying with a factor 703 / 1,519 = 0.46. Total 2D3a for EU-12 and 12 EECCA countries is thus: 0.46 * (2,700 (-1,700; +3,700) = 1,200 (-780; +1,700) g/person. The derived emission factor is used to calculate NMVOC emissions from the NFR sector 2D3a for the years 2005 and onward.

NMVOC emissions for years 1990-2000 are calculated using EMEP/Corinair Emission Inventory Guidebook 2007 Tier 1 default emission factor for domestic solvent use 2,590 g/person. The emission factors for years 2001-2004 are interpolated.

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 1990-2015

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
1991	1.568	0.330	0.332	0.416	0.266	0.500	0.585	0.815
1992	1.555	0.327	0.329	0.412	0.263	0.496	0.581	0.808
1993	1.511	0.318	0.320	0.401	0.256	0.482	0.564	0.785
1994	1.477	0.311	0.312	0.392	0.250	0.471	0.552	0.768
1995	1.448	0.305	0.306	0.384	0.245	0.462	0.541	0.753
1996	1.425	0.300	0.301	0.378	0.241	0.454	0.532	0.741
1997	1.406	0.296	0.297	0.373	0.238	0.448	0.525	0.731
1998	1.393	0.293	0.295	0.369	0.236	0.444	0.520	0.724
1999	1.379	0.290	0.292	0.366	0.234	0.440	0.515	0.717
2000	1.401	0.295	0.296	0.371	0.237	0.447	0.523	0.728
2001	1.393	0.261	0.263	0.329	0.210	0.396	0.464	0.646
2002	1.384	0.228	0.229	0.287	0.184	0.346	0.405	0.564
2003	1.375	0.197	0.198	0.248	0.158	0.298	0.349	0.486
2004	1.366	0.164	0.165	0.207	0.132	0.249	0.292	0.406
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

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
1991	0.125	0.338	0.112	0.038	0.079	0.125	4.060	8.779
1992	0.124	0.335	0.111	0.038	0.079	0.124	4.027	8.707
1993	0.121	0.326	0.108	0.037	0.076	0.121	3.914	8.463
1994	0.118	0.319	0.106	0.036	0.075	0.118	3.825	8.271
1995	0.116	0.312	0.104	0.035	0.073	0.116	3.751	8.109
1996	0.114	0.307	0.102	0.034	0.072	0.114	3.691	7.981
1997	0.112	0.303	0.101	0.034	0.071	0.112	3.642	7.874
1998	0.111	0.300	0.100	0.034	0.070	0.111	3.608	7.801
1999	0.110	0.297	0.099	0.033	0.070	0.110	3.572	7.724
2000	0.112	0.302	0.100	0.034	0.071	0.112	3.629	7.847
2001	0.099	0.268	0.089	0.030	0.063	0.099	3.217	7.799
2002	0.087	0.234	0.078	0.026	0.055	0.087	2.809	7.748
2003	0.075	0.202	0.067	0.023	0.047	0.075	2.420	7.701
2004	0.062	0.168	0.056	0.019	0.039	0.062	2.022	7.651
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

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
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

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.

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 borne 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 borne 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.

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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 2015, NMVOC emissions from this sector had increased by 38.9% 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

The Tier 1 default emission factors have been taken from the online version of the GAINS model (IIASA, 2008[16]). A (rounded) weighted average emission factor over all the countries in the model has been derived from dividing the total NMVOC emissions by the total paint use. Data for the year 2000 have been used in order to estimate an average emission factor to describe the situation; however, care should be taken when applying this emission factor. Due to the EU Directive 2004/42/EC, which came into force on 1 January 2007, it is no longer permitted to bring decorative or vehicle refinishing paint products to the market with a VOC content that exceeds the maximum for those product categories in EU Member States. For non-EU countries, however, emissions may be significantly higher than the estimate provided here. This has been taken into account in the 95% confidence intervals. These are expert

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

judgements based on former values and the more specific implied emission factors from GAINS.

Emissions from the industrial coating application sector have been significantly reduced by the introduction of the Solvent Emissions Directive (1999/13/EC).

In Estonia, the Directive 2004/42/EC was implemented in 2005 and came into force in 2007 (I stage) and 2010 (II stage). The Solvent Emissions Directive (1999/13/EC) was implemented and came into force in 2004 (2007 for existing installations). In 2013 Estonia implemented the Industrial Emissions Directive 2010/75/EU.

Decorative Coating Application

For the years 2000-2009, the EMEP Guidebook 2016 Tier 1 emission factor 150 g/kg paint applied is used for calculations. The general equation is:

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

where

$E_{pollutant}$ = the emission of the specified pollutant;
$AR_{production}$ = the activity rate for the paint application (consumption of paint);
$EF_{pollutant}$ = the emission factor for this pollutant.

For the years 1990-1999, Corinair (2000) emission factors are used for calculations. As this guidebook provides different emission factors for solvent borne and water borne paints, an averaged emission factor is calculated by taking into account the proportion of solvent borne and water borne paints used.

The NMVOC emission factor for decorative solvent borne paints (all) is 300-400 g/kg paint applied (average 350 g/kg paint applied is used) and for water borne paints is 33 g/kg paint applied.

Precise division by solvent borne and water borne paint production is not known. The ratio is estimated by production for the year 2000, when approximately 55% of paint produced was solvent borne and 45% was water borne. Furthermore, by taking import and export data into account, it was estimated that 58% of decorative paint used in 1995 was solvent borne and 42% of paint was water borne.

The weighted average emission factor for the years 1990-1999 can be calculated as follows:

(58% x 350 g/kg + 42% x 33 g/kg) / 100% = 217 g/kg paint applied

Industrial Coating Application

For the years 1990-2005, EMEP Guidebook 2009 Tier 1 emission factor 400 g/kg paint applied is used for calculations. The general equation is:

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

where

$E_{pollutant}$ = the emission of the specified pollutant;
$AR_{production}$ = the activity rate for the paint application (consumption of paint);
$EF_{pollutant}$ = the emission factor for this pollutant.

Different emission factors are proposed for vehicle refinishing (in the 280-700 g/kg range of paint applied, no abatement included). The emission factor 600 g/kg paint applied is chosen for the year 1990-1999 as three different factors are similar to this value. Since the year 2000 emission factor 400 g/kg paint applied is used for vehicle refinishing.

Since 2006, detailed NMVOC emissions from point sources with activity data are reported by operators and collected into the OSIS database by SNAP codes.

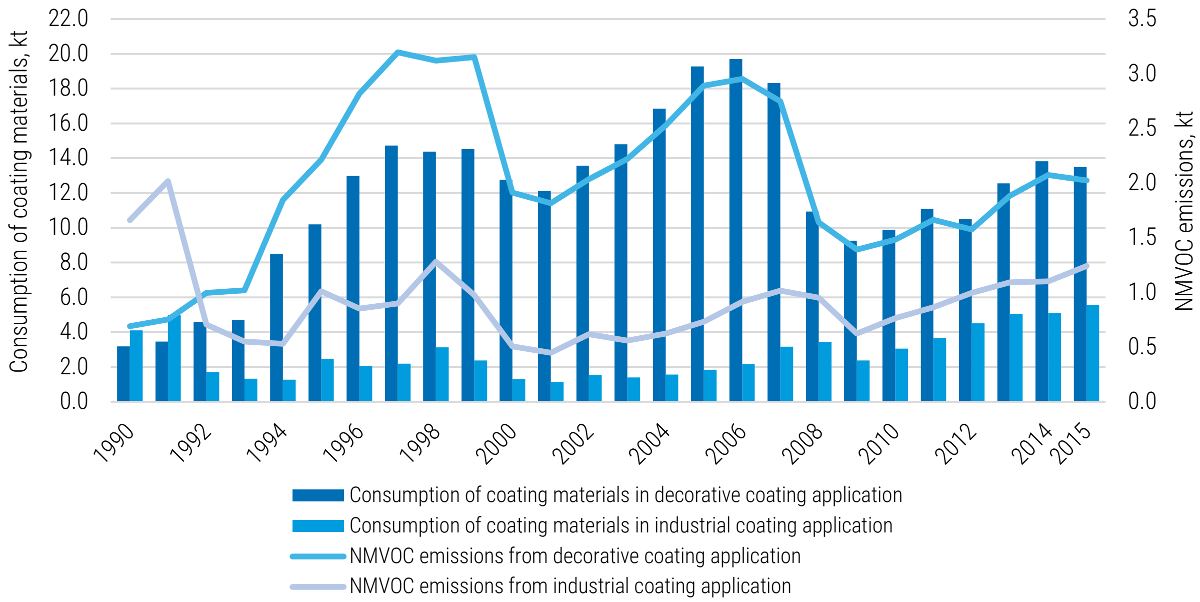

Figure 4.13 Consumption of coating materials and NMVOC emissions from decorative and industrial coating application in the period of 1990-2015

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 distinctive of the Soviet Union. A huge restructuring in industry took place, and many of the large enterprises went bankrupt and were shut down because of inefficient operation.

NMVOC emissions and activity data in Figure 4.13 are based on data presented in the Tables 4.26-27.

4.2.6.3. Activity Data

The quantity of paints and lacquers used in total in Estonia is estimated according to the import and export data (CN codes 3208, 3209 and 3210) and production data (total amount of paints and lacquers) from Statistics Estonia (for the years 1995-2001) and Eurostat (for the years 2002 and onward).

Data related to import and export are not available for the years 1990-1994; therefore, these amounts were calculated using the change in the current prices at that time in the industrial production of chemicals and chemical products.

Some paint is used by point sources (permitted companies) and most of the remaining paint is used for decorative coating application. Also, some of the paint is used for car repairing.

There is no statistical information regarding the amount of paint used for car repairing. Therefore, expert opinion was sought from a representative of the Association of Estonian Automobile Sales and Maintenance Companies "repair unit".

The expert opinion was received from 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 repairing in Estonia is estimated to have risen from 100 tonnes in 1990 up to 212 tonnes in 2015. As this is a rough estimate, the annual growth is estimated to be equal.

The paint use for decorative coating application is estimated in the following way:

Paint used for decorative coating application = total paint use – paint used by all point sources – paint used by car repairing (diffuse part)

It is unknown how much paint has been used by permitted companies between 1990 and 2005. Therefore, a reverse calculation is carried out, taking into account the emission factor for industrial coating application (NMVOC: 400 g/kg paint applied). All reported emissions from point sources are estimated to be from industrial coating applications.

Data regarding paint use in point sources are available in the OSIS database for the years 2006-2015.

Decorative paint is used by construction enterprises, professional painters (SNAP 060103) and private consumers (SNAP 060104) (Table 4.26).

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 at large construction stores revealed that:

1. sales division by companies and private customers depends on the marketing policy of the store,
2. a change in the division between 1995 and 2015 also depends on the marketing policy, and
3. in the years 2004-2007, an increase in paint use was mainly caused by the rapid increase in developments and construction; the increased use of paint was mainly caused by professional painters and construction companies.

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

In the period 2001-2007, Estonia experienced extensive development and construction, during which time it is estimated that the private use of paints was similar to the amount used in 2000.

Therefore, the following assumptions were made:

- For the years 1990-2003 and 2008-2015, it is estimated that up to 60% of paint went to professional painters and the remaining 40% to private customers.
- Consumption among private consumers in 2005-2007 is assumed to be equal to consumption in 2000, and the remaining part is deemed to have been used by professional painters and construction companies. The year 2004 is viewed as a transitional year between 2003 and 2005.

Table 4.26 NMVOC emissions and the consumption of coating materials from decorative paint application by SNAP codes in the period of 1990-2015 (kt)

SNAP code	060103		060104	
Year	NMVOC	Activity data	NMVOC	Activity data
1990	0.414	1.908	0.276	1.272
1991	0.450	2.076	0.300	1.384
1992	0.597	2.752	0.398	1.835
1993	0.611	2.813	0.407	1.876
1994	1.107	5.101	0.738	3.401
1995	1.328	6.122	0.886	4.081
1996	1.691	7.790	1.127	5.194
1997	1.918	8.838	1.279	5.892
1998	1.871	8.620	1.247	5.747
1999	1.890	8.710	1.260	5.807
2000	1.148	7.654	0.765	5.102
2001	1.090	7.266	0.727	4.844
2002	1.221	8.138	0.814	5.426
2003	1.332	8.880	0.888	5.920
2004	1.687	11.247	0.840	5.600
2005	2.125	14.166	0.765	5.100
2006	2.188	14.588	0.765	5.100
2007	1.982	13.213	0.765	5.100

SNAP code	060103		060104	
Year	NMVOC	Activity data	NMVOC	Activity data
2008	0.983	6.554	0.655	4.370
2009	0.834	5.560	0.556	3.706
2010	0.889	5.926	0.593	3.951
2011	0.998	6.651	0.665	4.434
2012	0.944	6.296	0.630	4.197
2013	1.129	7.529	0.753	5.019
2014	1.243	8.290	0.829	5.527
2015	1.214	8.095	0.810	5.397

Table 4.27 NMVOC emissions and consumption of coating materials from industrial paint application by SNAP codes in the period of 1990-2015 (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	3.938	NA	NA	0.060	0.100	NA	NA	IE	IE	IE	IE	0.025	0.063
1991	1.955	4.887	NA	NA	0.063	0.104	NA	NA	IE	IE	IE	IE	IE	IE
1992	0.639	1.598	NA	NA	0.065	0.109	NA	NA	IE	IE	IE	IE	IE	IE
1993	0.428	1.071	NA	NA	0.068	0.113	NA	NA	IE	IE	0.054	0.135	IE	IE
1994	0.430	1.076	NA	NA	0.071	0.118	NA	NA	IE	IE	0.027	0.067	0.001	0.004
1995	0.795	1.989	NA	NA	0.073	0.122	NA	NA	IE	IE	0.047	0.119	0.094	0.236
1996	0.626	1.565	NA	NA	0.076	0.126	NA	NA	IE	IE	0.037	0.093	0.112	0.280
1997	0.610	1.526	NA	NA	0.078	0.131	NA	NA	IE	IE	0.097	0.243	0.112	0.280
1998	0.976	2.439	NA	NA	0.081	0.135	NA	NA	IE	IE	0.110	0.276	0.113	0.284
1999	0.689	1.721	NA	NA	0.084	0.140	NA	NA	IE	IE	0.088	0.220	0.113	0.284
2000	--	--	NA	NA	0.058	0.178	NA	NA	0.117	0.292	0.119	0.298	0.211	0.528
2001	--	--	NA	NA	0.059	0.175	NA	NA	0.116	0.290	0.218	0.544	0.054	0.136
2002	--	--	NA	NA	0.061	0.161	NA	NA	0.080	0.201	0.244	0.611	0.231	0.577
2003	--	--	NA	NA	0.063	0.164	NA	NA	0.082	0.206	0.184	0.461	0.229	0.572
2004	--	--	NA	NA	0.065	0.170	NA	NA	0.137	0.342	0.209	0.523	0.212	0.530
2005	--	--	0.002	0.004	0.066	0.169	NA	NA	0.131	0.329	0.184	0.459	0.350	0.874
2006	--	--	0.003	0.006	0.068	0.170	NA	NA	0.171	0.505	0.407	0.828	0.265	0.650
2007	--	--	0.002	0.002	0.072	0.178	NA	NA	0.357	1.126	0.439	1.191	0.147	0.659
2008	--	--	NA	NA	0.073	0.183	NA	NA	0.335	1.024	0.369	1.188	0.173	1.050
2009	--	--	NA	NA	0.075	0.187	NA	NA	0.160	0.477	0.302	1.362	0.085	0.343
2010	--	--	NA	NA	0.076	0.191	NA	NA	0.157	0.575	0.409	1.552	0.123	0.730
2011	--	--	NA	NA	0.077	0.196	NA	NA	0.135	0.470	0.463	2.056	0.188	0.938
2012	--	--	NA	NA	0.080	0.208	0.002	0.005	0.109	0.385	0.539	2.723	0.264	1.193
2013	--	--	NA	NA	0.084	0.221	0.011	0.021	0.117	0.385	0.575	3.158	0.304	1.257
2014	--	--	NA	NA	0.085	0.236	0.013	0.024	0.101	0.355	0.607	3.228	0.296	1.259
2015	--	--	NA	NA	0.089	0.338	0.010	0.018	0.087	0.264	0.710	3.539	0.345	1.396

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.

4.2.6.4. 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.

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.

4.2.6.5. Source-Specific Planned Improvements

Some corrections and recalculations of the NMVOC emissions 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[17]).

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 2015, NMVOC emissions from this sector had decreased by 15.6% 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

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

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

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

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

where

$E_{pollutant}$ = the emission of the specified pollutant;
$AR_{production}$ = the activity rate for the paint application (consumption of paint);
$EF_{pollutant}$ = the emission factor for this pollutant.

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[18].

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 1995-2001 and from Eurostat for the years 2002 and onward. 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 2015.

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 2015, the OSIS database received activity data regarding solvent use for degreasing in point sources.

For the years 2006-2015, activity data for calculations were calculated as follows:

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

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 4.28 NMVOC emissions and the consumption of solvents from degreasing by SNAP codes in the period of 1990-2015

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
1991	0.071	0.155	1.097	1.568	NA	NA	NA	NA	NA	NA
1992	0.061	0.132	1.088	1.555	NA	NA	NA	NA	NA	NA
1993	0.067	0.145	1.058	1.511	NA	NA	NA	NA	NA	NA
1994	0.102	0.223	1.034	1.477	NA	NA	NA	NA	NA	NA
1995	0.143	0.312	1.014	1.448	NA	NA	NA	NA	NA	NA
1996	0.260	0.566	0.998	1.425	NA	NA	NA	NA	NA	NA
1997	0.239	0.519	0.984	1.406	NA	NA	NA	NA	NA	NA
1998	0.203	0.440	0.975	1.393	NA	NA	NA	NA	NA	NA
1999	0.207	0.451	0.965	1.379	NA	NA	NA	NA	NA	NA
2000	0.179	0.388	0.981	1.401	NA	NA	0.001	0.001	NA	NA
2001	0.140	0.305	0.975	1.393	0.001	0.002	0.002	0.004	0.001	0.001
2002	0.165	0.359	0.968	1.384	0.003	0.006	0.002	0.005	0.000	0.001
2003	0.147	0.320	0.963	1.375	0.002	0.005	0.002	0.005	0.001	0.001
2004	0.147	0.319	0.956	1.366	0.003	0.007	0.003	0.006	0.000	0.000
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
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	1.316	0.010	0.011	0.004	0.013	0.038	0.062

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 2001-2015.

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[19]; UBA, 1989[20]). 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[21]) – 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 4.29.

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

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Table 4.29 The results of the interviews with the dry cleaning operators

Question	Answers			
	Virumaa Puhastus	Euroclean	Pernau Pesumaja	Rea Pesumaja
Technology used?	Closed-circuit machines	Closed-circuit machines (automatic programs)	Closed-circuit machines with activated carbon	Closed-circuit machines
Cleaning agent used?	PER	PER	PER	PER
Quantity of cleaning agent?	30 kg per year	400 kg per year	165 kg per year	1,070 kg per year
Quantity of cleaned textiles?	ca 2,000 kg	Do not have statistics	Register by pieces (app. equal to 6.2 tonnes)	Register by pieces
Waste management?	Collected	Collected and given to hazardous waste company	Collected and given to hazardous waste company	Collected and given to hazardous waste company

4.2.8.3. Activity Data

As the quantity of textile treated is very difficult to estimate because even dry cleaning shops do not have the relevant statistics, solvent consumption is taken as a basis for NMVOC calculations.

Solvent emissions direct from the cleaning machine into the air represent about 80% of solvent consumption (i.e. 80% of solvent used for the replacement of lost solvent) for open-circuit equipment and a little more than 40% for a closed-circuit machine.

All dry cleaning facilities questioned have closed-circuit equipment and use PER as a cleaning agent. Used solvent goes to hazardous waste companies.

The quantity of PER used in Estonia can be estimated by import and export data. Data regarding import and export are not available for the years 1990-1994; therefore, these amounts were calculated by the change in percentage of the current prices in industrial production of chemicals and chemical products in that period.

According to OSIS, no production of tetrachloroethylene / perchloroethylene is reported for the years 2006-2015.

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 equals about 40%. The emission factor for dry cleaning is 400 g/kg solvent use.

Table 4.30 NMVOC emissions and the consumption of solvents from dry cleaning in the period of 1990-2015 (kt)

SNAP code	060202	
Year	NMVOC	Activity data
1990	0.015	0.036
1991	0.012	0.031
1992	0.011	0.026
1993	0.012	0.029
1994	0.018	0.044
1995	0.025	0.062
1996	0.030	0.076
1997	0.005	0.012
1998	0.024	0.060
1999	0.050	0.124
2000	0.050	0.126
2001	0.047	0.117
2002	0.056	0.131
2003	0.064	0.152
2004	0.064	0.152
2005	0.062	0.149
2006	0.065	0.158
2007	0.054	0.131
2008	0.051	0.124

SNAP code	060202	
Year	NMVOC	Activity data
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

For the dry cleaning sector for the years 1990 to 2001, only statistical data are used, whereas for the period 2002 to 2015, 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 0.8% to the total national NMVOC emissions in 2015 and only 2.5% to the whole solvent sector.

By 2015, NMVOC emissions from the chemical products sector had decreased by 64% 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 2006-2015 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 2006-2015.

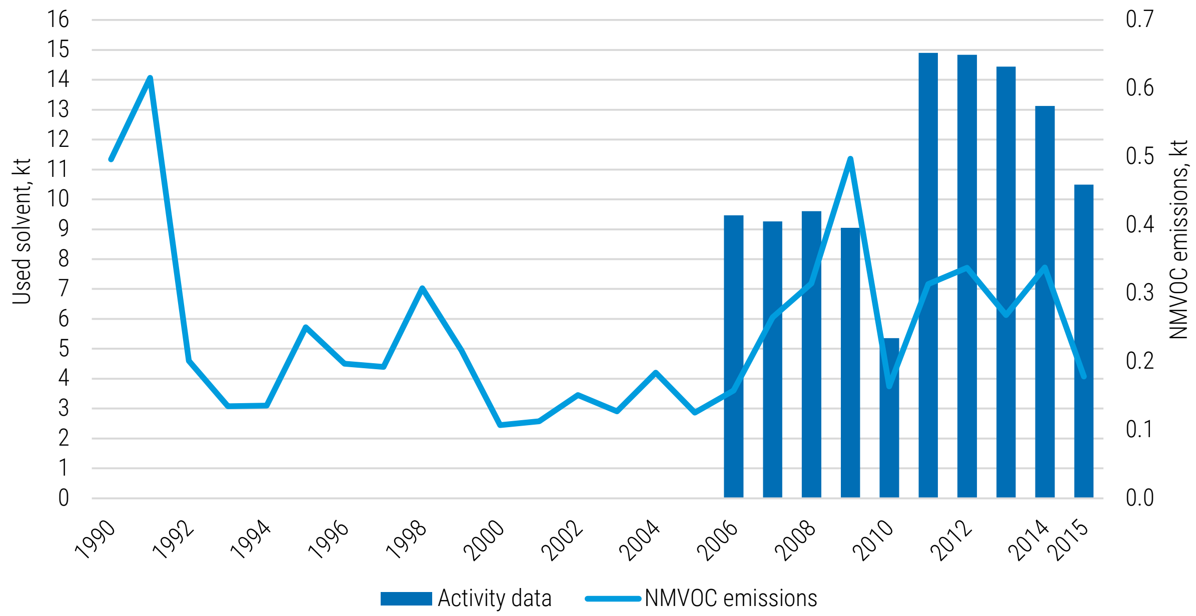

Figure 4.14 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 1990-2015

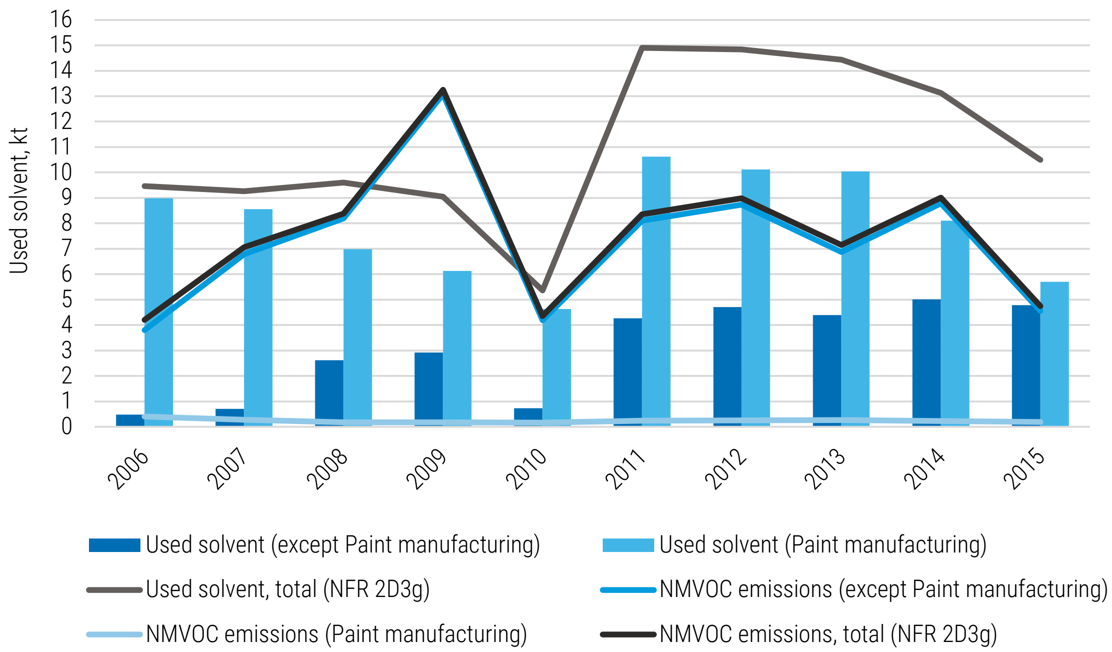

Figure 4.15 Consumption of solvents and NMVOC emissions from chemical products manufacturing or processing in the period of 2006-2015

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 4.31 NMVOC emissions and the consumption of solvents from chemical products manufacturing or processing by SNAP codes in the period of 1990-2015 (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
1991	0.615	NA	NA	NA	NA	NA	NA	NA	NA	NA
1992	0.201	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	0.135	NA	NA	NA	NA	NA	NA	NA	NA	NA
1994	0.135	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	0.250	NA	NA	NA	NA	NA	NA	NA	NA	NA
1996	0.197	NA	NA	NA	NA	NA	NA	NA	NA	NA
1997	0.192	NA	NA	NA	NA	NA	NA	NA	NA	NA
1998	0.307	NA	NA	NA	NA	NA	NA	NA	NA	NA
1999	0.217	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	0.107	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001	0.113	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	0.151	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	0.127	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	0.184	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

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
1991	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1994	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	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

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SNAP code	060308		060309		060312		060313		060314	
Year	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data	NMVOC	Activity data
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	1.641

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[22]).

- Publication 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, 20058).

- Rotogravure & 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-

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

diluted ink and an average emission of 1.4 kg NMVOC/kg non-diluted ink (EGTEI, 20058).

The emissions of NMVOCs from printing have been significantly reduced following the introduction of the Solvent Emissions Directive 1999/13/EC in March 1999. 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 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[23], it can be concluded that the following techniques are applied (with relevant emission factors) for press and edition/ publication:

- cold set web offset – 54 kg/t (g/kg) ink consumed;
- heat set web offset – 82 kg/t (g/kg) ink consumed;
- rotogravure – 425 kg/t (g/kg) ink consumed.

As these stay below the current emission factor, it does not change over the period.

4.2.10.3. Activity Data

The quantity of ink (CN code 3215) used in Estonia can be estimated by the import and export data from Statistics Estonia (1995-2001) and Eurostat (2002 and onward). 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.

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

4.2.10.4. Results

A number of printing facilities are permitted.

Between 2006 and 2015, activity data regarding ink use in point sources were collected in the OSIS database. For the years 2006 to 2015, activity data for calculations were calculated as follows:

Ink use in diffuse sources = total ink use – ink use 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 4.32 NMVOC emissions and the consumption of solvents from the printing industry by SNAP code in the period of 1990-2015 (kt)

SNAP code	060403	
Year	NMVOC	Activity data
1990	0.080	0.160
1991	0.066	0.133
1992	0.054	0.109
1993	0.058	0.116
1994	0.090	0.180
1995	0.126	0.252
1996	0.134	0.269
1997	0.172	0.345
1998	0.214	0.427
1999	0.223	0.445
2000	0.248	0.497
2001	0.273	0.545
2002	0.323	0.645
2003	0.392	0.783
2004	0.474	0.949
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	0.457	2.490
2015	0.473	2.492

4.2.10.5. Source-Specific QA/QC and Verification

Normal statistical quality checking related to the assessment of magnitude and trends is carried out. Emission data from the OSIS database are compared to the previous years in order to detect calculation errors, errors in the reported data or in allocation. Reasons behind any fluctuation in the emission figures are studied. The data reported and entered into the OSIS database by operators are firstly checked by specialists from the Estonian Environmental Board and then by specialists from the ESTEA.

4.2.10.6. Source-Specific Planned Improvements

No major improvements are planned for the next submission.

4.2.11. Other Solvent Use (NFR 2D3i)

4.2.11.1. Source Category Description

This sector includes activities such as fat, edible and non-edible oil extraction, application of glues and adhesives, preservation of wood, underseal treatment and conservation of vehicles and vehicles dewaxing.

1) Fat, edible and non-edible oil extraction

This activity includes solvent extraction of edible oils from oilseeds and the drying of leftover seeds before resale as animal feed.

If the oil content of the seed is high, such as in olives, the majority of the oil is pressed out mechanically. Where the oil content is lower or the remaining oil is to be taken from material that has already been pressed, solvent extraction is used.

Hexane has become a preferred solvent for extraction. In extracting oil from seeds, the cleaned and prepared seeds are washed several times in warm solvent. The remaining seed residue is treated with steam to capture the solvent and oil that remain in it.

The oil is separated from the oil-enriched wash solvent and from the steamed-out solvent. The solvent is recovered and re-used. The oil is further refined.

2) Preservation of wood

This activity encompasses industrial processes for the impregnation with or immersion of timber in organic solvent based preservatives, creosote or water based preservatives. Wood preservatives may be supplied for both industrial and domestic use. This activity covers only industrial use and does not include the domestic use of wood preservatives, which is covered under the NFR source category 2D3a, Domestic solvent use. Most of the information currently available on emissions relates to the industrial use of wood preservatives. This section is not intended to cover the surface coating of timber with paints, varnishes or lacquer.

3) Vehicles dewaxing

Some new cars have a protective covering applied to their bodies after painting to provide protection during transport. For example, in the UK this is usually only done on cars destined for export. Removal of the coating is usually only done at import centres. In continental Europe, cars are transported long distances on land as well as imported from overseas, so the driving forces affecting the use of such coatings may be different.

Transport protection coverings are not applied to the whole car body, but only to regions of the body considered vulnerable to damage during transport. The pattern of application varies from one manufacturer to another. Some manufacturers do only the bumper, while others do only the driver's door; some do the horizontal surfaces while others do the sides as well.

There are various methods for applying coverings for protection during transport. Traditionally, a hydrocarbon wax was used, which had to be removed using a mixture of hot water, kerosene and detergent. Recently, two alternative methods have been introduced. The first of these is a water-soluble wax, which can be removed with hot water alone without the need for kerosene. The second is a self-adhesive polyethylene film called 'Wrap Guard'. This can be peeled off by hand and disposed of as ordinary commercial waste. Most European car manufacturers are currently either already using self-adhesive polyethylene film or are evaluating it. It is expected that within a few years all European manufacturers will be using self-adhesive polyethylene film as their only method of applying transportation protective coverings, as has been the case in the US for the past number of years.

4) Treatment of vehicles

This section addresses the application of protective coatings to the undersides of cars. It is only a very small source of emissions and can be considered negligible nowadays.

Before the early 1980s, car manufacturers did not apply any coating to the underside of their cars. If a car owner wanted to protect his car against rust and stone chip damage, he had to pay to have his car 'undersealed' at a garage or workshop. This involved the application of a bituminous coating. The market for this service is no longer very large in much of Western Europe. It may still occur in Eastern Europe, in countries that have cold climatic conditions, and in the restoration and maintenance of vintage cars, but this activity is likely to be insignificant.

5) Industrial application of adhesives

Sectors using adhesives are very diverse as are production processes and application techniques.

Relevant sectors include the production of adhesive tapes, composite foils, the transportation sector (passenger cars, commercial vehicles, mobile homes, rail vehicles and aircrafts), the manufacture of shoes and leather goods, the wood material and furniture industry (EGTEI, 2003[24]).

In 2015, NMVOC emissions from the NFR 2D3i sector had decreased by 47.1% compared to the year 1990.

[24] 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.

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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[25] for the period of 1990-2000, 522 g/kg adhesive[26] for the period of 2005 and onward. The emission factors for the period of 2001-2004 are interpolated.

Activity Data

Solvent borne adhesives have the CN code 3506 91 00 (adhesives based on polymers of heading 3901 to 3913 or on rubber (excl. products suitable for use as glues or adhesives put up for retail sale as glues or adhesives, with a net weight of ≤ 1 kg)).

As this sector does not cover the domestic use of glues and adhesives, glues and adhesives for retail sale are not included.

The quantity of industrially used adhesives is estimated by import, export and production data (CN code 3506 91 00). Import and export data are available from Statistics Estonia and Eurostat. Production data are available from the OSIS database for the years 2006-2015. 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 2015, activity data regarding adhesives use in point sources are collected in the OSIS database (SNAP 060405).

For the years 2006-2015, activity data for calculations are calculated as follows:

Adhesives use in diffuse sources = total adhesive use – adhesive use 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.

[25] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009
[26] EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016

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[27]). 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 in the European Union, a reduction coefficient for the emission factor is applied.

Table 4.33 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;

[27] The Festmeter is that amount of solid wood which is contained in a one-meter cube; it is therefore identical with one cubic meter of solid wood.

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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 2000-2015 are gathered from OSIS and CollectER databases, and are reported by operators.

4.2.11.3. Results

Table 4.34 NMVOC emissions from other solvent use and the activity data by SNAP codes in the period of 1990-2015

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
1991	1.014	NA	NA	NA	0.215	0.275	NA	NA	0.136	1.568	NA	NA
1992	0.332	NA	NA	NA	0.155	0.198	NA	NA	0.141	1.555	NA	NA
1993	0.224	NA	NA	NA	0.127	0.163	NA	NA	0.154	1.511	NA	NA
1994	0.223	NA	NA	NA	0.155	0.199	NA	NA	0.161	1.477	NA	NA
1995	0.412	NA	NA	NA	0.218	0.279	NA	NA	0.180	1.448	NA	NA
1996	0.325	NA	NA	NA	0.438	0.562	NA	NA	0.187	1.425	NA	NA
1997	0.316	NA	NA	NA	0.296	0.379	NA	NA	0.195	1.406	NA	NA
1998	0.506	NA	NA	NA	0.448	0.574	NA	NA	0.201	1.393	NA	NA
1999	0.357	NA	NA	NA	0.556	0.712	NA	NA	0.199	1.379	NA	NA
2000	--	--	NA	NA	0.906	1.162	0.00050	NA	0.200	1.401	0.008	NA
2001	--	--	NA	NA	0.866	1.189	0.00193	NA	0.180	1.393	0.008	NA
2002	--	--	0.0013	NA	1.202	1.776	0.00014	NA	0.159	1.384	0.030	NA
2003	--	--	0.0017	NA	1.282	2.051	NA	NA	0.138	1.375	0.025	NA
2004	--	--	0.0016	NA	1.183	2.063	NA	NA	0.118	1.366	0.001	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	0.069	NO	--	0.028	0.238
2007	--	--	0.0017	NA	1.194	3.967	0.01457	0.029	NO	--	0.005	0.289
2008	--	--	0.0017	NA	1.068	2.516	0.00736	0.017	NO	--	0.020	0.353
2009	--	--	0.0016	NA	0.736	1.794	0.01376	0.026	NO	--	0.013	0.052
2010	--	--	0.0015	NA	0.399	1.260	0.01143	0.018	NO	--	0.012	0.069
2011	--	--	0.0009	NA	0.483	1.476	0.01075	0.022	NO	--	0.022	0.081
2012	--	--	0.0003	NA	0.584	1.721	0.01061	0.022	NO	--	0.034	0.137
2013	--	--	0.0012	NA	0.513	1.817	0.01128	0.029	NO	--	0.037	0.108

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
2014	--	--	0.0032	NA	0.499	1.825	0.01293	0.036	NO	--	0.036	0.132
2015	--	--	0.0021	NA	0.610	2.509	0.01321	0.030	NO	--	0.044	0.093

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 IIR.

4.2.12.2. Methodological Issues

1) Use of fireworks (SNAP 060601)

The Tier 2 emission factors are used for pollutant emissions calculations.

Table 4.35 Emission factors from the EMEP/EEA Air Pollutant Emission 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 4.36 Emission factors from the EMEP/EEA Air Pollutant Emission 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

Pollutant	Emission Factor	Unit
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 4.37 The use of fireworks and pollutant emissions in the period of 1990-2015

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
1991	3.906	0.012	0.028	0.001	0.429	0.390	0.203
1992	6.009	0.018	0.043	0.002	0.660	0.600	0.312
1993	9.244	0.028	0.066	0.002	1.015	0.924	0.480
1994	14.222	0.043	0.102	0.004	1.562	1.421	0.739
1995	21.880	0.066	0.156	0.006	2.403	2.186	1.136
1996	29.528	0.089	0.211	0.008	3.243	2.950	1.534
1997	67.817	0.205	0.485	0.018	7.448	6.776	3.522
1998	90.045	0.272	0.644	0.023	9.890	8.997	4.677
1999	110.417	0.333	0.789	0.029	12.127	11.033	5.735
2000	68.993	0.208	0.493	0.018	7.578	6.894	3.584
2001	83.688	0.253	0.598	0.022	9.191	8.362	4.347
2002	98.639	0.298	0.705	0.026	10.834	9.856	5.123
2003	127.588	0.385	0.912	0.033	14.013	12.749	6.627
2004	191.336	0.578	1.368	0.050	21.014	19.118	9.938
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

Table 4.37 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
1991	3.906	0.005	0.006	0.061	1.734	0.000	0.117	3.062	1.015
1992	6.009	0.008	0.009	0.094	2.668	0.000	0.180	4.711	1.562
1993	9.244	0.012	0.014	0.144	4.104	0.001	0.277	7.247	2.403
1994	14.222	0.019	0.021	0.222	6.314	0.001	0.427	11.150	3.698
1995	21.880	0.029	0.032	0.341	9.714	0.001	0.656	17.154	5.689
1996	29.528	0.039	0.044	0.461	13.110	0.002	0.886	23.150	7.677
1997	67.817	0.090	0.100	1.058	30.111	0.004	2.035	53.169	17.632

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Year	Product, t	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
		kg							
1998	90.045	0.120	0.133	1.405	39.980	0.005	2.701	70.596	23.412
1999	110.417	0.147	0.163	1.723	49.025	0.006	3.313	86.567	28.708
2000	68.993	0.092	0.102	1.076	30.633	0.004	2.070	54.091	17.938
2001	83.688	0.111	0.124	1.306	37.157	0.005	2.511	65.611	21.759
2002	98.639	0.131	0.146	1.539	43.796	0.006	2.959	77.333	25.646
2003	127.588	0.170	0.189	1.990	56.649	0.007	3.828	100.029	33.173
2004	191.336	0.254	0.283	2.985	84.953	0.011	5.740	150.007	49.747
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

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 4.38).

Table 4.38 The use of tobacco and pollutant emissions from tobacco combustion in the period of 1990-2015

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
1991	3.577	0.017	0.006	0.197	0.015	0.097	0.097	0.097	0.043	0.0004
1992	1.780	0.009	0.003	0.098	0.007	0.048	0.048	0.048	0.022	0.0002
1993	2.630	0.013	0.005	0.145	0.011	0.071	0.071	0.071	0.032	0.0003
1994	2.287	0.011	0.004	0.126	0.009	0.062	0.062	0.062	0.028	0.0002
1995	2.218	0.011	0.004	0.122	0.009	0.060	0.060	0.060	0.027	0.0002
1996	2.097	0.010	0.004	0.116	0.009	0.057	0.057	0.057	0.025	0.0002
1997	3.199	0.015	0.006	0.176	0.013	0.086	0.086	0.086	0.039	0.0003
1998	2.035	0.010	0.004	0.112	0.008	0.055	0.055	0.055	0.025	0.0002
1999	2.148	0.010	0.004	0.118	0.009	0.058	0.058	0.058	0.026	0.0002
2000	1.949	0.009	0.004	0.107	0.008	0.053	0.053	0.053	0.024	0.0002
2001	1.948	0.009	0.004	0.107	0.008	0.053	0.053	0.053	0.024	0.0002
2002	2.308	0.011	0.004	0.127	0.010	0.062	0.062	0.062	0.028	0.0002
2003	2.345	0.011	0.004	0.129	0.010	0.063	0.063	0.063	0.028	0.0002
2004	2.339	0.011	0.004	0.129	0.010	0.063	0.063	0.063	0.028	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

Year	Use of tobacco, kt	NMVOC	NO_x	CO	NH_3	TSP	PM_{10}	$PM_{2.5}$	BC	PCDD/F
		kt								g I-Teq
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	1.848	0.009	0.003	0.102	0.008	0.050	0.050	0.05	0.022	0.0002

Table 4.38 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
1991	3.577	0.397	0.161	0.161	0.161	19.315	9.658	9.658	19.315
1992	1.780	0.198	0.080	0.080	0.080	9.612	4.806	4.806	9.612
1993	2.630	0.292	0.118	0.118	0.118	14.201	7.101	7.101	14.201
1994	2.287	0.254	0.103	0.103	0.103	12.349	6.175	6.175	12.349
1995	2.218	0.246	0.100	0.100	0.100	11.980	5.990	5.990	11.980
1996	2.097	0.233	0.094	0.094	0.094	11.324	5.662	5.662	11.324
1997	3.199	0.355	0.144	0.144	0.144	17.272	8.636	8.636	17.272
1998	2.035	0.226	0.092	0.092	0.092	10.988	5.494	5.494	10.988
1999	2.148	0.238	0.097	0.097	0.097	11.600	5.800	5.800	11.600
2000	1.949	0.216	0.088	0.088	0.088	10.524	5.262	5.262	10.524
2001	1.948	0.216	0.088	0.088	0.088	10.522	5.261	5.261	10.522
2002	2.308	0.256	0.104	0.104	0.104	12.463	6.231	6.231	12.463
2003	2.345	0.260	0.106	0.106	0.106	12.663	6.331	6.331	12.663
2004	2.339	0.260	0.105	0.105	0.105	12.632	6.316	6.316	12.632
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	1.848	0.205	0.083	0.083	0.083	9.978	4.989	4.989	9.978

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, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$	Tier 1
3B4gii	Broilers	Includes emissions from broilers	NO_x, NMVOC, NH_3, 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	NO_x, NH_3	Tier 1
3Da2a	Animal manure applied to soils	NH_3 emissions from this sector are allocated to NFR 3B1a, 3B1b and 3B2	NH_3	Tier 2
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
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 2015 was as follows: NO_x – 5%, NH_3 – 90.8%, NMVOC – 22%, PM_{10} and TSP – 7%. The share of other pollutants was not as significant.

The emissions of NO_x, TSP, NH_3 and NMVOC decreased by 46.6%, 49.6%, 49.3% and 54% 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 in the 1990s. The number of livestock on farms and the use of nitrogen fertilisers were significantly decreased. After Estonia joined the EU in 2004, livestock numbers and the consumption of mineral N-fertilisers increased in comparison to mid-nineties. The amounts of NH_3 and NO_x emissions in recent years has also been affected by improved animal productivity and nitrogen extraction (Table 5.10).

In 2015, the emissions of NO_x, NMVOC, NH_3 and particles increased by 3%, 5%, 2.9%, and 7% respectively compared to 2014, mainly due to the increase in cattle dairy and laying hens categories.

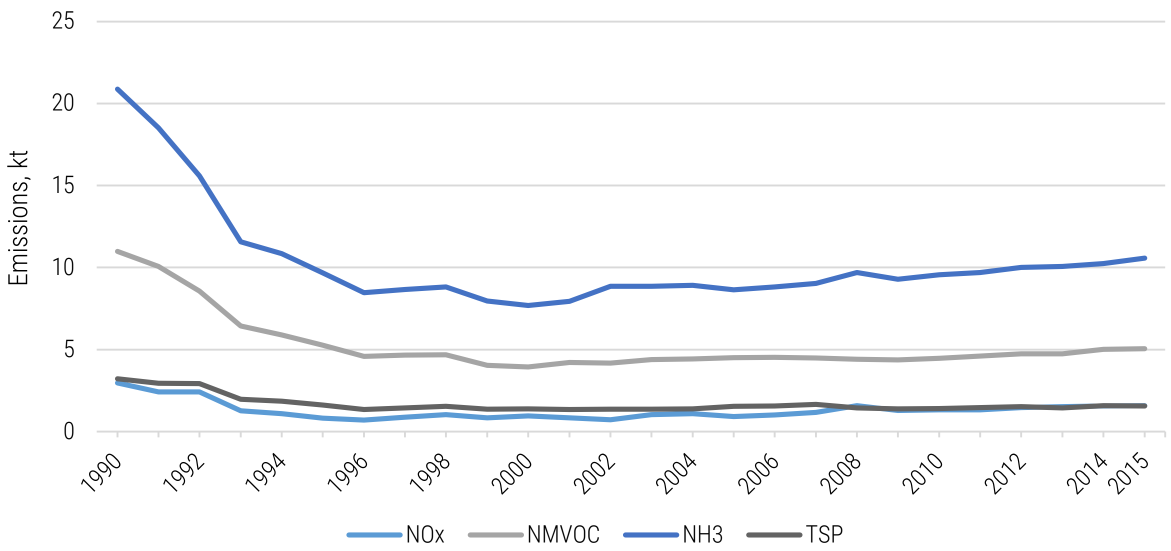

Figure 5.1 NO_x, NH_3, NMVOC and TSP emissions from the agriculture sector in the period of 1990-2015 (kt)

Table 5.2 Total emissions from the agriculture sector in the period of 1990-2015 (kt)

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
1990	2.968	10.979	20.876	3.210	NR	NR
1991	2.426	10.065	18.512	2.951	NR	NR
1992	2.413	8.562	15.591	2.927	NR	NR
1993	1.261	6.432	11.559	1.971	NR	NR
1994	1.101	5.885	10.840	1.859	NR	NR
1995	0.809	5.270	9.685	1.620	NR	NR
1996	0.711	4.589	8.459	1.354	NR	NR
1997	0.870	4.656	8.658	1.437	NR	NR
1998	1.041	4.687	8.811	1.544	NR	NR
1999	0.841	4.035	7.968	1.367	NR	NR
2000	0.947	3.945	7.689	1.392	0.111	0.939
2001	0.837	4.206	7.944	1.348	0.108	0.825
2002	0.723	4.178	8.853	1.357	0.106	0.866
2003	1.024	4.383	8.853	1.362	0.108	0.866
2004	1.082	4.437	8.920	1.393	0.109	0.902
2005	0.912	4.502	8.644	1.541	0.111	1.065
2006	1.015	4.518	8.815	1.561	0.113	1.107

Year	NO_x	NMVOC	NH_3	TSP	$PM_{2.5}$	PM_{10}
2007	1.178	4.494	9.026	1.656	0.110	1.175
2008	1.588	4.410	9.695	1.444	0.106	0.986
2009	1.280	4.365	9.285	1.375	0.101	0.906
2010	1.325	4.466	9.562	1.397	0.103	0.925
2011	1.328	4.613	9.703	1.471	0.108	1.002
2012	1.467	4.747	10.008	1.527	0.110	1.037
2013	1.519	4.740	10.060	1.437	0.106	0.967
2014	1.566	5.020	10.251	1.571	0.115	1.071
2015	1.583	5.045	10.572	1.551	0.117	1.069
Trend 1990-2015, %	-46.6	-54.1	-49.4	-51.7	5.8	13.8

Half of NH_3 emissions comes from the agricultural soil sector (including animal manure application to soils and grazing) – 57% – and 43% is from the use of synthetic fertilisers (Figure 5.2). The main source of pollution of PM_{10} is agricultural crop operations – 74% (Figure 5.3).

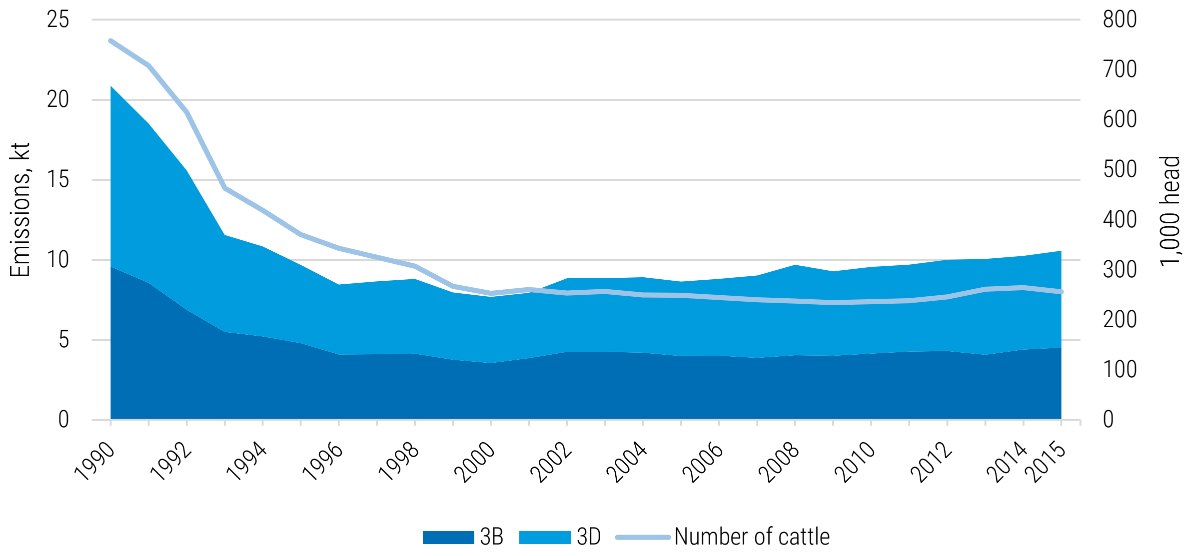

Figure 5.2 NH_3 emission distributions by the agriculture sector activities in the period of 1990-2015

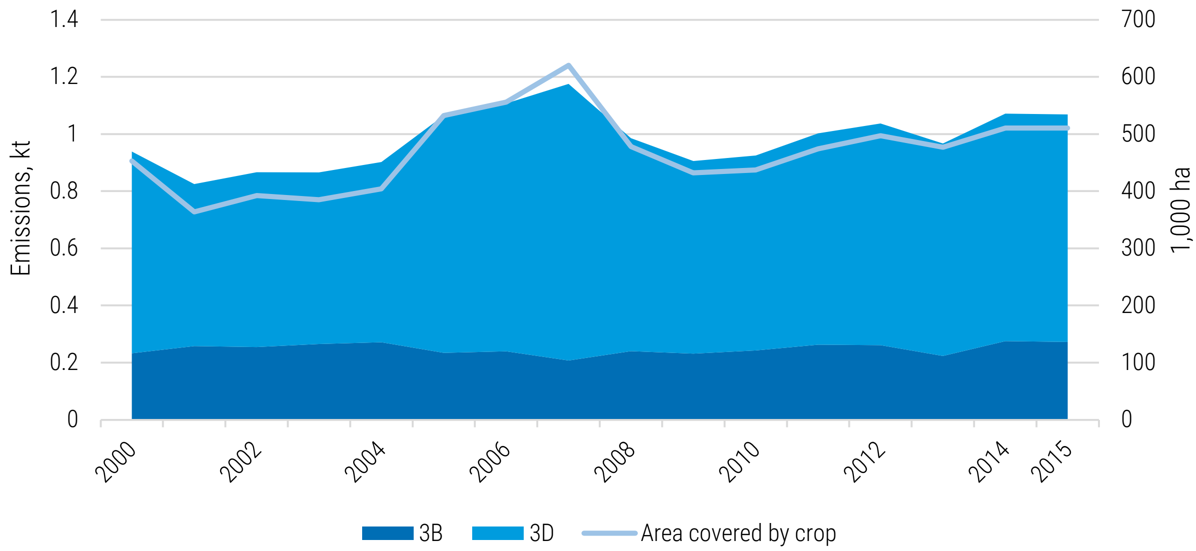

Figure 5.3 PM_{10} emissions from livestock (3B) and agricultural soils (3D) in in the period of 2000-2015

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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 2015. 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 emissions from cattle-dairy, cattle non-dairy, and swine animal manure applied to soils are reported under NFR 3D2a, and NH_3 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.

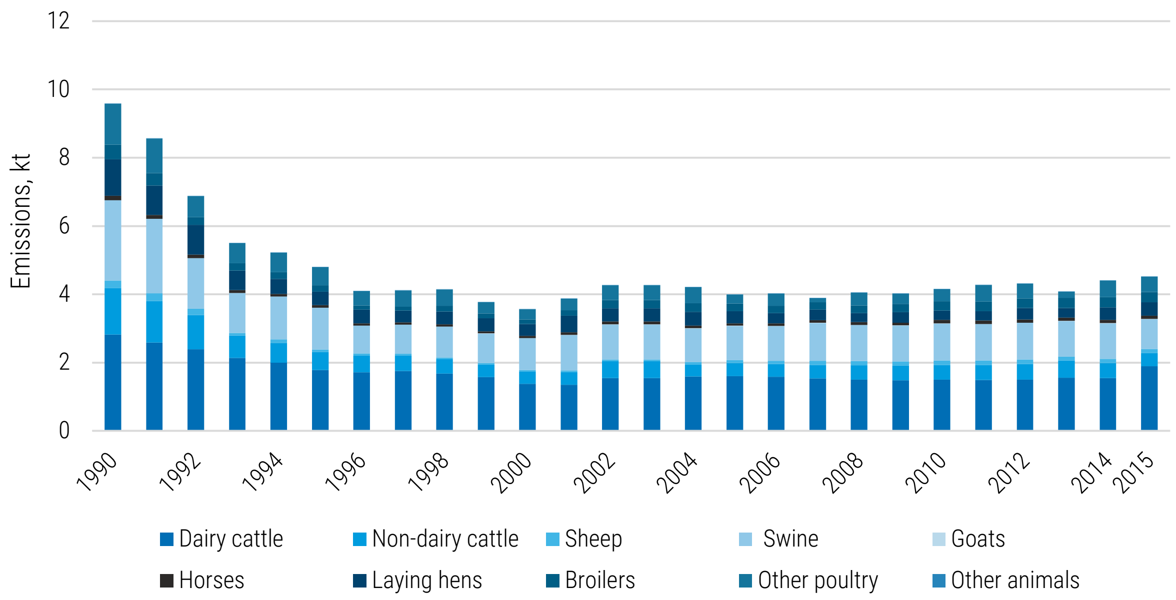

Figure 5.4 NH_3 emissions from manure management in the period of 1990-2015

During the period of 1990–2015, the emission of NH_3 decreased by 51.7% (Figure 5.4). The reduction in air pollution was mainly due to the rapid economic changes in agriculture in the 1990s.

In 2015, ammonia emissions have increased by 2% compared to 2014, due to a decrease in dairy cattle and laying hens livestock during the same period.

Table 5.3 Total emissions of NO_x from manure management in the period of 1990-2015 (kt)

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	0.004	0.005	0.000
1991	0.027	0.029	0.001	0.008	0.000	0.002	0.009	0.003	0.004	0.000
1992	0.025	0.024	0.001	0.005	0.000	0.001	0.009	0.002	0.003	0.000
1993	0.022	0.016	0.000	0.004	0.000	0.001	0.006	0.002	0.002	0.000
1994	0.020	0.014	0.001	0.005	0.000	0.001	0.005	0.002	0.002	0.000

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Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1995	0.018	0.012	0.000	0.004	0.000	0.001	0.004	0.002	0.002	0.000
1996	0.018	0.011	0.000	0.004	0.000	0.001	0.004	0.001	0.002	0.000
1997	0.019	0.010	0.000	0.003	0.000	0.001	0.004	0.001	0.002	0.000
1998	0.018	0.010	0.000	0.004	0.000	0.001	0.004	0.002	0.002	0.000
1999	0.017	0.009	0.000	0.004	0.000	0.001	0.004	0.001	0.001	0.000
2000	0.015	0.008	0.000	0.004	0.000	0.001	0.004	0.001	0.001	0.000
2001	0.015	0.008	0.000	0.004	0.000	0.001	0.005	0.001	0.001	0.000
2002	0.018	0.009	0.000	0.004	0.000	0.001	0.004	0.002	0.002	0.000
2003	0.016	0.012	0.000	0.004	0.000	0.001	0.004	0.002	0.002	0.000
2004	0.016	0.008	0.000	0.004	0.000	0.001	0.004	0.002	0.002	0.000
2005	0.016	0.009	0.000	0.004	0.000	0.001	0.004	0.002	0.001	0.000
2006	0.015	0.009	0.001	0.005	0.000	0.001	0.003	0.002	0.001	0.000
2007	0.014	0.009	0.001	0.005	0.000	0.001	0.003	0.002	0.001	0.000
2008	0.013	0.009	0.001	0.005	0.000	0.001	0.003	0.002	0.002	0.000
2009	0.012	0.009	0.001	0.005	0.000	0.001	0.003	0.002	0.001	0.000
2010	0.011	0.010	0.001	0.005	0.000	0.001	0.003	0.002	0.002	0.000
2011	0.011	0.010	0.001	0.005	0.000	0.001	0.003	0.003	0.002	0.000
2012	0.012	0.010	0.001	0.004	0.000	0.001	0.003	0.003	0.002	0.000
2013	0.012	0.011	0.001	0.004	0.000	0.001	0.003	0.003	0.001	0.000
2014	0.012	0.010	0.001	0.005	0.000	0.001	0.004	0.003	0.002	0.000
2015	0.015	0.010	0.001	0.004	0.000	0.001	0.004	0.003	0.002	0.000
Trend 1990-2015, %	-49.6	-68.6	-45.7	-55.8	100.0	-26.6	-62.9	-29.5	-62.3	-57.1

Table 5.4 Total emissions of NMVOC from manure management in the period of 1990-2015 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1990	3.074	4.247	0.044	1.225	0.001	0.067	0.367	0.211	0.616	0.448
1991	2.800	3.934	0.045	1.132	0.001	0.061	0.295	0.179	0.522	0.448
1992	2.544	3.215	0.039	0.766	0.002	0.051	0.300	0.110	0.322	0.394
1993	2.245	2.105	0.015	0.608	0.001	0.040	0.199	0.104	0.304	0.339
1994	2.046	1.853	0.019	0.653	0.001	0.039	0.151	0.098	0.295	0.285
1995	1.816	1.647	0.015	0.637	0.001	0.036	0.137	0.093	0.274	0.256
1996	1.762	1.526	0.012	0.428	0.001	0.033	0.139	0.057	0.219	0.107
1997	1.802	1.406	0.011	0.446	0.001	0.033	0.119	0.056	0.245	0.174
1998	1.794	1.326	0.009	0.475	0.002	0.030	0.129	0.084	0.248	0.179
1999	1.537	1.147	0.009	0.433	0.002	0.030	0.131	0.070	0.171	0.143
2000	1.517	1.084	0.009	0.473	0.002	0.033	0.119	0.067	0.153	0.098
2001	1.589	1.174	0.009	0.537	0.003	0.043	0.164	0.078	0.176	0.120
2002	1.438	1.231	0.010	0.530	0.003	0.041	0.138	0.100	0.198	0.153
2003	1.552	1.250	0.010	0.530	0.003	0.045	0.133	0.119	0.220	0.190
2004	1.620	1.187	0.014	0.526	0.002	0.040	0.139	0.123	0.242	0.197
2005	1.628	1.217	0.015	0.532	0.002	0.037	0.120	0.112	0.137	0.245
2006	1.632	1.214	0.019	0.541	0.002	0.038	0.105	0.106	0.180	0.201
2007	1.592	1.224	0.023	0.576	0.003	0.041	0.106	0.103	0.062	0.231
2008	1.581	1.224	0.025	0.553	0.003	0.041	0.091	0.111	0.193	0.177
2009	1.562	1.228	0.025	0.555	0.003	0.042	0.106	0.117	0.154	0.201
2010	1.595	1.245	0.027	0.562	0.003	0.053	0.095	0.131	0.184	0.195
2011	1.603	1.265	0.026	0.555	0.003	0.051	0.094	0.140	0.251	0.217
2012	1.654	1.328	0.025	0.569	0.003	0.048	0.114	0.137	0.223	0.216
2013	1.729	1.453	0.023	0.545	0.003	0.049	0.097	0.147	0.094	0.191
2014	1.720	1.505	0.024	0.541	0.003	0.049	0.124	0.151	0.247	0.216
2015	2.084	1.251	0.024	0.452	0.003	0.049	0.136	0.149	0.233	0.226
Trend 1990-2015, %	-32.2	-70.6	-45.8	-63.1	138.2	-26.7	-62.9	-29.5	-62.2	-49.5

Table 5.5 Total emissions of NH_3 from manure management in the period of 1990-2015 (kt)

Year	Dairy cattle*	Non-dairy cattle *	Sheep	Swine*	Goats	Horses	Laying hens	Broilers	Other poultry	Other animals
1990	2.818	1.360	0.222	2.355	0.003	0.127	1.068	0.429	1.197	0.005
1991	2.585	1.219	0.227	2.177	0.003	0.115	0.859	0.364	1.014	0.005
1992	2.392	0.996	0.195	1.473	0.005	0.098	0.872	0.225	0.626	0.004
1993	2.140	0.651	0.078	1.170	0.003	0.077	0.580	0.212	0.591	0.004
1994	1.997	0.584	0.096	1.256	0.002	0.074	0.438	0.199	0.573	0.003
1995	1.780	0.527	0.078	1.225	0.003	0.068	0.398	0.190	0.533	0.003
1996	1.717	0.487	0.060	0.820	0.003	0.062	0.405	0.116	0.426	0.001
1997	1.757	0.443	0.055	0.858	0.003	0.062	0.345	0.114	0.476	0.002
1998	1.676	0.421	0.046	0.913	0.003	0.058	0.375	0.171	0.482	0.002
1999	1.572	0.368	0.045	0.866	0.004	0.058	0.380	0.142	0.332	0.001
2000	1.380	0.352	0.047	0.935	0.005	0.062	0.347	0.136	0.298	0.001
2001	1.354	0.374	0.046	1.029	0.006	0.081	0.478	0.159	0.341	0.001
2002	1.549	0.491	0.050	1.023	0.006	0.086	0.388	0.243	0.428	0.002
2003	1.549	0.491	0.050	1.023	0.006	0.086	0.388	0.243	0.428	0.002
2004	1.592	0.351	0.068	0.991	0.005	0.075	0.403	0.251	0.471	0.002
2005	1.600	0.391	0.078	1.008	0.004	0.071	0.348	0.227	0.266	0.003
2006	1.584	0.372	0.096	1.015	0.005	0.073	0.306	0.216	0.351	0.002
2007	1.534	0.401	0.114	1.113	0.006	0.078	0.309	0.210	0.120	0.002
2008	1.496	0.424	0.126	1.051	0.006	0.078	0.264	0.227	0.376	0.002
2009	1.483	0.425	0.128	1.047	0.007	0.080	0.310	0.238	0.299	0.002
2010	1.501	0.428	0.134	1.076	0.007	0.101	0.278	0.267	0.358	0.002
2011	1.492	0.440	0.132	1.063	0.007	0.096	0.273	0.286	0.488	0.002
2012	1.504	0.458	0.127	1.075	0.008	0.092	0.333	0.279	0.434	0.002
2013	1.558	0.502	0.116	1.037	0.007	0.093	0.284	0.300	0.182	0.002
2014	1.545	0.441	0.120	1.047	0.006	0.093	0.361	0.308	0.480	0.002
2015	1.895	0.380	0.120	0.874	0.007	0.093	0.396	0.303	0.452	0.002
Trend 1990-2015, %	-32.7	-72.0	-45.8	-62.9	138.1	-26.7	-62.9	-29.5	-62.2	-49.6

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

Table 5.6 Total emissions of $PM_{2.5}$ from manure management in the period of 2000-2015 (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
Trend 2000-2015, %	-11.7	15.4	156.7	-5.5	25.0	50.8	14.0	123.4	51.7	135.0

Table 5.7 Total emissions of PM_{10} from manure management in the period of 2000-2015 (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	0.0004
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
Trend 2000-2015, %	-11.7	15.4	158.0	-3.5	25.0	49.5	14.0	123.3	51.7	132.5

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 renewed EMEP/EEA Air Pollutant Emission Inventory 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 to calculate emissions from manure management of dairy cattle, non-dairy cattle, and swine. Tier 1 were also used to calculate emissions from the manure management of sheep, goats, horses, poultry and fur animals. In addition, according to the 2016 review of the expert team recommendation, emissions from the sheep and goats category were calculated separately for the first time.

The Tier 1 method uses readily available statistical data and default emission factors. The Tier 1 default emission factors also assume an average or typical process description.

The Tier 1 approach uses the following general equation:

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

where

AAP_{animal} – the number of animals of a particular category present on average during the year;
$EF_{pollutant\_animal}$ – the emission factor for this process and the technology.

Emissions from manure are calculated separately for each animal category; the separate calculation for a slurry or solid manure management system depends on the animal category (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 renewed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 were used to calculate NMVOC emissions from the manure management of dairy cattle.

The Tier 2 approach uses the following general equation:

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

where

$MJ_{\_i}$ - is the gross feed intake in megajoules (MJ) per year;

AAP_{anima_i} - number of animals of a particular category present on average within the year;

$E_{NMVOC,silage\_store\_i}$, $E_{NMVOC,silage\_feeding\_i}$, $E_{NMVOC,building\_i}$, $E_{NMVOC,store\_i}$, $E_{NMVOC,appl.\_i}$, $E_{NMVOC,graz\_i}$ - NMVOC emissions from silage store, silage feeding, building, store and grazing.

For the calculation method of the gross feed intake by the dairy cattle described in Estonian GHG National Inventory Report 2017[28] (Table 5.11) and emission factor from the renewed EMEP/EEA Guidebook 2016 were used (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	0.200	0.0002002	0.0000353	0.0000069

The Tier 2 methods from the renewed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 were used to calculate NO and NH_3 emission 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) of dairy cattle, non-dairy cattle, 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. The NH_3 emission from dairy cattle, non-dairy cattle, and swine manure application to soils (NFR 3D2a) were calculated separately from

[28] Estonian GHG National Inventory Report 2017, Ch. 5 Agriculture (CFR 3)

sector 3B for the first time. In the previous submission, these emissions were summed up.

Tier 2 method uses a mass flow approach based on the concept of the flow of Total Ammoniacal Nitrogen (TAN) through the manure management system. Calculations were done with the Excel spreadsheet provided in the previous EMEP/EEA Guidebook Appendix B of Chapter 3B – Manure Management. For the calculation method of total annual nitrogen, excretion by the dairy cattle and non-dairy cattle described in the Estonian GHG National Inventory Report 2017[29] were used. The results of nitrogen excretion estimation are presented in Tables 5.10 and 5.11. For nitrogen excretion, rates from swine (Regulation no. 8 of the Minister of the Environment, 25.03.2014) were used. For cattle and swine, slurry-based and solid-manure-based housing types are distinguished. For each stage of manure management, the Tier 2 default NH_3-N EFs and default data on proportions of TAN excreta were used. According to the EMEP/EEA Guidebook 2016, there are different emission factors for housing, manure storage, and grazing (Table 5.13).

Table 5.10 Nitrogen excretion and gross energy intake by dairy cattle livestock in 1990-2015[30]

Year	Nitrogen excretion rate, kg N/head/yr	Gross energy intake, MJ/head/year
1990	85.1	87,965
1991	83.3	85,410
1992	81.0	81,395
1993	80.6	80,300
1994	81.0	78,475
1995	82.1	79,205
1996	84.9	82,490
1997	88.1	85,775
1998	88.7	90,155
1999	94.2	87,600
2000	88.5	92,345
2001	101.4	98,550
2002	101.8	97,455
2003	101.2	97,820
2004	103.3	101,105
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

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, and pasture/range) was used. A detailed description of the manure management system (MMS) was given in the Estonian GHG National Inventory Report 2017. 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.

[29] Estonian GHG National Inventory Report 2017, Ch. 5 Agriculture (CFR 3)
[30] https://www.riigiteataja.ee/aktilisa/1280/3201/4033/KKM_m8_lisa.pdf

For further insight regarding the activity data and methodology applied to manure management system and N excretions estimations, see Estonian NIR 1990–2015 submitted under the UNFCCC.

Table 5.13 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 1990-2015. 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 5.14 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
1991	264.3	444.0	161.8	2.2	7.8	757.1	41.5	1 788.9	1 653.7	1 067.2	145.6
1992	253.4	361.2	139.5	3.3	6.6	513.4	27.7	1 816.1	1 020.6	658.6	117.4
1993	226.7	236.5	55.4	1.9	5.2	399.0	25.3	1 207.8	963.3	621.6	89.1
1994	211.4	208.1	68.9	1.7	5.0	433.2	26.6	912.5	904.7	603.1	60.9
1995	185.4	185.0	55.4	2.0	4.6	425.4	23.4	828.3	862.2	561.0	38.5
1996	171.6	171.4	43.2	1.9	4.2	259.8	38.6	843.4	528.2	448.0	14.3
1997	167.7	157.9	38.9	2.0	4.2	261.1	45.2	719.2	517.5	501.4	14.0
1998	158.6	148.9	33.0	2.4	3.9	282.3	44.1	780.9	779.1	507.9	19.9
1999	138.4	128.9	32.4	3.1	3.9	253.5	32.2	791.7	645.4	349.3	10.6
2000	131.0	121.8	33.3	3.7	4.2	261.6	38.6	723.5	616.7	313.5	6.8
2001	128.6	131.9	33.1	4.2	5.5	304.9	40.1	995.6	724.9	359.0	17.5
2002	115.6	138.3	34.3	4.5	5.3	303.1	37.7	834.3	924.6	404.6	32.3
2003	116.8	140.4	35.4	4.1	5.8	308.0	36.6	807.9	1 103.6	450.1	55.2
2004	116.5	133.3	48.7	3.6	5.1	305.4	34.7	839.6	1 142.2	495.7	58.4
2005	112.8	136.7	55.4	3.1	4.8	312.2	34.3	725.7	1 033.8	279.8	87.2
2006	108.4	136.4	68.6	3.6	4.9	308.4	37.4	637.6	980.9	369.0	71.0
2007	103.0	137.5	81.1	4.5	5.3	343.3	35.7	643.3	956.0	125.9	80.1
2008	100.4	137.5	90.2	4.2	5.3	330.8	34.1	550.1	1 031.0	395.6	78.6
2009	96.7	138.0	91.2	4.6	5.4	331.0	34.1	644.8	1 083.2	314.4	90.6
2010	96.5	139.8	95.8	5.0	6.8	336.6	35.1	578.2	1 212.2	377.2	87.7
2011	96.2	142.1	94.0	4.8	6.5	330.1	35.6	568.9	1 298.3	513.7	97.6
2012	96.8	149.2	90.9	5.4	6.2	340.8	34.3	693.9	1 267.9	456.5	96.6
2013	97.9	163.5	82.7	5.1	6.3	325.4	33.3	590.8	1 361.5	191.5	98.4
2014	95.6	169.1	85.8	4.6	6.3	323.3	34.6	752.8	1 398.0	505.1	111.2
2015	115.7	140.5	85.9	5.0	6.3	279.4	25.1	825.0	1 376.9	475.6	116.5

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 5.15.

Table 5.15 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 emissions from animal manure applied to soils are reported under NFR 3D2a, and NH_3 emissions from grazing under NFR 3Da3. In addition, this year, NO_x and NH_3 emissions from sewage sludge and compost application are reported, for the first time, under NFR 3Da2b and 3Da2c respectively.

The share of agricultural soils in the total NH_3 emissions in 2015 was 52%.

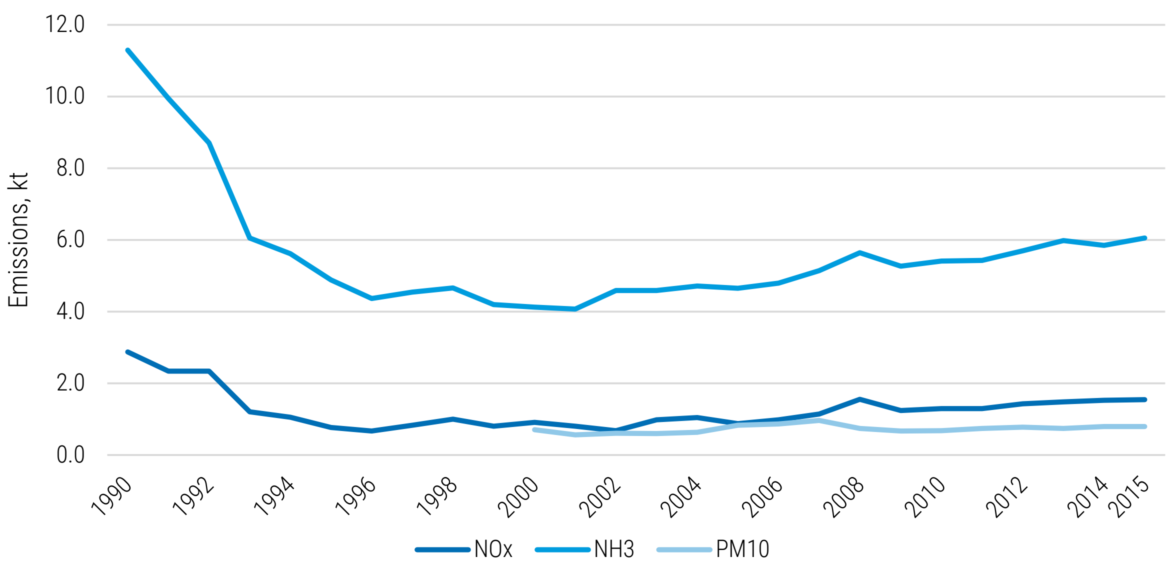

Figure 5.5 NO_x, NH_3 and PM_{10} emissions from agricultural soils in the period of 1990-2015

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During the period of 1990–2015, the emission of NH_3 decreased to 46.4% (Figure 5.5), mainly due to changes in Estonian agriculture. All the emission time series are presented in Tables 5.16–5.18.

In 2015, NO_x, and NH_3 emissions increased by 3% compared to 2014, mainly due to an increase in the cattle dairy sectors.

Table 5.16 NMVOC, $PM_{2.5}$, PM_{10} and TSP emissions from agricultural soils in the period 1990-2015 (kt)

Year	NMVOC	$PM_{2.5}$	PM_{10}	TSP
1990	0.679	NR	NR	1.231
1991	0.649	NR	NR	1.177
1992	0.819	NR	NR	1.485
1993	0.469	NR	NR	0.852
1994	0.445	NR	NR	0.807
1995	0.358	NR	NR	0.649
1996	0.306	NR	NR	0.555
1997	0.364	NR	NR	0.659
1998	0.411	NR	NR	0.746
1999	0.362	NR	NR	0.657
2000	0.389	0.027	0.706	0.706
2001	0.313	0.022	0.567	0.567
2002	0.337	0.024	0.612	0.612
2003	0.331	0.023	0.601	0.601
2004	0.348	0.024	0.631	0.631
2005	0.458	0.032	0.830	0.830
2006	0.478	0.033	0.867	0.867
2007	0.534	0.037	0.968	0.968
2008	0.411	0.029	0.745	0.745
2009	0.372	0.026	0.674	0.674
2010	0.376	0.682	0.682	0.682
2011	0.408	0.028	0.740	0.740
2012	0.428	0.030	0.776	0.776
2013	0.410	0.029	0.744	0.744
2014	0.439	0.031	0.796	0.796
2015	0.439	0.031	0.796	0.796
Trend 1990-2015, %	-35.3	12.8	12.8	-35.3

Table 5.17 NH_3 emissions from agricultural soils in the period 1990-2015 (kt)

Year	Inorganic N-fertilizers	Animal manure applied to soils	Sewage sludge applied to soils	Other organic fertilisers applied to soils	Urine and dung deposited by grazing animals
1990	3.585	4.646	0.010	0.010	3.042
1991	2.918	4.256	0.010	0.010	2.751
1992	2.918	3.446	0.010	0.011	2.322
1993	1.497	2.860	0.010	0.011	1.676
1994	1.303	2.776	0.010	0.012	1.516
1995	0.945	2.551	0.010	0.013	1.363
1996	0.828	2.244	0.009	0.009	1.273
1997	1.024	2.286	0.009	0.016	1.208
1998	1.247	2.255	0.009	0.003	1.149
1999	0.995	2.160	0.009	0.009	1.026
2000	1.120	2.018	0.009	0.028	0.952
2001	0.980	2.073	0.009	0.026	0.985
2002	1.163	2.386	0.009	0.099	0.933
2003	1.163	2.386	0.009	0.099	0.933
2004	1.242	2.397	0.009	0.096	0.967
2005	1.004	2.521	0.009	0.137	0.977

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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
2006	1.131	2.531	0.009	0.142	0.983
2007	1.249	2.620	0.009	0.281	0.979
2008	1.773	2.595	0.009	0.262	1.005
2009	1.366	2.611	0.009	0.300	0.982
2010	1.431	2.692	0.009	0.285	0.993
2011	1.490	2.716	0.009	0.195	1.015
2012	1.649	2.765	0.009	0.217	1.057
2013	1.683	2.874	0.009	0.268	1.147
2014	1.790	2.795	0.009	0.188	1.067
2015	1.790	2.977	0.009	0.219	1.055
Trend 1990-2015, %	-50.1	-35.9	-16.4	2 113.8	-65.3

Table 5.18 NO_x emissions from agricultural soils in the period 1990-2015 (kt)

Year	Inorganic N-fertilizers	Sewage sludge applied to soils	Other organic fertilisers applied to soils
1990	2.868	0.003	0.005
1991	2.334	0.003	0.005
1992	2.334	0.003	0.005
1993	1.198	0.003	0.006
1994	1.043	0.003	0.006
1995	0.756	0.003	0.007
1996	0.662	0.003	0.004
1997	0.819	0.003	0.008
1998	0.997	0.003	0.001
1999	0.796	0.003	0.005
2000	0.896	0.003	0.014
2001	0.784	0.003	0.013
2002	0.668	0.003	0.012
2003	0.930	0.003	0.049
2004	0.993	0.003	0.048
2005	0.803	0.003	0.068
2006	0.904	0.003	0.071
2007	0.999	0.003	0.141
2008	1.418	0.003	0.131
2009	1.093	0.003	0.150
2010	1.145	0.003	0.143
2011	1.192	0.003	0.098
2012	1.319	0.003	0.109
2013	1.346	0.003	0.134
2014	1.432	0.003	0.094
2015	1.432	0.003	0.110
Trend 1990-2015, %	-50.1	-16.4	2 113.8

5.3.2. Methodological Issues

Emission calculations from agricultural soils are based on the Tier 1 method. The main reason for this is the luck of detailed activity data (including use of fertilizers). Emissions from grazing and animal manure applied to soils (detailed description Ch. 5.2.2.2) are based on the Tier 2 method from the renewed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. 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 it was in the 2016 submission. The Tier 1 method uses readily available statistical data (Table 5.20) and default emission factors (Table 5.19).

The Tier 1 approach uses the general equation:

$$E= AD \ x \ EF_{pollutant}$$

where

AD - activity data of a particular category present within the year;
$EF_{pollutant}$ - emission factor for this process and the technology.

Table 5.19 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} fertilizer-N applied	0.050
3Da2b	NH_3	kg NH_3 capita^{-1}	0.007
	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
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 synthetic N-fertilizer use, the area covered by these crops and population is available from Statistics Estonia (www.stat.ee) for the years 1990-2015. In addition, Information regarding compost application from Estonian Environment Agency were used.

Table 5.20 Active data for agricultural soil sector in the period of 1990-2015

Year	Synthetic N-fertilizers, tonnes	Area covered by crop, ha	Compost applied on soils, tonnes	Population mln.inhab
1990	58,360	952,103	6,775	1.571
1991	58,360	754,579	7,117	1.568
1992	58,360	952,103	7,477	1.555
1993	29,949	545,833	7,857	1.511
1994	26,068	517,607	8,256	1.477
1995	18,905	415,952	8,899	1.448
1996	16,560	355,638	6,004	1.425
1997	20,471	422,690	11,218	1.406
1998	24,932	478,345	2,027	1.393
1999	19,895	421,067	6,434	1.379
2000	22,396	452,538	19,010	1.401
2001	19,603	363,504	17,937	1.393
2002	16,700	392,196	16,359	1.384
2003	23,255	384,951	67,339	1.375
2004	24,833	404,309	65,600	1.366
2005	20,083	532,319	93,578	1.359
2006	22,610	556,083	97,332	1.351
2007	24,982	620,449	192,256	1.343
2008	35,455	477,786	179,204	1.338
2009	27,328	432,051	204,876	1.336
2010	28,628	437,302	195,002	1.333
2011	29,803	474,102	133,383	1.330
2012	32,978	497,269	148,362	1.325
2013	33,659	476,623	183,237	1.320
2014	35,803	510,317	128,368	1.316
2015	35,804	510,318	149,984	1.313

5.3.3. Uncertainty

An uncertainty analysis was carried for to the year 2015 inventory. The uncertainty in the emission factors for NO_x, NMVOC, NH_3, $PM_{2.5}$, PM_{10} and TSP from agricultural soils is estimated to be 100%, and in the activity data 2%. Uncertainty estimates for agricultural soils are described together with manure management sector in Table 5.15.

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. Sources-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 2017 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 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, CO
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
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)
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
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
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

The waste sector in the emission inventory is mostly an insignificant sector, except dioxin emissions, which in 2015 comprised about 36.6% 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 2015 compared to the year 2002, which is the main source for dioxin emissions in the waste sector.

6.2. Uncertainty

An uncertainty analysis was carried out to the year 2015 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, 2015	Unit	Share in total emission, %	Uncertainty, %	Trend uncertainty 1990-2015, %
NO_x	0.025	kt	0.08	0.04%	0.001%
NMVOC	0.131	kt	0.57	0.53%	0.46%
SO_x	0.030	kt	0.09	0.03%	0.001%
NH_3	0.108	kt	0.93	0.46%	0.24%
$PM_{2.5}$	0.095	kt	1.03	0.78%	0.42%
PM_{10}	0.109	kt	0.78	0.56%	0.11%
TSP	0.125	kt	0.59	0.42%	0.02%
CO	0.109	kt	0.09	0.04%	0.02%
Pb	0.331	t	1.16	1.17%	0.11%
Cd	0.011	t	1.50	1.45%	0.15%
Hg	0.021	t	3.84	1.97%	0.15%
PCDD/F	1.512	g I-TEQ	36.59	56.49%	4.92%
B(a)p	0.00001	t	0.001	0.001%	0.001%
B(b)f	0.00001	t	0.0004	0.001%	0.001%
B(k)f	0.00001	t	0.001	0.002%	0.001%
I(1,2,3-cd)p	0.0000001	t	0.000003	0.00001%	0.00%
HCB	0.008	kg	2.69	5.71%	20.50%
PCB	0.020	kg	0.47	0.61%	0.07%

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 disposal at landfills. This sector, however, is only a minor source of air pollutant emissions. Small quantities of NO_x, NMVOC, SO_x, NH_3 and CO 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 1990-2015

Year	NMVOC	NH_3	$PM_{2.5}$	PM_{10}	TSP
	kt	t			
1990	1.213	NE	NR	NR	0.360
1991	1.201	NE	NR	NR	0.356
1992	1.189	NE	NR	NR	0.353
1993	1.214	NE	NR	NR	0.360
1994	0.980	NE	NR	NR	0.291
1995	1.107	NE	NR	NR	0.329
1996	1.138	NE	NR	NR	0.338

Year	NMVOC	NH3	PM2.5	PM10	TSP
	kt	t			
1997	1.285	NE	NR	NR	0.382
1998	1.032	NE	NR	NR	0.306
1999	1.004	NE	NR	NR	0.298
2000	0.810	NE	0.017	0.114	0.240
2001	0.913	NE	0.019	0.128	0.271
2002	0.944	NE	0.020	0.133	0.280
2003	1.084	NE	0.023	0.152	0.322
2004	0.896	NE	0.019	0.126	0.266
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

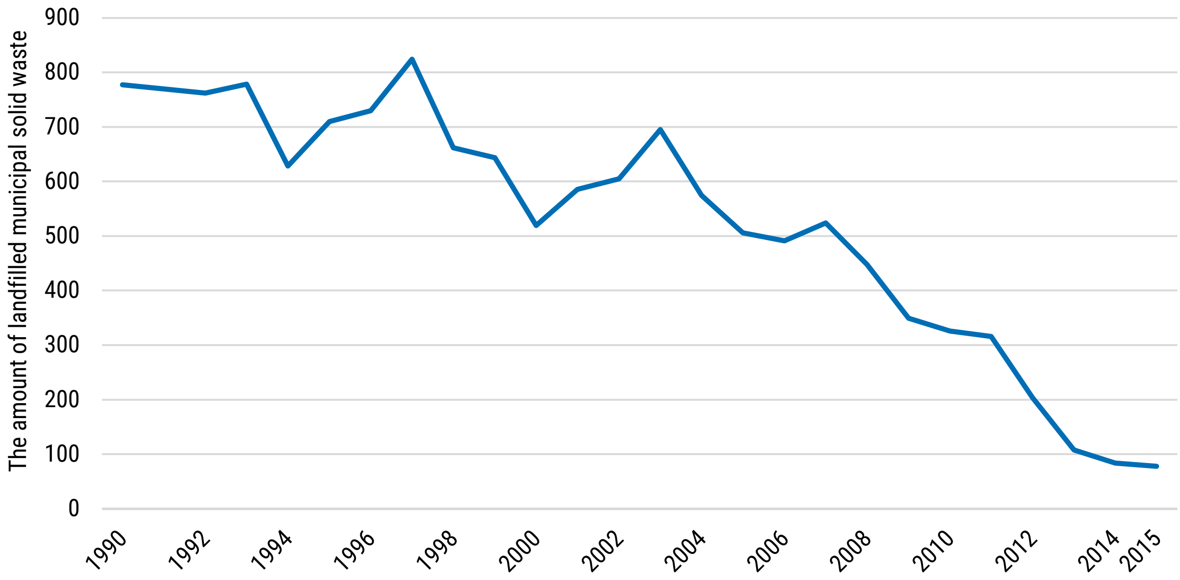

Figure 6.1 The amount of landfilled solid waste in the period of 1990-2015 (kt)

6.3.2. Methodological Issues

For diffuse sources EMEP/EEA Ai 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 2015 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

Emission calculations from landfills by using data from the waste management system.

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). Small quantities of NMVOC, NH_3 and CO may be emitted.

Table 6.4 Emissions of NH_3 from compost production in the period of 1990-2015 (kt)

Year	NMVOC	NH_3	CO
1990	NE	0.004	0.004
1991	NE	0.005	0.004
1992	NE	0.005	0.004
1993	NE	0.005	0.004
1994	NE	0.005	0.005
1995	NE	0.006	0.005
1996	NE	0.004	0.003
1997	NE	0.007	0.006
1998	NE	0.001	0.001
1999	NE	0.004	0.004
2000	NE	0.013	0.011
2001	NE	0.012	0.010
2002	NE	0.011	0.009
2003	NE	0.044	0.038
2004	NE	0.050	0.043
2005	0.001	0.069	0.059
2006	0.003	0.076	0.065
2007	0.004	0.123	0.104
2008	0.003	0.137	0.116
2009	0.004	0.153	0.129
2010	0.004	0.144	0.122
2011	0.004	0.104	0.088
2012	0.004	0.098	0.083
2013	0.004	0.119	0.101
2014	0.004	0.086	0.078
2015	0.003	0.107	0.097

Table 6.5 Emissions from anaerobic digestion at biogas facilities in the period of 2011-2015

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

6.4.2. Methodological Issues

Point sources emissions are based on operator reports. In 2015 there were 12 anaerobic digestion operators and 3 composting operators.

Additional data to calculate diffuse sources emissions of NH_3 and CO in compost production sector are obtained from the waste management system. For these calculations, the Tier 2 method is used. Default emission factor for NH_3 and CO are obtained 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	0.66
CO	kg/Mg waste	0.56

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

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 1990-2015.

Table 6.7 Emissions from industrial waste incineration in the period of 1990-2015

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

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

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Year	Pb	As	Cr	Cu	Ni	Zn	PAHs Total	PCDD/F
	kg							g I-Teq
2014	NA	NA	NE	6.000	NA	NE	NE	0.250
2015	NA	NA	NE	4.100	NE	NE	NE	0.638

Table 6.8 Emissions from clinical waste incineration in the period of 1990-2015

Year	PCDD/F	PCBs
	g I-TEQ	kg
1990	0.470	NE
1991	0.470	NE
1992	0.460	NA
1993	0.450	NA
1994	0.440	NA
1995	0.430	NA
1996	0.430	NA
1997	0.620	NA
1998	0.560	NA
1999	0.290	NA
2000	0.280	NE
2001	0.220	NE
2002	0.540	NE
2003	0.483	0.001
2004	0.500	NE
2005	0.520	NE
2006	0.040	NE
2007	0.040	NA
2008	0.026	NA
2009	0.074	NA
2010	0.066	NA
2011	0.066	IE
2012	0.068	IE
2013	0.017	IE
2014	0.073	IE
2015	0.085	IE

Table 6.9 Pollutants emissions from cremation in the period of 1993-2015

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
1994	0.436	0.007	0.060	NA	NR	NR	0.020	NR	0.074
1995	0.723	0.011	0.099	NA	NR	NR	0.034	NR	0.123
1996	1.039	0.016	0.142	NA	NR	NR	0.049	NR	0.176
1997	1.534	0.024	0.210	NA	NR	NR	0.072	NR	0.260
1998	1.974	0.031	0.270	NA	NR	NR	0.092	NR	0.335
1999	2.383	0.038	0.326	NA	NR	NR	0.111	NR	0.404
2000	2.527	0.040	0.346	NA	0.106	0.106	0.118	NE	0.429
2001	2.937	0.046	0.402	NA	0.124	0.124	0.137	NE	0.498
2002	3.305	0.052	0.453	NA	0.139	0.139	0.154	NE	0.561
2003	3.647	0.057	0.500	NA	0.153	0.153	0.170	NE	0.619
2004	3.968	0.063	0.544	NA	0.167	0.167	0.185	NE	0.673
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

Table 6.9 continues on the next page.

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
1994	0.016	0.003	0.787	0.007	0.007	0.007	0.009	0.010	0.085
1995	0.026	0.004	1.305	0.012	0.012	0.011	0.015	0.017	0.140
1996	0.038	0.006	1.876	0.017	0.017	0.016	0.022	0.025	0.202
1997	0.056	0.009	2.770	0.025	0.025	0.023	0.032	0.037	0.298
1998	0.072	0.012	3.566	0.033	0.032	0.030	0.041	0.047	0.383
1999	0.087	0.015	4.303	0.039	0.039	0.036	0.050	0.057	0.462
2000	0.092	0.015	4.564	0.042	0.042	0.038	0.053	0.061	0.490
2001	0.107	0.018	5.304	0.048	0.048	0.044	0.062	0.070	0.570
2002	0.120	0.020	5.969	0.055	0.054	0.050	0.069	0.079	0.641
2003	0.133	0.022	6.587	0.060	0.060	0.055	0.077	0.087	0.708
2004	0.144	0.024	7.167	0.065	0.065	0.060	0.083	0.095	0.770
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

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
1994	0.014	0.007	0.004	0.003	0.004	0.079	0.216
1995	0.024	0.012	0.006	0.006	0.006	0.131	0.359
1996	0.034	0.017	0.009	0.008	0.009	0.189	0.516
1997	0.050	0.025	0.013	0.012	0.013	0.279	0.762
1998	0.065	0.032	0.017	0.015	0.017	0.359	0.981
1999	0.078	0.038	0.021	0.019	0.020	0.433	1.184
2000	0.083	0.040	0.022	0.020	0.021	0.459	1.256
2001	0.096	0.047	0.026	0.023	0.025	0.534	1.460
2002	0.108	0.053	0.029	0.026	0.028	0.601	1.642
2003	0.119	0.058	0.032	0.029	0.031	0.663	1.813
2004	0.130	0.064	0.035	0.031	0.034	0.722	1.972
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

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 (tonnes)

Year	Total MSW	MSW burned
1990	382,150.6	7643.0
1991	382,150.6	7643.0
1992	432,580.0	8651.6
1993	371,770.0	7435.4
1994	472,639.3	9452.8
1995	522,097.2	10441.9
1996	564,703.6	11294.1
1997	593,258.1	11865.2
1998	557,157.1	11143.1
1999	564,264.7	11285.3
2000	570,582.4	11411.6
2001	398,710.1	7974.2
2002	431,674.7	8633.5
2003	451,115.8	9022.3
2004	470,851.1	4708.5
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

Table 6.11 Pollutants emissions from domestic waste burning in the period of 1990-2015

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
1991	13.757	0.153	12.993	NR	NR	139.867	NR	5.350
1992	15.573	0.173	14.708	NR	NR	158.324	NR	6.056
1993	13.384	0.149	12.640	NR	NR	136.068	NR	5.205
1994	17.015	0.189	16.070	NR	NR	172.986	NR	6.617
1995	18.795	0.209	17.751	NR	NR	191.088	NR	7.309
1996	20.329	0.226	19.200	NR	NR	206.682	NR	7.906
1997	21.357	0.237	20.171	NR	NR	217.132	NR	8.306
1998	20.058	0.223	18.943	NR	NR	203.920	NR	7.800
1999	20.314	0.226	19.185	NR	NR	206.521	NR	7.900
2000	20.541	0.228	19.400	104.987	156.340	208.833	3.675	7.988
2001	14.354	0.159	13.556	73.363	109.247	145.928	2.568	5.582
2002	15.540	0.173	14.677	79.428	118.279	157.993	2.780	6.043
2003	16.240	0.180	15.338	83.005	123.606	165.108	2.905	6.316
2004	8.475	0.094	8.004	43.318	64.507	86.166	1.516	3.296
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

Table 6.11 continues on the next page.

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
1991	794.873	25.986	21.400	16.356	1.414	0.711	0.917	6.879
1992	899.766	29.415	24.224	18.514	1.601	0.805	1.038	7.786
1993	773.282	25.280	20.819	15.912	1.376	0.691	0.892	6.692
1994	983.090	32.139	26.468	20.229	1.749	0.879	1.134	8.508
1995	1,085.962	35.503	29.237	22.346	1.932	0.971	1.253	9.398
1996	1,174.584	38.400	31.623	24.169	2.089	1.050	1.355	10.165
1997	1,233.977	40.342	33.222	25.391	2.195	1.103	1.424	10.679
1998	1,158.887	37.887	31.201	23.846	2.061	1.036	1.337	10.029
1999	1,173.670	38.370	31.599	24.151	2.088	1.050	1.354	10.157
2000	1,186.811	38.800	31.953	24.421	2.111	1.061	1.369	10.270
2001	829.317	27.112	22.328	17.065	1.475	0.742	0.957	7.177
2002	897.883	29.354	24.174	18.476	1.597	0.803	1.036	7.770
2003	938.321	30.676	25.262	19.308	1.669	0.839	1.083	8.120
2004	489.685	16.009	13.184	10.076	0.871	0.438	0.565	4.238
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

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
1991	0.306	0.032	0.024	0.024	0.015	0.041
1992	0.346	0.036	0.028	0.027	0.017	0.046
1993	0.297	0.031	0.024	0.023	0.015	0.039
1994	0.378	0.040	0.030	0.029	0.019	0.050
1995	0.418	0.044	0.033	0.032	0.021	0.055
1996	0.452	0.047	0.036	0.035	0.023	0.060
1997	0.475	0.050	0.038	0.037	0.024	0.063
1998	0.446	0.047	0.036	0.035	0.022	0.059
1999	0.451	0.047	0.036	0.035	0.023	0.060
2000	0.456	0.048	0.037	0.035	0.023	0.060
2001	0.319	0.033	0.026	0.025	0.016	0.042
2002	0.345	0.036	0.028	0.027	0.017	0.046
2003	0.361	0.038	0.029	0.028	0.018	0.048
2004	0.188	0.020	0.015	0.015	0.009	0.025
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

6.5.2. Methodological Issues

Emissions from cremation, 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

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 2013-2015 (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	0.113	0.031	0.068	0.042

Table 6.14 Emissions from industrial wastewater handling in the period of 1994-2015 (tonnes)

Year	NO_x	NMVOC	SO_x	NH_3
1994	NA	29.427	NA	NA
1995	NA	27.735	NA	NA
1996	NA	25.373	NA	NA
1997	NA	25.296	NA	NA
1998	NA	25.059	NA	NA
1999	NA	22.984	NA	NA
2000	NA	22.428	NA	NA
2001	NA	22.628	NA	NA
2002	NA	21.408	NA	NA
2003	NA	24.411	NA	NA
2004	NA	27.123	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	1.098	2.183	0.134
2015	0.317	0.831	0.056	0.530

6.6.2. Methodological Issues

Emissions from waste water handling are based on data from facilities. In 2015 there were 6 operators.

In addition to the facility data, NMVOC emissions 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 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

Emission calculations from waste water treatment by using data from the waste management system. Also, specify data for latrines.

6.7. Other Waste (NFR 5E)

6.7.1. Source Category Description

This chapter covers emissions from other waste, which includes data from facilities (2 operators in 2015) and from car fires, detached and undetached house fires, apartment and industrial building fires. Detailed data about fires is obtained from Estonian Rescue Board and is available since 1998.

Table 6.15 Emissions from other waste in the period of 1998-2015

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
1999	NE	NE	NE	NE	NE	NR	NR	0.208
2000	NE	NE	NE	NE	NE	0.200	0.200	0.200
2001	NE	NE	NE	NE	NE	0.202	0.202	0.202
2002	NE	NE	NE	NE	NE	0.208	0.208	0.208
2003	NE	NE	NE	NE	NE	0.182	0.182	0.182
2004	NE	NE	NE	NE	NE	0.161	0.161	0.161
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

Year	NO_x	NMVOC	SO_x	NH_3	CO	$PM_{2.5}$	PM_{10}	TSP
	t					kt		
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

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
1999	0.609	1.227	1.227	1.944	1.854	4.310	NE	NE
2000	0.583	1.175	1.175	1.860	1.775	4.126	NE	NE
2001	0.589	1.186	1.186	1.878	1.791	4.164	NE	NE
2002	0.607	1.222	1.222	1.935	1.846	4.292	NE	NE
2003	0.533	1.074	1.074	1.701	1.623	3.773	NE	NE
2004	0.470	0.948	0.948	1.500	1.431	3.327	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

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
1999	2.103	NE	NE	NE	NE
2000	2.012	NE	NE	NE	NE
2001	2.034	NE	NE	NE	NE
2002	2.094	NE	NE	NE	NE
2003	1.841	NE	NE	NE	NE
2004	1.628	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

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 Board were used.

Table 6.16 Emission factors for other waste sector

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

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
1991	0.006	0.017	0.001	0.001	0.077	0.094	0.145	0.077	0.174
1992	0.179	0.536	0.036	0.036	2.367	2.893	4.471	2.367	5.361
1993	0.065	0.194	0.013	0.013	0.857	1.048	1.619	0.857	1.941
1994	0.046	0.137	0.009	0.009	0.605	0.739	1.142	0.605	1.369
1995	0.019	0.056	0.004	0.004	0.246	0.301	0.465	0.246	0.558
1996	0.058	0.174	0.012	0.012	0.767	0.937	1.449	0.767	1.737
1997	0.115	0.344	0.023	0.023	1.519	1.856	2.869	1.519	3.440
1998	0.005	0.016	0.001	0.001	0.072	0.087	0.135	0.072	0.162
1999	0.110	0.331	0.022	0.022	1.461	1.786	2.760	1.461	3.309
2000	0.068	0.205	0.014	0.014	0.914	1.117	1.726	0.914	2.051
2001	0.006	0.019	0.001	0.001	0.082	0.100	0.155	0.082	0.186

Year	NO_x	NMVOC	SO_x	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO
2002	0.208	0.625	0.042	0.042	2.772	3.388	5.236	2.772	6.245
2003	0.021	0.062	0.004	0.004	0.272	0.332	0.514	0.272	0.620
2004	0.038	0.114	0.008	0.008	0.495	0.605	0.936	0.495	1.137
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

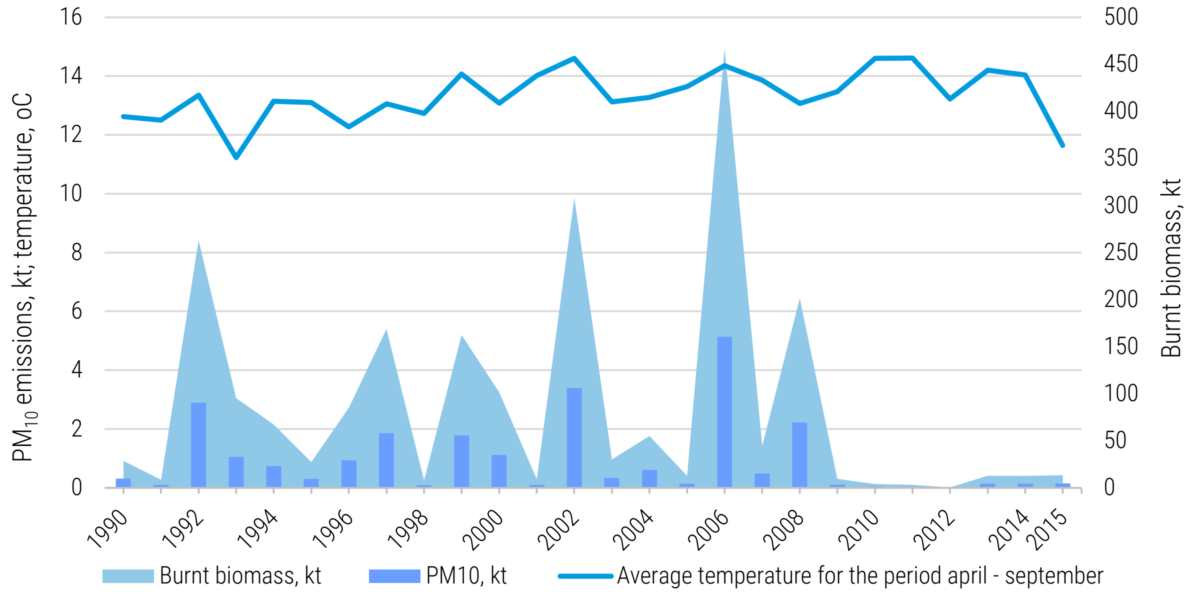

Figure 7.1 Burnt biomass, particulates emission and average temperature in the period 1990-2015

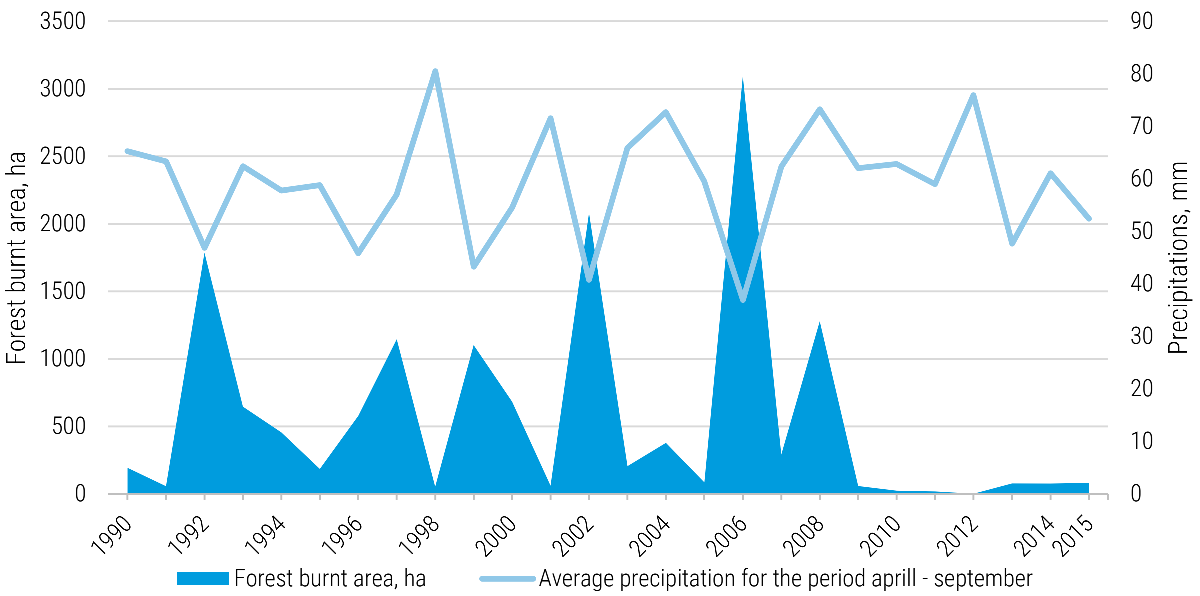

Figure 7.2 The forest burnt area and average precipitation amount

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.[31]

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.

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
1991	58.000	8536.749
1992	1787.000	263020.191
1993	647.100	95243.629
1994	456.400	67175.386
1995	185.900	27361.754
1996	579.000	85220.308
1997	1146.500	168747.985
1998	54.000	7948.008
1999	1103.000	162345.423
2000	683.800	101529.709
2001	61.870	9130.654
2002	2081.700	308000.218
2003	206.600	30206.186
2004	378.900	55043.524
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.

[31] Yearbook Forest 2014

7.2.4. Source-Specific Planned Improvements

Improve the activity data (burnt biomass) for the 1990 - 1999.

7.3. Other Natural Sources (NFR 11C)

7.3.1. Source Category Description

The Estonian inventory of air pollutants from natural emissions includes NMVOC emission from non-managed deciduous/coniferous forests and managed deciduous/coniferous forests, as well as emissions of grassland and other low vegetation including crops. The emissions natural sources sector are presented in Table 7.5.

Table 7.5 NMVOC emission from other natural sources in the period of 1990–2015 (kt)

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

7.3.2. Methodological Issues

All methodologies for calculating biogenic emissions essentially involve multiplying an emissions factor for a type of vegetation by a statistic providing for the amount of vegetation in the country or grid square. Two major alternatives for this are:

- to perform these calculations at a general or preferably species-specific level (applied to forests in this report), or
- to perform the calculations for different ecosystem types (applied to grassland and crops).

Based on the EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016, in conclusion, total VOC emissions per year from these activities can be calculated based on the following equation:

$$\text{Emission of VOC per vegetation type}$$
$$= F \times A$$
$$= (\varepsilon \times D \times \Gamma) \times A$$
$$= D.A.[\Gamma - iso \times \varepsilon_{iso} + \Gamma - mts/ovoc \times (\varepsilon_{mts} + \varepsilon_{ovoc})]$$

where

A (m²) – area used per vegetation type;
D (g/m²) – 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[32] 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

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

to calculate emission factors. There are also emission factors for Estonia included in the table.

Table 7.6 The input parameters for trees and ecosystem types used to calculate emission factors

Common name	Latin name	Type*	Biomass density D, g/m²	Isoprenes ε-iso, µg/g.h	Monoterpenes ε-mts, µg/g.h	o-VOC ε-ovoc, µg/g.h	Emission factor, t/km²
Pine	*Pinus sylvestris*	E	700	0	1.5	1.5	1.41
Spruce	*Picea abies*	E	1 400	1	1.5	1.5	3.50
Birch	*Betula*	D	320	0	0.2	1.5	0.31
Asp	*Populus*		320	60	0.0	1.5	8.37
Common Alder	*Alnus*	D	320	0	1.5	1.5	0.54
Ash	*Fraxinus*	D	320	0	0.0	1.5	0.27
Oak	*Quercus robur*	D	320	60	0.2	1.5	8.41
Grassland (meadows/ pastures)	-	-	400	0	0.1	1.5	0.36
Grass related crops	-	-	800	0.002	0.1	1.5	0.72

**D=deciduous; E=evergreen*

Activity Data

The area used per vegetation type can be obtained from Statistics Estonia. For the years 1990 and 1995, information on forest land is not available, therefore the information from the Yearbook Forests 2008 was used. From this reference, the available information about the closest years – 1988 and 1994 – was applied accordingly for the years 1990 and 1995. The distribution of forest land area by dominant tree species in counties is performed by using information from the forest register (Centre of Forest Protection and Silviculture).

Statistics on agricultural lands obtained from Statistics Estonia contain information on crop fields and cereal field area for the years 1990-2015. These data were used for calculating the total emission. Information on permanent grasslands is available for the years 2005-2015. There is no information in the statistical database for the years 1990-2000. For calculating the total emission, areas were calculated by using data from CORINE Land Cover 1990 and 2000.

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
1999	698.5	368.6	606.3	115.0	67.0	185.4	37.7
2000	707.1	366.1	616.8	116.6	64.8	181.3	35.8
2001	700.4	366.4	626.4	111.8	64.9	177.6	34.1
2002	679.9	363.4	628.7	114.1	62.4	182.6	33.8
2003	678.1	360.9	650.7	113.9	62.4	188.9	36.5
2004	699.2	365.3	648.4	114.2	65.5	189.5	35.9
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

Year	Pine-woods	Spruce-woods	Birch-woods	Aspen-woods	Alder-woods	Grey alder-woods	Other stands
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 2014.

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 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 2016 and 2017 are made by using exact calculation numbers.

1A4bi Residential: Stationary

In comparison with the previous submission, the emissions of all PAHs were recalculated for period 1990-2014. Recalculation concern using correct emission factors for liquid fuels. The differences in emissions between 2015 and 2016 submissions are presented in Table 8.1. Also were recalculated emissions for all pollutants for the year 2014. The reason for the recalculation was activities data correction.

Table 8.1 The differences of PAHs emissions (t) in Residential: Stationary emissions for the year 1990-2014 between 2016 and 2017 submissions (%)

Year	B(a)p			B(b)f			B(k)f		
	2016	2017	%	2016	2017	%	2016	2017	%
1990	1.616	1.439	-10.9	1.701	1.612	-5.2	1.082	0.927	-14.3
1991	1.548	1.430	-7.7	1.686	1.626	-3.5	1.021	0.917	-10.2
1992	0.914	0.891	-2.5	0.905	0.894	-1.3	0.608	0.588	-3.3
1993	0.832	0.820	-1.5	0.782	0.776	-0.8	0.556	0.545	-1.9
1994	1.111	1.107	-0.4	0.966	0.964	-0.2	0.754	0.750	-0.5
1995	2.150	2.146	-0.2	1.909	1.907	-0.1	1.456	1.452	-0.2
1996	2.537	2.510	-1.1	2.282	2.268	-0.6	1.716	1.692	-1.4
1997	2.564	2.542	-0.9	2.310	2.299	-0.5	1.733	1.713	-1.1
1998	1.934	1.905	-1.5	1.733	1.719	-0.8	1.309	1.284	-1.9
1999	1.962	1.913	-2.5	1.812	1.788	-1.4	1.320	1.277	-3.3
2000	1.863	1.818	-2.4	1.699	1.677	-1.3	1.257	1.217	-3.1
2001	1.677	1.657	-1.2	1.520	1.510	-0.7	1.130	1.112	-1.6
2002	1.655	1.613	-2.6	1.504	1.482	-1.4	1.116	1.079	-3.3
2003	1.566	1.531	-2.3	1.398	1.380	-1.3	1.060	1.028	-2.9
2004	1.532	1.510	-1.4	1.399	1.388	-0.8	1.027	1.008	-1.8
2005	1.255	1.234	-1.6	1.150	1.139	-0.9	0.840	0.822	-2.1
2006	1.158	1.136	-1.9	1.048	1.037	-1.1	0.778	0.759	-2.5
2007	1.357	1.338	-1.4	1.193	1.184	-0.8	0.918	0.902	-1.8
2008	1.347	1.323	-1.8	1.184	1.172	-1.0	0.912	0.890	-2.3
2009	1.323	1.306	-1.3	1.153	1.144	-0.7	0.897	0.882	-1.7
2010	1.296	1.282	-1.0	1.134	1.127	-0.6	0.876	0.865	-1.3
2011	1.080	1.062	-1.7	0.954	0.945	-0.9	0.728	0.712	-2.2
2012	1.086	1.071	-1.4	0.955	0.947	-0.8	0.733	0.719	-1.9
2013	0.986	0.972	-1.4	0.869	0.862	-0.8	0.664	0.652	-1.8
2014	0.880	0.907	3.1	0.774	0.803	3.7	0.592	0.608	2.7

Table 8.1 continues

Year	I(1,2,3-cd)p			PAHs Total		
	2016	2017	%	2016	2017	%
1990	1.526	1.172	-23.17	5.924	5.151	-13.1
1991	1.372	1.135	-17.29	5.627	5.108	-9.2
1992	0.889	0.843	-5.14	3.316	3.216	-3.0
1993	0.847	0.823	-2.89	3.017	2.963	-1.8
1994	1.220	1.212	-0.69	4.052	4.033	-0.5
1995	2.320	2.312	-0.35	7.835	7.817	-0.2
1996	2.710	2.656	-2.00	9.245	9.126	-1.3
1997	2.731	2.686	-1.66	9.339	9.240	-1.1
1998	2.073	2.016	-2.77	7.049	6.923	-1.8
1999	2.042	1.943	-4.82	7.137	6.921	-3.0
2000	1.963	1.873	-4.58	6.782	6.585	-2.9
2001	1.769	1.728	-2.29	6.096	6.007	-1.5
2002	1.746	1.661	-4.86	6.021	5.835	-3.1
2003	1.680	1.609	-4.23	5.703	5.548	-2.7
2004	1.590	1.547	-2.71	5.547	5.453	-1.7
2005	1.296	1.254	-3.18	4.540	4.450	-2.0
2006	1.213	1.169	-3.66	4.197	4.100	-2.3
2007	1.469	1.432	-2.52	4.936	4.855	-1.6
2008	1.459	1.410	-3.32	4.902	4.796	-2.2
2009	1.445	1.411	-2.39	4.818	4.742	-1.6
2010	1.406	1.379	-1.92	4.713	4.653	-1.3
2011	1.157	1.122	-3.09	3.919	3.841	-2.0
2012	1.169	1.138	-2.67	3.944	3.876	-1.7
2013	1.057	1.029	-2.62	3.577	3.516	-1.7
2014	0.943	0.961	1.92	3.190	3.279	2.8

Table 8.2 The differences of pollutants emission in Residential: Stationary emissions sector for 2014 year between 2016 and 2017 submissions (%)

Pollutant	Unit	2016	2017	Difference, %
NO_x	Gg	4.99374	5.15044	3.1
NMVOC	Gg	3.48809	3.60913	3.5
SO_x	Gg	0.42797	0.43100	0.7
NH_3	Gg	0.33342	0.34893	4.7
$PM_{2.5}$	Gg	2.27064	2.33795	3.0
PM_{10}	Gg	2.35896	2.42875	3.0
TSP	Gg	2.55858	2.63621	3.0
BC	Gg	0.82908	0.86218	4.0
CO	Gg	69.26212	70.98321	2.5
Pb	Mg	0.46480	0.46480	0.0
Cd	Mg	0.20271	0.20271	0.0
Hg	Mg	0.01009	0.01085	7.6
As	Mg	0.00405	0.00405	0.0
Cr	Mg	0.36180	0.36180	0.0
Cu	Mg	0.10058	0.10061	0.0
Ni	Mg	0.03560	0.03560	0.0
Se	Mg	0.00853	0.00853	0.0
Zn	Mg	8.04409	8.04409	0.0
PCDD/F	g	1.01184	1.04788	3.6
B(a)p	Mg	0.88011	0.90709	3.1
B(b)f	Mg	0.77438	0.80284	3.7
B(k)f	Mg	0.59247	0.60834	2.7
I(1,2,3-cd)p	Mg	0.94265	0.96078	1.9
PAHs Total	Mg	3.18961	3.27904	2.8

Pollutant	Unit	2016	2017	Difference, %
HCB	kg	0.16202	0.16444	1.5
PCBs	kg	0.06245	0.06247	0.0

1A4ci Agriculture/Forestry/Fishing: Stationary

In comparison with the previous submission, the emissions of PCB were recalculated for the year 1993. The reason for the recalculation was emission factors unit correction for coal (was 1000 time higher).

The differences in emissions between 2015 and 2016 submissions are presented in Table 8.3.

Table 8.3 The differences of PCB emissions (kg) in Agriculture/Forestry/Fishing: Stationary for the year 1993 between 2016 and 2017 submissions (%)

Year	PCB		
	2016	2017	%
1993	3.98	0.22	-94.47

8.1.2. Transport Sector

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2016 and 2017 are made by using exact calculation numbers.

1A3ai-ii (i-ii) Domestic and international aviation

BC emissions from the aviation sector have been recalculated. BC emissions data have been corrected under NFR codes 1A3ai(i) and 1A3aii(i) in the period of 2000–2008 and 2011. Same goes for NFR codes 1A3ai(ii) and 1A3aii(ii) in 2014. Recalculations entailed using a corrected f-BC emission factor in emission calculations.

The differences in the aviation sector emissions between the submissions for 2016 and 2017 are presented in Table 8.4.

Table 8.4 The differences in the aviation sector BC emissions (t) between 2016 and 2017 submissions (%)

Year	1A3ai(i)			1A3aii(i)			1A3ai(ii)			1A3aii(ii)		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2000	0.147	0.146	-0.7	0.006	0.005	-18.2						
2001	0.132	0.131	-0.8	0.006	0.005	-17.8						
2002	0.120	0.119	-0.8	0.012	0.011	-8.6						
2003	0.151	0.150	-0.7	0.009	0.008	-11.7						
2004	0.206	0.205	-0.5	0.008	0.007	-13.3						
2005	0.308	0.307	-0.3	0.006	0.005	-15.5						
2006	0.301	0.300	-0.3	0.009	0.008	-11.3						
2007	0.368	0.367	-0.3	0.007	0.006	-13.5						
2008	0.447	0.446	-0.2	0.007	0.006	-14.9						
2011	0.298	0.297	-0.3	0.010	0.009	-10.4						
2014							0.971	3.106	220	0.002	0.007	220

1A3b Road transport

SO_2 emissions from the road transport sector have been recalculated for the year 2014. Recalculations entailed using corrected sulphur content in fuels. In addition, other pollutants emissions also changed because sulphur content is related to correction functions in emission calculations for gasoline fuel in the COPERT 4 programme. The pollutants most affected by this recalculation have been NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP and CO.

The differences in road transport emissions between the submissions for 2016 and 2017 are presented in Table 8.5.

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Table 8.5 The differences in road transport emissions (kt) between the 2016 and 2017 submissions (%)

Year	1A3bi			1A3bii		
	2016	2017	%	2016	2017	%
NO_x	3.044428	3.044430	0.0001			
NMVOC	1.133971	1.133974	0.0003			
SO_2	0.005172	0.004876	-5.7252	0.000804	0.000718	-10.7464
$PM_{2.5}$	0.147935	0.147928	-0.0047	0.037753	0.037751	-0.0051
PM_{10}	0.147935	0.147928	-0.0047	0.037753	0.037751	-0.0051
TSP	0.147935	0.147928	-0.0047	0.037753	0.037751	-0.0051
CO	10.817703	10.817726	0.0002	0.626000	0.626001	0.0001

Table 8.5 continues

Year	1A3biii			1A3biv		
	2016	2017	%	2016	2017	%
NO_x						
NMVOC						
SO_2	0.002364	0.002075	-12.2476			
$PM_{2.5}$	0.081742	0.081740	-0.0027			
PM_{10}	0.081742	0.081740	-0.0027			
TSP	0.081742	0.081740	-0.0027			
CO				0.502766	0.502768	0.0004

1A3dii National navigation

All the emissions for the year 1993 are recalculated. Recalculations entailed using corrected fuel consumption data. The differences in the national navigation sector emissions between the 2016 and 2017 submissions are presented in Table 8.6.

Table 8.6 The differences in national navigation pollutant emissions between the 2016 and 2017 submissions (%)

Year	Unit	1A3dii		
		2016	2017	%
NO_x	kt	1.421	0.192	-86.5
NMVOC	kt	0.276	0.037	-86.5
SO_x	kt	0.370	0.050	-86.5
NH_3	t	0.259	0.035	-86.5
TSP	kt	0.170	0.023	-86.5
CO	kt	0.733	0.099	-86.5
Cd	kg	0.370	0.050	-86.5
Cr	t	1.850	0.250	-86.5
Cu	t	0.063	0.009	-86.5
Ni	t	2.590	0.350	-86.5
Se	kg	0.370	0.050	-86.5
Zn	t	0.037	0.005	-86.5
B(a)p	t	1.110	0.150	-86.5
B(b)f	t	1.850	0.250	-86.5

Year	Unit	1A3dii		
		2016	2017	%
PAHs Total	t	2.960	0.400	-86.5

1A3di (i) International maritime navigation

All the PCB emissions have been recalculated for the period of 1990–2014. Recalculations in the international maritime sector were made based on the correction in PCB emission factors in the EMEP/EEA Guidebook. In detail, PCB emission factor for marine diesel and gas oil was 0.38 mg/tonne of fuel in the EMEP/EEA Guidebook 2009 and changed into 0.038 mg/tonne of fuel in the EMEP/EEA Guidebook 2013 and 2016.

Therefore, PCB emissions have decreased between 1990 and 2014. The differences in international maritime navigation sector emissions between the 2016 and 2017 submissions are presented in Table 8.7.

Table 8.7 The differences in international maritime PCB emissions (kt) between the 2016 and 2017 submissions (%)

Year	1A3di (i)		
	2016	2017	%
1990	0.096	0.087	-9.6
1991	0.113	0.102	-9.9
1992	0.063	0.048	-23.3
1993	0.074	0.049	-33.5
1994	0.061	0.039	-35.7
1995	0.044	0.030	-31.3
1996	0.046	0.034	-25.8
1997	0.052	0.042	-20.3
1998	0.056	0.046	-18.4
1999	0.057	0.045	-22.1
2000	0.053	0.039	-27.1
2001	0.050	0.034	-31.0
2002	0.059	0.042	-28.4
2003	0.057	0.042	-26.6
2004	0.078	0.061	-22.0
2005	0.061	0.046	-25.2
2006	0.115	0.100	-13.4
2007	0.138	0.128	-7.7
2008	0.143	0.136	-4.8
2009	0.128	0.123	-4.0
2010	0.125	0.118	-5.8
2011	0.105	0.097	-7.8
2012	0.218	0.189	-13.5
2013	0.239	0.225	-5.7
2014	0.179	0.162	-9.5

8.2. Industry Sector (NFR 2)

8.2.1. Industrial Processes

2A5b Construction and demolition

$PM_{2.5}$ and PM_{10} emission have been recalculated for the period 2000-2014 and TSP 1990-1999. Recalculations for this sector were made based on the correction of activity data. In contrast to the previous year submission, for calculation of emission were used completed dwelling (houses, apartments and non-residential buildings) for new construction and demolition, but not granted permits. A major role in changing emissions played updated emission factor in new Air Pollutant Emission Inventory Guidebook 2016.

The differences in emissions between 2015 and 2016 submissions are presented in Table 8.8.

Table 8.8 The differences in NFR 2A5b emissions (kt) for the year 1990-2014 between 2016 and 2017 submissions (%)

Year	$PM_{2.5}$			PM_{10}			TSP		
	2016	2017	%	2016	2017	%	2016	2017	%
1990	NR	NR	NR	NR	NR	NR	0.350	4.975	1 319.7
1991	NR	NR	NR	NR	NR	NR	0.246	3.497	1 319.7
1992	NR	NR	NR	NR	NR	NR	0.180	2.611	1 352.8
1993	NR	NR	NR	NR	NR	NR	0.136	1.362	905.2
1994	NR	NR	NR	NR	NR	NR	0.061	1.182	1 833.7
1995	NR	NR	NR	NR	NR	NR	0.076	0.829	998.0
1996	NR	NR	NR	NR	NR	NR	0.083	1.085	1 203.9
1997	NR	NR	NR	NR	NR	NR	0.098	1.157	1 076.0
1998	NR	NR	NR	NR	NR	NR	0.113	1.949	1 631.6
1999	NR	NR	NR	NR	NR	NR	0.089	1.462	1 547.8
2000	0.005	0.050	817.0	0.054	0.496	817.1	0.108	1.636	1 417.5
2001	0.006	0.051	685.7	0.065	0.511	685.8	0.130	1.685	1 200.1
2002	0.011	0.073	553.4	0.112	0.732	553.4	0.224	2.418	981.2
2003	0.010	0.085	779.8	0.097	0.854	779.8	0.194	2.822	1 356.2
2004	0.018	0.135	660.1	0.178	1.355	660.1	0.356	4.473	1 157.9
2005	0.020	0.134	570.2	0.200	1.338	570.2	0.398	4.418	1 009.3
2006	0.025	0.151	508.2	0.249	1.514	508.2	0.497	5.000	906.8
2007	0.023	0.147	551.4	0.226	1.474	551.3	0.452	4.870	978.5
2008	0.021	0.170	727.1	0.206	1.702	727.2	0.411	5.621	1 269.1
2009	0.011	0.114	903.3	0.113	1.135	903.3	0.226	3.749	1 560.6
2010	0.010	0.079	702.8	0.098	0.785	702.9	0.195	2.593	1 229.0
2011	0.012	0.076	538.0	0.118	0.756	538.0	0.236	2.496	956.0

Year	$PM_{2.5}$			PM_{10}			TSP		
	2016	2017	%	2016	2017	%	2016	2017	%
2012	0.013	0.079	504.4	0.130	0.787	504.4	0.260	2.599	900.5
2013	0.014	0.115	730.7	0.139	1.153	730.6	0.277	3.807	1 274.6
2014	0.014	0.096	596.7	0.138	0.962	596.7	0.276	3.177	1 053.2

2H2 Food and beverages industry

The NMVOC emission have been recalculated for the 2014. Recalculations for this sector were made based on the correction of activity data.

Table 8.9 The differences in NFR 2H2 NMVOC emissions (kt) for the year 2014 between 2016 and 2017 submissions (%)

Year	NMVOC		
	2016	2017	%
2014	0.69584	0.652501	-6.19

8.2.2. Solvent and Other Product Use

2D3d Coating applications, 2D3e Degreasing, 2D3h Printing, 2D3i Other solvent use

The NMVOC emission have been recalculated for the 2014. Recalculations for this sector were made based on the correction of statistical activity data.

Table 8.10 The differences in NFR 2D3 NMVOC emissions (kt) for the year 2014 between 2016 and 2017 submissions (%)

NFR	NMVOC		
	2016	2017	%
2D3d	3.174026	3.174533	0.02
2D3e	0.978607	0.978745	0.01
2D3h	0.456692	0.458042	0.30
2D3i	0.550186	0.550552	0.07

2G Other product use

Pollutant emissions for tobacco combustion have been recalculated for the years 2013 and 2014. Recalculations for this sector were made based on the correction of statistical activity data.

Table 8.11 The differences in NFR 2G pollutant emissions (kt) for the years 2013 and 2014 between 2016 and 2017 submissions (%)

Pollutant	Year	2013	2014
NOx	2016	0.003417	0.003397
	2017	0.003399	0.003396
	%	-0.53	-0.03
NMVOC	2016	0.008881	0.008771
	2017	0.008833	0.008769
	%	-0.54	-0.02
NH_3	2016	0.007615	0.007521
	2017	0.007573	0.007518
	%	-0.55	-0.04
$PM_{2.5}$	2016	0.07238	0.075805
	2017	0.07211	0.075789
	%	-0.37	-0.02
PM_{10}	2016	0.093477	0.100630
	2017	0.093207	0.100614
	%	-0.29	-0.02
TSP	2016	0.097834	0.105758
	2017	0.097565	0.105741
	%	-0.27	-0.02
BC	2016	0.022294	0.022019
	2017	0.022172	0.022012
	%	-0.55	-0.03
CO	2016	0.104245	0.103556
	2017	0.103696	0.103522
	%	-0.53	-0.03
Cd	2016	0.010559	0.010552
	2017	0.010505	0.010549
	%	-0.51	-0.03
Hg	2016	0.004979	0.004923
	2017	0.004952	0.004921
	%	-0.54	-0.04
As	2016	0.005539	0.005581
	2017	0.005512	0.005580
	%	-0.49	-0.02
Cu	2016	0.205137	0.239513
	2017	0.205083	0.239509
	%	-0.03	-0.002
PCDD/F	2016	0.000183	
	2017	0.000182	
	%	-0.55	
B(a)p	2016	0.000204	
	2017	0.000203	
	%	-0.49	
B(b)f	2016	0.000083	
	2017	0.000082	
	%	-1.20	
B(k)f	2016	0.000083	
	2017	0.000082	
	%	-1.20	
I(1,2,3-cd)p	2016	0.000083	
	2017	0.000082	

Pollutant	Year	2013	2014
	%	-1.20	
PAHs Total	2016	0.000453	
	2017	0.000449	
	%	-0.88	

8.3. Agriculture Sector (NFR 3)

8.3.1. Manure Management

Overviews of recalculations are given below by each subsector. The comparison between the submissions for 2016 and 2017 are made by using exact calculation numbers.

NO_x, NH_3, NMVOC, TSP, $PM_{2.5}$ and PM_{10} emissions from dairy cattle, non-dairy cattle, other animals (fur animals) and swine have been recalculated for the years 1990–2014. Recalculations entail using corrected activity data (Nitrogen excretion rate, number of animals). For calculating NMVOC emissions from dairy cattle manure management, the Tier 2 methodology was used instead of Tier 1 for the first time. In addition, the new emission factors for NO_x, NMVOC, TSP, $PM_{2.5}$ and PM_{10} emissions from the renewed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016 were used.

NO_x, $PM_{2.5}$, PM_{10} and TSP emissions from horse manure management have been recalculated for the years 1990–2014. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2016. Also using corrected activity data.

NO_x, $PM_{2.5}$, PM_{10} and TSP emissions from poultry management have been recalculated for the years 1990–2014. Recalculations entail using the new emission factors from the renewed EMEP/EEA Guidebook 2016.

Table 8.12 The differences in dairy cattle manure management NH_3, NO_x and NMVOC emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	5.066	2.818	-44.4	0.030	0.030	0.2	3.818	3.074	-19.5
1991	4.617	2.585	-44.0	0.027	0.027	0.5	3.594	2.800	-22.1
1992	4.258	2.392	-43.8	0.025	0.025	0.1	3.446	2.544	-26.2
1993	3.782	2.140	-43.4	0.022	0.022	1.1	3.083	2.245	-27.2
1994	3.232	1.997	-38.2	0.018	0.020	13.0	2.875	2.046	-28.8
1995	2.868	1.780	-37.9	0.016	0.018	14.0	2.521	1.816	-28.0
1996	2.930	1.717	-41.4	0.017	0.018	6.8	2.334	1.762	-24.5
1997	2.996	1.757	-41.4	0.018	0.019	7.8	2.281	1.802	-21.0
1998	2.920	1.676	-42.6	0.017	0.018	5.1	2.157	1.794	-16.8
1999	2.510	1.572	-37.4	0.015	0.017	18.4	1.882	1.537	-18.4
2000	2.471	1.380	-44.2	0.015	0.015	1.6	1.782	1.517	-14.9
2001	2.267	1.354	-40.3	0.015	0.015	-1.7	1.749	1.589	-9.1
2002	2.267	1.549	-31.7	0.015	0.018	18.4	1.572	1.438	-8.6
2003	2.560	1.549	-39.5	0.014	0.016	16.9	1.588	1.552	-2.3
2004	2.679	1.592	-40.6	0.014	0.016	16.7	1.584	1.620	2.2
2005	2.686	1.600	-40.4	0.013	0.016	19.2	1.534	1.628	6.1
2006	2.716	1.584	-41.7	0.013	0.015	18.0	1.474	1.632	10.7
2007	2.619	1.534	-41.4	0.011	0.014	20.4	1.401	1.592	13.7
2008	2.896	1.496	-48.3	0.013	0.013	4.0	1.365	1.581	15.8
2009	2.936	1.483	-49.5	0.012	0.012	2.3	1.315	1.562	18.8
2010	3.009	1.501	-50.1	0.011	0.011	1.6	1.312	1.595	21.6
2011	2.985	1.492	-50.0	0.011	0.011	2.6	1.308	1.603	22.5
2012	3.097	1.504	-51.4	0.012	0.012	-0.1	1.317	1.654	25.7
2013	3.203	1.558	-51.4	0.012	0.012	1.1	1.331	1.729	29.8
2014	3.183	1.545	-51.5	0.012	0.012	1.0	1.300	1.720	32.3

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Table 8.13 The differences in dairy cattle manure management particles emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.224	0.387	72.7	NR	NR		NR	NR	
1991	0.211	0.365	72.7	NR	NR		NR	NR	
1992	0.203	0.350	72.7	NR	NR		NR	NR	
1993	0.181	0.313	72.7	NR	NR		NR	NR	
1994	0.169	0.292	72.7	NR	NR		NR	NR	
1995	0.148	0.256	72.7	NR	NR		NR	NR	
1996	0.137	0.237	72.7	NR	NR		NR	NR	
1997	0.134	0.231	72.7	NR	NR		NR	NR	
1998	0.127	0.219	72.7	NR	NR		NR	NR	
1999	0.111	0.191	72.7	NR	NR		NR	NR	
2000	0.105	0.181	72.7	0.047	0.083	75.0	0.03	0.054	78.3
2001	0.103	0.177	72.7	0.046	0.081	75.0	0.03	0.053	78.3
2002	0.092	0.160	72.7	0.042	0.073	75.0	0.027	0.047	78.3
2003	0.093	0.161	72.7	0.042	0.074	75.0	0.027	0.048	78.3
2004	0.093	0.161	72.7	0.042	0.073	75.0	0.027	0.048	78.3
2005	0.090	0.156	72.7	0.041	0.071	75.0	0.026	0.046	78.3
2006	0.087	0.150	72.7	0.039	0.068	75.0	0.025	0.044	78.3
2007	0.082	0.142	72.7	0.037	0.065	75.0	0.024	0.042	78.3
2008	0.080	0.139	72.7	0.036	0.063	75.0	0.023	0.041	78.3
2009	0.077	0.133	72.7	0.035	0.061	75.0	0.022	0.040	78.3
2010	0.077	0.133	72.7	0.035	0.061	75.0	0.022	0.040	78.0
2011	0.077	0.133	72.7	0.035	0.061	75.0	0.022	0.039	78.3
2012	0.077	0.134	72.6	0.035	0.061	75.3	0.022	0.040	78.0
2013	0.078	0.135	72.7	0.035	0.062	75.0	0.023	0.040	78.2
2014	0.076	0.132	72.7	0.034	0.060	75.0	0.022	0.039	78.3

Table 8.14 The differences in non-dairy manure management NH_3, NO_x and NMVOC emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	3.829	1.360	-64.5	0.030	0.030	0.0	3.531	4.247	20.3
1991	3.722	1.219	-67.3	0.029	0.029	-0.1	3.286	3.934	19.7
1992	3.033	0.996	-67.2	0.024	0.024	0.0	2.673	3.215	20.3
1993	1.992	0.651	-67.3	0.016	0.016	-0.1	1.750	2.105	20.3
1994	1.719	0.584	-66.0	0.014	0.014	0.0	1.540	1.853	20.3
1995	1.499	0.527	-64.8	0.012	0.012	0.0	1.369	1.647	20.3
1996	1.398	0.487	-65.2	0.011	0.011	0.0	1.268	1.526	20.3
1997	1.307	0.443	-66.1	0.010	0.010	0.0	1.168	1.406	20.3
1998	1.213	0.421	-65.3	0.010	0.010	0.0	1.102	1.326	20.3
1999	1.084	0.368	-66.0	0.009	0.009	0.0	0.954	1.147	20.3
2000	1.018	0.352	-65.4	0.008	0.008	-0.1	0.901	1.084	20.3
2001	1.161	0.374	-67.8	0.009	0.008	-7.0	0.976	1.174	20.3
2002	1.161	0.491	-57.8	0.009	0.009	0.0	1.023	1.231	20.3
2003	1.311	0.491	-62.6	0.011	0.012	9.9	1.039	1.250	20.3
2004	1.155	0.351	-69.6	0.009	0.008	-9.7	0.986	1.187	20.3
2005	1.188	0.391	-67.1	0.009	0.009	-0.1	1.012	1.217	20.3
2006	1.185	0.372	-68.6	0.009	0.009	-4.9	1.009	1.214	20.3
2007	1.217	0.401	-67.1	0.009	0.009	0.0	1.018	1.224	20.3
2008	1.205	0.424	-64.8	0.009	0.009	0.0	1.018	1.224	20.3
2009	1.238	0.425	-65.7	0.009	0.009	0.0	1.021	1.228	20.3
2010	1.258	0.428	-66.0	0.010	0.010	0.0	1.035	1.245	20.3
2011	1.286	0.440	-65.8	0.010	0.010	0.0	1.052	1.265	20.3

Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
2012	1.351	0.458	-66.1	0.010	0.010	0.0	1.104	1.328	20.3
2013	1.488	0.502	-66.3	0.011	0.011	0.0	1.210	1.453	20.1
2014	1.350	0.441	-67.4	0.010	0.010	0.0	1.251	1.505	20.3

Table 8.15 The differences in non-dairy manure management particles emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.254	0.219	-14.0	NR	NR		NR	NR	
1991	0.237	0.206	-13.0	NR	NR		NR	NR	
1992	0.192	0.168	-12.5	NR	NR		NR	NR	
1993	0.126	0.110	-12.5	NR	NR		NR	NR	
1994	0.111	0.096	-13.1	NR	NR		NR	NR	
1995	0.099	0.085	-13.9	NR	NR		NR	NR	
1996	0.091	0.079	-13.6	NR	NR		NR	NR	
1997	0.084	0.073	-13.1	NR	NR		NR	NR	
1998	0.079	0.069	-13.6	NR	NR		NR	NR	
1999	0.069	0.060	-12.7	NR	NR		NR	NR	
2000	0.065	0.057	-12.8	0.029	0.026	-10.5	0.019	0.017	-12.6
2001	0.070	0.060	-14.1	0.032	0.028	-11.8	0.021	0.018	-14.0
2002	0.074	0.064	-13.0	0.033	0.030	-10.7	0.022	0.019	-12.8
2003	0.075	0.065	-13.4	0.034	0.030	-11.1	0.022	0.019	-13.2
2004	0.071	0.062	-12.6	0.032	0.029	-10.3	0.021	0.019	-12.4
2005	0.073	0.064	-12.3	0.033	0.030	-10.0	0.022	0.019	-12.1
2006	0.073	0.064	-12.0	0.033	0.030	-9.7	0.022	0.019	-11.7
2007	0.073	0.065	-11.3	0.033	0.030	-9.0	0.022	0.020	-11.0
2008	0.073	0.065	-11.6	0.033	0.030	-9.4	0.022	0.020	-11.3
2009	0.074	0.066	-10.8	0.033	0.030	-8.6	0.022	0.020	-10.5
2010	0.074	0.067	-10.3	0.034	0.031	-8.1	0.022	0.020	-9.9
2011	0.076	0.068	-9.9	0.034	0.031	-7.7	0.023	0.021	-9.5
2012	0.080	0.072	-9.9	0.036	0.033	-7.6	0.024	0.022	-9.5
2013	0.087	0.079	-9.8	0.039	0.036	-7.5	0.026	0.024	-9.3
2014	0.090	0.082	-9.5	0.041	0.038	-7.3	0.027	0.025	-9.1

Table 8.16 The differences in swine manure management NH_3, NO_x and NMVOC emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	4.188	2.355	-43.8	0.008	0.008	8.4	3.796	1.225	-67.7
1991	3.871	2.177	-43.8	0.007	0.008	8.4	3.505	1.132	-67.7
1992	2.620	1.473	-43.8	0.005	0.005	8.7	2.371	0.766	-67.7
1993	3.782	1.170	-69.1	0.004	0.004	8.2	1.893	0.608	-67.9
1994	2.234	1.256	-43.8	0.004	0.005	8.4	2.043	0.653	-68.0
1995	2.168	1.225	-43.5	0.004	0.004	8.5	1.970	0.637	-67.7
1996	1.480	0.820	-44.6	0.003	0.004	18.3	1.527	0.428	-72.0
1997	1.532	0.858	-44.0	0.003	0.003	8.2	1.619	0.446	-72.5
1998	1.633	0.913	-44.1	0.003	0.004	7.9	1.688	0.475	-71.9
1999	1.557	0.866	-44.4	0.003	0.004	7.5	1.417	0.433	-69.5
2000	1.682	0.935	-44.4	0.004	0.004	6.6	1.534	0.473	-69.2
2001	1.841	1.029	-44.1	0.004	0.004	10.1	1.722	0.537	-68.9
2002	1.841	1.023	-44.4	0.004	0.004	6.1	1.684	0.530	-68.5
2003	1.839	1.023	-44.4	0.004	0.004	7.1	1.688	0.530	-68.6
2004	1.781	0.991	-44.4	0.004	0.004	7.7	1.653	0.526	-68.2

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Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
2005	1.827	1.008	-44.8	0.004	0.004	-4.3	1.674	0.532	-68.2
2006	1.839	1.015	-44.8	0.005	0.005	3.3	1.700	0.541	-68.2
2007	2.037	1.113	-45.4	0.006	0.005	-15.0	1.814	0.576	-68.2
2008	1.911	1.051	-45.0	0.005	0.005	11.9	1.744	0.553	-68.3
2009	1.894	1.047	-44.7	0.004	0.005	8.0	1.744	0.555	-68.2
2010	1.950	1.076	-44.8	0.005	0.005	7.5	1.780	0.562	-68.4
2011	1.929	1.063	-44.9	0.005	0.005	7.4	1.761	0.555	-68.5
2012	1.931	1.075	-44.3	0.004	0.004	7.2	1.785	0.569	-68.1
2013	1.864	1.037	-44.4	0.004	0.004	6.7	1.712	0.545	-68.2
2014	1.884	1.047	-44.5	0.004	0.005	6.9	1.721	0.541	-68.5

Table 8.17 The differences in swine manure management particles emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.964	0.665	-31.0	NR	NR		NR	NR	
1991	0.895	0.618	-31.0	NR	NR		NR	NR	
1992	0.606	0.419	-31.0	NR	NR		NR	NR	
1993	0.476	0.328	-31.2	NR	NR		NR	NR	
1994	0.516	0.354	-31.3	NR	NR		NR	NR	
1995	0.503	0.347	-31.0	NR	NR		NR	NR	
1996	0.338	0.230	-31.9	NR	NR		NR	NR	
1997	0.348	0.236	-32.2	NR	NR		NR	NR	
1998	0.370	0.252	-32.1	NR	NR		NR	NR	
1999	0.323	0.226	-30.1	NR	NR		NR	NR	
2000	0.340	0.234	-31.1	0.153	0.036	-76.5	0.024402	0.002	-93.3
2001	0.390	0.266	-31.8	0.176	0.041	-76.9	0.028001	0.002	-93.4
2002	0.385	0.260	-32.6	0.173	0.040	-77.2	0.027641	0.002	-93.5
2003	0.389	0.264	-32.1	0.175	0.040	-77.2	0.027934	0.002	-93.5
2004	0.384	0.253	-34.1	0.173	0.038	-77.7	0.027555	0.002	-93.7
2005	0.391	0.260	-33.5	0.176	0.039	-77.6	0.028063	0.002	-93.7
2006	0.391	0.254	-35.0	0.176	0.039	-77.9	0.028038	0.002	-93.7
2007	0.427	0.286	-33.1	0.192	0.043	-77.6	0.030677	0.002	-93.7
2008	0.411	0.277	-32.7	0.185	0.042	-77.5	0.029533	0.002	-93.7
2009	0.412	0.274	-33.4	0.185	0.041	-77.7	0.029549	0.002	-93.7
2010	0.419	0.284	-32.2	0.189	0.043	-77.4	0.030087	0.002	-93.7
2011	0.413	0.280	-32.2	0.186	0.042	-77.4	0.029612	0.002	-93.6
2012	0.423	0.281	-33.6	0.190	0.042	-77.8	0.030351	0.002	-93.8
2013	0.404	0.270	-33.3	0.182	0.041	-77.7	0.029029	0.002	-93.7
2014	0.404	0.274	-32.2	0.182	0.041	-77.4	0.028978	0.002	-93.7

Table 8.18 The differences in horse manure management emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NO_x			TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.0011	0.0017	53.5	0.002	0.0041	175.3	NR	NR		NR	NR	
1991	0.0010	0.0016	53.7	0.001	0.0038	167.9	NR	NR		NR	NR	
1992	0.0009	0.0013	53.8	0.001	0.0032	164.2	NR	NR		NR	NR	
1993	0.0007	0.0011	54.2	0.001	0.0025	177.8	NR	NR		NR	NR	
1994	0.0007	0.0010	54.2	0.001	0.0024	166.7	NR	NR		NR	NR	
1995	0.0006	0.0009	54.2	0.001	0.0022	176.3	NR	NR		NR	NR	
1996	0.0006	0.0009	54.5	0.001	0.0020	152.5	NR	NR		NR	NR	
1997	0.0006	0.0009	54.5	0.001	0.0020	152.5	NR	NR		NR	NR	
1998	0.0005	0.0008	54.6	0.001	0.0019	168.6	NR	NR		NR	NR	
1999	0.0005	0.0008	54.6	0.001	0.0019	168.6	NR	NR		NR	NR	
2000	0.0006	0.0009	54.5	0.001	0.0020	167.2	0.0	0.001	23.0	0.00050	0.00059	17.1
2001	0.0007	0.0011	54.0	0.001	0.0026	166.7	0.0	0.001	22.2	0.00066	0.00077	16.7
2002	0.0007	0.0011	54.2	0.001	0.0026	167.3	0.0	0.001	22.6	0.00064	0.00075	17.9
2003	0.0008	0.0012	53.9	0.001	0.0028	167.2	0.0	0.001	22.6	0.00070	0.00082	17.8
2004	0.0007	0.0010	54.2	0.001	0.0025	166.9	0.0	0.001	23.1	0.00061	0.00072	17.6
2005	0.0006	0.0010	54.3	0.001	0.0023	167.4	0.0	0.001	22.7	0.00058	0.00068	18.1
2006	0.0006	0.0010	54.2	0.001	0.0024	167.6	0.0	0.001	22.4	0.00059	0.00069	17.3
2007	0.0007	0.0011	54.2	0.001	0.0026	167.3	0.0	0.001	22.6	0.00064	0.00075	17.9
2008	0.0007	0.0011	54.2	0.001	0.0026	167.3	0.0	0.001	22.6	0.00064	0.00075	17.9
2009	0.0007	0.0011	53.5	0.001	0.0026	167.5	0.0	0.001	22.4	0.00065	0.00076	17.3
2010	0.0009	0.0014	53.8	0.001	0.0033	167.2	0.0	0.002	22.5	0.00082	0.00096	17.6
2011	0.0009	0.0013	53.8	0.001	0.0031	166.7	0.0	0.001	22.2	0.00078	0.00091	17.6
2012	0.0008	0.0013	56.3	0.001	0.0030	170.9	0.0	0.001	24.5	0.00070	0.00087	17.6
2013	0.0008	0.0013	53.9	0.003	0.0030	0.2	0.0	0.001	0.3	0.00088	0.00089	0.9
2014	0.0008	0.0013	53.9	0.003	0.0030	0.2	0.0	0.001	0.3	0.00088	0.00089	0.9

Table 8.19 The differences in laying hens manure management emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NO_x			TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.007	0.0	66.7	0.265	0.42256	59.664	NR	NR		NR	NR	
1991	0.005	0.0	66.7	0.213	0.33989	59.664	NR	NR		NR	NR	
1992	0.005	0.0	66.7	0.216	0.34506	59.664	NR	NR		NR	NR	
1993	0.004	0.0	66.7	0.144	0.22948	59.664	NR	NR		NR	NR	
1994	0.003	0.0	66.7	0.109	0.17338	59.663	NR	NR		NR	NR	
1995	0.002	0.0	66.7	0.099	0.15738	59.663	NR	NR		NR	NR	
1996	0.003	0.0	66.7	0.100	0.16025	59.663	NR	NR		NR	NR	
1997	0.002	0.0	66.6	0.086	0.13665	59.663	NR	NR		NR	NR	
1998	0.002	0.0	66.7	0.093	0.14837	59.664	NR	NR		NR	NR	
1999	0.002	0.0	66.7	0.094	0.15042	59.664	NR	NR		NR	NR	
2000	0.002	0.0	66.7	0.086	0.13747	59.663	0.1	0.029	-66.4	0.017	0.002	-87.0
2001	0.003	0.0	66.7	0.118	0.18916	59.664	0.1	0.040	-66.4	0.023	0.003	-87.0
2002	0.003	0.0	66.7	0.099	0.15852	59.664	0.1	0.033	-66.4	0.019	0.003	-87.0
2003	0.002	0.0	66.7	0.096	0.15351	59.664	0.1	0.032	-66.4	0.019	0.002	-87.0
2004	0.003	0.0	66.7	0.100	0.15953	59.664	0.1	0.034	-66.4	0.019	0.003	-87.0
2005	0.002	0.0	66.7	0.086	0.13788	59.663	0.1	0.029	-66.4	0.017	0.002	-87.0
2006	0.002	0.0	66.6	0.076	0.12115	59.664	0.1	0.026	-66.4	0.015	0.002	-87.0
2007	0.002	0.0	66.6	0.077	0.12222	59.662	0.1	0.026	-66.4	0.015	0.002	-87.0
2008	0.002	0.0	66.7	0.065	0.10452	59.664	0.1	0.022	-66.4	0.013	0.002	-87.0
2009	0.002	0.0	66.7	0.077	0.12251	59.664	0.1	0.026	-66.4	0.015	0.002	-87.0
2010	0.002	0.0	66.6	0.069	0.10986	59.663	0.1	0.023	-66.4	0.013	0.002	-87.0
2011	0.002	0.0	66.7	0.068	0.10809	59.664	0.1	0.023	-66.4	0.013	0.002	-87.0

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Year	NO_x			TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
2012	0.002	0.0	66.7	0.083	0.13184	59.664	0.1	0.028	-66.4	0.016	0.002	-87.0
2013	0.002	0.0	66.7	0.070	0.11225	59.664	0.1	0.024	-66.4	0.014	0.002	-87.0
2014	0.002	0.0	66.7	0.090	0.14303	59.664	0.1	0.030	-66.4	0.017	0.002	-87.0

Table 8.20 The differences in poultry manure management emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NO_x			TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.002	0.0	100.0	0.135	0.07807	-42.0	NR	NR		NR	NR	
1991	0.002	0.0	99.9	0.114	0.06615	-42.0	NR	NR		NR	NR	
1992	0.001	0.0	99.9	0.070	0.04083	-42.0	NR	NR		NR	NR	
1993	0.001	0.0	100.1	0.066	0.03853	-42.0	NR	NR		NR	NR	
1994	0.001	0.0	99.9	0.062	0.03619	-42.0	NR	NR		NR	NR	
1995	0.001	0.0	100.0	0.059	0.03449	-42.0	NR	NR		NR	NR	
1996	0.001	0.0	100.0	0.036	0.02113	-42.0	NR	NR		NR	NR	
1997	0.001	0.0	100.2	0.036	0.02070	-42.0	NR	NR		NR	NR	
1998	0.001	0.0	100.0	0.054	0.03116	-42.0	NR	NR		NR	NR	
1999	0.001	0.0	100.2	0.045	0.02582	-42.0	NR	NR		NR	NR	
2000	0.001	0.0	99.8	0.043	0.02467	-42.0	0.0	0.012	-71.0	0.006	0.001	-77.8
2001	0.001	0.0	100.0	0.050	0.0290	-42.0	0.1	0.014	-71.0	0.007	0.001	-77.8
2002	0.001	0.0	99.9	0.064	0.03698	-42.0	0.1	0.018	-71.0	0.008	0.002	-77.8
2003	0.001	0.0	99.9	0.076	0.04414	-42.0	0.1	0.022	-71.0	0.010	0.002	-77.8
2004	0.001	0.0	100.0	0.079	0.04569	-42.0	0.1	0.023	-71.0	0.010	0.002	-77.8
2005	0.001	0.0	100.0	0.071	0.04135	-42.0	0.1	0.021	-71.0	0.009	0.002	-77.8
2006	0.001	0.0	100.0	0.068	0.03924	-42.0	0.1	0.020	-71.0	0.009	0.002	-77.8
2007	0.001	0.0	100.0	0.066	0.03824	-42.0	0.1	0.019	-71.0	0.009	0.002	-77.8
2008	0.001	0.0	100.0	0.071	0.04124	-42.0	0.1	0.021	-71.0	0.009	0.002	-77.8
2009	0.001	0.0	100.0	0.075	0.04333	-42.0	0.1	0.022	-71.0	0.010	0.002	-77.8
2010	0.001	0.0	100.0	0.084	0.04849	-42.0	0.1	0.024	-71.0	0.011	0.002	-77.8
2011	0.001	0.0	100.1	0.090	0.05193	-42.0	0.1	0.026	-71.0	0.012	0.003	-77.8
2012	0.001	0.0	100.0	0.087	0.05072	-42.0	0.1	0.025	-71.0	0.011	0.003	-77.8
2013	0.001	0.0	99.9	0.094	0.05446	-42.0	0.1	0.027	-71.0	0.012	0.003	-77.8
2014	0.001	0.0	100.0	0.096	0.05592	-42.0	0.1	0.028	-71.0	0.013	0.003	-77.8

Table 8.21 The differences in other poultry manure management particles emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.086	0.176	104.5	NR	NR		NR	NR	
1991	0.073	0.149	104.5	NR	NR		NR	NR	
1992	0.045	0.092	104.5	NR	NR		NR	NR	
1993	0.043	0.087	104.5	NR	NR		NR	NR	
1994	0.041	0.084	104.5	NR	NR		NR	NR	
1995	0.038	0.079	104.5	NR	NR		NR	NR	
1996	0.031	0.063	104.5	NR	NR		NR	NR	
1997	0.034	0.070	104.5	NR	NR		NR	NR	
1998	0.035	0.071	104.5	NR	NR		NR	NR	

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1999	0.024	0.049	104.5	NR	NR		NR	NR	
2000	0.021	0.044	104.5	0.010	0.044	337.5	0.001	0.006	400.0
2001	0.025	0.050	104.5	0.011	0.050	337.5	0.001	0.007	400.1
2002	0.028	0.057	104.5	0.013	0.057	337.5	0.002	0.008	400.1
2003	0.031	0.063	104.5	0.014	0.063	337.5	0.002	0.009	399.9
2004	0.034	0.069	104.5	0.016	0.069	337.5	0.002	0.010	399.9
2005	0.019	0.039	104.5	0.009	0.039	337.5	0.001	0.006	400.0
2006	0.025	0.052	104.5	0.012	0.052	337.5	0.001	0.007	400.0
2007	0.009	0.018	104.5	0.004	0.018	337.4	0.001	0.003	400.4
2008	0.027	0.055	104.5	0.013	0.055	337.5	0.002	0.008	399.9
2009	0.022	0.044	104.5	0.010	0.044	337.5	0.001	0.006	399.8
2010	0.026	0.053	104.5	0.012	0.053	337.5	0.002	0.008	399.9
2011	0.035	0.072	104.5	0.016	0.072	337.5	0.002	0.010	400.0
2012	0.031	0.064	104.5	0.015	0.064	337.5	0.002	0.009	400.1
2013	0.013	0.027	104.5	0.006	0.027	337.5	0.001	0.004	400.0
2014	0.035	0.071	104.5	0.016	0.071	337.5	0.002	0.010	400.1

Table 8.22 The differences in fur animals manure management NH_3, NO_x and NMVOC emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH_3			NO_x			NMVOC		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.003	0.005	58.8	0.00003	0.00007	133.3	0.283	0.448	58.5
1991	0.003	0.005	58.8	0.00003	0.00007	133.3	0.283	0.448	58.5
1992	0.002	0.004	72.8	0.00002	0.00006	200.0	0.228	0.394	72.8
1993	0.002	0.004	96.6	0.00002	0.00005	150.0	0.173	0.339	96.2
1994	0.001	0.003	141.0	0.00001	0.00004	300.0	0.118	0.285	141.2
1995	0.001	0.003	242.9	0.00001	0.00004	300.0	0.075	0.256	242.5
1996	0.000	0.001	279.3	0.00000	0.00002		0.028	0.107	286.2
1997	0.000	0.002	539.3	0.00000	0.00003		0.027	0.174	539.9
1998	0.000	0.002	362.5	0.00000	0.00003		0.039	0.179	364.0
1999	0.000	0.001	604.8	0.00000	0.00002		0.021	0.143	592.6
2000	0.000	0.001	621.4	0.00000	0.00002		0.013	0.098	638.1
2001	0.000	0.001	254.3	0.00000	0.00002		0.034	0.120	254.8
2002	0.001	0.002	201.5	0.00001	0.00002	100.0	0.063	0.153	144.1
2003	0.001	0.002	78.2	0.00001	0.00003	200.0	0.107	0.190	77.6
2004	0.001	0.002	73.5	0.00001	0.00003	200.0	0.113	0.197	73.5
2005	0.002	0.003	44.8	0.00002	0.00004	100.0	0.169	0.245	44.6
2006	0.001	0.002	45.8	0.00001	0.00003	200.0	0.138	0.201	46.1
2007	0.002	0.002	48.8	0.00002	0.00004	100.0	0.155	0.231	48.4
2008	0.002	0.002	15.9	0.00002	0.00003	50.0	0.152	0.177	16.1
2009	0.002	0.002	14.4	0.00002	0.00003	50.0	0.176	0.201	14.4
2010	0.002	0.002	14.9	0.00002	0.00003	50.0	0.170	0.195	14.4
2011	0.002	0.002	14.4	0.00002	0.00003	50.0	0.189	0.217	14.4
2012	0.002	0.002	15.0	0.00002	0.00003	50.0	0.187	0.216	15.1
2013	0.002	0.002	0.0	0.00002	0.00003	50.0	0.191	0.191	0.0
2014	0.002	0.002	0.0	0.00002	0.00003	50.0	0.216	0.216	0.0

Table 8.23 The differences in fur animals manure management particles emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	TSP			PM_{10}			$PM_{2.5}$		
	Old	Recalc.	Difference	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	0.003	0.004	58.4	NR	NR		NR	NR	
1991	0.003	0.004	58.4	NR	NR		NR	NR	
1992	0.002	0.004	73.0	NR	NR		NR	NR	
1993	0.002	0.003	96.9	NR	NR		NR	NR	
1994	0.001	0.003	140.0	NR	NR		NR	NR	
1995	0.001	0.002	243.5	NR	NR		NR	NR	
1996	0.000	0.001	280.8	NR	NR		NR	NR	
1997	0.000	0.002	544.0	NR	NR		NR	NR	
1998	0.000	0.002	361.1	NR	NR		NR	NR	
1999	0.000	0.001	600.0	NR	NR		NR	NR	
2000	0.000	0.001	658.3	0.0001	0.0004	566.7	0.00003	0.00020	566.7
2001	0.000	0.001	261.3	0.0001	0.0005	257.1	0.00007	0.00025	257.1
2002	0.001	0.001	144.8	0.0003	0.0006	142.3	0.00014	0.00032	128.6
2003	0.001	0.002	77.8	0.0005	0.0008	73.3	0.00023	0.00039	69.6
2004	0.001	0.002	73.3	0.0005	0.0008	72.3	0.00025	0.00041	64.0
2005	0.002	0.002	44.6	0.0007	0.0010	42.3	0.00037	0.00050	35.1
2006	0.001	0.002	46.1	0.0006	0.0008	45.6	0.00030	0.00041	36.7
2007	0.001	0.002	48.6	0.0007	0.0010	46.2	0.00034	0.00048	41.2
2008	0.001	0.002	16.3	0.0006	0.0007	14.1	0.00033	0.00036	9.1
2009	0.002	0.002	14.1	0.0007	0.0008	13.7	0.00038	0.00041	7.9
2010	0.002	0.002	13.9	0.0007	0.0008	12.7	0.00037	0.00040	116.2
2011	0.002	0.002	14.2	0.0008	0.0009	12.7	0.00041	0.00045	9.8
2012	0.002	0.002	14.9	0.0008	0.0009	14.1	0.00041	0.00044	7.3
2013	0.002	0.002	0.0	0.0008	0.0008	-1.3	0.00041	0.00039	-4.9
2014	0.002	0.002	0.0	0.0009	0.0009	-1.1	0.00047	0.00044	-6.4

8.3.2. Agricultural Soils

NO_x and NH_3 from inorganic N-fertilizer and particles have been recalculated for 1990–2014. Recalculations entail using new emission factors from the renewed EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016. The NH_3 emission from dairy cattle, non-dairy cattle, and swine, 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 and NH_3 emissions from sewage sludge and compost application are reported under NFR 3Da2b and 3Da2c respectively.

In addition, particles from cultivated crops were reported under NFR 3Dc instead of 3Da1 as it was in the 2016 submission.

Table 8.24 The differences in fertilizer application emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH_3			NO_x		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1990	6.023	3.585	-40.5	1.864	2.868	53.8
1991	4.902	2.918	-40.5	1.517	2.334	53.8
1992	4.902	2.918	-40.5	1.517	2.334	53.8
1993	2.516	1.497	-40.5	0.779	1.198	53.8
1994	2.190	1.303	-40.5	0.678	1.043	53.8
1995	1.588	0.945	-40.5	0.492	0.756	53.8

Year	NH$_3$			NO$_x$		
	Old	Recalc.	Difference	Old	Recalc.	Difference
1996	1.391	0.828	-40.5	0.431	0.662	53.8
1997	1.720	1.024	-40.5	0.532	0.819	53.8
1998	2.094	1.247	-40.5	0.648	0.997	53.8
1999	1.671	0.995	-40.5	0.517	0.796	53.8
2000	1.881	1.120	-40.5	0.582	0.896	53.8
2001	1.647	0.980	-40.5	0.510	0.784	53.8
2002	1.403	0.835	-40.5	0.434	0.668	53.8
2003	1.953	1.163	-40.5	0.605	0.930	53.8
2004	2.086	1.242	-40.5	0.646	0.993	53.8
2005	1.687	1.004	-40.5	0.522	0.803	53.8
2006	1.899	1.131	-40.5	0.588	0.904	53.8
2007	2.098	1.249	-40.5	0.650	0.999	53.8
2008	2.978	1.773	-40.5	0.922	1.418	53.8
2009	2.296	1.366	-40.5	0.711	1.093	53.8
2010	2.405	1.431	-40.5	0.744	1.145	53.8
2011	2.503	1.490	-40.5	0.775	1.192	53.8
2012	2.770	1.649	-40.5	0.857	1.319	53.8
2013	2.827	1.683	-40.5	0.875	1.346	53.8
2014	3.007	1.790	-40.5	0.931	1.432	53.8

Table 8.25 The differences in grazing emissions (kt) between the 1990–2014 and 2016 and 2017 submissions (%)

Year	NH$_3$		
	Old	Recalc.	Difference
1990	4.018	3.042	-24.3
1991	3.830	2.751	-28.2
1992	3.203	2.322	-27.5
1993	2.256	1.676	-25.7
1994	1.951	1.516	-22.3
1995	1.716	1.363	-20.6
1996	1.624	1.273	-21.6
1997	1.546	1.208	-21.9
1998	1.456	1.149	-21.1
1999	1.275	1.026	-19.6
2000	1.216	0.952	-21.7
2001	1.307	0.985	-24.6
2002	1.307	0.933	-28.7
2003	1.172	0.933	-20.4
2004	1.243	0.967	-22.2
2005	1.262	0.977	-22.5
2006	1.268	0.983	-22.5
2007	1.261	0.979	-22.3
2008	1.262	1.005	-20.4
2009	1.264	0.982	-22.3
2010	1.274	0.993	-22.0
2011	1.288	1.015	-21.2
2012	1.348	1.057	-21.6
2013	1.458	1.147	-21.3
2014	1.370	1.067	-22.1

8.4. Waste Sector (NFR 5)

There are some recalculations of pollutant emissions in the waste sector due to the corrections in statistical activity data, corrections in emission calculations and corrections in OSIS point sources database, where emissions were allocated under wrong SNAP code.

The comparison between the submissions for 2016 and 2017 are made by using exact calculation numbers. The differences between 2016 and 2017 submissions are presented in Tables 8.26-30.

Table 8.26 The difference in solid waste disposal on land (NFR 5A) emissions (kt) between 2016 and 2017 submissions (%)

Year	NMVOC			NH_3			$PM_{2.5}$			PM_{10}		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2003	1.104318	1.084318	-1.8									
2007				NE	0.000036	100.0						
2008				NE	0.000038	100.0	0.0000848	0.0000148	-82.6	0.000237	0.000098	-58.6
2009	0.569156	0.545258	-4.2									
2013	0.175398	0.167953	-4.2									
2014	0.139205	0.130297	-6.4									

Table 8.27 The difference in anaerobic digestion (NFR 5B2) emissions (kt) at biogas facilities between 2016 and 2017 submissions (%)

Pollutant	Year	2011	2012	2013	2014
NO_x	2016	NA	NA		
	2017	0.001529	0.001529		
	%	100.0	100.0		
NMVOC	2016	NA	NA		
	2017	0.0000765	0.000077		
	%	100.0	100.0		
SO_x	2016	NA	NA		
	2017	0.000068	0.000068		
	%	100.0	100.0		
NH_3	2016	NA	NA	0	0
	2017	0.000344	0.000344	0.000344	0.000344
	%	100.0	100.0	100.0	100.0
TSP	2016	NA	NA		
	2017	0.000002	0.000002		
	%	100.0	100.0		
CO	2016	NA	NA		
	2017	0.001444	0.001444		
	%	100.0	100.0		

Table 8.28 The difference in open burning of waste (NFR 5C2) emissions between 2016 and 2017 submissions (%)

	NO_x, kt			NMVOC, kt			SO_x, kt			$PM_{2.5}$, kt		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2014	0.005805	0.005487	-5.5	0.000064	0.000061	-5.4	0.005482	0.005182	-5.5	0.029669	0.028045	-5.5
	PM_{10}, kt			TSP, kt			BC, kt			CO, kt		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2014	0.044180	0.041762	-5.5	0.059015	0.055785	-5.5	0.001038	0.000982	-5.4	0.002257	0.002134	-5.5
	Pb, t			Cd, t			Hg, t			As, t		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2014	0.335384	0.317029	-5.5	0.010964	0.010364	-5.5	0.009030	0.008535	-5.5	0.006901	0.006523	-5.5
	Cr, t			Cu, t			Ni, t			Zn, t		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2014	0.000597	0.000564	-5.5	0.000300	0.000283	-5.6	0.000387	0.000366	-5.4	0.002902	0.002744	-5.5
	PCDD/F, g I-TEQ			B(a)p, t			B(b)f, t			B(k)f, t		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2014	0.128994	0.121934	-5.5	0.000014	0.000013	-4.0	0.000010	0.00001	-3.1	0.000010	0.000009	-10.0
	PAHs Total, t			HCB, kg			PCBs, kg					
	2016	2017	%	2016	2017	%	2016	2017	%			
2014	0.000034	0.000032	-5.5	0.006450	0.006097	-5.5	0.017092	0.016156	-5.5			

Table 8.29 The difference in industrial wastewater handling (NFR 5D2) emissions (kt) between 2016 and 2017 submissions (%)

Year	NMVOC		
	2016	2017	%
2014	0.026432	0.001098	-95.8

Table 8.30 The difference in other waste (NFR 5E) emissions between 2016 and 2017 submissions (%)

Year	$PM_{2.5}$, kt			PM_{10}, kt			TSP, kt			Cu, t			PCDD/F, g I-TEQ		
	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%	2016	2017	%
2012										0.002	0.002	-0.1			
2013										0.002	0.002	-0.1			
2014	0.075	0.083	10.5	0.075	0.083	10.5	0.075	0.083	10.5	0.002	0.002	10.5	0.762	0.843	10.7

Table 8.30 continues

Year	As, t			Cr, t		
	2016	2017	%	2016	2017	%
1998	0.002	0.002	0.2	0.002	0.002	0.2
1999	0.002	0.002	0.3	0.002	0.002	0.2
2000	0.002	0.002	0.2	0.002	0.002	0.3
2001	0.002	0.002	0.3	0.002	0.002	0.2
2002	0.002	0.002	0.2	0.002	0.002	0.2
2003	0.002	0.002	0.2	0.002	0.002	0.2
2004	0.001	0.002	0.2	0.001	0.001	0.2
2005	0.002	0.002	0.2	0.002	0.002	0.3
2006	0.002	0.002	0.2	0.002	0.002	0.3
2007	0.001	0.001	0.1	0.001	0.001	0.1
2008	0.001	0.001	0.2	0.001	0.001	0.3
2009	0.001	0.001	0.3	0.001	0.001	0.3
2010	0.001	0.001	0.3	0.001	0.001	0.3
2011	0.001	0.001	0.4	0.001	0.001	0.4
2012	0.001	0.001	0.2	0.001	0.001	0.3
2013	0.001	0.001	0.1	0.001	0.001	0.3
2014	0.001	0.001	11.1	0.001	0.001	10.7

ANNEX

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

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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	%	%	%		%	%	%	%	%
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
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

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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	NO_x	0.3300	0.0848	2%	50%	50.04%	0.000002	-0.06011	0.10977	-0.03005	0.00310	0.00001
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

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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	%	%	%		%	%	%	%	%
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
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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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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	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	%	%	%		%	%	%	%	%
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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	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	%	%	%		%	%	%	%	%
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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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	%	%	%		%	%	%	%	%
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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	NFR sector	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_{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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	NFR sector	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	%	%	%		%	%	%	%	%
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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NFR sector		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)	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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	NFR sector	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	%	%	%		%	%	%	%	%
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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			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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			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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			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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			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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			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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			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

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	%	%	%		%	%	%	%	%
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

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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	%	%	%		%	%	%	%	%
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%

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	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

	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	%	%	%		%	%	%	%	%
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%

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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	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

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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	%	%	%		%	%	%	%	%
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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	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	%	%	%		%	%	%	%	%
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%

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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	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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	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	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%

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	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%