FINLAND's INFORMATIVE INVENTORY REPORT 2017

Air Pollutant Emissions 1980-2015

under the UNECE CLRTAP and the EU NECD

Part 3

IPPU

Revised 28 April 2017 from the submission on 15.3.2017

FINNISH ENVIRONMENT INSTITUTE

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The documentation of the IPPU sector
has been updated to this 1 May 2017 resubmission
since the original submission on 15.3.2017

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4 INDUSTRIAL PROCESSES AND PRODUCT USE (NFR 2)

4.1 Overview of the sector

Changes in chapter	
Update of text	Aoril 2017 KS; JMP
Other (e.g. language, layout)	April 2017

In Finland, the main activities in the Industrial processes and product use sector in respect to air pollutant emissions, are mineral, chemical, metal and forest industries, as presented in Figure 4.1.

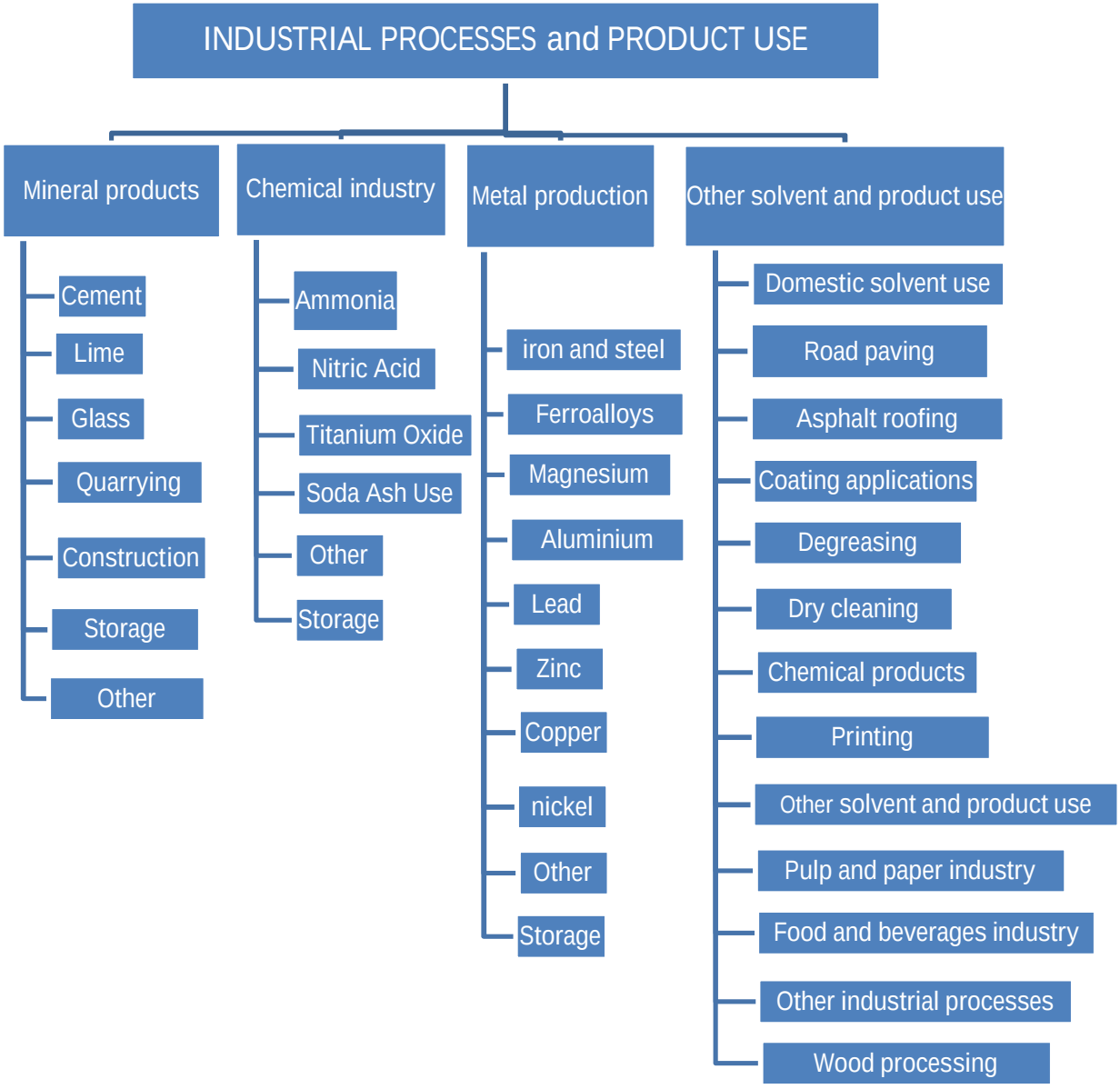


Figure 4.1. Industrial process included in the Finnish air pollutant inventory.

Allocation of emissions in the NFR Table

Emissions from industrial activities are allocated under the NFR categories as follows:

Energy NFR 1	production of electricity consumed in the industry electricity and heat autoproducers in the industry use of off-road machinery and industrial transport
IPPU NFR2	production processes
Waste NFR5	industrial waste management

Data reported by the plants

Plant operators report their emissions to the supervising authorities[1] according to the monitoring requirements in the environmental permits. In many cases the reporting obligations determined in the monitoring programmes are for the total emissions of the plants and not separately for fuel combustion or the individual processes. Therefore, it has not always been possible to make a split between emissions from fuel based and non-fuel based sources in the inventory, and emissions are then reported as IE (included elsewhere).

For those plants that report only total emissions, the process related emissions are estimated to be the difference between the total emissions reported by the plant and the default emissions calculated on basis of fuel consumption. This difference is reported under the industrial processes. In cases where it has not been possible to make a split between energy and process related emissions, or when the emissions are clearly fuel based, all emissions are reported under NFR 1A2gviii.

Emission trends

Emissions from industrial processes are affected by changes in production volumes, changes in the processes or in the use of raw materials and auxiliary chemicals. The production volumes decreased in the 1990s' when a number of plants shut down their operations due to the recession, and increased again since 1996 until recently, when a decreasing trend has returned with the economic turndown (Figure 4.2).

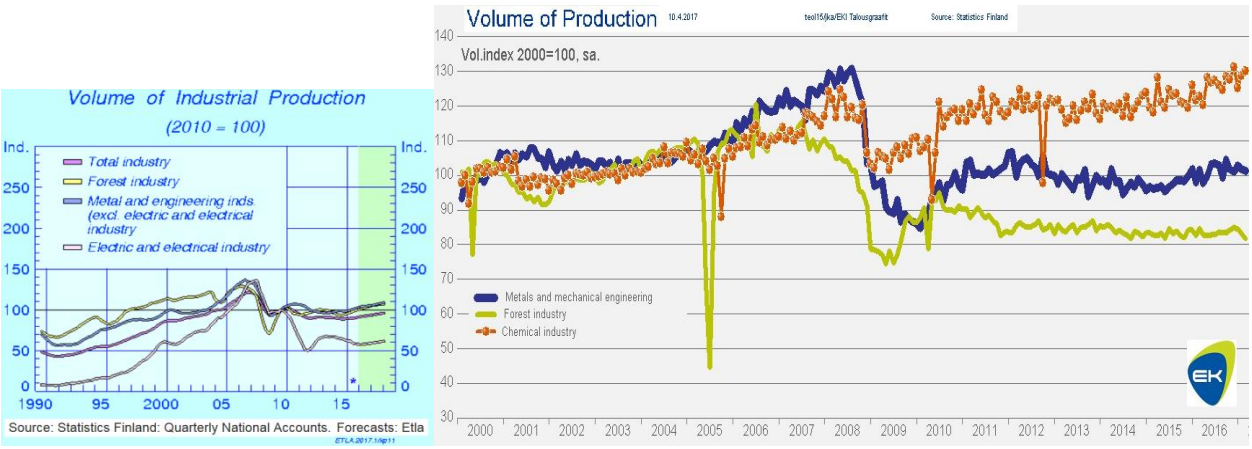


Figure 4.2. Industrial production 1990-2016 (Confederation of Finnish Industries, Statistics Finland, ETLA, 2017)

[1] The emission data is available from the VAHTI database after it has been checked and approved by the authorities.

4.2 Mineral Products (NFR 2.A)

Changes in chapter	
Update of emission figures	April 2017 JMP
Update of text	April 2017 KS, JMP
Other (e.g. language, layout)	April 2017 KS

4.2.1 Source category description

Industrial activities falling under NFR 2A Mineral products are listed inTable 4.1. The allocation of emissions to energy and industrial processes sectors may differ between the years as no recalculation of time series has not yet been carried out. Corrections in the allocations will be made when the recalculations are finalized.

Table 4.1. Industrial activities and air pollutant emissions under NFR 2A Mineral products.

NFR	Source	Emissions reported under NFR 2A
2A1	Cement production	NMVOC, Hg, Ni, PCDD/F, PCB
2A2	Lime production	TSP, PM_{10}, $PM_{2.5}$, BC, Cu, Ni, Zn, Cr, Pb, PCDD/F, PCB
2A3	Glass production	PM2.5, PM10, TSP, BC, NMVOC, PCDD/F
2A5a	Quarrying and mining of minerals other than coal	TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, As, Cr, Cu, Ni, Zn
2A5b	Construction and demolisation	TSP, PM_{10}, $PM_{2.5}$, (heavy metal emissions Pb, Cd, Hg, As, Cr, Cu, Ni should be allocated under 1A2gviii).
2A5c	Storage, handling and transport of mineral products	TSP, PM_{10}, $PM_{2.5}$
2A6	Other mineral products	Not Occuring

4.3 Cement production (NFR 2A1)

Changes in chapter	
Update of emission figures	March 2017 JMP
Other (e.g. language, layout)	April 2017 KS, JMP
Update of text	April 2017 JMP, KS
Recalculations	none

4.3.1 Source category description

SNAP 040612	Cement has been produced in Finland since 1914. There are currently two operating plants in Finland. At a third plant procution ceased in 1993. The current plants fall under the IED and report their emissions according to the monitoring requirements in their environmental permits. REF (recovered fuels prepared out of waste material) is used as fuel in these plants, in addition to rubber waste (since 1996). The plants also have have permission to use bio-based fuels (plant or grain based fuels) for experimental use. Fuel combustion emissions are reported under the energy sector.
Emissions	Source of emissions
SOx, NOx, CO, NH3	These are emissions from fuel combustion, They are reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii.
NMVOC	Cement production prosess emissions (partly reported by the plants and partly calculated), allocated under 2A1
TSP, PM10, PM2.5	Fuel combustion, reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii.
Hg	Waste fuel combustion, reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii.
PCDD/F	waste fuel combustion (rubber, REF..)
PCB	waste fuel combustion (rubber, REF..)

4.3.2 Emission trend

Cement industry is a minor source of air pollutant emissions in Finland. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.2.

Cement production volumes affect emissions over the years. Note that the allocation of activities under the NFR categories and the methods used to calculate emissions are not necessarily consistent over the years. The time series of emissions has not been recalculated and thus the variations in the emissions do not fully correspond to actual variations in emissions.

Table 4.2. Contribution of cement production to total emissions in 2015.

Pollutant	Emissions from cement production in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
Hg	0.012	0.64	Mg	2	100
Ni	0.006	16.92	Mg	<0.1	100
NMVOC	0.023	87.76	Gg	<0.1	42.4
PCBs	2.348	151.89	kg	1.5	0
PCDD/Fs	0.01	14.25	g I-Teq	<0.1	0

4.3.3 Methodological issues

As presented inTable 4.2 heavy metal emissions and part of NMVOC emissions are reported by the plants and the data is used in the inventory. For those plants that do not report emissions, are calculated for 1990-2015 as follows:

NMVOCs
For the years 1990-1995 all NMVOC emissions are calculated. NMVOC emissions from cement production have been reported into VAHTI since 1996 by one plant according to the monitoring requirements. For the other plants the EF of 0.033 kg/t is used. The EF is an expert estimate (SYKE, 2007) based on an implied EF calculated on basis of emission data from one cement factory. Calculated emissions from cement production are presented in Table 4.4

POPs
PCDD/F emissions have been reported since 2001. For the years prior to 2001 all emission were calculated. The EF used for calculation of emissions PCDD/F is 25.8 g I-Teq (expert estimate; SYKE, 2007). After 2001 emission data reported by the plants are used in the inventory. Because this data includes both process and energy consumption related emissions, part of the emissions has been allocated to the energy sector under NFR 1A2fii, but not consistently over the years. The allocation will be checked when recalculation of the time series has been carried out.

The EF used for calculation of PCB emissions is 2000 ug/t (BiPRO, 2006).

Cement production volumes used as activity data presented in Table 4.3 are based on yearly statistics in Kemia-Kemi Journal before the year 2000 and after that on data reported by the plants. Calculated emissions from cement production are presented in Table 4.4.

PAH-4 emissions reported in the NFR table are based on data reported by the plants to the environmental authorities. However, these emissions turned out not to be from the process but from fuel combustion and are therefore currently allocated to the energy sector. The allocation over the years will be checked when the time series is recalculated.

Table 4.3. Cement production volumes (t/a) from yearly statistics in Kemia-Kemi Journal 1990-1999 and from VAHTI database from 2000 onwards

Year	t/a	Year	t/a	Year	t/a	Year	t/a
1980	1 815 128	1990	1 649 220	2000	1 423 091	2010	1 195 913
1981	1 862 913	1991	1 343 000	2001	1 324 705	2011	1 401 427
1982	1 906 639	1992	1 133 000	2002	1 194 676	2012	1 272 857
1983	1 978 925	1993	836 000	2003	1 185 886	2013	1 276 953
1984	1 691 511	1994	864 000	2004	1 295 058	2014	1 258 953
1985	1 695 367	1995	906 970	2005	1 347 007	2015	1 173 918
1986	1 495 411	1996	975 425	2006	1 539 786		
1987	1 579 284	1997	1 151 990	2007	1 771 724		
1988	1 618 509	1998	1 232 235	2008	1 633 243		
1989	1 693 304	1999	1 309 935	2009	1 025 421		

Table 4.4. Calculated NMVOC, PCDD/F and PCB emissions from cement production

Year	NMVOC (kg)	PCDD/F (g I-TEQ)	PCB (kg)	Year	NMVOC (kg)	PCDD/F (g I-TEQ)	PCB (kg)
1990	54	0.043	3.30	2010	13	0.010	2.39
1991	44	0.035	2.69	2011	17	0.014	2.80
1992	37	0.029	2.27	2012	14	0.011	2.55
1993	28	0.022	1.67	2013	14	0.011	2.55
1994	29	0.022	1.73	2014	13	0.010	2.52
1995	30	0.023	1.81	2015	13	0.010	2.35
1996	9*	0.026	1.95				
1997	12	0.030	2.30				
1998	14	0.032	2.46				
1999	14	0.034	2.62				
2000	16	0.034	2.85				
2001	15	0.012**	2.65				
2002	14	0.012	2.39				
2003	14	0.012	2.37				
2004	13	0.010	2.59				
2005	14	0.011	2.69				
2006	16	0.013	3.08				
2007	19	0.014	3.54				
2008	18	0.014	3.27				
2009	10	0.008	2.05				

*NMVOC emissions are calculated for the years 1990-1995 and after that reported by the plants.
** For years prior to 2001 all emission are calculated. Since 2001 emission data reported by the plants is used, however, the allocation between the energy (NFR 1A2fii) and process sectors needs to be checked when the recalculation of the time series is carried out.

4.3.4. Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.3.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.3.6 Source-specific recalculations including changes made in response to the review process

None.

4.3.7 Source-specific planned improvements

Planned for 2018 submission

- The allocation between the energy (NFR 1A2fii) and process sectors to be checked.

4.4 Lime production (NFR 2A2)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.4.1 Overview of the sector

SNAP 040614	LIME DECARBONIZING Production volumes of lime were constent over the period 1990-2002. A new plant was started in 2003. All plants fall under the IED and report their emissions according to monitoring requirements in their environmental permits. The category also includes lime stone mines (quarrying of lime).
Emissions	Source of emissions
SO2, NOx, CO	Fuel combustion, reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii.
TSP, PM10, PM2.5, BC	Fuel combustion, reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii. PM_{10} and $PM_{2.5}$ fractions have been calculated from the TSP emissions using fraction factors of 50% and 14% from TSP (AEAT, 2000).
Cd, Hg, Cr	Fuel combustion, reported by the plants according to the monitoring and reporting requirements in the environmental permits and allocated under NFR 1A2gviii.
PCDD/F	waste incineration (recycled and waste oils)
PCB	waste incineration (waste oil)

4.4.2 Emission trends

The emission trends are impacted by annual production volumes. There have been changes in the allocation of activities under the NFR over the years, therefore the current time series is not consistent. The allocation will be checked when the time series is recalculated.
The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.5.

Table 4.5. Contribution of lime production to total emissions in 2015.

Pollutant	Emissions from lime	Total emissions	Unit	Share of total	% reported by the plants
BC	<0.001	4.60	Gg	<0.1	0
Cr	<0.001	15.63	Mg	<0.1	100
Cu	0.003	39.57	Mg	<0.1	100
Ni	<0.001	16.92	Mg	<0.1	100
Pb	<0.001	13.93	Mg	<0.1	100
TSP	0.003	50.02	Gg	<0.1	100
Zn	0.005	129.07	Mg	<0.1	100
PCBs	0.248	151.89	kg	0.2	0
PCDD/Fs	0.129	14.25	g I-Teq	0.9	0
PM10	0.001	32.15	Gg	<0.1	0
PM2.5	<0.001	21.98	Gg	<0.1	0

4.4.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available, the emissions have been calculated. Calculated emissions from lime production are presented in Table 4.7.

Particles
PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions reported by the plants using fraction factors of 50% and 14%, respectively (AEAT, 2000).
Black carbon emissions have been calculated using the factor of 0.46 % of PM2.5 emissions (GB16, EEA 2016).

POPs
Emissions are calculated using lime production annual statistics in the Kemia-Kemi Journal presented in Table 4.6 and the following emission factors: for PCDD/F 78 ng I-TEQ/t (UNEP, 1999) and for PCB 0.15 mg/t (BiPRO, 2006).

Table 4.6. Activity data for lime production. Source: annual statistics in Kemia-Kemi Journal

Year	Lime production (t)	Year	Lime production (t)	Year	Lime production (t)
1990	1 950 000	2000	1 860 800	2010	1 758 216
1991	1 535 400	2001	2 042 200	2011	1 652 233
1992	1 315 800	2002	2 259 900	2012	1 652 233*
1993	1 718 100	2003	1 919 000	2013	1 652 233*
1994	1 755 400	2004	1 900 300	2014	1 652 233*
1995	1 645 200	2005	1 852 400	2015	1 652 233*
1996	1 716 500	2006	2 212 000		
1997	1 894 400	2007	2 067 197		
1998	1 961 800	2008	1 950 433		
1999	2 017 800	2009	1 681 000		

*due lack of activity data, the production rate od 2011 is used for the years 2011-2015

Table 4.7. Calculated PCDD/F emissions from lime production

Year	PCDD/F (g I-TEQ)	Year	PCDD/F (g I-TEQ)
1990	0.15	2006	0.17
1991	0.12	2007	0.16
1992	0.10	2008	0.15
1993	0.13	2009	0.13
1994	0.14	2010	0.14
1995	0.13	2011	0.13
1996	0.13	2012	0.13
1997	0.15	2013	0.13
1998	0.15	2014	0.13
1999	0.16	2015	0.13
2000	0.15		
2001	0.16		
2002	0.18		
2003	0.15		
2004	0.15		
2005	0.14		

4.4.4 Uncertainty analysis and source specific recalculations

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.4.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.4.6 Source-specific recalculations including changes made in response to the review process

None.

4.4.7 Source-specific planned improvements

Planned for 2018
- Check of production rates for the years 2011-2015
- The allocation of emissions between energy and process sectors

4.5 Glass *production (NFR 2A3)*

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	2014
Other (e.g. language, layout)	April 2017 KS
Recaculations	None

4.5.1 Source category description

SNAP 040613	GLASS MANUFACTURING
	Activities under this sector include manufacturing of glass, glass fibre, glass wool and glasfelt manufacturing. During 1988-2013 there were 6 operating glass manufacture plants in Finland: - The only flatt glass producer using float technique (since 1987) was in operation between 1969-2008. - Two plants have produced glassfibre, one of them was closed down 2009 and the other changed to manufacturing of glassfelt since 2010. - The production volumes of 3 plants, which all produce dinnerware, deceased strongly after 2010 and gradually only certain parts of the dinnerware were manufactured in Finland. At the end of 2014 one of these plants was closed down. - In 2015 only glass felt and some minor glass ovens are left.
Emissions	Source of emissions
particles (TSP, PM10, PM2.5, BC) heavy metals (Pb, Cd, Cu, Se, Zn)	Emissions due to fuel combustion are reported under the Energy sector
SOx	Emissions due to fuel combustion are reported under the Energy sector
NMVOC, PCDD/F	NMVOC emissions for glass wool are calculated according to GB2016. NMVOC and PCDD/F emissions for glass manufacturing are calculated as the difference of emissions reported by the plants and default emissions calculated on basis of fuel consumption.

4.5.2 Emission trends

Glass production volumes and thus also emissions have decreased to only some percentages from their levels in the 1990's or from the high production volume period in 2005-2008 as presented in Table 4.9.

In 2009 a large flat glass production plant was closed and in 2008 the only container glass production plant. Glass wool was produced between1996-2010, since then the process was changed to manufacturing of glassfelt. In 2015 there are some glass production units and glass felt production left. Large variations in emissions are due to variations in emissions reported by the plants to supervising authority, mainly based on the fluctuating production levels.

The shares of emissions of total emissions and the shares of emissions reported by the plants are presented in Table 4.8. Note that while the shares of emissions are generally low, cadmium emissions contributed to 10% of the total Cd emissions during 2008-2013. Cd emissions originated from raw material processing in dinnerware production. In 2014 raw material processing was relocated and the activity causing Cd emissions was closed down.

Table 4.8. Contribution of emissions from Glass products to total emissions in 2015

Pollutant	Emissions from glass products in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
BC	<0.001	4.60	Gg	<0.1	0
NMVOC	0.002	87.76	Gg	<0.1	100
TSP	0.008	50.02	Gg	<0.1	100
PCDD/Fs	<0.001	14.25	g I-Teq	<0.1	0
PM10	0.007	32.15	Gg	<0.1	0
PM2.5	0.006	21.98	Gg	<0.1	0

4.5.3 Methodological issues

SOx, NOx, particles and heavy metals
The emissions originate in energy production and are mainly reported by the plants according to the monitoring requirements in the environmental permits. The allocation of these emissions under NFR2A3 and 1A2gviii has changed over the years and the consistency will be improved when the time series is recalculated.

Particles
TSP emissions are generated in the glass smelting process. TSP emissions are reported by the plants according to their emissions monitoring requirements.
PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions using fraction factors of 90% and 80% from TSP (expert estimate SYKE, 2005).
Black carbon emissions have been calcuted using the emission factor 0.062 % of PM2.5 (GB16, EEA 2016).

NMVOC
Emissions for 1990-2011 were previously calculated with the emission factor of 0.005 kg/t from USEPA AP-42 (USEPA, 1990) and activity data based on an expert estimation using information collected in the Finnish national BAT Group for glass industry (Conclusions of Finnish BAT group for Glass Industry, 2001). The same value was used for all the years.

Calculated NMVOC emissions are presented in 0.

NH3
Ammonia emissions for the years after 2007 are based on emission data reported by the plants according to their environmental permit monitoring requirements. For the period of 1996-2007 data reported by the plants was available only for 2007. Currently the same emission value is used over the whole period of 1996-2007 but these emissions will be checked against production volumes for the submission in 2018.

For the years 1990-1995 and 2011-2015 ammonia emissions from glass production are not yet calculated, however, the magnitude of emissions in 1990-1995 is assumed to be 0.02 kt and in

2011-2015 of the magnitude of 0.01 kt. Inclusion of these emissions is planned for the 2018 submission.

For the 2015 submission NH_3 emissions from glass wool production were included to the inventory for the first time for the whole time series 1996-2010, when glass wool was produced in Finland.

NMVOC emissions are presented in 0.

The generation of emissions from glass felt production will be studied for the submission in 2018.
PCDD/F
Emissions have been calculated using the emission factor of 32 ng I-TEQ/t from UNEP (UNEP, 1999) and are presented in 0.

Activity data
Activity data was revised in the 2014 submission for the whole time series based on annual production volumes.

In 2014 the two operating companies reported their emissions to the supervising authorities, in 2015 only one operator is left. Based on data available for plants reporting their emissions it has not been possible to develop a national emission factor due to the varying quality of data. Therefore, for the rest of glass manufactures the emission factor of 0.01 kg/t of glass produced (BREF Manufacture of Glass, Table 4.40, 2013) was applied, together with the production rates of the companies.

Glass production volumes are presented in 0.

Table 4.9. Activity data for glass production (tonnes/year)

Year	AD for plants that do not report emissions to supervising authorities, used in calculation of NMVOC emissions (VAHTI)	AD in all glass production installations, used in calculation of POP and NH3 emissions (VAHTI)
1990	137 600*	169 153
1991	137 600*	168 678
1992	137 600*	169 096
1993	137 600*	168 490
1994	137 600*	168 491
1995	137 600*	168 530
1996	137 600	169 100
1997	138 332	169 167
1998	133 394	163 491
1999	118 625	152 725
2000	119 034	171 134
2001	141 592	187 718
2002	131 642	180 908
2003	146 343	186 023
2004	145 838	184 596
2005	257 764	301 203
2006	252 745	301 340
2007	260 019	310 513
2008	189 584	242 782
2009**	55 568	89 751
2010**	6 072	41 359
2011**	8 035	54 111
2012	7 968	15 149
2013	6 855	15 278
2014	3 218	11 437
2015	3 218***	7 182

* information collected in the Finnish national BAT Group for glass industry ** emissions have been declining since 2009 due to closure of a large flat glass plant and a container glass plant in 2009. *** year 2015 activity data not available, used years 2014 data

Table 4.10. Calcaluted NH3, NMVOC and PCDD/F emissions from glass manufacturing

Year	NMVOC (kg)	PCDD/F (g I-TEQ)	NH_3 (kt)
1990	1.376	0.0054	NE*
1991	1.376	0.0054	NE*
1992	1.376	0.0054	NE*
1993	1.376	0.0054	NE*
1994	1.376	0.0054	NE*
1995	1.376	0.0054	NE*
1996	1.376	0.0054	0.018
1997	1.383	0.0054	0.018
1998	1.334	0.0052	0.018
1999	1.186	0.0049	0.018
2000	1.190	0.0055	0.018
2001	1.416	0.0060	0.018
2002	1.316	0.0058	0.018
2003	1.463	0.0060	0.018
2004	1.458	0.0059	0.018
2005	2.578	0.0096	0.018
2006	2.527	0.0096	0.018
2007	2.600	0.0099	0.018
2008	1.896	0.0078	0.008
2009	0.556	0.0029	0.010
2010	0.061	0.0013	0.011
2011	0.080	0.0017	NE*
2012	0.080	0.0005	NE*
2013	0.069	0.0005	NE*
2014	0.003	0.0004	NE*
2015	0.003	0.0002	NE*

* the emission levels assumed at 0.02 kt for 1990-1995 and at 0.01 kt for 2011-2015, will be calculated to the 2018 submission

4.5.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.5.5 Source-specific QA/QC and verification

Normal statistical quality checks related to assessment of magnitude and trends have been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.5.6 Source-specific recalculations including changes made in response to the review process

2014

- The emission factor for NMVOC emissions and activity data were revised in the 2014 submission for the whole time series. Previosly, the same activity data was used for whole time series, since 2014 submission production rates of the companies are used.
-

4.5.7 Source-specific planned improvements

Planned for 2018 submission

- Calculation of NH3 emissions for 1990-1995 and for 2011-2015
- Check of glass production volumes
- Emission levels in 1990-2006 to be checked against production volumes
- The generation of emissions from glass felt production to be studied.

4.6 Quarrying and mining of minerals other than coal (NFR 2A5a)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	2009
Other (e.g. language, layout)	April 2017 KS
Recaculations	None

4.6.1 Source category description

SNAP 040616 and 040623	EXTRACTION OF MINERAL ORES and QUARRYING includes copper and zinc, talc manufacturing, limestone and quartzite quarrying
Emissions	Source of emissions
NOx, SOx, CO	fuel combustion (to be reallocated under NFR1A2gviii)
Particles (TSP, PM10, PM2.5) and heavy metals (Pb, Cd, As, Cr, Cu, Ni, Zn)	Cu and Zn emissions for all mines are calculated with a national method other heavy metals reported by plants

Metal and mineral ore mining activities and developing metallurgical technology and mining equipment have a long history in Finland. Metals and minerals present in the bedrock are mined on basis of their composition, extent, and geographical location of the deposit, operating expenditures, and global market prices. To open a mine, an environmental permit is needed.

Mining of metallic minerals in Finland includes iron, chromium, copper, nickel, zinc, gold, vanadium, titanium, lead, cobalt, silver, tungsten, and molybdenum, along with ores containing rare-earth elements. In 2014, there were 11 metallic mineral mines (Table 4.12 and 0) operating in Finland. Eight of these were gold mines, and the other mines produced chromium, copper, nickel, zinc, sulphur, cobalt, silver and platinum group metals (PGM). In addition three mines are commencing operation (GTK, Geolocigal Survey of Finland, 2016).

Industrial minerals are excavated for the production of, for example, building materials, fertilisers, dishes, paper, plastics, electronics, cosmetics, medicines, foodstuffs, and clean drinking water. Industrial stones are crushed and ground, then used as raw material for stone wool, cement, and similar products. The major industrial minerals mined in Finland are carbonates, apatite and talc[2]. Significant processing and refining of copper and nickel concentrates in Harjavalta, zinc in Kokkola, chromium in Kemi, and of iron in Raahe.

The shares of emissions of total emissions and emissions reported by the plants are presented in 0.

[2] http://en.gtk.fi/informationservices/mineralproduction/index.html

Table 4.11. Contribution of Quarrying and mining of minerals other than coal (NFR 2A5a) to total emissions in 2015.

Pollutant	Emissions from Quarrying and mining of minerals other than coal in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
As	0.006	2.43	Mg	0.2	100
Cd	0.001	0.92	Mg	0.1	100
Cr	0.002	15.63	Mg	<0.1	100
Cu	0.039	39.57	Mg	<0.1	100
Ni	0.002	16.92	Mg	<0.1	100
Pb	0.001	13.93	Mg	<0.1	100
TSP	0.088	50.02	Gg	0.2	15.8
Zn	0.033	129.07	Mg	<0.1	100
PM10	0.043	32.15	Gg	0.1	0
PM2.5	0.007	21.98	Gg	<0.1	0

The structure of the Finnish mining industry is presented in Figure 4.33 and the mining sites in Figure 4.44.

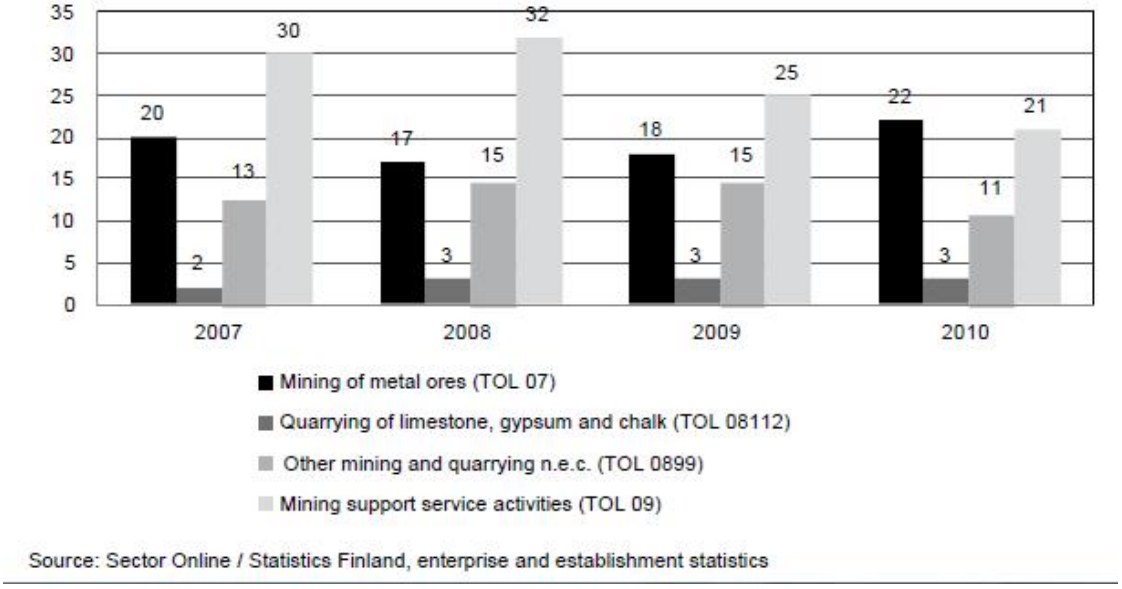


Figure 4.3. Number of enterprises 2007-2010 in mining industry

Table 4.12. Mining in Finland 2014 (Geological Survey of Finland 23.2.2016) www.en.gtk.fi

Group	Mines/ Quarries	Total output (t)	Total ore output (t)	Ore %	Leftover rock (t)
Metallic ores	11	35 818 369	13 403 495	37 %	22 414 874
Carbonate rocks	14	5 403 199	3 691 566	68 %	1 711 633
Other industrial minerals*	7	33 121 115	12 043 018	36 %	21 078 097
Industrial rocks	2	159 645	124 985	78 %	34 660
Natural stones*	6	341 863	281 496	82 %	60 367
In total	**40**	**74 844 191**	**29 544 560**	**39 %**	**45 299 631**

** Includes also gemstones ** Dimension stones included in the Finnish Mining Law*

Table 4.13. Mining in Finland 2014 (Geological Survey of Finland23.2.2016 www.en.gtk.fi)

Mine/Quarry	Locality	Commodity	Total output (t)	Total ore output (t)	Ore %	Leftover rocks (t)	Mine type
Suurikuusikko	Kittilä	Au	1 493 940	1 168 993	78	324 947	UG
Jokisivu	Huittinen	Au	135 844	125 844	93	10 000	UG
Orivesi	Orivesi	Au	237 569	170 782	72	66 787	UG
Pampalo	Ilomantsi	Au	575 740	343 062	60	232 678	UG
Rämepuro	Ilomantsi	Au	434 972	52 280	12	382 692	UG
Kevitsa	Sodankylä	Cu, Ni, PGM, Au	28 138 953	6 933 619	25	21 205 334	OP
Kylylahti	Polvijärvi	Cu, Co, Ni, Zn	673 600	671 465	100	2 135	UG
Pahtavaara	Sodankylä	Au	228 378	167 072	73	61 306	UG
Laiva	Raahe	Au	203 385	108 836	54	94 549	OP
Kemi	Keminmaa	Cr	2 319 416	2 284 970	99	34 446	UG
Pyhäsalmi	Pyhäjärvi	Zn, Cu, S	1 376 572	1 376 572	100	0	UG
Total: 11			**35 818 369**	**13 403 495**	**37**	**22 414 874**	

PGM = platinum group metals, Kv=quartz

4.6.2 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

Allocation of emissions from quarrying and mining of minerals other than coal were changed for the 2009 submission according to the revised CLRTAP guidelines. Therefore, emissions for previous inventories are currently not completely comparable but will be recalculated when the whole inventory is recalculated.

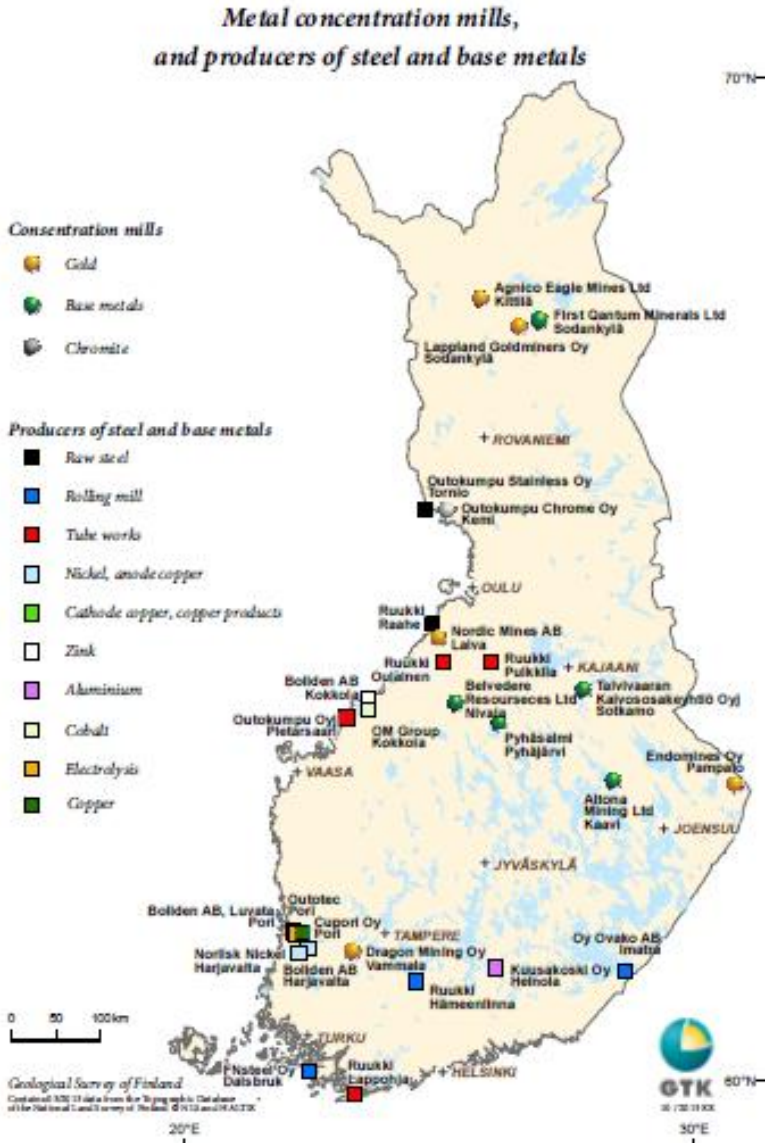
Particles and heavy metals

Particle and heavy metal emissions are generated in zinc and copper ore quarrying and preparation and are reported by the plants according to their emissions monitoring requirements.

Particle emissions for mined copper and zinc ores are calculated using emission factors TSP 0.05086 kg/t, PM10 0.025 kg/t and PM2.5 0.000375 kg/t (EEA/EMEP GB 2009/2016).

Heavy metal emissions are reported by the plants according to their monitoring obligations in their environmental permits.

Activity data presented in Table 4.14 has been obtained from First Quantum Minerals Ltd. Calculated emissions from quarrying and mining of minerals other than coal.



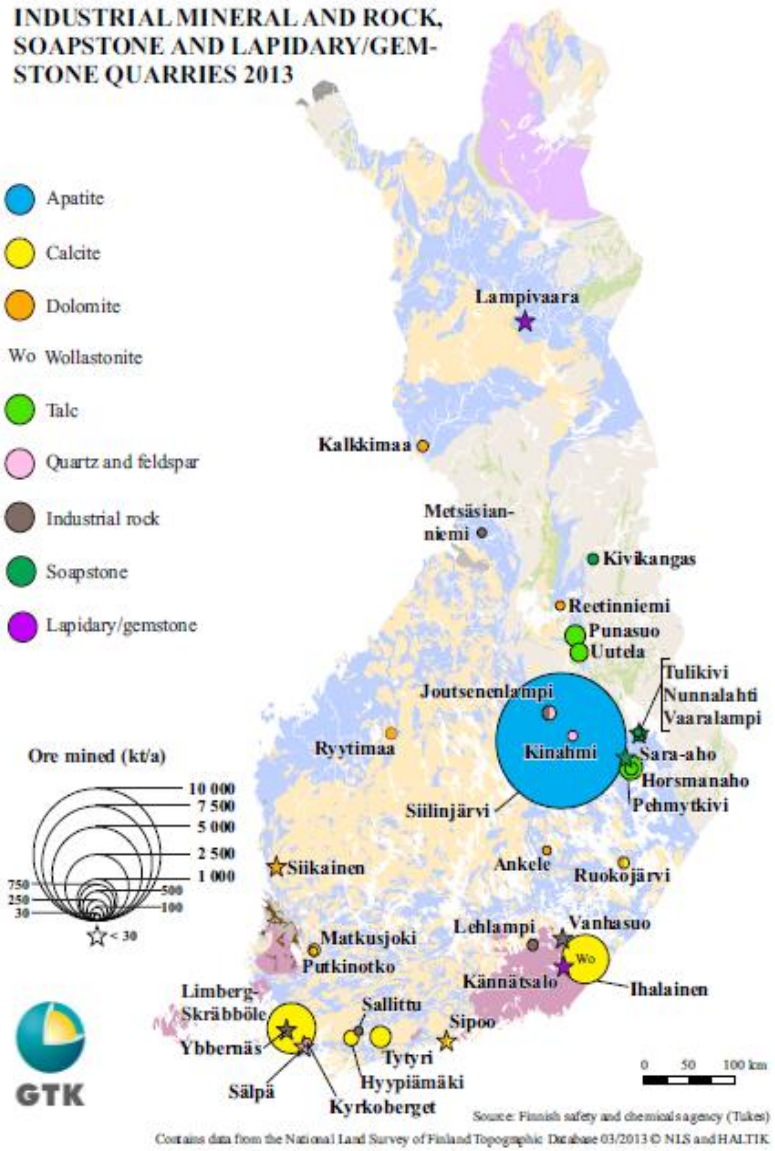


Figure 4.4. Metal consentration mills (left) and industrial mineral and rock mines (right) in 2013, http://en.gtk.fi/informationservices/mineralproduction/index.html

Table 4.14. Mining of copper and zinc ores: activity data (First Quantum Minerals Ltd)

Year	Amount of mined copper ore (1000 t)	Amount of mined zinc ore (1000 t)	Year	Amount of mined copper ore (1000 t)	Amount of mined zinc ore (1000 t)
1990	1439	357	2009	1298	172
1991	1575	389	2010	1307	191
1992	1350	213	2011	1245	205
1993	1402	156	2012	1120	163
1994	1311	149	2013	1321	138
1995	1087	119	2014	1321*	138*
1996	1076	190	2015	1321*	138*
1997	1013	221			
1998	988	216	*years 2014 and 2015 amounts of mined ores not available, years 2013 amounts have been used		
1999	1020	143			
2000	1211	118			
2001	1031	128			
2002	996	167			
2003	1325	246			
2004	1378	236			
2005	1378	257			
2006	1372	227			
2007	1209	247			
2008	1182	177			

Table 4.15. Calcaluted particle emissions from quarrying and mining of minerals other than coal

Year	$PM_{2.5}$ (t)	PM_{10} (t)	TSP (t)	Year	$PM_{2.5}$ (t)	PM_{10} (t)	TSP (t)
1990	6.74	44.91	91.37	2010	5.62	37.45	76.19
1991	7.37	49.11	99.90	2011	5.44	36.24	73.73
1992	5.86	39.07	79.48	2012	4.81	32.07	65.24
1993	5.84	38.94	79.22	2013	5.47	36.45	74.16
1994	5.48	36.50	74.26	2014	5.47	36.45	74.16
1995	4.52	30.16	61.36	2015	5.47	36.45	74.16
1996	4.75	31.65	64.39				
1997	4.63	30.85	62.76				
1998	4.51	30.10	61.23				
1999	4.36	29.09	59.18				
2000	4.98	33.22	67.58				
2001	4.35	28.97	58.94				
2002	4.36	29.07	59.13				
2003	5.89	39.27	79.90				
2004	6.05	40.35	82.10				
2005	6.13	40.88	83.16				
2006	6.00	39.97	81.31				
2007	5.46	36.40	74.05				
2008	5.10	33.97	69.11				
2009	5.51	36.75	74.77				

4.6.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.6.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.6.5 Source-specific recalculations including changes made in response to the review process

None.

4.6.6 Source-specific planned improvements

None.

4.7 Construction and demolition (NFR 2A5b)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.7.1 Source category description

SNAP 040624	PUBLIC WORKS AND BUILDING SITES Activities include manufacturing of light expanded clay aggregate (LECA), granulates and asphalt mixing plants. Emissions from rock-crushing plants are included in the emissions of asphalt stations in cases where the activity is required to have an environmental permit. Small rock-crushing plants are not included in the inventory.
Emissions	Source of emissions
TSP, PM10, PM2.5	calculated
Heavy metals (Pb, Cd, As, Cr, Cu, Ni, Zn)	reported by the plants (should be allocated under the Energy sector)

Process emissions from asphalt mixing plants are reported under NFR 2A5b and fuel combustion related emissions under NFR 1A2gviii.

Construction and demolition is a minor source of particle emissions.

The shares of total emissions and of emissons reported by the plants are presented inTable 4.2 Table 4.16.

Table 4.16. Contribution of Construction and demolition (NFR 2A5b) to total emissions in 2015.

Pollutant	Emissions from Construction and	Total emissions in	Unit	Share of total	% reported by the
As	0.01	2.43	Mg	0.4	100
Cd	0.004	0.92	Mg	0.4	100
Cr	0.003	15.63	Mg	<0.1	100
Cu	0.021	39.57	Mg	<0.1	100
Hg	<0.001	0.64	Mg	0.1	100
Ni	0.004	16.92	Mg	<0.1	100
Pb	0.007	13.93	Mg	<0.1	100
TSP	1.515	50.02	Gg	3	1.2
PM10	0.764	32.15	Gg	2.4	0
PM2.5	0.086	21.98	Gg	0.4	0

4.7.2 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. About twenty asphalt mixing plants have an environmental permit and report their emissions according to their monitoring requirements.

The majority of asphalt mixing plants do not fall under the IED but are regulated by the local environmental authorities and fall thus under the notification procedure i.e. new plants are required to report to a register. The register covers technical information (e.g. construction of the plant, stack height, process techniques, storage of liquids) but no emission data. Emissions from these plants are calculated on basis of asphalt production.

Particle emissions
Emissions are calculated using the following emission factors from TNO, 2002:
Dwellings: 0.215154 t/1000 m^2 (TSP), 0.107576985 t/1000 m^2 (PM_{10}) and 0.010758 t/1000 m^2 ($PM_{2.5}$)
Utilities: 0.122689 t/1000 m^2 (TSP), 0.061344732 t/1000 m^2 (PM_{10}) and 0.006134 t/1000 m^2 ($PM_{2.5}$).

Volumes of constructed dwellings and utilities used as activity data are presented in Table 4.17.

Table 4.17. Volumes of constructed dwellings and utilities (Statistics Finland).

Year	Volume of construction, 1000 m²		Year	Volume of construction, 1000 m²	
	Dwellings	Utilities		Dwellings	Utilities
1990	5588	6428	2006	4362	4979
1991	4122	5046	2007	3888	6273
1992	3330	3726	2008	3025	5271
1993	2866	2899	2009	2630	3950
1994	2808	2969	2010	3758	4322
1995	1988	3090	2011	3538	4317
1996	2426	3362	2012	3176	3830
1997	3112	4017	2013	2919	6572
1998	3370	4467	2014	2726	6880
1999	3767	4572	2015	2019	6900
2000	3644	4848			
2001	3145	4761			
2002	3270	4467			
2003	3731	4279			
2004	3957	4515			
2005	4370	4958			

Table 4.18. Calculated particle emissions from Construction and demolition.

Year	$PM_{2.5}$ (t)	PM_{10} (t)	TSP (t)	Year	$PM_{2.5}$ (t)	PM_{10} (t)	TSP (t)
1990	99.5	995.5	1990.9	2010	66.9	669.4	1338.8
1991	75.3	752.9	1505.9	2011	64.5	645.4	1290.7
1992	58.7	586.8	1173.6	2012	57.7	576.6	1153.2
1993	48.6	486.1	972.2	2013	71.7	717.1	1434.3
1994	48.4	484.2	968.5	2014	71.5	715.3	1430.5
1995	40.3	403.4	806.8	2015	74.8	748.1	1496.2
1996	46.7	467.2	934.5				
1997	58.1	581.3	1162.5				
1998	63.7	636.6	1273.2				
1999	68.6	685.7	1371.5				
2000	68.9	689.4	1378.8				
2001	63.0	630.4	1260.8				
2002	62.6	625.8	1251.6				
2003	66.4	663.9	1327.7				
2004	70.3	702.7	1405.4				
2005	77.4	774.3	1548.6				
2006	77.5	774.7	1549.4				
2007	80.3	803.1	1606.1				
2008	64.9	648.8	1297.6				
2009	52.5	525.3	1050.6				

4.7.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.7.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.7.5 Source-specific recalculations including changes made in response to the review process

None.

4.7.6 Source-specific planned improvements

None.

4.8 Storage, handling and transport of mineral products (NFR2A5c)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.8.1 Source category description

SNAP 040900	STORAGE, HANDLING AND TRANSPORT OF MINERAL PRODUCTS Activities included here are storage and handling of aluminoxide, bentonite, clay, cement, coal, coke, fly ash and kaolin
Emissions	Source of emissions
TSP, PM_{10}, $PM_{2.5}$	calculated

Emissions from storage, handling and transport of mineral products have been included in the inventory since the submission in 2009. The category is a minor source of particle emissions.

The shares of emissions are presented in Table 4.19.

Table 4.19. Contribution of Storage, handling and transport of mineral products (NFR2A5c) to total emissions and the shares of emissions reported by the plants in 2015.

Pollutant	Emissions from Storage, handling and transport of mineral products in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
TSP	0.622	50.02	Gg	1.2	0
PM10	0.242	32.15	Gg	0.8	0
PM2.5	0.025	21.98	Gg	0.1	0

4.8.2 Methodological issues

Particle emissions are calculated using emission factors (TNO, 2002) presented in Table 4.20.

Table 4.20. TSP. PM_{10}. $PM_{2.5}$ emission factors for NFR 2A5c storage and handling.

Source	EFs t/t (TNO, 2002)		
	TSP	PM_{10}	$PM_{2.5}$
Storage and handling, aluminoxide	0.0002	0.00008	0.000008
Storage and handling, bentonite	0.00004	0.0000128	0.0000016
Storage and handling, clay	0.000025	0.000008	0.000001
Storage and handling, cement	0.00001	0.00005	0.0000005
Storage and handling, coal	0.00015	0.00006	0.000006
Storage and handling, coke	0.00011	0.000044	0.0000044
Storage and handling, fly ash	0.0001	0.000032	0.000004
Storage and handling, kaolin	0.00004	0.0000128	0.0000016

Activity data collected from Finland Custom Statistics (ULJAS), the Confederation of Finnish Construction Industries and the Finnish Energy Industries Federation is presented in 0.

Calculated TSP, PM_{10} and $PM_{2.5}$ emissions from storage, handling and transport of mineral products are presented in Table 4.22.

Table 4.21. Activity data for storage and handling of minerals

AD (t/m2)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Reference
Amount of imported alumina	3317	1134	1524	5781	3537	1669	3366	2353	2006	2564	ULJAS
Amount of imported bentonite	7841	7583	6273	8808	12583	18688	22722	48491	56864	53935	ULJAS
Amount of handled clay as tiles and light gravel	413000	490000	446000	431000	407000	392000	360000	413090	416715	444477	The Confederation of Finnish Construction Industries + Production amount of light gravel (VAHTI)
Amount of used cement as production and import	1917740	1513330	1254919	1023578	1058023	1106527	1217959	1433304	1627917	1767248	VAHTI + ULJAS
Amount of imported coal	6101614	5174521	4264324	5953057	8104916	5887526	6252607	7474226	4727631	3596331	ULJAS
Amount of produced and imported coke	1273047	1175507	1184466	1291656	1326901	1083946	1067868	1106694	1119537	1267754	The Federation of Finnish Technology Industries + ULJAS
Amount of produced fly ash	939702	939702	939702	939702	939702	739563	959487	893000	619000	605000	Finergy
Amount of imported kaolin	967917	937236	1017452	1175689	1328205	1378081	1198212	1402209	1359976	1249452	ULJAS

AD (t/m2)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Reference
Amount of imported alumina	2179	2204	2042	1904	2220	2659	2327	3297	2350	1733	ULJAS
Amount of imported bentonite	30609	50898	27758	26569	27321	26395	32520	37739	31445	19334	ULJAS
Amount of handled clay as tiles and light gravel	502238	510000	492841	512000	492000	479986	482598	487106	448689	298194	The Confederation of Finnish Construction Industries + Production amount of light gravel according to VAHTI
Amount of used cement as production and import	1939579	1762180	1493126	1613900	1756330	904064	2027988	2443914	2167516	1358273	VAHTI + ULJAS
Amount of imported coal	5072701	6174440	5788973	10145016	8283891	4724395	6684023	6676418	5677080	5941051	ULJAS
Amount of produced and imported coke	1327170	1306480	1365237	1390807	1417438	1398969	1390541	1438165	1395458	245805	The Federation of Finnish Technology Industries + ULJAS
Amount of produced fly ash	590000	811000	877800	1142200	713909	541376	740483	706218	503602	541056	Finergy
Amount of imported kaolin	1493786	1301200	1207343	1305240	1301806	1144335	1261699	1155040	1147686	739685	ULJAS

AD (t/m2)	2010	2011	2012	2013	2014	2015					
Amount of imported alumina	2421	2423	2478	2198	2573	2834					ULJAS
Amount of imported bentonite	16084	21318	25469	21227	26449	43347					ULJAS
Amount of handled clay as tiles and light gravel	423563	438594	389280	352800	352800	352800					The Confederation of Finnish Construction Industries + Production amount of light gravel according to VAHTI
Amount of used cement as production and import	1807747	1985441	1792816	1651613	1703571	1595705					VAHTI + ULJAS
Amount of imported coal	5902004	6954191	3892598	4022356	5421559	3500330					ULJAS
Amount of produced and imported coke	440170	443407	319132	359	437	480					The Federation of Finnish Technology Industries + ULJAS
Amount of produced fly ash	692256	537737	537737	537737	5377737	5377737					Finergy
Amount of imported kaolin	944809	936544	860243	628512	745438	696962					ULJAS

Table 4.22. Calculated particle emissions from storage, handling and transport of mineral products.

Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)	Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)
1990	48.9	477.8	1218.4	2010	43.0	420.6	1070.5
1991	42.7	415.9	1064.9	2011	48.8	479.9	1215.3
1992	37.3	361.1	928.9	2012	29.6	288.4	736.4
1993	48.0	468.3	1198.6	2013	28.5	278.1	708.9
1994	61.3	600.7	1530.8	2014	37.1	363.9	924.3
1995	46.2	451.3	1153.4	2015	25.5	247.8	633.8
1996	49.0	477.7	1222.0				
1997	56.8	555.0	1415.3				
1998	39.3	382.5	978.0				
1999	33.0	320.2	820.8				
2000	42.6	415.0	1059.3				

2001	49.6	484.3	1235.9				
2002	47.5	462.9	1183.4				
2003	75.0	735.8	1871.6				
2004	62.3	612.2	1553.4				
2005	39.5	385.9	985.1				
2006	52.8	516.7	1314.2				
2007	52.9	518.1	1315.3				
2008	45.7	447.8	1136.0				
2009	41.1	403.6	1024.0				

4.8.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.8.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.8.5 Source-specific recalculations including changes made in response to the review process

None.

4.8.6 Source-specific planned improvements

None.

4.9 Other Mineral products (NFR 2A6)

Changes in chapter	
Update of emission figures	March 2017
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.9.1 Source category description

SNAP 040613z 040615 040618 040628 040629	OTHER (MINERAL PRODUCTS), BATTERIES MANUFACTURING, LIMESTONE AND DOLOMITE USE, BRICKS AND TILES (DECARBONIZING), FINE CERAMIC MATERIALS (DECARBONIZING)

Earler manufacture of batteries and reprocessing of limestone were reported under NFR 2A6. However, most of the plants have been closed down. Emissions from the remaining plants are energy related and therefore reported under NFR 1A2fviii.

4.10 Chemical Industry (NFR 2.B)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS&JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

4.10.1 Source category description

Chemical industry branches in Finland 1990-2015 are listed in Table 4.24.

Table 4.23. Industrial activities and air pollutant emissions under NFR 2B Chemical Industry.

NFR	Chemical Industy	Description		Emissions reported
2B1	Ammonia production	There has been no ammonia production in Finland since 1993.		NO
2B2	Nitric acid production	Three nitric acid plants, a fourth was closed down in 1992. In 2004 a new plant replaced an older plant, which was closed down in 2005.		NOx
2B10a	Other chemical industry			NOx, NMVOC, SOx, NH3, TSP, PM10, PM2.5, BC, Hg, Cu, Ni, PCDD/F, HCB, PCB
	040401	Sulfuric acid		
	040406	Ammonium phosphate		
	040407	NPK fertilisers		
	040410	Titanium dioxide		
	040413	Chlorine production		
	040414	Phosphate fertilizers		
	040416	Other	Calcium Carbonate manufacturing	
	040416	Other	Silicon wafer manufacturing	
	040416	Other	Production of oxygen, nitrogen and hydrogen	
	040416	Other	Al- and Fe-chemicals manufacturing	
	040416	Other	Manufacturing of ion exchange and chromatographic resins and special polymers	
	040416	Other	Pigments manufacturing	
	040416	Other	Manufacturing of explosives	
	040416	Other	Fertilizer manufacturing	
	040416	Other	Manufacturing of cobolt based special chemicals	
	040416	Other	Hydrogenperoxide plant	
	040416	Other	Manufacturing of natrium silicate	
	040416	Other	Potassium sulphate manufacturing	
	040416	Other	Formic acid and hydrogen peroxide manufacturing	
	040416	Other	Manufacturing of viscose staple fibres and by-products	
	040501	Ethylene		
	040506	Polyethylene Low Density		
	040507	Polyethylene High Density		
	040509	Polypropylene		
	040511	Polystyrene		
	040512	Styrene butadiene		
	040513	Styrene-butadiene latex		
	040527	Other (phytosanitary,...)	Entzyme production	
	040527	Other (phytosanitary,...)	Manufacturing of techno-chemical products	
	040527	Other (phytosanitary,...)	Manufacturing of benzene, cumene and phenols	
	040527	Other (phytosanitary,...)	Drag reducing additive production	
	040527	Other (phytosanitary,...)	Manufacturing of organic base chemicals	
	040527	Other (phytosanitary,...)	Manufacturing of tall oil	
	040527	Other (phytosanitary,...)	Manufacturing of organic fine chemicals	
	040527	Other (phytosanitary,...)	Manufacturing of pharmaceuticals	
	040527	Other (phytosanitary,...)	Manufacturing of titanium dioxide pigments	
	040527	Other (phytosanitary,...)	Manufacturing of lignosulphonate products	
	040527	Other (phytosanitary,...)	Cleaning of solvents and manufacturing of solvent mixtures	
	040527	Other (phytosanitary,...)	Manufacturing of biocides and other agricultural chemicals	
	040527	Other (phytosanitary,...)	Manufacturing of carboxymethylcellulose	
2B10b	Storage, handling and transport of chemical products	Chemical and fuel storages, storage and handling of phosphates.		NMVOC, TSP, PM_{10}, $PM_{2.5}$

4.10.2 Methodological issues

Emissions of those plants that report their emissions to the supervising authorities[3] according to the monitoring requirements in the environmental permits are in most cases reported as aggregated for the whole plant and not by individual processes. It has not been possible to make a complete split between emissions from fuel based and non-fuel based sources in the air emissions inventory system. In cases where it has been possible to separate fuel combustion emissions from process emissions, these are reported separately under NFR 2B categories. For those plants that report only total emissions, the split is based on the default emissions calculated on basis of fuel consumption which is subtracted from the emissions reported by the plants, and reported under the NFR 1A2c. In case it has not been possible to make a split between energy and process related emissions, all emissions are reported under NFR 1A2c.

4.11 Ammonia production (NFR 2B1)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS&JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.11.1 Source category description

SNAP 040403	AMMONIA PRODUCTION Ammonia was produced between the years 1951-1993 in Finland. The annually produced amounts of ammonia were between 12-30 kt. Ammonia was mainly used as raw material of fertilizers and in the production of nitric acid.

4.11.2 Emission trends

The magnitude of NMVOC emissions between1990-1993 is around 0.01-0.03 kilotons. NH3 emissions have not yet been included in the inventory. The magnitude of emissions when using the EF from Guidebook 2016 (0.01 kg/t) would be around 0.0001-0.0003 kilotonnes annually.

4.11.3 Methodological issues

NOx and CO
Emissions are energy related and reported under NFR 1A2fviii.

NMVOC
Emissions are calculated based on production rates for 1990-1993 and an emission factor of 1kg/t produced NH3 (NPI, 1999).

Information of the production volumes and NMVOC and NH3 emissions will be added to the IIR in the 2018 submission.

4.11.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.11.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.11.6 Source-specific recalculations including changes made in response to the review process

None.

[3] The emission data is available from the VAHTI database after it has been checked and approved by the authorities.

4.11.7 Source-specific planned improvements

Planned for 2018 submission

- Information of ammonia production volumes 1990-1993 will be added to the IIR in the 2018 submission.
- NH3 emissions in 1990-1994 will be included in the inventory and documented in the IIR.
- Information of NMVOC emissions in 1990-1993 will be included in the inventory (emissions are included)

4.12 Nitric acid production (NFR 2B2)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS&JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.12.1 Source category description

SNAP 040402	NITRIC ACID PRODUCTION Nitric acid is currently produced at three sites. In 1990–1992 there were four plants producing nitric acid. In 2004 a new plant replaced an older plant, which was closed down in 2005. The operating plants are single-stage medium pressure plants (3.8, 6.5 and 7.5 bar). Two of the plants are situated at the same site and the produced nitric acid is mainly used for the integrated fertiliser production. Total annual total production volume has varied from 430 to 620 Gg of nitric acid per year.
Emissions	Source of emissions
NOx	Emissions are reported by the plants according to their reporting obligations in the environmental permits and available in VAHTI database. NOx emissions include NO_2, NO, N_2O_3, N_2O_4, HNO_3 compounds.

Air pollutant emissions from nitric acid production vary according to the production volumes over the years. The allocation of activities has been changed over the years and is not currently consistent in the time series.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.2
Table 4.244.

Table 4.24. Contribution of nitric acid production to total emissions in 2015.

Pollutant	Emissions from other mineral products in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NOx (as NO2)	0.435	139.68	Gg	0,3	100

4.12.2 Methodological issues

The emissions are reported by the plants.

4.12.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.12.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.12.5 Source-specific recalculations including changes made in response to the review process

None.

4.12.6 Source-specific planned improvements

None.

4.13 Adipic acid production (NFR 2B3)

SNAP 040521	ADIPIC ACID PRODUCTION Adipic acid production has not occurred in Finland in 1980-2015.

4.14 Carbide production (NFR 2B5)

SNAP 040412	CARBIDE PRODUCTION Carbide production has not occurred in Finland in 1980-2015.

4.15 Titanium dioxide production (NFR 2B6)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS&JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.15.1 Source category description

SNAP 040410	TITANIUM DIOXIDE PRODUCTION One plant has produced titanium dioside pigments since 1957. These pigments have been used in paint and cosmetics industry and also in manufacture of printing inks. The annual production rate of TiO2 is currently 130 000 tonnes.
Emissions	Source of emissions
TSP, PM_{10}, $PM_{2.5}$	Particle emissions are reported by the plant according to its environmental monitoring programme from dry kiln.

4.15.2 Emission trends

The shares of emissions of total emissions and the shares reported by the plants are presented in 05

Table 4.25. Contribution of Titanium dioxide production (NFR 2B6) to total emissions in 2015.

Pollutant	Emissions from Titanium dioxide production in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
TSP	0.015	50.02	Gg	<0.1	100
PM10	0.008	32.15	Gg	<0.1	0
PM2.5	0.002	21.98	Gg	<0.1	0

4.15.3 Methodological issues

Particles
TSP emissions are reported by the plants. PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions using fraction factors of 100% from TSP (Karvosenoja, 2002).

4.15.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.15.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.15.6 Source-specific recalculations including changes made in response to the review process

None.

4.15.7 Source-specific planned improvements

None.

4.16 Soda ash production (NFR 2B7)

Changes in chapter	
Update of emission figures	
Update of text	April 2017 JMP, KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

SNAP 040619	SODA ASH PRODUCTION AND USE NFR 2B7 SODA ASH PRODUCTION Soda ash has not been produced in Finland in 1990-2015. Soda ash is used in Finland in the production of tile, steel, calcium chloride, phosphates, mineral wool and in the energy industry. Emissions from soda ash use in these sectors are reported by the plants according to the monitoring programmes in their environmental permits (available in VAHTI). The emissions are allocated under the NFR category of the main activity of these plants using soda ash and it is not possible to report the emissions separately under NFR 2B7.

In the NFR table NFR 2B7 has been reported as NA, although the notation key should be NO because no soda ash production occurs in Finland.

4.16.1 Source-specific planned improvements

Planned for 2018 submission
The notation key "NO" will be corrected instead of the notation key "NA" currently reported.

4.17 Other chemical industry (NFR 2B10a)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 2015 KS
Recalculations	none

4.17.1 Source category description

SNAP 040401	SULPHURIC ACID Number of plants (<5) Production capacity: 1 000 000 t sulphuric acid
Emissions	Source of emissions
NOx,SOx, TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040406	AMMONIUM PHOSPHATE Number of plants (<5) Phosphoric acid is produced from phosphorus containing minerals, the most important mineral is phosphorite (=apatite $3Ca_3(PO_4)_2*CaF_2$). There are two different methods to produce phosphoric acid; thermal and wet process; in Finland the wet process has been used. In the wet process the raw phosphate is dissolved in to sulphur acid and the released phosphoric acid is separated from calcium sulphate. Production capacity: 300 000 t phosphoric acid and polyphosphoric acids
Emissions	Source of emissions
SOx	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040407	**NPK FERTILISERS** Number of plants (<5) Production capacity: 1.5 million t mineral or chemical fertlisers (including N,P,K)
Emissions	Source of emissions
NH_3, TSP,PM_{10}, $PM_{2.5}$	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040413	**CHLORINE PRODUCTION** Number of plants (<5) Production capacity: 200 000 t chlorine
Emissions	Source of emissions
Hg	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040414	**PHOSPHATE FERTILIZERS** Number of plants (< 5)
Emissions	Source of emissions
	No emissions in 2014 neither in 2015

SNAP **040416**	**OTHER** Production of oxygen, nitrogen and hydrogen Number of plants <5 Production capacity: oxygen (liquid) 45 000t/a, nitrogen (liquid) 40 000t/a and argon (liquid) 8000t/a
Emissions	Source of emissions
NMVOC, NOx, SOx	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Al- and Fe-chemicals manufacturing Number of plants <5 Production capacity: ~30 000t/a Al-salts
Emissions	Source of emissions
TSP, PM_{10}. $PM_{2.5}$, BC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of ion exchange and chromatographic resins and special polymers Number of plants <5 Production capacity ~1000 m3/a ion exhange resins
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Pigments manufacturing Number of plants <5 Production capacity: ~50 000t/a Al-silicate and silicone dioxide pigments
Emissions	Source of emissions
TSP, PM10. PM2.5, BC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of explosives Number of plants <5 Production capacity: not availble
Emissions	Source of emissions
NMVOC; NOx, SOx	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Fertilizer manufacturing Number of plants <5 Production capacity: not available
Emissions	Source of emissions
TSP, PM10. PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits No emissions in 2014 neither in 2015

SNAP **040416**	**OTHER** Manufacturing of cobolt based special chemicals Number of plants <5 Production capacity: not available
Emissions	Source of emissions
Cu, Ni, NMVOC,SOx	No emissions in 2015

SNAP **040416**	**OTHER** Hydrogen peroxide plant Number of plants <5 Production capacity: ~130 000 t/a hydrogen peroxide
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of natrium silicate Number of plants <5 Production capacity: ~45 000t/a silicate
Emissions	Source of emissions
TSP, PM10. PM2.5, BC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of synthetic fibre Number of plants – none in 2010 century Production capacity: not availble
Emissions	Source of emissions
	NO emissions in 2014 and 2015

SNAP **040416**	**OTHER** Potassium sulphate manufacturing Number of plants <5 Production capacity: ~200 000 t/a potassium sulphate
Emissions	Source of emissions
HCB, PCDD/F	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of fine chemicals Number of plants <5 Production capacity: not available
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040416**	**OTHER** Manufacturing of PCC (Precipitated calcium carbonate) Number of plants<5 Production capacity: not availble
Emissions	Source of emissions
NOx, SOx	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040501**	**ETHYLENE** Number of plants <5 Production capacity: ~400 000 t/a
Emissions	Source of emissions
NMVOC, TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040506**	**POLYETHYLENE LOW DENSITY** Number of plants <5 Production capacity: not available
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040507	**POLYETHYLENE HIGH DENSITY** Number of plants <5 Production capacity:~350 000 t/a
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040508	**PVC** Polyvinylchloridehas been manufactured in Finland in 1969-2006 Number of plants Production capacity
Emissions	Source of emissions

SNAP 040509	**POLYPROPYLENE** Number of plants <5 Production capacity: ~200 000 t/a
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP **040511**	**POLYSTYRENE** Number of plants <5 Production capacity ~50 000 t/a
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040512	**STYRENE-BUTADIENE** Number of plants <5 Production capacity ~300 000 t/a
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040513	**STYRENE-BUTADIENE LATEX** Number of plants <5 Production capacity; 180 000 t synthetic rubberlatex
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040525	PESTICIDE PRODUCTION Earlier energy related emissions were erroneously reported under this category. No activities in Finland.
Emissions	Source of emissions
NMVOC, PAH-4	No emissions in 2014

SNAP 040527	OTHER (PHYTOSANITARY,...) Entzyme production Number of plants <5 Production capacity: not available
Emissions	Source of emissions
TSP,PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040527	OTHER (PHYTOSANITARY,...) Manufacturing of techno-chemical products Number of plants 12 Production capacity: not available
Emissions	Source of emissions
SO_x,TSP, PM_{10}, $PM_{2.5}$, NMVOC, BC, PCB	reported by the plants according to the monitoring and reporting obligations in their environmental permits

4.17.2 Emission trends

Other chemical industry is a major source of HCB emissions from the manufacturing of potassium sulphate and also contributed to over 10% of Hg emissions in 2015 originating from chlorine production.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.26.

Table 4.26. Contribution of Chemical Industry: other (NFR 2B10a) to total emissions in 2015.

Pollutant	Emissions from other chemical industry in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
BC	<0.001	4.60	Gg	<0.1	0
Cu	0.006	39.57	Mg	<0.1	100
Hg	0.069	0.64	Mg	10.8	100
NH3	0.403	31.85	Gg	1.3	100
Ni	0.038	16.92	Mg	0.2	100
NMVOC	2.312	87.76	Gg	2.6	100
NOx (as NO2)	0.136	139.68	Gg	<0.1	100
TSP	0.394	50.02	Gg	0.8	100
HCB	8.93	20.94	kg	42.6	100
PCBs	0.004	151.89	kg	<0.1	100
PCDD/Fs	0.15	14.25	g I-Teq	1.1	100
PM10	0.324	32.15	Gg	1	0
PM2.5	0.203	21.98	Gg	0.9	0
SOx (as SO2)	0.376	42.06	Gg	0.9	100
PAHs	<0.001	9.41	Mg	<0.1	100

4.17.3 Methodological issues

The emissions falling under this source are reported by the plants according to the monitoring and reporting obligations in their environmental permits. When no plant specific data is available emissions have been calculated as presented below.

Particles
Particle emissions from this sector in the inventory are based on TSP emission data reported by the plants (VAHTI). PM_{10} and $PM_{2.5}$ emissions are calculated from TSP emissions using size fraction factors as follows:
- Production of sulphuric acid: 100 % for both $PM_{2.5}$ and PM_{10} (TNO, 2002).
- Production of fertilizers and phosphates: 98% for PM_{10} and 66 %, $PM_{2.5}$ (IIASA, 2001/AEAT, 2000)
- Production of inorganic chemicals, ethylene, polyethylene, PVC, other organic chemicals and chemicals products: 80 % for PM_{10} and 50 % for $PM_{2.5}$ (national expert estimate, Karvosenoja, 2002).

Black carbon
Black carbon emissions have been calculated using the fraction factor of 1.8 % of $PM_{2.5}$ (GB2013, EEA 2013) for the following sources: Al- and Fe-chemicals and pigments manufacturing, manufacturing of natrium silicate and techno-chemical products.

NOx
Nitrogen dioxide emissions from this sector in the inventory are based on emission data reported by the plants (VAHTI) from the following sectors:
- Production of sulfuric acid
- Manufacturing of ammunition
- Production of pigments used in paper making.

SOx
Sulphur dioxide emissions from this sector in the inventory are based on emission data reported by the plants (VAHTI) from the following sectors:
- Production of sulphuric acid
- Production of fertilizers
- Prodcution of cobolt based chemicals
- Production of pigments used in paper making
- Production of techno-chemical products

NH3
Ammonia emissions are generated in production of fertilizers and are based on emission data reported by the plants.

NMVOC
Chemical industry processes emitting NMVOCs include
- Production of oxygen, nitrogen and hydrogen
- Manufacturing of ion exchange and chromatographic resins and special polymers
- Manufacturing of explosives
- Manufacturing of cobolt based special chemicals
- Hydrogen peroxide plant
- Manufacturing of fine chemicals
- Production of polyethylene low density, high density polypropylene, polystyrene
- Production of styrene butadiene and styrene-butadiene latex
- Pesticide production
- Manufacturing of techno-chemical products

NMVOC emissions from this sector in the inventory are either based on data reported by the plants according to their environmental permits, or if emissions would not be reported in the inventory year, the emissions from the previous year have been included in the inventory, instead.

Heavy metals
Nickel and copper emissions are generated in manufacturing of cobolt based special chemicals and reported by the operators according to their environmental permits.

Mercury is emitted from chlorine production using the mercury process. There is also chlorine-alkali production which uses the membrane method, however, no mercury emissions are generated from this process.

POPs
Emissions of HCB, PCDD/Fs and PAHs from the manufacturing of potassium sulphate, as well as PCDD/F emissions from the manufacturing of organic fine chemicals are reported by the plants and available in VAHTI for the use in the inventory.

HCB emissions vary strongly due to the fluctuating quality and volume of auxiliary chemicals used in the process. The plant is monitoring the raw material quality closely and studying emissions and abatement possibilities. Annual HCB emissions are calculated by the plant and reported to the environmental authorities.

4.17.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.17.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.17.6 Source-specific recalculations including changes made in response to the review process

None.

4.17.7 Source-specific planned improvements

None.

4.18 Storage, handling and transport of chemical products (NFR 2B10b)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculation	none

4.18.1 Source category description

SNAP 040415 and 040522	**STORAGE AND HANDLING OF INORGANIC CHEMICAL PRODUCTS, STORAGE AND HANDLING OF ORGANIC CHEMICAL PRODUCTS** Chemical and fuel storages, storage and handling of phosphates.
Emissions	**Emission source**
TSP, PM_{10}, $PM_{2.5}$	reported by the plants according to the monitoring and reporting obligations in their environmental permits, calculated
NMVOC, SOx	reported by the plants according to the monitoring and reporting obligations in their environmental permits

4.18.2 Emission trends

The shares of emissions of total emissions and the shares reported by the plants are presented in 07.

Table 4.27. Contribution of Storage, handling and transport of chemical products (NFR 2B10b) to total emissions in 2015.

Pollutant	Emissions From NFR 2B10b in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	0.109	87.76	Gg	0.1	100
NOx (as NO2)	<0.001	139.68	Gg	<0.1	100
TSP	0.033	50.02	Gg	<0.1	0.4
PM10	0.01	32.15	Gg	<0.1	0
PM2.5	0.001	21.98	Gg	<0.1	0
SOx (as SO2)	<0.001	42.06	Gg	<0.1	100

4.18.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions have been calculated as presented in Table 4.2929.

Particles
Particulate emissions from storage and handling of phosphates are calculated with emission factors: $PM_{2.5}$ 0.0000016 t/t, PM_{10} 0.0000128 t/t and TSP 0.00004 t/t (TNO, 2002). Activity data presented in 08 is provided by the fertilizer producers (available in VAHTI datasystem) and in the Customs statistics (ULJAS).

NMVOC
Emissions are reported by the plants.

Table 4.28. Activity data for storage and handling of phosphates (Customs Statistics ULJAS).

Year	Activity data (t of produced phosphates)	Year	Activity data (t of produced phosphates)	Year	Activity data (t of produced phosphates)
1990	584 000	2000	824 000	2010	765 000
1991	510 000	2001	823 000	2011	752 000
1992	621 000	2002	856 000	2012	814 400
1993	668 000	2003	853 000	2013	838 300
1994	704 000	2004	879 000	2014	888 940
1995	762 000	2005	823 000	2015	810 309
1996	780 000	2006	857 000		
1997	748 000	2007	824 000		
1998	820 000	2008	777 000		
1999	820 000	2009	655 000		

Table 4.29. Calculated particle emissions from storage, handling and transport of chemicals products.

Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)	Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)
1990	0.82	6.52	20.39	2010	1.20	9.63	30.10
1991	0.99	7.94	24.82	2011	1.30	10.42	32.58
1992	1.07	8.54	26.70	2012	1.34	10.73	33.53
1993	1.13	9.01	28.17	2013	1.42	11.38	35.56
1994	1.22	9.76	30.50	2014	1.30	10.37	32.41
1995	1.25	9.98	31.19	2015	0.82	6.52	20.39
1996	1.20	9.58	29.93				
1997	1.31	10.50	32.81				
1998	1.31	10.49	32.78				
1999	1.32	10.55	32.97				
2000	1.32	10.53	32.91				
2001	1.37	10.95	34.22				
2002	1.37	10.92	34.13				
2003	1.41	11.25	35.15				
2004	1.32	10.53	32.90				
2005	1.37	10.97	34.28				
2006	1.32	10.55	32.97				
2007	1.24	9.94	31.07				
2008	1.05	8.38	26.18				
2009	1.22	9.80	30.61				

4.18.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.18.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.18.6 Source-specific recalculations including changes made in response to the review process

None.

4.18.7 Source-specific planned improvements

None.

4.19 Metal Production (NFR 2C)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculation	none

4.19.1 Source category description

Metal Production activities in Finland include iron and steel production, copper products, refined steel, sinc, nickel and alloys. Detailed information on industrial activities falling under NFR 2C Metal Production Industry in the Finnish inventory is presented in Table 4.300.

Table 4.30. Activities and emissions reported under the metal production sector.

NFR	Processes		Description	Emissions reported
2C1	Iron and steel production		Iron and steel plants (< 5 plants), both emissions reported by the plant and calculated at the inventory agency	NO_X, NMVOC, SO_X, , TSP, PM_{10}, $PM_{2.5}$, CO, Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, PCDD/F, PAH-4, PCB, BC
2C2	Ferroalloys production		Ferrochromium production plants (< 5 plants) are part of integrated stainless steel plants, emission reported by the plants	NMVOC, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, Hg, , Cr, Cu, Ni, Zn, As, BC, PAH-4,
2C5	Lead production		No lead production occurs	NA
2C6	Zinc production		< 5 zinc production plants, emissions both reported by the plants and calculated at the inventory agency	NMVOC, TSP, PM_{10}, $PM_{2.5}$Cd, Hg, As, Cr, Cu, Zn, PCDD/F
2C7a	Copper production		Copper production plants (< 5 plants) and production of upgraded copper products. Emissions both calculated or reported by the plants	NMVOC, SO_X, TSP, PM_{10}, $PM_{2.5}$, CO, Pb, Cd, As, Cu, Ni, Zn, PCDD/F, HCB, PCB, BC
2C7b	Nickel production		< 5 plants	NMVOC, SOx, NH_3, Ni
2C7c	Other metal production			NO_X, NMVOC, SO_X, NH_3, TSP, PM_{10}, $PM_{2.5}$, Pb, Cd, As, Cr, Cu, Ni, Zn, , HCB, PCB
	040307	Galvanizing		
	040309	Other	Recycling of waste and scrap	
	040309	Other	Aluminium foundry	
	040309	Other	Handling of FeCr slag	
	040309	Other	Surface treatment of metals	
	040309	Other	Secondary aluminium production	
	040309	Other	Manufacturing of furniture (zinc electroplating)	
	040309	Other	Manufacturing of metallic construction mountings	
	040309	Other	Cable manufacturing	
	040309	Other	Manufacturing of nails	
	040309	Other	Lock manufacturing	
2C7d	Storage, handling and transport of metal products		Storage and handling of iron ore.	TSP, PM_{10}, $PM_{2.5}$

4.19.2 Methodological issues

Emissions of those plants that report their emissions to the supervising authorities[4] according to the monitoring requirements in the environmental permits are reported as “IE” and allocated under 1A2a or 1A2b in the NFR table. This is because the reporting obligations determined in the monitoring programmes are for the total emissions of the plants and not separated between fuel combustion and other processes. In most cases it has not been possible to split emissions in the NFR categories. In cases where it has been possible to separate fuel combustion emissions from process emissions, these are reported separately under the NFR 2C categories. For those plants that report only total emissions, the split is based on the default emissions calculated on basis of fuel consumption which is reduced from the emissions reported by the plants, and reported under the NFR 1A2a for iron and steel or under 1A2b for non-ferrous metals processes. In case it has not been possible to make a split between energy and process related emissions, all emissions are reported under NFR 1A2a or 1A2b.

For those plants that do not report their emissions to supervising authorities, emissions have been calculated based on production data available in VAHTI or on statistical information from industrial associations, and emission factors.

The share of especially heavy metal, POP and NMVOC emissions reported to the environmental authorities available in VAHTI has increased during the recent years due to the implementation of the E-PRTR regulation. Part of the emissions in the inventory, which were previously calculated with international emission factors, are now reported by individual companies based on measurements or plant specific other information.

When the plants do not have plant specific information for the basis of estimation of emissions, they use national emission factors, which are the same that are also used in the inventories and are available for the use of the plants at a website maintained by the Finnish Environment Institute for this purpose[5]. Because the time series has not been updated for the previous years due to pending recalculation of energy sector emissions, the timeseries of these emissions are not completely consistent. National emission factors will be checked and new emission factors calculated based on site specific information on emissions and production volumes while recalculating the time series.

Emission trends in 2000-2015 from Metal production are presented here aggregated since only the years 2007 - 2010 are available disaggregated between the following sectors: iron and steel industry (NFR 2C1), Ferroalloys production (NFR 2C2), Copper production (NFR 2C5a), Zinc production (NFR 2C5d), Other metal production (NFR 2C5e) and Storage, handling and transport of metal products (NFR 2C5f).

Air pollutant emissions from metal production depend on the production and chemical use volumes over the years. The allocation of activities that have been changed over the years will be checked during the recalculations.

4.19.3 Source specific improvements

Planned for the 2018 submission

- Check of the consistency of the allocation of energy and process related emissions in the timeseries.
- Recalculation of the time series of POP, heavy metal and NMVOC emissions when the recalculation of energy sector emissions has been finalized.

Planned for the 2019 submission

Check of national emission factors and calculation of new emission factors based on site specific information.

[4] The emission data is available from the VAHTI database after it has been checked and approved by the authorities.

4.20 Iron and steel production (NFR 2C1)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculated	none

4.20.1 Source category description

SNAP 040202, 040203, 040205, 040206, 040207, 040208, 040209, 040210	IRON AND STEEL PRODUCTION The first blast furnace in Finland was built in 1616 in Mustio. In 1916 the first smelter plant was established. Currently steel is produced at four plants in Finland with an annual total capacity of about 5 million tonnes. Both ore and recycled steel (about 2 million tonnes annually) are used. Sintering unit – 1994 - December 2011, expanded in 1971 Blast furnace – 1961-2012 Blast furnace - 1964, renovated in 1995 Blast furnace – 1975, renovated in 1996 and 2011 . The Finnish plants use both iron ore and scrap metal and produce iron ore, iron pellets, steel, hot and cold rolled coils/sheets, steel bars,strips, plates, billets, wire rod products. Emissions from iron and steel plants are both reported by the plants according to their monitoring and reporting requirements in the environmental permits, and also calculated at the inventory agency. Emissions related to fuel combustion are mainly reported under NFR 1A2a, however, the allocation of part of emissions reported by the plants may differ between the years, and part of energy related emissions can be reported under NFR 2C in some years when it has not been possible to calculate the shares for the correct allocation.

Units	Emissions	Emission data reported by the plants	Calculated for
Steel production, < 5 plants (the other of the remaining blast furnaces was closed down in 2012)	NMVOC	75% (< 5 plants)	25% (< 5 plants)
	PAH-4	50% (< 5 plants)	50% (< 5 plants)
	PCDD/F	75% (< 5 plants)	25% (< 5 plants)
	PCB	25% (< 5 plants)	75% (< 5 plants)
	As, Cd, Pb, Zn	100% (< 5 plants)	-
	Cr, Cu, Hg, Ni	100% (< 5 plants)	-
	CO	100% (< 5 plants)	-
	NOx, SOx	100% (< 5 plants)	-
	TSP	100% (< 5 plants)	PM10, PM2.5, BC
Pig iron tapping	PAH-4	-	100% (< 5 plants)
Sinter processes,< 5 plants (last unit was closed down in December 2011)	NMVOC	100% (< 5 plants)	-
	PAH-4	100% (< 5 plants)	-
	PCDD/F	100% (< 5 plants)	-
	PCB	-	100% (< 5 plants)
	HCB	-	100% (< 5 plants)
	TSP	100% (< 5 plants)	PM10, PM2.5
	Cd, Cr	100% (< 5 plants)	-
	Pb	100% (< 5 plants)	-
	SOx, NOx	100% (< 5 plants)	-
Rolling mills, < 5 plants	As, Cr, Cu, Pb, Ni	100% (< 5 plants)	-
	Hg, Cd	100% (< 5 plants)	-
	Zn	100% (< 5 plants)	-
	TSP	100% (< 5 plants)	PM10, PM2.5, PM
	NMVOC	100% (< 5 plants)	-
	SOx	100% (< 5 plants)	-
	NOx	100% (< 5 plants)	-
Other, 26 plants	NH3	100% (< 5 plants)	-

	As	100% (5 plants)	-
	Hg	<5 plants	-
	CO	<5 plants	-
	TSP	10-20 plants	PM10, PM2.5, PM
	Cd	5-10 plants	-
	Cr, Cu, Zn	10-20 plants	-
	Pb	10-20 plants	-
	Ni	10-20 plants	-
	NMVOC	10-20 plants	-
	SOx, NOx	<5 plants	-

Steel producers in Finland

Producers of steel and non-ferrous metals in Finland in 2014 are presented in Figure 4.5.

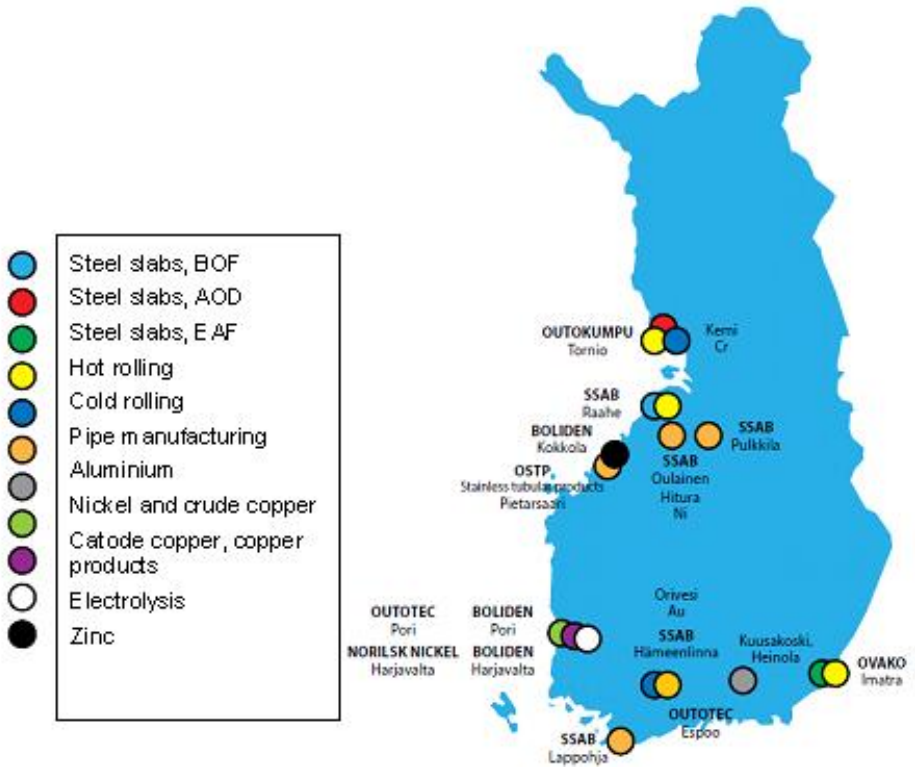


Figure 4.5 Producers of steel and non-ferrous metals in Finland in 2014

Production of steel[6]

Processes used in the production of steel from iron ore and scrap metal in Finland are described below (Figure 4.6).

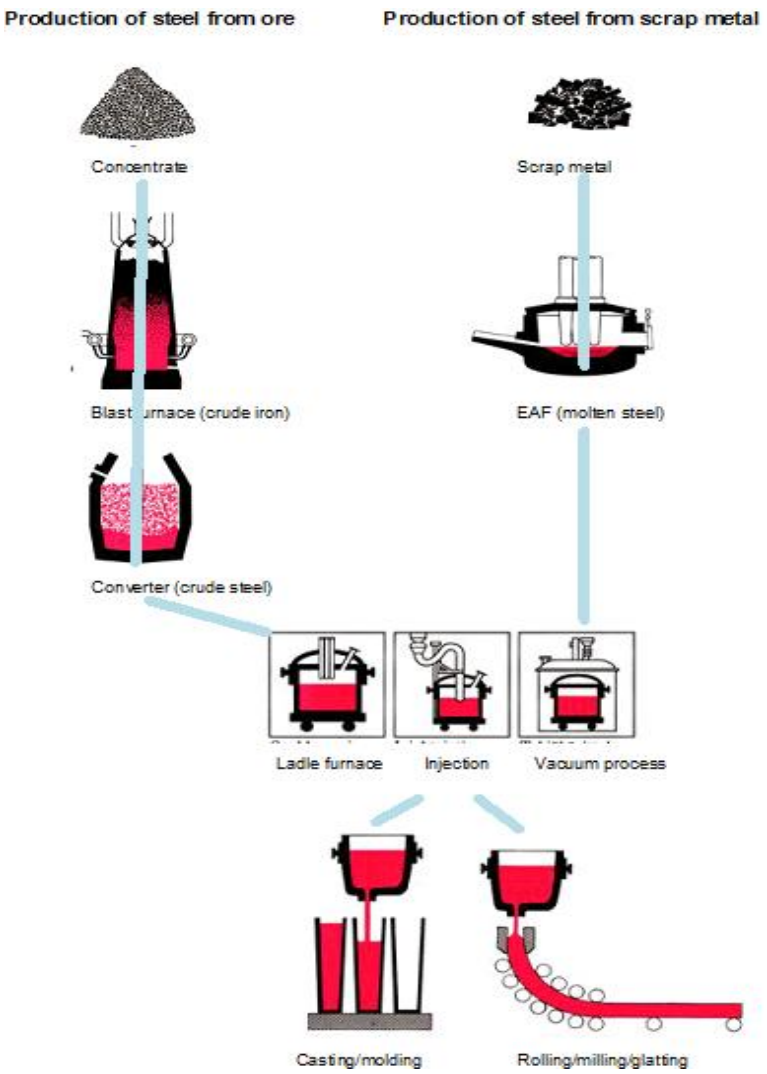


Figure 4.6 Production of steel from iron ore and scrap metal in Finland according to Teräskirja (Book of Steel in Hiilitieto, 2017)

Production from ore

Steel production processes in Finland include oxygen injection, EAF and AOD methods. In 2015 two blast furnaces were in operation. The blast furnaces are small but belong to the most efficient ones in Europe regarding production volumes and fuel use as well as the use of coal per steel tonne produced.

Process units for iron and ferrochrome production use coal and coke and utilise carbon monoxide and hydrogen containing process gases as energy sources. Processes include coking plant, blast furnace, sinter plant, sulphur removal, ladle furnace, BOF converters, LD converter, casting, hot and cold rolling.

In the production of carbon steel iron ore is reduced in blast furnaces using coke and oil into crude iron. Coke and oil are added to reduce the oxygen present in the iron ore. Crude iron contains 4.5% coal and the iron turns into steel in the converter (steel is iron where the coal content is below 2%). Combustion

[6] http://www.outokumpu.com/en/products-properties/more-stainless/producing-stainless-steel/Pages/default.aspx
http://www.ovako.com/en/Products/Standard-steel-grades/
http://usa.amegroup.com/Website/Content/GuestInformation/SiteDetail/Steel/8766/FNsteel_-_Koverhar
https://hiilitieto.fi/hiilitietoa/perustietoa-hiilesta/hiili-terasteollisuudessa/

gases from coking are used as energy sources in the processes of the steel mill and contribute to 60% of the energy demand.

In the production of ferrochrome which is rawmaterial for stainless steel, coal is used to reduce chrome concentrate and combustion gases from this are used as fuel.

Processing of steel from scrap and alloys

Electric arc furnace (EAF) is used for steel production from scrap metal in Finland. Molten ferro chromium smelting is used in addition to EAF. The steps in processing metal scrap include

1) Melting of raw materials in an electric arc furnace (EAF)
   During the melting process, the arc reaches temperatures of up to 3,500 °C, and the molten steel can reach up to 1,800 °C. The additional injection of chemical energy, in the form of carbon, ferrosilicon, oxygen, or fuel gas mixtures, speeds up the melting process.

2) Removal of carbon, sulfur, and possibly nitrogen, in a steel converter
   After melting, the steel is further processed in an AOD (Argon Oxygen Decarburization) converter or through a VOD (Vacuum Oxygen Decarburization).
   In the AOD the carbon content is reduced to a target amount and to supply additional alloying elements. When liquid ferrochrome is used, an iron-rich scrap mix with low alloy content is melted in the arc furnace. Nickel and molybdenum, together with the liquid ferrochrome, are then added to the AOD converter.
   The VOD (Vacuum Oxygen Decarburization) is used to produce very low carbon or nitrogen content for high chromium ferritic stainless steels.

3) Tuning of the steel composition and temperature
   Secondary metallurgical treatment is done in a ladle station, ladle furnace, or as a vacuum treatment of the liquid steel to adjust and to homogenize both the temperature and chemistry of the molten material.

4) Casting of slabs or ingots
   The liquid steel ladle is transported to casting.

Hot rolling

In hot rolling the cast microstructure of semi-finished casting products is broken down maintaining but maintaining a structure to prevent the steel from hardening. The finished product's surface is covered with an iron- and chromium-rich oxide that forms at high temperatures. It is usually removed in the annealing and pickling line, which restores the smooth metallic surface.

Cold rolling, annealing, and pickling

a) Small-diameter working rolls work out the strip profile and flatness. Restoring the material properties after cold rolling is carried out in a heat treatment and all oxide scale is removed in acid pickling baths, and then finishing off with high pressure water rinsing. Alternatively, a bright annealing line (BA-line) is used to restore the material properties hydrogen or a mixture of hydrogen and nitrogen. As no oxygen is available inside the furnace, no additional oxide scale is formed and whatever oxide remains on the strip is reduced to metal.
b) Skin pass rolling (temper rolling) is a light cold-rolling treatment with low reduction (0.5–1%) to improve the strip shape, finish, and mechanical properties.

Final processing
To tailor coils and plates to customer requirements the following processes are used:
- Roller or stretch leveler
- Edge trimming to the desired width
- Slitting into narrow coils
- Cutting into desired length sheets/plates
- Shearing/cutting into an order-sized shapes.
- Coating and preparing edges for special welding requirements
- Surface preparation such as grinding, brushing, pattern rolling, or embossing

4.20.2 Emission trends

This sector contributed more than 10% of the total Cr and Hg emissions and approximately 5% of total As, Ni and PCB emissions.

The shares of emissions of total emissions and the shares reported by the plants are presented in Table 4.311.

Table 4.31. Contribution of Iron and Steel production (NFR 2C1) to total emissions in 2015.

Pollutant	Emissions iron and steel industry in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
As	0.115	2.43	Mg	4.7	100
BC	<0.001	4.60	Gg	<0.1	0
Cd	0.02	0.92	Mg	2.2	100
CO	0.513	324.57	Gg	0.2	100
Cr	3.953	15.63	Mg	25.3	100
Cu	0.788	39.57	Mg	2	100
Hg	0.121	0.64	Mg	19	100
Ni	1.029	16.92	Mg	6.1	100
NMVOC	0.177	87.76	Gg	0.2	100
NOx (as NO2)	<0.001	139.68	Gg	<0.1	100
Pb	0.245	13.93	Mg	1.8	100
TSP	0.209	50.02	Gg	0.4	100
Zn	2.802	129.07	Mg	2.2	100
PCBs	13.812	151.89	kg	9.1	31.9
PCDD/Fs	0.537	14.25	g I-Teq	3.8	100
PM10	0.144	32.15	Gg	0.4	0
PM2.5	0.123	21.98	Gg	0.6	0
SOx (as SO2)	0.003	42.06	Gg	<0.1	100
PAHs	0.012	9.41	Mg	0.1	17.5

4.20.3 Methodological issues

Sulphur dioxide, nitrogen dioxide and heavy metals
Sulphur dioxide, nitrogen dioxide and heavy metal emissions from the iron and steel industry are based on data reported by the plants.

Particle emissions
Particle emissions are generated in the foundries and sinter plants. TSP emissions are reported by the plants to the supervising authorities and are available in VAHTI to be used in the inventory. PM_{10} and $PM_{2.5}$ emissions have been calculated with fraction factors as follows:
- Foundries: 78% for both PM_{10} and $PM_{2.5}$ (AEAT, 2000)
- Sinter plants: 40% for PM_{10} and 25% for PM2.5 (Guidebook 2006, (EEA, 2006))
- Steelworks (BOF): 95% for PM_{10} and 90% for $PM_{2.5}$ (Guidebook 2006 (EEA, 2006))
- Steelworks (EF) and rolling of steel: 75% for PM_{10} and $PM_{2.5}$ (AEAT, 2000)

Black carbon
BC emissions are calculated using following emission factors:
- Basic oxygen furnace, electric furnace steel plant, rolling mills and foundries: 0.36 % of PM2.5 (Guidebook 2016 (EEA, 2016))
- Sinter and pelletizing plant: 0.17 % of PM2.5 (Guidebook 2016 (EEA, 2016))

NMVOC
Emission data from steel plants are reported by the plants to the supervising authorities. For those plants, which do not report their NMVOC emissions, the emissions are calculated with activity data and emission factors as follows:

- Basic oxygen furnace steel plant, emission factor 0.08 kg/t (Guidebook 2002,(EEA 2002)
- Electric arc furnace steel plant, emission factor 0.46 kg/t (Guidebook 2016, (EEA,2016)

POP (Table 4.33)
Some of the steel mills report their POP emissions to the environmental authorities. For those plants which do not report their emissions, POP emissions are calculated with emission factors as follows:
Production of steel, EFs:
- PCDD/F 0.002 ug I-TEQ/t (SEPA, 1996)
- PAH-4 0.07 mg/t (UBA, 1998)
- PCB 3.6 mg/t (EEA, 2006).

Production of iron, EFs:
- PAH-4 4.3 mg/t PAH-4 (EPA, 1988)

Production of sinter, EFs:
- HCB 0.032 mg/t Guidebook 2006, (EEA, 2006)
- PCB 0.2 mg/t Guidebook 2006, (EEA, 2006)

Activity data is presented in Table 4.322. Emissions can currently be presented only for those activities where no point source data is included due to the pending recalculation of the energy sector time series. The time series is not consistent at the moment, the allocation of the point sources is not consistent over the years, and, most importantly, it is currently not possible to separate between the calculated and reported emissions for the earlier years. Emission data is therefore only presented for NMVOCs.

Table 4.32. Production of coke and steel and iron (reported by plants to the VAHTI-database)

Year	Production of coke (1000t)	Production of crude steel (1000t)	Production of sinter (t)	Production of iron (t)
1990	487	2 861	2 992 000	2 280 000
1991	471	2 890	3 049 000	2 330 000
1992	498	3 077	3 133 000	2 450 000
1993	874	3 256	3 178 000	2 530 000
1994	922	3 420	3 224 000	2 600 000
1995	920	3 176	2 832 000	3 242 000
1996	910	3 301	2 292 000	3 730 000
1997	879	3 734	2 673 000	3 350 000
1998	912	3 952	2 689 000	3 716 000
1999	900	3 956	2 770 000	3 783 000
2000	910	4 096	2 780 000	3 903 000
2001	909	3 938	2 650 000	3 857 000
2002	912	4 003	2 574 000	3 975 000
2003	895	4 766	2 815 000	4 600 000
2004	904	4 830	2 782 000	3 036 566
2005	894	4 738	2 857 000	3 056 165
2006	870	5 054	2 922 119	3 157 894
2007	865	4 431	2 644 780	2 915 130
2008	860	4 417	2 680 894	2 942 946
2009	740	3 066	2 104 435	2 042 112
2010	828	4 040	2 256 069	2 564 451
2011	852	3 989	2 184 169	2 522 316
2012	880	3 728	0	2 340 089
2013	877	3 465	0	2 107 032
2014	888	3 759	0	2 219 096
2015	876	3 939	0	2 270 261

Table 4.33. Calculated POP emissions from iron and steel production.

Year	PCB (kg)	Benzo(a)pyrene (kg)	Benzo(b)fluoranthene (kg)	Benzo(k)fluoranthene (kg)	Indeno(1,2,3-cd) pyrene (kg)
1990	6.6	32.9	33.1	33.0	32.7
1991	6.7	33.4	33.5	33.5	33.2
1992	7.2	34.4	34.6	34.5	34.3
1993	7.6	35.0	35.2	35.1	34.8
1994	8.0	35.6	35.8	35.7	35.4
1995	7.4	32.5	32.7	32.6	32.2
1996	7.7	27.4	27.5	27.4	27.2
1997	8.7	30.5	30.6	30.5	30.4
1998	9.2	31.0	31.2	31.1	31.0
1999	9.2	31.9	32.1	32.0	31.9
2000	9.5	32.1	32.3	32.2	32.1
2001	9.2	22.7	22.9	22.8	22.7

2002	9.3	22.8	23.0	22.9	22.8
2003	11.2	23.5	23.7	23.6	23.5
2004	11.3	21.9	22.0	22.0	21.8
2005	11.1	21.9	22.1	22.0	21.9
2006	11.6	5.1	5.3	5.2	5.0
2007	10.1	5.0	5.0	5.0	4.9
2008	10.3	4.9	5.0	5.0	4.8
2009	7.4	2.8	2.8	2.8	2.8
2010	9.4	4.4	4.4	4.4	4.4
2011	9.3	4.4	4.5	4.4	4.4
2012	8.9	2.6	2.6	2.6	2.5
2013	8.3	2.3	2.3	2.3	2.3
2014	9.0	2.4	2.4	2.4	2.4
2015	9.4	2.5	2.5	2.5	2.5

4.20.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.20.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.20.6 Source-specific recalculations including changes made in response to the review process

None.

4.20.7 Source-specific planned improvements

Planned for 2018 submission

- Consistency of the timeseries will be checked related to data reported by the plants and calculated emissions and their allocation under the NFR categories.
- National emission factors will be checked and new emission factors calculated based on site specific information on emissions and production volumes while recalculating the time series.

4.21 Ferroalloys production (2C2)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.21.1 Source category description

SNAP 040302	FERRO ALLOYS Ferrochromium production plants (< 5 plants) are part of integrated stainless steel plants, emission reported by the plants Production capacity in 2015: 600 000t
Emissions	Source of emissions
NMVOC, PAH	reported by the plants according to the monitoring and reporting obligations in their environmental permits
TSP, PM10, PM2.5, BC	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Pb, Cd, Hg, As, Cr, Cu, Ni, Zn,	reported by the plants according to the monitoring and reporting obligations in their environmental permits

Ferrochromium production occurs in the integrated stainless steel plants (see Figure 4.6).

The emissions are either allocated to NFR 2C2 or 2C1 according to information of the main activity of the plant as stated in their environmental permits.

4.21.2 Emission trends

Ferroalloys production is a major source of chromium emissions. In 2014 several malfunction situations occurred at a production unit during the year, which could be seen as an increase in the level of zinc and chrome emissions. In 2015 all plants operated normally, so all pollutants contributed less than 1% of the total emissions.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.344.

Table 4.34. Contribution of Ferroalloys production (NFR 2C2) to total emissions in 2015.

Pollutant	Emissions ferroalloys production in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
As	<0.001	2.43	Mg	<0.1	100
BC	0.008	4.60	Gg	0.2	0
Cd	0.003	0.92	Mg	0.3	100
Cr	0.371	15.63	Mg	2.4	100
Cu	0.07	39.57	Mg	0.2	100
Hg	<0.001	0.64	Mg	<0.1	100
Ni	0.089	16.92	Mg	0.5	100
NMVOC	<0.001	87.76	Gg	<0.1	100
Pb	0.013	13.93	Mg	<0.1	100
TSP	0.095	50.02	Gg	0.2	100
Zn	0.655	129.07	Mg	0.5	100
PM10	0.087	32.15	Gg	0.3	0
PM2.5	0.078	21.98	Gg	0.4	0
PAHs	<0.001	9.41	Mg	<0.1	100

4.21.3 Methodological issues

As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, TSP, PAH4 and NMVOC
Emissions are reported according to requirements for monitoring and reporting in the environmental permits of the plants. When no plant specific data is available emissions has been calculated.

PM_{10} and $PM_{2.5}$
Emissions are calculated using size fraction factors of 92% for PM10 and 82% for PM2.5 (AEAT, 2000) from TSP emissions that are reported by the plants.

Black carbon
Emissions have been calculated using the fraction factor of 10 % of PM2.5 (GB 2016, EEA 2016).

4.21.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.21.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.21.6 Source-specific recalculations including changes made in response to the review process

None.

4.21.7 Source-specific planned improvements

None.

4.22 Aluminium production (NFR 2C3)

There is no primary aluminium production in Finland.

Emissions from the production of secondary aluminium and from aluminium casting are reported under NFR 2C7c.

4.23 Lead production (2C5)

There is no lead production in Finland.

4.24 Zinc production (NFR 2C6)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.24.1 Source category description

SNAP 040309c	Zinc production plants (< 5 plants), emissions both reported by the plants and calculated at the inventory agency
Emissions	Source of emissions
TSP, PM_{10}, $PM_{2.5}$	reported by the plants according to the monitoring and reporting obligations in their environmental permits
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Cd, Hg, As, Cu, Zn,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
PCDD/F	calculated (EF*AD)

Special high grade zinc is produced in Finland by an electrolytic process in a smelter. The electrolytic process includes four main stages: 1) Roasting of zinc concentrate in temperature of more than 900 ^{o}C (ZnO as product), 2) Leaching stage, where the zinc oxide is separated from the other calcines 3) Impurities elimination 4) Electrolysis. According to 2006 IPCC Guidelines this process does not result in non-energy CO_2 emissions. (Finlands GHG-NIR, 2016)

4.24.2 Emission trends

Zinc production is a source of heavy metals, NMVOC, particles and PCDD/F. Zn emissions from this sector contribute to nearly 4% of the total emissions. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.355.

Table 4.35. Contribution of Zinc production (NFR 2C6) to total emissions in 2015.

Pollutant	Emissions from	Total emissions	Unit	Share of total	% reported by
As	0.005	2.43	Mg	0.2	100
Cd	0.024	0.92	Mg	2.6	100
Cu	0.066	39.57	Mg	0.2	100
Hg	<0.001	0.64	Mg	0.1	100
NMVOC	0.001	87.76	Gg	<0.1	0
TSP	0.009	50.02	Gg	<0.1	100
Zn	4.995	129.07	Mg	3.9	100
PCDD/Fs	0.03	14.25	g I-Teq	0.2	0
PM10	0.002	32.15	Gg	<0.1	0
PM2.5	<0.001	21.98	Gg	<0.1	0

4.24.3 Methodological issues

TSPs and heavy metals (As, Hg, Cd, Cu, Pb, Zn)
The plants report these emissions according to the monitoring programmes in the environmental permits to the environmental authorities and the data are available in VAHTI for use in the inventories. These emissions are included in the inventory as the difference between data reported by the plants and the default emissions calculated on basis of energy consumption. It will be further studied in the coming years, if the energy emission factor should be revised to be higher or if these really are process emissions.

When no plant specific data is available emissions has been calculated.

Small particles
PM_{10} and $PM_{2.5}$ emissions are calculated using size fraction factors of 92% for PM10 and 82% or PM2.5 from TSP emissions, which are reported by the plants (AEAT, 2000). Particle emissions which are calculated using TSP emissions reported by the plants cannot be separated from the calculated emissions in the time series and can be presented separately only when the time series is recalculated for the energy sector emissions.

NMVOC and PCDD/F
NMVOC and PCDD/F emissions from primary zinc smelting in hot dip galvanizing processes were reported to the supervising authorities for the year 2007 only. As these emissions were not reported for the years 2008-2015, emissions are calculated for the years after 2007 based on production data (see 06) of the plant and a plant specific emission factor (calculated as IEF from 2007 data). An implied emission factor 0.005 t/t for NMVOC and 0.098 t/t for PCDD/F (SYKE, 2009) have been used for 1990-2015. Production volumes are available either at plant level in VAHTI or from the Federation of Finnish Technology Industries. The calculated emissions are presented in 07.

Table 4.36. Activity data for zinc production and primary zinc smelting in hot dip galvanizing process in 1990-2015. (reported by plants to the VAHTI-database)

Year	Zinc production (t)	Primary zinc smelting (t)	Year	Zinc production (t)	Primary zinc smelting (t)
1990	175 000	23 094	2006	282 261	49 121
1991	170 389	21 092	2007	305 543	38 000
1992	170 523	24 270	2008	297 772	37 625
1993	170 934	26 527	2009	295 049	28 927
1994	173 244	18 331	2010	307 144	36 250
1995	176 583	31 428	2011	307 352	34 078
1996	176 223	31 999	2012	314 742	37 392
1997	175 334	33 526	2013	311 682	28 918
1998	198 940	32 339	2014	302 024	30 636
1999	225 190	31 931	2015	305 717	32 516
2000	222 881	43 125			
2001	248 816	47 716			
2002	235 337	51 684			
2003	265 853	49 890			
2004	284 525	49 403			
2005	281 904	43 459			

Table 4.37. Calculated NMVOC and PCDD/F emissions from zinc production.

Year	NMVOC(kg)	PCDD/F (g I-TEQ)	Year	NMVOC(kg)	PCDD/F (g I-TEQ)
1990	0.818	0.017	2010	1.435	0.030
1991	0.796	0.017	2011	1.436	0.030
1992	0.797	0.017	2012	1.471	0.031
1993	0.799	0.017	2013	1.457	0.031
1994	0.810	0.017	2014	1.412	0.030
1995	0.825	0.017	2015	1.429	0.030
1996	0.824	0.017			
1997	0.819	0.017			
1998	0.930	0.020			
1999	1.052	0.022			

2000	1.042	0.022			
2001	1.163	0.024			
2002	1.100	0.023			
2003	1.243	0.026			
2004	1.330	0.028			
2005	1.318	0.028			
2006	1.319	0.028			
2007	1.428	0.030			
2008	1.391	0.029			
2009	1.379	0.029			

4.24.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.24.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.24.6 Source-specific recalculations including changes made in response to the review process

NMVOC emissions for whole time series added to the inventory in 2017 submission.

4.24.7 Source-specific planned improvements

Planned for 2019 submission
The allocation of emissions in the energy/process sectors will be further studied in the coming years, as well as the magnitude of the emission factor (if it should be higher for process emissions).

4.25 Copper production (NFR 2C7a)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	Copper AD corrected in the 2014 submission
Other (e.g. language, layout)	April 2017 KS
Recalculation	None

4.25.1 Source category description

SNAP 040309a	SNAP-NAME Copper production plants (< 5 plants) and production of upgraded copper products. Emissions both calculated or reported by the plants Production capacity see table 4.40
Emissions	Source of emissions
SO_X, CO,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
TSP, PM_{10}, $PM_{2.5}$,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Pb, Cd, AsCr, Cu, Ni, Zn,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
PCDD/F, HCB, PCB, BC	calculated (EF*AD)

4.25.2 Emission trends

Copper production is a major source of HCB and PCDD/F emissions. Other pollutants contribute less than 1% of the total emissions. The shares of emissions of total emissions and the shares reported by the plants are presented in 08.

Table 4.38. Contribution of Copper production (NFR 2C7a) to total emissions in 2015.

Pollutant	Emissions from copper production in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
As	0.05	2.43	Mg	2.1	100
BC	<0.001	4.60	Gg	<0.1	0
Cd	<0.001	0.92	Mg	<0.1	100
CO	0.006	324.57	Gg	<0.1	100
Cu	0.002	39.57	Mg	<0.1	100
Ni	<0.001	16.92	Mg	<0.1	100
NMVOC	0.009	87.76	Gg	<0.1	100
Pb	<0.001	13.93	Mg	<0.1	100
TSP	<0.001	50.02	Gg	<0.1	100
Zn	0.004	129.07	Mg	<0.1	100
HCB	6.01	20.94	kg	28.7	0
PCBs	0.176	151.89	kg	0.1	0
PCDD/Fs	1.157	14.25	g I-Teq	8.1	0
PM10	<0.001	32.15	Gg	<0.1	0
PM2.5	<0.001	21.98	Gg	<0.1	0
Se	0.121	0.44	Mg	27.5	100
SOx (as SO2)	<0.001	42.06	Gg	<0.1	100

4.25.3 Methodological issues

Total suspended particles, heavy metals (As, Cd, Cu, Pb, Zn) and sulphur dioxide
Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

Small particle emissions and black carbon
PM_{10} and $PM_{2.5}$ emissions are calculated using size fraction factors 92 % for PM_{10} and 82 % for $PM_{2.5}$ (AEAT, 2000) from TSP emissions. Black carbon emissions are calculated using the emission factor 0,1 % of PM2.5 (GB2016, EEA 2016).

POPs
PCDD/F, PCB and HCB emissions from production of copper as well as PCB and HCB emissions from wrought copper manufacturing are calculated separately for each plant using emission factors listed below

- PCDD/F: production of copper 8.4 ug I-TEQ/t (UNEP, 1999),
- HCB: production of copper 39 mg/t (Pacyna, 2003)
  wrought copper production 17.5235 mg/t (Toda 2005)
- PCB: production of copper 0.095742 mg/t (Toda, 2005)
  wrought copper production 4.427 mg/t (Toda, 2005).

Activity data used in the calculation is presented in 039. and the emissions in Table 4.400.

Table 4.39. Copper production volumes 1990-2015 (reported by plants to the VAHTI-database)

Year	Copper production (t)	Wrought copper production (t)	Year	Copper production (t)	Wrought copper production (t)
1990	90 200	113 941	2010	117 900	69 189
1991	90 100	113 941	2011	124 642	57 133
1992	110 500	113 941	2012	138 374	38 795
1993	107 000	113 941	2013	128 959	37 930
1994	98 200	113 941	2014	143 765	36 648
1995	88 300	113 941	2015	137 682	36 713
1996	150 300	113 941			
1997	159 000	113 941			
1998	156 000	113 941			
1999	149 600	113 941			
2000	155 400	126 287			
2001	169 250	120 449			
2002	160 900	115 477			
2003	160 566	109 683			
2004	151 647	114 007			

Year	Copper production (t)	Wrought copper production (t)	Year	Copper production (t)	Wrought copper production (t)
2005	157 933	110 707			
2006	164 306	100 391			
2007	118 911	90 933			
2008	142 154	83 454			
2009	110 479	58 332			

Table 4.40. Calculated POP emissions from copper production

Year	HCB (kg)	PCDD/F (g I-TEQ)	PCB (kg)	Year	HCB (kg)	PCDD/F (g I-TEQ)	PCB (kg)
1990	5.51	0.76	0.51	2010	5.81	0.99	0.32
1991	5.51	0.76	0.51	2011	5.86	1.05	0.26
1992	6.31	0.93	0.52	2012	6.08	1.16	0.18
1993	6.17	0.90	0.51	2013	5.69	1.08	0.18
1994	5.83	0.82	0.51	2014	6.25	1.21	0.18
1995	5.44	0.74	0.51	2015	6.01	1.16	0.18
1996	7.86	1.26	0.52				
1997	8.20	1.34	0.52				
1998	8.08	1.31	0.52				
1999	7.83	1.26	0.52				
2000	8.27	1.31	0.57				
2001	8.71	1.42	0.55				
2002	8.30	1.35	0.53				
2003	8.18	1.35	0.50				
2004	7.91	1.27	0.52				
2005	8.10	1.33	0.51				
2006	8.17	1.38	0.46				
2007	6.23	1.00	0.41				
2008	7.01	1.19	0.38				
2009	5.33	0.93	0.27				

4.25.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.25.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.25.6 Source-specific recalculations including changes made in response to the review process

2014
Activity data for copper production was corrected.

4.25.7 Source-specific planned improvements

None.

4.26 Nickel production (NFR 2C7b)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculation	none

4.26.1 Source category description

SNAP 040305	NICKEL PRODUCTION < 5 plants Production capacity 60 000- 90 000 tonnes nickel and nickel chemicals per year
Emissions	Source of emissions
SO2, NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits
NH3, Ni	reported by the plants according to the monitoring and reporting obligations in their environmental permits

4.26.2 Emission trend

Nickel production is a major source of Ni emissions, while other pollutants contribute less than 1% of the total emissions.

The shares of emissions of total emissions and shares reported by the plants are presented 01.

Table 4.41. Contribution of Nickel production (NFR 2C7b) to total emissions in 2015.

Pollutant	Emissions from nickel production in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NH3	0.07	31.85	Gg	0.2	100
Ni	1.692	16.92	Mg	10	100
NMVOC	0.046	87.76	Gg	<0.1	100
SOx (as SO2)	<0.001	42.06	Gg	<0.1	100

4.26.3 Methodological issues

NMVOC, NH_3, SO_x and nickel emissions are reported by the plants according to the monitoring requirements in the environmental permits.

4.26.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.26.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.26.6 Source-specific recalculations including changes made in response to the review process

None.

4.26.7 Source-specific planned improvements

None.

4.27 Other metal production (NFR 2C7c)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.27.1 Source category description

SNAP 040306	ALLIED METAL MANUFACTURING Number of plants <5 Production capacity:~1000 t casting products
Emissions	Source of emissions
Nox, Sox	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Cu, Pb, Zn	reported by the plants according to the monitoring and reporting obligations in their environmental permits
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits
SNAP 040307	GALVANIZING Number of plants 7 Production capacity: varies, in smaller plants ~10 000 t steel structures is hot galvanized in a year, in bigger plant ~1 000 000 tonnes of steel in coils is reprocessed in a year
Emissions	Source of emissions
Zn, Cr	reported by the plants according to the monitoring and reporting obligations in their environmental permits
HCB	calculated (EF*AD)
NH_3, TSP, PM_{10}, $PM_{2.5}$	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Recycling of waste and scrap Number of plants <5 Production capacity: waste metals and waste containing metals 200 000 t/a, decomissioned vechicles 80 000 t/a .
Emissions	Source of emissions
As, Cd, Pb, Zn,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
HCB, PCB, PCP	calculated (EF*AD)
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Surface treatment of metals Number of plants<5 Production capacity: not available, plenty of small plants, supply and demand varies yearly
Emissions	Source of emissions
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Pb, Zn, Cr, Ni,	reported by the plants according to the monitoring and reporting obligations in their environmental permits
NMVOC, NH3,	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Secondary aluminium production and aluminium casting Number of plants < 5 Production capacity: ~50 000 t/a aluminium profiles
Emissions	Source of emissions
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits
PCDD/F, HCB, PCB, PCP	calculated (EF*AD)
SOx, NOx	For some years these emissions are allocated under NFR2 but the correct allocation is under NFR1
As, Cd, Ni, NH3	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Cable manufacturing Number of plants <5 Production capacity: ~500 000 t/a cables
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Zinc wire manufacturing Number of plants <5 Production capacity: ~10 000 t/a wire
Emissions	Source of emissions
Zn	reported by the plants according to the monitoring and reporting obligations in their environmental permits
SNAP 040309z	OTHER Lock Manufacturing Number of plants <5 Production capacity: not available
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits
Zn,Cr	reported by the plants according to the monitoring and reporting obligations in their environmental permits
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Chromite mine and concentration plant Number of plants <5 Production capacity: not available
Emissions	Source of emissions
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Handling of FeCr slag Number of plants <5 Production capacity: not availble
Emissions	Source of emissions
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Manufacturing of small caliber cartridges Number of plants <5 Production capacity: ~80 000 000 catridges, ~60 000 000 bullets
Emissions	Source of emissions
Pb	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Handling of noble metals Number of plants <5 Production capacity: not available
Emissions	Source of emissions
PCB	calculated (EF*AD)

SNAP 040309z	OTHER Handling of copper and nickel concentrates Number of plants <5 Production capacity ~70 000 t/a raw nickel matte
Emissions	Source of emissions
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits
As, Cu, Pb	reported by the plants according to the monitoring and reporting obligations in their environmental permits
NMVOC	reported by the plants according to the monitoring and reporting obligations in their environmental permits

SNAP 040309z	OTHER Manufacturing of nails Number of plants <5 Production capacity: ~5000 t/a nails
Emissions	Source of emissions
Pb, Zn	reported by the plants according to the monitoring and reporting obligations in their environmental permits
TSP, PM10, PM2.5	reported by the plants according to the monitoring and reporting obligations in their environmental permits

Around thirty industrial installations that report their emissions to the authorities and for which data is available in VAHTI are included under NFR 2C7c. The installations work in recycling of waste and scrap metals, surface treatment, galvanizing, metallic construction mountings, cable manufacturing, and manufacturing of nails and locks. Secondary aluminium production and aluminium foundry are allocated under this NFR as well. Due to the competitive position of the installations it is difficult to publish production capacities in the list presented above and in many cases there is only one installation working in a specific field.

4.27.2 Emission trends

The shares of emissions of total emissions and shares reported by the plants are presented Table 4.422.

Table 4.42. Contribution of Other metal production (NFR 2C7c) to total emissions in 2015.

Pollutant	Emissions from nickel	Total emissions in	Unit	Share of total	% reported by the
As	0.154	2.43	Mg	6.3	100
Cd	<0.001	0.92	Mg	<0.1	100
Cr	0.041	15.63	Mg	0.3	100
Cu	0.269	39.57	Mg	0.7	100
Hg	<0.001	0.64	Mg	<0.1	100
NH3	<0.001	31.85	Gg	<0.1	100
Ni	<0.001	16.92	Mg	<0.1	100
NMVOC	0.012	87.76	Gg	<0.1	100
NOx (as NO2)	<0.001	139.68	Gg	<0.1	100
Pb	0.269	13.93	Mg	1.9	100
TSP	0.013	50.02	Gg	<0.1	100
Zn	0.335	129.07	Mg	0.3	100
HCB	0.082	20.94	kg	0.4	0
PCBs	0.096	151.89	kg	<0.1	0
PM10	0.008	32.15	Gg	<0.1	0
PM2.5	0.007	21.98	Gg	<0.1	0
SOx (as SO2)	<0.001	42.06	Gg	<0.1	100

4.27.3 Methodological issues

Heavy metals
As, Cd, Cr, Cu, Pb, Ni and Zn emissions are reported by the plants according to the monitoring requirements in the environmental permits.

Ammonia
Use of ammonium chloride in hot galvanizing causes ammonia emissions. Only one plant uses ammonium chloride, the other plants are using electrolytic resurfing.

Particles
TSP emissions are reported by the plants according to their monitoring and reporting obligations.

PM_{10} and $PM_{2.5}$ emissions from the production of secondary aluminium are calculated using size fraction factors of 60 % for PM_{10} and of 50 % for $PM_{2.5}$ (AEAT, 2000).
The same size fractions are also used for all other production processes under SNAP 040309z. For galvanizing (SNAP 040307) size fraction factors of 92 % for PM_{10} and of 82 % for $PM_{2.5}$ (AEAT, 2000).

HCB
HCB emissions from primary zinc smelting in the hot dip galvanizing process are calculated with the emission factor of 1.45644 mg/t (Toda, 2005) and activity received from the industry.

POP emissions
PCDD/F, PCB, HCB and PCP emissions from production of secondary aluminium as well as PCB emissions from aluminium casting are calculated for plants using emission factors listed below and activity data presented in 03.

PCDD/F	secondary aluminium	22 ug I-TEQ/t	(Miljöstyrelsen, 2000)
HCB	secondary aluminium	1.365 mg/t	(SYKE, 2007)
PCB	secondary aluminium	3.4 mg/t	(BiPRO, 2006)
PCP	secondary aluminium	0.128	(SYKE, 2007).
PCB	aluminium casting	0.135325 mg/t	(Toda, 2005).

Table 4.43. Secondary aluminium production and aluminium casting 1990-2015.

Production of secondary aluminium (t) (The Federation of Finnish Technology Industries)		Aluminium casting (t) (Expert estimate at SYKE 1990-1997) Statistics Finland 1998 onwards	
1990	23 926	1990	13 000
1991	22 054	1991	13 000
1992	27 249	1992	13 000
1993	29 905	1993	13 000
1994	30 828	1994	13 000
1995	33 539	1995	13 000
1996	33 577	1996	13 000
1997	38 229	1997	13 000
1998	40 525	1998	13 378
1999	43 242	1999	15 193
2000	43 361	2000	17 799
2001	34 252	2001	16 548
2002	28 014	2002	17 910
2003	23 652	2003	63 907
2004	24 629	2004	21 421
2005	20 242	2005	22 602
2006	21 696	2006	36 146
2007	22 904	2007	38 240
2008	24 867	2008	37 132
2009	14 355	2009	29 258
2010	22 477	2010	33 896
2011	22 400	2011	31 573
2012	20 238	2012	30 649
2013	20 991	2013	32 929
2014	20 906	2014	32 929*
2015	20 490	2015	32 929*

Note: Values are total production amounts. If plant has reported emissions to the supervising authoritites (VAHTI), emissions are not calculated for the one in question

- due the lack of activity data, year's 2013 data is used for 2014 and 2015

Precious metals

From production of gold and silver metals also PCB emissions are calculated with emission factor 159.795 mg/t (Toda, 2005) and using activity data presented in 04.

Table 4.44. Precious metals; production of gold and silver (t) 1990-2015 (Statistics Finland)

Year	Production of gold and silver (t) (Statistics Finland)	Year	Production of gold and silver (t) (Statistics Finland)
1990	31.8	2006	44.4
1991	32.2	2007	36.0
1992	28.6	2008	61.6
1993	30.4	2009	62.1
1994	27.4	2010	70.6
1995	29.1	2011	80.0
1996	36.9	2012	137
1997	36.1	2013	109
1998	34.7	2014	160
1999	36.8	2015	137
2000	28.6		
2001	28.4		
2002	34.6		
2003	41.4		
2004	38.9		
2005	38.2		

Calculated POP emissions from other metal production are presented in 05.

Table 4.45. Calculated POP emissions from other metal production. Note; emission are not calculated for those years were VAHTI-data is not available (marked as –)

Year	HCB (kg)	PCDD/F (g I-TEQ)	PCB (kg)	Year	HCB (kg)	PCDD/F (g I-TEQ)	PCB (kg)
1990	0.065	0.53	0.088	2010	0.081	0.49	0.092
1991	0.060	0.49	0.082	2011	0.080	0.49	0.093
1992	0.071	0.60	0.099	2012	0.083	0.45	0.095
1993	0.078	0.66	0.108	2013	0.071	-	0.093
1994	0.082	0.68	0.111	2014	0.073	0.46	0.101
1995	0.090	0.74	0.120	2015	0.075	-	0.096
1996	0.091	0.74	0.122				
1997	0.099	0.84	0.138				
1998	0.101	0.89	0.145				
1999	0.104	0.95	0.155				
2000	0.123	0.95	0.154				
2001	0.113	0.75	0.123				
2002	0.111	0.62	0.103				
2003	0.102	0.52	0.096				
2004	0.103	0.54	0.093				
2005	0.088	0.45	0.078				
2006	0.098	0.48	0.086				
2007	0.084	0.50	0.089				
2008	0.087	0.55	0.099				
2009	0.060	-	0.063				

4.27.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.27.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.27.6 Source-specific recalculations including changes made in response to the review process

None.

4.27.7 Source-specific planned improvements

None.

4.28 Storage, handling and transport of metal products (NFR 2C7d)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.28.1 Source category description

SNAP 040211	Storage, handling and transport of metal products storage and handling of iron ore.
Emissions	Emission source
TSP, PM_{10}, $PM_{2.5}$	calculated (EF*AD)

4.28.2 Emission trend

The shares of emissions of total emissions and shares reported by the plants are presented in Table 4.466.

Table 4.46. Contribution of Storage, handling and transport of metal products (NFR 2C7d) to total emissions in 2015.

Pollutant	Emissions from Storage, handling and transport of metal products in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
TSP	0.686	50.02	Gg	1.4	0
PM10	0.322	32.15	Gg	1	0
PM2.5	0.027	21.98	Gg	0.1	0

4.28.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions have been calculated.

Particle emissions from storage, handling and transport of iron ore are calculated with emissions factors 0,002 t/t, (TSP); 0,000094 t/t (PM10) and 0,000008 t/t (PM2.5), (TNO, 2002).

Production of iron ore used as activity data is presented in 0**7.**

Table 4.47. Activity data for iron ore in 1990-2015 (Customs Statistics ULJAS)

YEAR	Iron ore (t))	YEAR	Iron ore (t)	YEAR	Iron ore (t)
1990	3 058 362	2000	3 917 135	2010	3 055 661
1991	3 085 141	2001	3 916 263	2011	3 611 830
1992	3 363 742	2002	3 791 709	2012	3 224 219
1993	3 360 634	2003	4 238 321	2013	2 542 827
1994	3 617 472	2004	3 921 570	2014	3 094 723
1995	2 964 994	2005	4 215 633	2015	3 428 486
1996	3 305 776	2006	3 484 500		
1997	3 732 484	2007	3 159 252		
1998	3 922 551	2008	3 124 424		
1999	3 818 566	2009	2 206 222		

Calculated particle emissions from storage, handling and transport of metal products are presented in Table 4.488

Table 4.48. Calculated POP emissions from storage, handling and transport of metal products

Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)	Year	$PM_{2,5}$ (t)	PM_{10} (t)	TSP (t)
1990	24.5	287.5	611.7	2010	24.4	287.2	611.1
1991	24.7	290.0	617.0	2011	28.9	339.5	722.4
1992	26.9	316.2	672.7	2012	25.8	303.1	644.8
1993	26.9	315.9	672.1	2013	20.3	239.0	508.6
1994	28.9	340.0	723.5	2014	24.8	290.9	618.9
1995	23.7	278.7	593.0	2015	27.4	322.3	685.7
1996	26.4	310.7	661.2				
1997	29.9	350.9	746.5				
1998	31.4	368.7	784.5				
1999	30.5	358.9	763.7				
2000	31.3	368.2	783.4				
2001	31.3	368.1	783.3				
2002	30.3	356.4	758.3				
2003	33.9	398.4	847.7				
2004	31.4	368.6	784.3				
2005	33.7	396.3	843.1				
2006	27.9	327.5	696.9				
2007	25.3	297.0	631.9				
2008	25.0	293.7	624.9				
2009	17.6	207.4	441.2				

4.28.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.28.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.28.6 Source-specific recalculations including changes made in response to the review process

None.

4.28.7 Source-specific planned improvements

None.

4.29 Other solvent and product use (NFR 2D-2L)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Other (e.g. language, layout)	April 2017 KS

4.29.1 Source category description

Other solvent and product use includes domestic solvent use, road paving with spahalt, asphalt roofing, coating applications, degreasing, dry cleaning, chemical producst, printing and other solvent and product use. NMVOC and particle emissions are typical emissions for these categories. In Other product use, use of tobacco and fireworks are also source of heavy metals and POP emissions. Acitivites and emissions reported under the other solvent and product use sector are presented in Table 4.49.

Table 4.49. Activities and emissions reported under the other solvent and product use sector.

NFR	Processes	Description	Emissions reported
2D3a	Domestic solvent use including fungicides	Personal care and cosmetics, household cleaning, car dare and other products	NMVOC
2D3b	Road paving with asphalt		NMVOC, BC, TSP, PM10, PM2.5, PCDD/PCDF
2D3c	Ashalt roofing	Aspahlt mixing plants	NMVOC
2D3d	Coating applications	Decorative, industrial and other coating	NMVOC, TSP, PM10, PM2,5
2D3e	Degreasing	Chlorinated organic solvents are not produced in Finland, all the used solvents are imported.	NMVOC, TSP, PM10, PM2,5
2D3f	Dry cleaning	Included in degreasing (2D3e)	
2D3g	Chemical Products	- pharmaceutical industry - textile and leather industry - plastics manufacturing and handling - rubber conversion - manufacture of paints, inks and glues - manufacturing adhevise, tapes and films	NMVOC, TSP, PM10, PM2,5
2D3h	Printing	printing	NMVOC
2D3i	Other solvent use	- glass and mineral wool enduction - fat, edible oil extraction - preservation of wood - industrial application of glues and adhesives	NMVOC, TSP, PM10, PM2,5
2G	Other product use	Use of fireworks and tobacco	As, Cd, Cr, Cu, Hg, Pb, CO, NH3, NOx, SOx, NMVOC, TSP, PM10, PM2,5, BC, PCDD/PCDF, PAHs

Emissions of those plants that report their emissions to the supervising authorities[7] according to the monitoring requirements in the environmental permits are in most cases reported as IE. This is because in most cases the reporting obligations determined in the monitoring programmes are for the total emissions of the plants and not separated between fuel combustion and other processes. Thus it has not been possible to make a complete split between emissions from fuel based and non-fuel based sources.

In cases where it has been possible to separate fuel combustion emissions from process emissions, these are reported separately under NFR 2D categories. For those plants that report only total emissions, the split is based on the default emissions calculated on basis of fuel consumption which is reduced from the emissions reported by the plants, and reported under the NFR 1A2gviii.

4.30 Domestic solvent use including fungicides (NFR 2D3a)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	2016 NMVOC
Other (e.g. language, layout)	April 2017 KS
Recalculations	2016 NMVOC

4.30.1 Source category description

SNAP 060408 SNAP 060411	Domestic solvent use (other than paint application) Domestic use of pharmaceutical products Use of personal care and cosmetics, household cleaning products, car care prodcuts and other products
Emissions	Emission source
NMVOC	calculated (EF*AD)

4.30.2 Emission trend

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.500.

Table 4.50. Contribution of domestic solvent use (NFR 2D3a) to total NMVOC emissions in 2015.

Pollutant	Emissions from domestic solvent use in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	4.220	87.76	Gg	4.8	0

4.30.3 Methodological issues

The calculation of NMVOC emissions from domestic solvent use was revised for the whole time series in the 2016 submission.

Method used until 2015
For the use of personal care, adhesive and sealant, household cleaning and car care products an NMVOC emissions estimate prepared by the Finnish Cosmetic, Toiletry and Detergent Association at the beginning of the 2000's was used until the submission in 2015. The aggregate estimate of 4.66 kt/a covering all these sources was based on a questionnaire sent to members of the Association and took into account the different NMVOC compounds and their volatilation rates from the different product types. The estimate was used as a constant value for all years and thus did not take into account product development or changes in the use of products or in the legislation. The latest available estimation by the Association was from 2003 (Finnish Cosmetics, 2002).

Method used from 2016
During summer 2015 a project was carried out at SYKE to get more accurate information of the level and trend of NMVOC emisisons from domestic sourses. As a result of the project a new calculation model was developed and estimates prepared for years 1990, 1995, 2000, 2005, 2010 and 2014. The summary of the results is presented in Table 4.511. The emission estimates in the model are planned to be updated every 5 years.

Table 4.51. NMVOC emissions from Household Products Use in 1990, 1995, 2000, 2005, 2010 and 2014 (Rantanen et al., 2015)

NMVOC emissions [kt/a]	1990	1995	2000	2005	2010	2014
Cosmetics and toiletries	1.80	1.84	2.10	2.23	2.69	2.69
Household cleaning products	0.61	0.58	0.61	0.68	0.64	0.68
Car care products	0.42	0.84	0.90	1.02	0.90	0.74
Other products	0.02	0.03	0.04	0.06	0.08	0.11
TOTAL	2.85	3.30	3.66	3.98	4.31	4.21

A short description of the calculation principles in the model

The model follows the actual domestic sales of different products. Only products identified as sources of NMVOC emissions are included in the model (Table 4.52). The following groups are currently not currently included in the inventory due to lack of sales data: pharmaceuticals, office and Do It Yourself (DIY) products, adhesives and sealants.

Table 4.52. Product groups, NMVOC containing products and data collection basis in the domestic sources NMVOC emissions model

Product category	NMVOC containing products	Data collection basis
Cosmetics and toiletries	hygiene, hair care (4 subgroups), soap (1) and parfume products (2 subgroups).	money spent
Househould cleaning products	glass surface cleaning agents (3 subgroups), airrefresheners, general cleansing agents (2 subgroups)	money spent
Car care products	car wax, whindscreen washing agents (2 subgroups), de-icing, degreasing and engine detergents	sales volumes
Other products	lighter fluids for grilling and repellents.	sales volumes

Information on money spent on products was received from the Finnish Cosmetic, Toiletry and Detergent Association and this was divided between each of the subgroups based on expert estimates. NMVOC emissions were estimated based on sales volumes in litres derived from average product specific prices (€/l) and density of the product as well as from the contents and volatilization rates of NMVOC compounds typically in the products.

Sales volumes in litres was derived from selected companies and then scaled according to the sales shares to the whole country taking into account the specific sales profiles of different types of companies. NMVOC emissions were estimated based on sales volumes and the contents and volatilization rates of NMVOC compounds typically in the products.

In the NFR tables emissions for the intermediate years between those years calculated in the project are extrapolated. A method to calculate the emissions using GDP or population will be developed for these years. The emission estimates are planned to be updated every 5 years. In 2017 submission the same emission estimate was used for year 2015 than in 2014.

A detailed documentation of the model with information on data sources, assumptions made and detailed calculations is presented in Rantanen et al., 2015.

4.30.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.30.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.30.6 Source-specific recalculations including changes made in response to the review process

2016

The calculation of NMVOC emissions from domestic solvent use was revised for the whole time series.

4.30.7 Source-specific planned improvements

2020

- New data collection on NMVOC containing products' sales at the latest in 2020.
- Fine-tuning of the NMVOC model to reflect changes in legislation and product development and to calculate the emissions using GDP or population for years which are not covered by data collection.

4.31 Road paving with asphalt (2D3b)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.31.1 Source Category description

SNAP 040611	**Asphalt roofing** Asphalt mixing plants
Emissions	Source of emissions
TSP, PM_{10}, $PM_{2.5}$, BC, NMVOC, PCDD/F	calculated
PCB	PCB emissions are not estimated into air, only through solubility to water and soil
PAH-4	Coal tar is not used in road work in Finland (impact the reuse of asphalt material) and therefore PAH emissions are estimated not to occur in the mainlad of Finland. However, in the Aland Islands (as in Sweden) coal tar has been used since 1973. The emissions from Aland are not currently included in the inventory.

Approximately twenty asphalt mixing plants have an environmental permit and report their emissions according to their monitoring requirements. The majority of asphalt mixing plants does not fall under IED but are regulated by the local environmental authorities and are part of the notification procedure, i.e. new plants are required to report to a register. The register covers technical information (e.g. construction of the plant, stack height, process techniques, storage of liquids).

4.31.2 Emission trend

Road paving with asphalt is a minor source of NMVOC, particle and PCDD/F. The emissions from road paving with asphalt vary according to the production volumes over the years.

Emissions from bitumen oils, bitumen emulsions and industry bitumens are allocated under NFR 2D3c Asphalt roofing, while road bitumens and road bitumen solutions are allocated under NFR 2D3b Road paving with asphalt.

Process emissions from asphalt mixing plants are reported under NFR 2D3b and fuel combustion related emissions under NFR 1A2gviii. The allocation of activities has been changed over the years and is currently not consistent over the time series. The recalculation of the whole time series is planned for the submission in 2018.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.53.

Table 4.53. Contribution of road paving with asphalt (NFR 2D3b) to total emissions in 2015.

Pollutant	Emissions from road paving with asphalt	Total emissions in	Unit	Share of total	% reported by
BC	0.003	4.60	Gg	<0.1	0
NMVOC	0.337	87.76	Gg	0.4	0
TSP	0.085	50.02	Gg	0.2	0
PCDD/Fs	0.011	14.25	g I-Teq	<0.1	0
PM10	0.064	32.15	Gg	0.2	0
PM2.5	0.058	21.98	Gg	0.3	0

4.31.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions have been calculated on basis of asphalt production.

Particles and black carbon

Particle emissions are calculated using the following emission factors; 0,000016 t/t (TSP), 0,000012 t/t (PM_{10}) and 0,000011t/t ($PM_{2.5}$). These emission factors by TNO (2002) are considered to reflect better national circumstances than the default EF in the EMEP/EEA Emission Inventory Guidebook 2016. Black carbon emissions are calcuted using the emission factor 5.7 % of $PM_{2.5}$ (GB16, EEA, 2016). Activity data used in the calculation is presented in Table 4.54.

Table 4.54. Amount of produced asphalt (1990-2015), Confederation of Finnish Construction Industries RT Infra Division (Infra ry, 2016)

Year	Amount of used asphalt (1000 t)	Year	Amount of used asphalt (1000 t)
1990	7900	2010	5 000
1991	7600	2011	4 965
1992	7800	2012	4 450
1993	6700	2013	4 500
1994	5800	2014	4 600
1995	6400	2015	5 300
1996	5000		
1997	5200		
1998	4900		
1999	4600		
2000	4500		
2001	4500		
2002	5000		
2003	5 500		
2004	5 600		
2005	6 200		
2006	5 500		
2007	5 880		
2008	6 050		
2009	5 176		

POP emissions

PCDD/F emissions are based on asphalt production, which is publicly available in industrial statistics (Table 4.54). The emission factor for asphalt production is 2 ng I-TEQ/t (UNEP 1999). The emissions are presented in 0.

NMVOCs

For NMVOC emissions from road paving with aphalt (NFR 2D3b) and asphalt roofing (NFR 2D3c) are calculated using the same method based on bitumen use, which is confidential. Data on bitumen use is received from the domestic bitumen producer (Nynas Oy, previously Fortum Oil and Gas Ltd., Ref. Blomberg, 2006, Remes. H., 2016). This bitumen use data is divided into five groups: road bitumens, road bitumen solutions, bitumen oils, bitumen emulsions and industry bitumens.

To this, the imported amount of bitumen from customs statistics database ULJAS is added and divided in corresponding five groups as an expert estimation at SYKE. (Table 4.55)

NMVOC emissions from bitumen are measured annually by the producer. Bitumen emulsions are applied cold, they are water-based and do not contain solvents. For bitumen solutions and oils the NMVOC emission rate corresponds to the actual solvent content. The NMVOC emission rate of road bitumen and industrial bitumens is determined using the heating weight loss in the thin layer test (5 hours, 163 ºC).

The emissions are presented in 0.

Activity data

Activity data used in the inventory for 2006-2015 is based on the sum of production and import data, which is confidential, and cannot be published. Activity data for 1990-2005 is based on only confidential production data, because for these years import has been estimated (Blomberg, 2006) negligible.

Table 4.55. NMVOC fractions of bitumens (Nynäs Oy).

Year	Production group	VOC fraction %	Year	Production group	VOC fraction %
1988-1990	Road bitumen	0-0.1	2004-2010	Road bitumen	0-0.1
	Road bitumen solutions	10-50		Road bitumen solutions	10-50
	Bitumen oils	~10		Bitumen oils	~10
	Bitumen emulsions	0*		Bitumen emulsions*	0
	Industry bitumen solutions	40-60		Industry bitumens	0.1
1991-2003	Road bitumen	0-0.1	2012 onwards	Road bitumen	0-0.1
	Road bitumen solutions	10-50		Road bitumen solutions	10-50
	Bitumen oils	~10		Bitumen oils	~5**
	Bitumen emulsions*	0		Bitumen emulsions*	0
	Industry bitumen	0.1		Industry bitumens	0.1
	Industry bitumen solutions	30-65			

*bitumen emulsions are applied cold, they are water-based and do not contain solvents
**new biobased degrable solvent

Table 4.56. Calculated emissions (particles, NMVOC, dioxins) from road paving with asphalt

Year	TSP (t)	PM10 (t)	PM2,5 (t)	BC (t)	NMVOC (t)	PCDD/Fs (g-ITeq)
1990	126.4	94.8	86.9	5.0	900	0.016
1991	121.6	91.2	83.6	4.8	1035	0.015
1992	124.8	93.6	85.8	4.9	1162	0.014
1993	107.2	80.4	73.7	4.2	1299	0.013
1994	92.8	69.6	63.8	3.6	1147	0.012
1995	102.4	76.8	70.4	4.0	995	0.013
1996	80.0	60.0	55.0	3.1	995	0.010
1997	83.2	62.4	57.2	3.3	775	0.011
1998	78.4	58.8	53.9	3.1	653	0.010
1999	73.6	55.2	50.6	2.9	536	0.009
2000	72.0	54.0	49.5	2.8	491	0.009
2001	72.0	54.0	49.5	2.8	514	0.009
2002	80.0	60.0	55.0	3.1	537	0.010
2003	88.0	66.0	60.5	3.4	560	0.012
2004	89.7	67.3	61.7	3.5	426	0.011
2005	99.2	74.4	68.2	3.9	451	0.012
2006	87.3	65.5	60.0	3.4	399	0.011
2007	94.1	70.6	64.7	3.7	550	0.012
2008	96.4	72.3	66.3	3.8	466	0.012
2009	82.8	62.1	56.9	3.2	393	0.010
2010	80.0	60.0	55.0	3.1	347	0.010
2011	79.4	59.6	54.6	3.1	289	0.010
2012	71.2	53.4	49.0	2.8	353	0.009
2013	72.0	54.0	49.5	2.8	294	0.009
2014	73.6	55.2	50.6	2.9	339	0.009
2015	84.8	63.6	58.3	3.3	337	0.011

4.31.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.31.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.31.6 Source-specific recalculations including changes made in response to the review process

None

4.31.7 Source-specific planned improvements

2018
The allocation of activities has been changed over the years and is currently not consistent over the time series. The recalculation of the whole time series is planned for the submission in 2018.

4.32 Asphalt roofing (NFR 2D3c)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculation	none

4.32.1 Source category description

SNAP 040610	Roof covering with asphalt materials Emissions from the use of bitumen oils, bitumen emulsions and industry bitumens are reported under this category,
Emissions	Source of emissions
NMVOC	calculated

4.32.2 Emission trend

Asphalt roofing is a minor source of NMVOC emissions and the emissions vary according to the production volumes over the years.

The time series of emissions has not been recalculated and thus the variations in the emissions do not fully represent actual variations in emissions.

The shares of emissions for each air pollutant reported under the NFR category are presented in 07.

Table 4.57. Contribution of asphalt roofing (NFR 2D3c) to total emissions in 2015.

Pollutant	Emissions from asphalt roofing in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	0.197	87.76	Gg	0.2	0

4.32.3 Methodological issues

The same calculation method is used for road paving with aphalt (NFR 2D3b) and asphalt roofing (NFR 2D3c). NMVOC emissions asphalt roofing are calculated based on data from the domestic bitumen producer (Nynas Oy, previously Fortum Oil and Gas Ltd., Ref. Blomberg, 2006, Remes., H. 2016) and the imported amount of bitumen (information from customs statistics database ULJAS).

The data presented in Table 4.55 represent NMVOC emission rates from the use of bitumen products, not from manufacture of products. The emitted NMVOCs are based on annual meaurements by the producer.

The domestic production data is divided between the different product groups and for each group the specific NMVOC content is determined. The product groups are road bitumes, road bitumen solution, bitumen oils, bitumen emulsions and industry bitumens. Emissions from bitumen oils, bitumen emulsions and industry bitumens are allocated under NFR group 2D3c Asphalt roofing, while road bitumens and road bitumen solutions are allocated under NFR 2D3b Road paving with asphalt. The division of the activity data between the product groups is based on information from Customs statistics and on expert estimation at SYKE as also for the imported amount of bitumen.

Activity data used in the inventory for 2006-2015 is based on the sum of production and import data, which is confidential, and cannot be published. Activity data for 1990-2005 is based on only confidential production data, because for these years import has been estimated (Blomberg, 2006) negligible.

Calculated NMVOC emissions from asphalt roofing are presented in Table 4.58.

Table 4.58. Calculated NMVOC emissions from other asphalt roofing

Year	NMVOC (t)	Year	NMVOC (t)
1990	6260	2010	283
1991	5758	2011	191
1992	5257	2012	209
1993	4755	2013	158
1994	3757	2014	181
1995	2748	2015	197
1996	1742		
1997	549		
1998	614		
1999	461		
2000	489		
2001	494		
2002	498		
2003	503		
2004	332		
2005	324		
2006	283		
2007	362		
2008	349		
2009	321		

4.32.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.32.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.32.6 Source-specific recalculations including changes made in response to the review process

None.

4.32.7 Source-specific planned improvements

Planned for 2018 submission
Recalculation of the time series.

4.33 Coating applications (NFR 2D3d)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculated	

4.33.1 Source category description

According EMEP/EEA Guidebook 2016 NFR 2D3d coating applications consists of decorative, industrial and other coating applications. Industrial activities in Finland falling under NFR 2D3d Coating applications are presented in Table 4.59.

Table 4.59. Activities and emissions reported from coating applications.

Source	Description	Emissions reported
Decorative coating application	Non-industrial paint application in construction and buildings (SNAP 060103) and domestic use (SNAP 060104)	NMVOC
Industial coating application	Paint application in car repairing (SNAP 060102), manufacturing of automobiles (SNAP 060101), coil coating (SNAP 060105), boat building (SNAP 060106), painting of wood (SNAP 060107) and other industrial coating (SNAP 060108).	NMVOC, TSP, PM_{10}, $PM_{2.5}$
Other coating applications	Road marking paints, non-decorative floor paints. (SNAP 060109) Usually other coating applications are reported under industrial coating applications because the allcoation between sectors is difficult.	NMVOC

The allocation of emissions between decorative and industrial coating apllications in the Finnish inventory is not consistent over the years. The division between decorative and industrial coating has been possible only since 2001. Emissions from years 1990-2000 are presented on a more aggregated level.

NMVOC emissions for other coating applications are included under decorative and industrial coating as it is not possible to calculate these separately based on the current activity data detail level. Attempts are made to improve activity data collection in the next inventory rounds in order to receive more detailed information for other coating applications.

The shares of emissions for each air pollutant reported under the NFR category are presented in 0.

Table 4.60. Contribution of coating applications (NFR 2D3d) to total emissions in 2015.

Pollutant	Emissions from coating applications in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	6.771	87.76	Gg	7.7	16.3
TSP	0.007	50.02	Gg	<0.1	100
PM10	0.004	32.15	Gg	<0.1	0
PM2.5	0.001	21.98	Gg	<0.1	0

4.33.2 Emission trends

NMVOC emissions from paint application are presented in 0 and in 0. The decrease in emissions in the beginning of the 1990's is due to the recession and fall in the consumption of paints. The consumption of paints started to grow again in 1994. Despite of the growth, NMVOC emissions have been decreasing due to lower content of volatile organic compounds in the various paints and coatings.

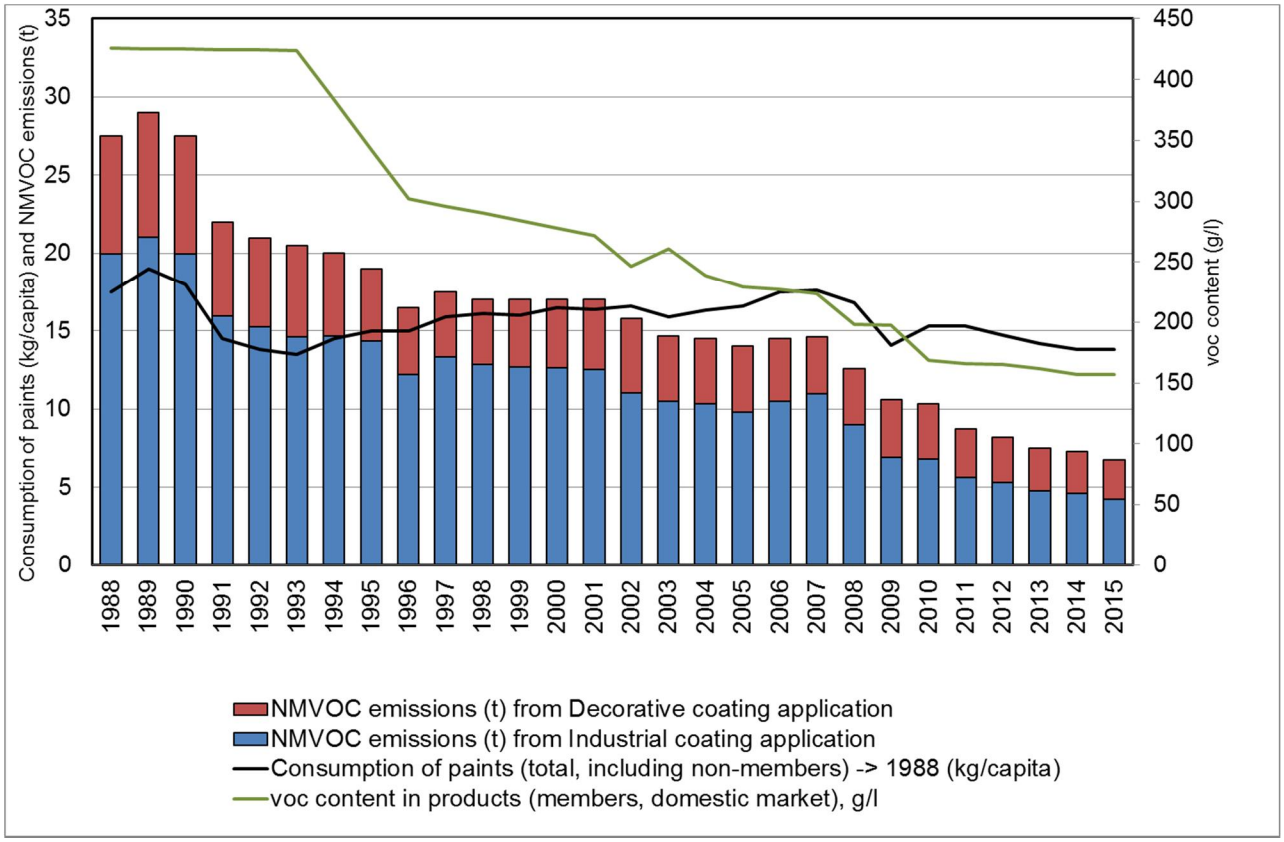


Figure 4.8 NMVOC emissions from paint application, VOC content and consumption of paints.

Table 4.61. NMVOC emissions reported under NFR 2D3d coating applications (Gg).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
decorative	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
industrial	27.5	26	22	21	20.5	19	18	18	18	17.9
other coating	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
decorative	IE[1]	4.1	4.3	4.0	3.9	4.0	3.9	3.5	3.6	3.8
industrial	17.9	12.9	11.5	10.7	10.6	10.0	10.6	11.1	9.0	6.8
decorative	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	IE[1]	0.01
	2010	**2011**	**2012**	**2013**	**2014**	**2015**				
decorative	2.6	3.2	2.9	2.7	2.6	2.5				
industrial	4.6	5.5	5.3	4.8	4.6	4.3				
decorative	NA	0.01	NA	NA	NA	NA				

[1]Included in industrial coating applications

4.33.3 Methodological issues

Reporting of NMVOC emissions from paint application

The paint sales and product statistics are divided into decorative (DIY/architectural) and industrial sectors.

Under decorative coating application SNAP categories 060103 and 060104 are reported.

It is not possible to separate emissions falling under industrial coating applications (SNAP 060101, 060102, 060105, 060106, 060107 and 060108) and other coating application (SNAP 060109) due to lack of detailed information. Part of the emissions falling under these sources is interconnected with emission data reported by the plants, which have reporting obligations only for their total emissions and not at activity level. Information sources for industrial and other coating applications are presented in Table 4.62. Paint application on *Wood* and *Other coating application* included in the table are included in industrial paint coating SNAP 060100 and cannot be reported separately.

Table 4.62. Information sources for the industrial and other coating applications

Sector	Paint application in	Reference
Industrial coating application	Manufacture of automobiles	Reported by operators, questionnaire to operators and Association of Finnish Paint Industry
	Coil coating	Reported by operators, questionnaire to operators and Association of Finnish Paint Industry
	Car repair	Reported by operators, questionnaire to operators and Association of Finnish Paint Industry
	Wood	Questionnaire to operators and Association of Finnish Paint Industry
	Other industrial paint application	Reported by operators, questionnaire to operators and Association of Finnish Paint Industry
Other coating application	Questionnaire to operators and the Association of Finnish Paint Industry (road marking paints)	

Decorative coating application (SNAP 060103 and 060104)

Emissions from application of paints of VTY members
Emissions from the application of paints produced by companies that are members of the Association of Finnish Paint Industry (VTY), are estimated by VTY, which compiles national statistics on the annual sales of paint products of its members. It covers about 90% of the paints produced in Finland. In the calculation of 2015 emissions, 97% of emissions are based on estimates by VTY.

Basis of calculation by VTY for the members
NMVOC emissions from decorative and industrial coating applications are calculated on the basis of the use volumes and solvent content of paints that develop over the years. The calculation is based on the actual formulations and the VOC content of raw materials used in the different formulations annually and on daily sales volumes of each product collected in each company's data system.

According to information from 2003 (Riala, 2003) 75% of paints used for construction and 90% of paints used for indoor painting were waterborne already then. According to the statistics collected by the members of the Association of Finnish Paint Industry the share of waterborne paints has been increased especially in the sector of industrial coatings since 2001.

For the baseline year 1988 for NMVOC emissions, the statistics of water and solvent based paints were further divided into subgroups of several types of products and various types of surfaces to be painted, such as "waterborne decorative indoor paints" or "solvent borne decorative indoor paints". For each of these subgroups the average NMVOC content and the average density have been estimated by the expert group set by the Member Companies of the Association of Finnish Paint Industry (VTY).

Emissions from application of paints of non-VTY members
Emissions due to the application of paints from those paint manufacturers that are not members of VTY (around 90%, in 2015 3%) are estimated based on data acquired from annual questionnaires sent out by Finnish Environment Institute SYKE. Information on paint production and sales of the companies as well as the likely use of paints (decorative/industrial) are collected from the companies. The questionnaire was earlier based on a mailed questionnaire and from 2011 an Internet based electronic data collection system has been used, in addition. The response rate to the questionnaire varies from year to year. The collection of emission data for 2015 was carried out using the Internet based collection and by sending out questionnaires (excel-sheet) by e-mail to 6 companies, out of which 6 responded. Most of the responses were provided in the excel sheet only while few manufactures used internet based collection system.

Basis of calculation by SYKE for non-VTY members
Information on the volume of paints/solvents used and their content of volatile organic compounds by CAS number and concentration are used in the calculation. The default volatility rate of 100% is used for the VOC compounds unless the operators provide a more accurate rate in their response. The questionnaire includes guidance for the operators if they choose to calculate the VOC emissions themselves. In any case, they report the details needed for the national inventory.

Calculated NMVOC emissions from coating applications are presented in Table 4.633.

Table 4.63. Calculated NMVOC emissions from coating applications

Year	NMVOC (t)	Year	NMVOC (t)
1990	27500	2010	10320
1991	26000	2011	8719
1992	22000	2012	8181
1993	20500	2013	7512
1994	20000	2014	7270
1995	19000	2015	6772
1996	18000		
1997	18000		
1998	18000		
1999	17900		
2000	17900		
2001	17000		
2002	15800		
2003	14663		
2004	14495		
2005	14007		
2006	14517		
2007	14634		
2008	12559		
2009	10575		

Particle emissions

Particulate matter emissions (TSP, PM_{10} and $PM_{2.5}$) from industrial coating application are based on TSP data reported by the plants which are available in VAHTI. Particle emissions are mainly generated during spray painting for example in a shipyard. PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions based on fraction factors 80% for PM10 and 50% for PM2.5 (Karvosenoja, 2002). In 2015 particle emission from paint applications were less than 0.1 % of total emissions.

The time series cannot currently be presented due to the interconnected data of point sources that can be separated only when the recalculation of the energy sector emissions has been finalized.

4.33.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.33.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.33.6 Source-specific recalculations including changes made in response to the review process

None.

4.33.7 Source-specific planned improvements

Not scheduled

- Improving the consistency of the allocation of emissions between decorative and industrial coating applications for the years 1990-2000.
- Separation of emissions for other coating applications and decorative and industrial coating

4.34 Degreasing (NFR 2D3e)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

4.34.1 Source category description

There is no production of chlorinated organic solvents in Finland, all the used solvents are imported.

Degreasing and dry cleaning is a source of NMVOC emissions. Chlorinated organic solvents are used in the metal and electronic industries to clean surfaces of different components and in dry cleaners. Activities listed in Table 4.644 are included in the inventory.

Table 4.64. Information sources for the NMVOC inventory under NFR 2D3e.

Product group	Activity where used	Reference
Chlorinated solvents in products	Metal degreasing SNAP 060201	Customs statistics and expert estimate
	Other industrial cleaning SNAP 060204	Customs statistics and expert estimate
	Electronic components manufacturing SNAP 060203	Customs statistics and expert estimate

Degreasing in the Finnish inventory includes part of the emissions from Dry cleaning (NFR 2D3f) which can not currently be reported separately.

4.34.2 Emission trend

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.655.

Table 4.65. Contribution of Degreasing (NFR 2D3e) to total emissions in 2015

Pollutant	Emissions from degreasing in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by plants
NMVOC	0.423	87.76	Gg	0.5	2.2
TSP*	<0.001	50.02	Gg	<0.1	100
PM10*	<0.001	32.15	Gg	<0.1	0
PM2.5*	<0.001	21.98	Gg	<0.1	0

*there may be incorrect allocation of particle emissions, will be checked for the next submission

4.34.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits.

When no plant specific data is available emissions has been calculated based on import statistics of pure chlorinated solvents and products containing chlorinated organic solvents and the volume of solvent waste processed in the hazardous waste treatment plants.

There is no production of chlorinated organic solvents in Finland. All the solvents used are imported and the amounts are obtainable from the Customs Statistics (ULJAS), but the split of their use between metal degreasing and dry cleaning is not available resulting in aggregated reporting.

Estimation of emissions from degreasing is based on the assumption that all purchased chemicals are used during the year of import. Activity data used in the calculation is presented in Table 4.666. The emission factor 0.7 kg/kg used in the calculation is an expert estimate by VTT Technical Research Centre of Finland since 2001 (YM, 1992). For the years 1990-2000 it is not possible to split the solvent volumes between solvents imported or solvents in imported products, so the solvent use is presented as a sum *and it is based on expert estimate*. (SYKE, 2002)

Calculated NMVOC emissions from degreasing are presented in Table 4.677.

Table 4.66. Activity data for NMVOC emissions under NFR 2D3e (sum, based on expert estimate)*

Year	Chlorinated organic solvents import (t) from ULJAS	Chlorinated organic solvents import in products (t) Expert estimate	Chlorinated organic solvents processed in the waste treatment plants (expert estimate) (t)
1990	2600*		
1991	2300*		
1992	2100*		
1993	1800*		
1994	1700*		
1995	1500*		
1996	1300*		
1997	1300*		
1998	1300*		
1999	1200*		
2000	1200*		
2001	1094	100	160
2002	1421	150	160
2003	1407	150	140
2004	1110	150	140
2005	1317	150	140
2006	1070	150	140
2007	855	150	140
2008	936	150	140
2009	863	150	140
2010	595	150	140
2011	371	150	140
2012	529	150	140
2013	680	150	140
2014	545	150	140
2015	603	150	140

Table 4.67. Calculated NMVOC emissions from degreasing

Year	NMVOC (t)	Year	NMVOC (t)
1990	2600	2010	398
1991	2300	2011	236
1992	2100	2012	339
1993	1800	2013	476
1994	1700	2014	383
1995	1500	2015	423
1996	1300		
1997	1300		
1998	1300		
1999	1200		
2000	1200		
2001	724		
2002	988		
2003	992		
2004	784		
2005	929		
2006	756		
2007	581		
2008	637		
2009	597		

4.34.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.34.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.34.6 Source-specific recalculations including changes made in response to the review process

None.

4.34.7 Source-specific planned improvements

None.

4.35 Dry cleaning (NFR 2D3f)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

NMVOC emissions from dry cleaning are included in the emissions calculated from the use of chlorinated organic solvents as presented in Table 4.67. In the inventory they are allocated under Degreasing (NFR 2D3e). The emissions cannot be reported separately due to missing tools to estimate the share of solvents used for dry cleaning.

4.36 Chemical products (NFR 2D3g)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
	April 2017 KS

4.36.1 Source category description

Information on industrial activities falling under NFR 2D3g Chemical Products is presented in Table 4.688.

Table 4.68. Activities and emissions reported under NFR 2D3g.

Activities included	Emissions
Pharmaceutical industry SNAP 060306 Textile and leather industry SNAP 060312 and 060313 Plastics manufacturing and handling of polymer plastics (e.g. polyester, polyvinylchloride, polystyrene foam processing) SNAP 060301, 060302, 060303 and 060304 Rubber conversion SNAP 060305 Manufacture of paints, inks and glues SNAP 060307, 060308 and 060309 Adhesive, magnetic tapes, films and photographs manufacturing SNAP 060311 Not estimated: asphalt blowing	NMVOC, TSP, PM_{10}, $PM_{2.5}$, NH_3

4.36.2 Emission trends

Chemical products is a minor source of NMOC emissions, the share of total emissions in NH3 and particles is less than 0.1 %. Since the 2011 inventory, SO_x and CO emissions are allocated under NFR 1A2d and 1A2c.

The shares of emissions for each air pollutant reported under the NFR category are presented in 069.

Table 4.69. Contribution of chemical products (NFR 2D3g) to total emissions in 2015.

Pollutant	Emissions from chemical products in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NH3	0.004	31.85	Gg	<0.1	19
NMVOC	2.034	87.76	Gg	2.3	60
TSP	0.002	50.02	Gg	<0.1	100
PM10	0.001	32.15	Gg	<0.1	0
PM2.5	<0.001	21.98	Gg	<0.1	0

4.36.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

Air pollutant emissions from chemical products depend on the use volumes of solvents. The allocation of activities has also been changed over the years and is not currently consistent in the time series. Methodologies used in the calculation of solvent use in the different chemical products manufacture and processing are presented in Table 4.700. For many of the activities allocated under this category, the emissions include only data reported by the plants.

Table 4.70. Information sources for the NMVOC inventory under NFR 2D3g.

Activity	**Methodology**
Polyester processing	Reported by operators + questionnaire to operators
Polyvinylchloride processing	Reported by operators
Polyurethane foam processing	Reported by operators
Polystyrene foam processing	Reported by operators
Rubber processing	Reported by operators
Pharmaceutical products manufacturing	Reported by operators + questionnaire to operators
Paints manufacturing	Reported by operators + questionnaire to operators
Inks manufacturing	Reported by operators
Glues manufacturing	Reported by operators
Adhesive, magnetic tapes, films &	Reported by operators
Textile finishing	Reported by operators + questionnaire to operators
Leather tanning	Reported by operators + questionnaire to operators
Other	Reported by operators + questionnaire to operators
Asphalt blowing	Not estimated

Paint manufacturing, plastic, textile and leather industries

NMVOC emission estimates from Chemical Products are based on emission data reported by the plants and on information from questionnaires to small and medium sized companies in the paint manufacturing, plastic and leather industries, which are not obligated to report their emissions to the environmental authorities.

NMVOC emissions, their sources and the number of companies allocated to this sector are presented in Table 4.711 to illustrate the contribution of the questionnaire to the total emissions of this sector. Calculated emissions from chemical products are presented in Table 4.722.

Table 4.71. The contribution of responses received to the questionnaire sent to companies in summer 2016 for the inventory of 2015 emissions, to the total emissions of the sector 2D3g.

Sector	Year	NMVOC emissions (t)	Source of information	Number of companies
Pharmaceutical industry	2015	127	VAHTI 100%	10 - 20
Plastic industry (incl. polyester, polyvinylchloride, polystyrene foam processing and other)	2015	1 700	VAHTI 33% Questionnaire 67%	10 - 20 50 -100
Textile and leather industry	2015	7.4	Questionnaire 100%	less than 10
Rubber conversion	2015	Incl. in plastic industry due to confidentiality	VAHTI 100%	less than 10
Manufacture of paints, inks and glues	2015	120	VAHTI 99.5% Questionnaire 1%	10 - 20 less than 10
Total NMVOC emissions from NFR 2D3g	2015	1990		

Plastic industries
Emissions are calculated on the basis of data from replies to the questionnaires[8]. Information on the volume of solvent containing substances used and their content of volatile organic compounds by CAS number and concentration are used in the calculation. The default volatility rate of 100% is used for the VOC compounds unless the operators provide a more accurate rate in their response.

For the year 2015 inventory, a questionnaire was sent to 85 companies, out of which 49 responded. In order to estimate emissions from those activities not covered by the replies, it was assumed that in 40 % of those activities not covered by the responses, had emissions.

Paint production
Majority of paint producers report emissions to the supervising authority and this emission data is thus available from VAHTI. Questionnaires are sent to those companies that are not obligated to report emissions from their production processes. These emissions are calculated with the help of responses to the questionnaire mentioned above using the emission data and/or data on solvent use from the replies.

For the year 2015 inventory, a questionnaire was sent out to 9 companies, from which 7 responded. To estimate emissions from those companies that did not respond, it was assumed that only 40 % of those activities not included in the responses, generated emissions.

Particle emissions
Emissions are mainly generated during the manufacturing of pharmaceutical products and inks. TSP emissions are reported by the plants. PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions based on fraction factors of 80 % for PM_{10} and of 50% for $PM_{2.5}$ (Karvosenoja, 2002).

NH3 emission from leather tanning
In the submission in 2015 NH_3 emissions from leather tanning were included for the first time. NH3 emissions are calculated according to EMEP/EEA Guidebook 2016 using the emission factor of 0.68 g/kg raw hid. As activity data, 2000 t raw hid/year for 1990-2015 is used and it is based on an estimate of production volumes provided in the companies' environmental permits. The same emission estimate is used for years 1990-2015 due to lack of better data.

Calculated emissions from chemical products are presented in Table 4.722.

Table 4.72. Calculated NMVOC and NH3 emissions from chemical products

Year	NMVOC (t) from paint production	NH3 (t) from leather tanning	Year	NMVOC (t) from paint production	NH3 (t) from leather tanning
1990	4281	2.9	2010	1520	2.9
1991	3850	2.9	2011	1442	2.9
1992	4024	2.9	2012	1372	2.9
1993	4253	2.9	2013	1269	2.9
1994	4393	2.9	2014	1228	2.9
1995	4596	2.9	2015	1240	2.9
1996	3428	2.9			
1997	3328	2.9			
1998	3340	2.9			
1999	3296	2.9			
2000	2695	2.9			
2001	2848	2.9			
2002	3570	2.9			
2003	2863	2.9			
2004	3547	2.9			
2005	3060	2.9			
2006	3113	2.9			
2007	2579	2.9			
2008	1715	2.9			
2009	1362	2.9			

[8] also an Internet based questionnaire is used, see information under "Coating application"

4.36.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.36.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.36.6 Source-specific recalculations including changes made in response to the review process

None.

4.36.7 Source-specific planned improvements

None.

4.37 Printing (NFR 2D3h)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

4.37.1 Source category description

4.37.2 Emission trends

Printing inks used in Finland vary widely in the composition, but they consist of three major components: pigments, binders and solvents. The type of ink which is used is usually the most important factor in estimating emissions from printing operations. Table 4.733 shows typical compositions of traditional printing inks in 2008.

Table 4.73. Typical compositions of traditional printing inks (Antson, 2008).

Composition of printing inks	Offset			Other pinting inks		
	newspaper %	sheet %	heatset %	Flexographic inks %	gravure printing %	screen printing %
pigments	10—20	15-25	10-20	5-30	5-15	5-8
binders	10-35	20-40	20-40	15-30	20-35	30-40
solvent	25-75	30-50	30-50	40-70	50-70	54-60
additives	0-5	0-5	0-6	0-8	0-5	1-2

NMVOC emission trend from printing activities is decreasing due to increased recovery of solvents and VOC compounds and cleaning of process emissions through e.g. incineration. The larger plants carry out NMVOC measurements from flue gases.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.2.

Table 4.74. Contribution of Printing (NFR 2D3h) to total emissions in 2015.

Pollutant	Emissions from printing in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	0.865	87.76	Gg	1	79.2

4.37.3 Methodological issues

NMVOC
Emissions from printing industry are based on emission reported by the plants as well as on information received as response to the questionnaire sent out by SYKE to printing houses that are not obligated to report their emissions to the supervising authority according to their environmental permits.

The largest printing houses that report their emissions account more than 72% of total NMVOC emissions from the printing industry. The remaining 28% of emissions are estimated on basis of data collected through the questionnaire (see for details under “Coating appliations”). For calculation of the year 2015 emissions, the questionnaire was sent to 113 companies, from which 59 responded. In order to estimate emissions from those companies that did not reply, it was assumed that only 40% of the emissions from those activities not included in the responses of the questionnaire, do not have emissions.

The volume of VOC containing substances, their VOC content by CAS numbers and a default volatility rate of 100% were used in the calculation, in case a more accurate volatility rate was not available.

Calculated NMVOC emissions from printing are presented in Table 4.755.

Table 4.75. Calculated NMVOC emissions from printing

Year	NMVOC (t)	Year	NMVOC (t)
1990	5649	2010	348
1991	4326	2011	326
1992	3360	2012	375
1993	1634	2013	254
1994	832	2014	204
1995	1385	2015	168
1996	1363		
1997	300		
1998	300		
1999	764		
2000	507		
2001	1285		
2002	1050		
2003	985		
2004	976		
2005	563		
2006	629		
2007	608		
2008	577		
2009	365		

4.37.4 Uncertainty and time series’ consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.37.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.37.6 Source-specific recalculations including changes made in response to the review process

None.

4.37.7 Source-specific planned improvements

Non-scheduled
Calculation of NMVOCs as carbon.

4.38 Other solvent use (NFR 2D3i)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.38.1 Source category description

Activities falling under NFR 2D3i Other solvent use in the Finnish inventory with emissions generated in the processes is presented in Table 4.766.

Table 4.76. Activities and emissions reported from the other solvent use sector.

NFR	Activity	Description	Emissions
2D3i	Other product use	Glass and mineral wool enduction (SNAP 060401-02), fat, edible oil extraction (SNAP 060404), preservation of wood (SNAP 060406), industrial application of glues and adhesives (SNAP 060405) *Not estimated*: domestic application of glues and adhesives	NMVOC, SO_X, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, PAHs, HCB

4.38.2 Emission trends

Other solvent and products use is minor source of NMVOC, particles, NH3, HCB and PAHs. The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.777.

Table 4.77. Contribution of Other solvent and product use (NFR 2D3i) to total emissions 2015.

Pollutant	Emissions from other solvent and product use in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
BC	<0.001	4.60	Gg	<0.1	0
NH3	0.147	31.85	Gg	0.5	100
NMVOC	1.512	87.76	Gg	1.7	7.4
TSP	0.089	50.02	Gg	0.2	100
HCB	0.001	20.94	kg	<0.1	0
PM10	0.083	32.15	Gg	0.3	0
PM2.5	0.076	21.98	Gg	0.3	0
SOx (as SO2)	0.014	42.06	Gg	<0.1	100
PAHs	0.026	9.41	Mg	0.3	0

4.38.3 Methdological issues

Methods used in the calculation of emissions from the different activities are presented below and a summary of calculated emissions in Table 4.81.

NMVOC
Acitivites and emissions estimation methods for NMVOC emissions in other solvent use is presented in Table 4.788.

Table 4.78. Activities and emission estimation methods for NMVOC emissions under NFR 2D3i.

Activity	Method
Glass wool enduction	Reported by operators
Mineral wool enduction	Reported by operators
Fat, edible and not edible oil exraction	Reported emissions by operators
Application of glues and adhesives	Domestic application: Finnish Cosmetics, Toiletry and Detergents Association (inclusion in the current emisions from Domestic solvent use needs to be checked) Industrial application: VAHTI database (emissions allocated to different sectors, for example 2I)
Preservation of wood	Calculation
Underseal treatment and conservation of vehicles	Finnish Cosmetics, Toiletry and Detergents Association (included in Domestic solvent use)
Vehicles dewaxing	Finnish Cosmetics, Toiletry and Detergents Association (inclusion in Domestic solvent use needs to be checked)

Other (preservation of seeds,...): use of pesticides in cultivations and in construction	Calculation

Glass and Mineral Wool Enduction

NMVOC
Emissions from glass and mineral wool enduction activities are reported by the plants.

NO_x, SO_x, NH_3 and CO
Emissions are generated during manufacturing of rock and mineral wool and are based on data reported by the plants.

Particles
TSP emissions are reported by the plants and PM_{10} and $PM_{2.5}$ emissions have been calculated from the TSP emissions based on fraction factors 95 % for PM10 and 91% for PM2.5 (AEAT, 2000). Black carbon emissions are calculated using the emission factor 0.06 % of PM2.5 (Aasestad, 2013).

Solvent Extraction of edible oils

NMVOC
Emissions from solvent extraction of edible oils from oilseeds are based on emission data reported by the plants. In past years also a questionnaire was send to companies that do not report their emissions. In 2012 it was discovered that these companies produce cold-drown vegetable oils and no NMVOCs are emitted during the production process. The time series recalculation is scheduled for the 2018 submission.

Industrial and domestic application of glues and adhesives

NMVOC
Emissions from industrial application of glues and adhesives are included in the total NMVOC emissions reported by the plants, and aggregated under the main activity of the plant, for instance under NFR 2I.

Domestic use of adhesive and sealants fall under NFR 2D3a. At the moment it has not been possible to estimate these emissions.

Impregnation of wood

NMVOC
Part of emissions from wood impregnation activities is reported by the plants and available in VAHTI database. Emissions from the remaining impregnation activities are calculated with and the NMVOC emission factor for impregnation of wood 100 kg/t. (SYKE, 2001). Activity data for impregnation of wood is received from Finnish Safety and Chemicals Agency as the amount of sold creosote oil.

PAH-4
Emissions from impregnation of wood and the use of impregnated wood have been calculated using the emission factor 4 g/t for impregnation of wood and 2.5 g/t for use of impregnated wood, both factors from UBA, 1998. Annual volumes of impregnation of wood are presented in Table 4.79. Data on the use of impregnated wood, which is the activity data for both impregnation of wood and for the use of impregnated wood (all PAHs are assumed to be released during one year).

Use of pesticides
Use of pesticides covers all use purposes from agriculture to domestic use. The data is confidential in most recent years and can therefore not be presented in the IIR.

PAH-4
Emissions from the use of pesticides is calculated using the sales data of pesticides presented in Table 4.79 and the emission factor of 80 kg/t (SYKE, 2001). The amount of pesticides sold is received from the Finnish Food Safety Authority (TUKES).

Table 4.79. Acitivty data: Use of pesticides and impregnation of wood 1988-2015

	Use of pesticides	Impregnation of wood
1988	NE	7 800 t creosote sold***
1989	NE	NE
1990	4 789 t pesticides sold**	7 500 t creosote sold***
1991	4 253 t pesticides sold**	7 500 t creosote sold***
1992	3 348 t pesticides sold**	7 000 t creosote sold***
1993	3 106 t pesticides sold**	6 500 t creosote sold***
1994	3 119 t pesticides sold**	6 400 t creosote sold***
1995	2 767 t pesticides sold**	4 600 t creosote sold***
1996	2 630 t pesticides sold**	4 000 t creosote sold***
1997	2 755 t pesticides sold**	5 000 t creosote sold***
1998	3 059 t pesticides sold**	6 500 t creosote sold***
1999	3 000 t pesticides sold**	5 500 t creosote sold***
2000	3 161 t pesticides sold**	7 800 t creosote sold***
2001	3 680 t pesticides sold**	7 900 t creosote sold***
2002	4 230 t pesticides sold**	6 030 t creosote sold***
2003	4 355 t pesticides sold**	6 640 t creosote sold***
2004	4 146 t pesticides sold**	7 357 t creosote sold***
2005	4 726 t pesticides sold**	6 120 t creosote sold***
2006	5 510 t pesticides sold**	7 072 t creosote sold***
2007	6 192 t pesticides sold**	5 886 t creosote sold***
2008	6 866 t pesticides sold**	C***
2009	6 503 t pesticides sold**	C****
2010	7 412 t pesticides sold**	C****
2011	8 691 t pesticides sold**	C****
2012	8 882 t pesticides sold**	C****
2013	9 518 t pesticides sold**	C****
2014	10 250 t pesticides sold**	C****
2015	11 547 t pesticides sold**	C****

*reference Statistics Finland
**reference Finnish Food Safety Authority Evira
***reference Finnish Environment Institute
****reference Finnish Safety and Chemicals Agency
***** reference National Institute for Health and Welfare

Use of chlorinated solvents

HCB

Emissions from the use of chlorinated solvents have been calculated with the emission factor 2 mg/ t from the EMEP/EEA Guidebook (EEA, 2005) and information from customs statistics (ULJAS) on the imports of chlorinated chemicals as presented in Table 4.800. Chlorinated solvents are not produced in Finland.

Table 4.80. Use of chlorinated solvents (Custom Statistics)

Use of chlorinated solvents per year (t) (Custom Statistics, ULJAS)					
1990	2 200 t	2000	1 250 t	2010	557 t
1991	2 050 t	2001	1 094 t	2011	371 t
1992	1 963 t	2002	1 421 t	2012	529 t
1993	1 875 t	2003	1 407 t	2013	680 t
1994	1 788 t	2004	1 110 t	2014	545 t
1995	1 700 t	2005	1 317 t	2015	603 t
1996	1 613 t	2006	1 070 t		
1997	1 525 t	2007	855 t		
1998	1 438 t	2008	936 t		
1999	1 350 t	2009	863 t		

A summary of calculated NMVOC, PAH-4 and PCB emissions from “Other solvent use” is presented in 081.

Table 4.81. Calculated NMVOC and POP emissions from other solvent use.

Year	NMVOC (t)	HCB (kg)	Benzo(a)pyrene (kg)	Benzo(b)fluoranthene (kg)	Benzo(k)fluoranthene (kg)	Indeno(1,2,3-cd) pyrene (kg)
1990	1939	0.004	12.6	8.7	8.7	8.7
1991	1616	0.004	12.6	8.7	8.7	8.7
1992	1433	0.004	11.7	8.1	8.1	8.1
1993	1314	0.004	10.9	7.5	7.5	7.5
1994	1247	0.004	10.7	7.4	7.4	7.4
1995	1044	0.003	7.7	5.3	5.3	5.3
1996	965	0.003	6.7	4.6	4.6	4.6
1997	1057	0.003	8.4	5.8	5.8	5.8
1998	1257	0.003	10.9	7.5	7.5	7.5
1999	927	0.003	9.2	6.4	6.4	6.4
2000	1135	0.003	13.1	9.0	9.0	9.0
2001	1203	0.002	13.2	9.1	9.1	9.1
2002	1128	0.003	10.1	7.0	7.0	7.0
2003	1180	0.003	11.1	7.7	7.7	7.7
2004	1186	0.002	12.3	8.5	8.5	8.5
2005	1158	0.003	10.3	7.1	7.1	7.1
2006	1313	0.002	11.8	8.2	8.2	8.2
2007	1223	0.002	9.0	6.1	6.1	6.1
2008	1324	0.002	10.8	7.4	7.4	7.4
2009	1111	0.002	8.7	5.9	5.9	5.9
2010	1123	0.001	5.3	3.6	3.6	3.6
2011	1231	0.001	6.2	4.2	4.2	4.2
2012	1234	0.001	6.1	4.1	4.1	4.1
2013	1570	0.001	11.2	7.5	7.5	7.5
2014	1153	0.001	4.0	2.6	2.6	2.6
2015	1444	0.001	7.9	5.3	5.3	5.3

4.38.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.38.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.38.6 Source-specific recalculations including changes made in response to the review process

None.

4.38.7 Source-specific planned improvements

Planned for the 2018 submission
Recalculation of the time series of NMVOC from Solvent Extraction of edible oils.

4.39 Other product use (NFR 2G)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS & JMP
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
RECALCULATED	

4.39.1 Source category description

Activities falling under NFR 2G Other product use in the Finnish inventory with emissions generated in the processes is presented in Table 4.822.0

Table 4.82. Activities and emissions reported from the other product use sector.

NFR	Activity	Description	Emissions
2G	Other product use	Use of fireworks and tobacco	NO_X, NMVOC, SO_X, NH_3, TSP, PM_{10}, $PM_{2.5}$,,BC, CO, Pb, Cd, Hg, As, Cr, Cu, PCDD/F, PAH-4, HCB

4.39.2 Emission trends

NMVOC emissions from tobacco smoking were included to the 2008 submission for the fist time and NH3 emissions were included to the inventory for first time in the 2015 submission. NH3 and NNVOC emissions from tobacco smoking are included from year 1990 forward, but NOx emissions only from 2001 onwards. The time series will be completed with all relevant emissions from year 1990 onward when the time series are recalculated. The possibility to include emissions from 1980 onward will be investigated.

Particle emissions from the use of fireworks were included to the 2004 inventory for the first time.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.833.

Table 4.83. Contribution of Other product use (NFR 2G) to total emissions 2015

Pollutant	Emissions from other product use in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
As	<0.001	2.43	Mg	<0.1	0
BC	<0.001	4.60	Gg	<0.1	0
Cd	<0.001	0.92	Mg	<0.1	0
CO	0.011	324.57	Gg	<0.1	0
Cr	<0.001	15.63	Mg	<0.1	0
Cu	<0.001	39.57	Mg	<0.1	0
Hg	<0.001	0.64	Mg	<0.1	0
NH3	<0.001	31.85	Gg	<0.1	0
NMVOC	<0.001	87.76	Gg	<0.1	0
NOx (as NO2)	<0.001	139.68	Gg	<0.1	0
Pb	<0.001	13.93	Mg	<0.1	0
TSP	0.094	50.02	Gg	0.2	0
PCDD/Fs	<0.001	14.25	g I-Teq	<0.1	0
PM10	0.094	32.15	Gg	0.3	0
PM2.5	0.094	21.98	Gg	0.4	0
SOx (as SO2)	0.008	42.06	Gg	<0.1	0
PAHs	<0.001	9.41	Mg	<0.1	0

4.39.3 Methdological issues

Tobacco smoking

Emissions from tobacco smoking are calculated with emission factors presented in Table 4.844.

Table 4.84. Emission factors for tobacco smoking (Guidebook 2016, 2016)

Pollutant	Emission factor	Reference
Nox	1.8 g/tobacco	EMEP/EEA Guidebook /2016
CO	55.1 g/t tobacco	EMEP/EEA Guidebook /2016
NMVOC	4.84 g/t tobacco	EMEP/EEA Guidebook /2016
NH3	4.15 g/t tobacco	EMEP/EEA Guidebook /2016
Particles, all (TSP, PM10, PM2.5)	0.027 t/t tobacco	EMEP/EEA Guidebook /2016
BC	0.45 of PM2.5	EMEP/EEA Guidebook /2016
As	0.16 t/t tobacco	Norwegian IIR, 2005
Cd	0.10 t/t tobacco	Norwegian IIR, 2005
Cu	0.15 t/t tobacco	Norwegian IIR, 2005
Cr	0.35 t/t tobacco	Norwegian IIR, 2005
Hg	0.10 t/t tobacco	Norwegian IIR, 2005
Pb	0.05 t/t tobacco	Norwegian IIR, 2005
PCDD/F	0.0013 ug I-TEQ/t	Norwegian IIR, 2005
PAH-4	8.3 mg/t tobacco	EMEP/EEA Guidebook, 2009

The annual sales statistics of cigars and cigarettes are used as activity data (Table 4.855) from Statistics Finland 1990-2010, since 2011 the statistics has been provided by National Institute for Healt and Welfare (THL).

Table 4.85. Activity data for tobacco smoking (Statiscs Finland, since 2011 National Institute for Healt and Welfare).

Sales of cigars and cigarettes (1990-2010 Statistics Finland, 2011-2015 National Institute for Health and Welfare (THL)			
1990	5 674 t	2006	3 751 t
1991	5 854 t	2007	3 672 t
1992	5 111 t	2008	5 917 t
1993	4 994 t	2009	3 665 t
1994	4 970 t	2010	4 219 t
1995	4 509 t	2011	4 629 t
1996	4 694 t	2012	3 674 t
1997	4 709 t	2013	3 789 t
1998	4 657 t	2014	4 317 t
1999	4 575 t	2015	4 391 t
2000	4 600 t		
2001	4 598 t		
2002	4 653 t		
2003	3 606 t		
2004	3 691 t		
2005	3 775 t		

Use of fireworks

In 2017 submission the calculation of use of fireworks was revised for whole time series. In the previous calculations the number of inhabitants was used as acitivty data. In the new calculation the amount of imported fireworks is used as activity data for the whole time series since 1990. The emission factors used are presented in Table 4.86 and the amount of imported fireworks in 07.

NOTE: There was an error in the calcutation sheet concerning SOx emissions. Corrected SOx emissions are presented in Table 4.888, and the emissions will be corrected to the NFR-tables in the next submission.

Table 4.86. Emission factors in use of fireworks (Guidebook 2016)

Pollutant	Value	Unit
SO2	3020	g/t product
CO	7150	g/t product
NOx	260	g/t product
TSP	109.830	g/t product
PM10	99.920	g/t product
PM2.5	51.940	g/t product
As	1.33	g/t product
Cd	1.48	g/t product
Cr	15.6	g/t product
Cu	444	g/t product
Hg	0.057	g/t product
Ni	30	g/t product
Pb	784	g/t product
Sn	260	g/t product

Table 4.87. Amount of imported fireworks (tonnes) (Custom Statiscis)

Year	Imported fireworks (t)	Year	Imported fireworks (t)	Year	Imported fireworks (t)
1990	396	2001	1418	2012	1853
1991	454	2002	1785	2013	1360
1992	939	2003	1528	2014	1474
1993	1040	2004	1727	2015	1497
1994	1721	2005	1859		
1995	1418	2006	2169		
1996	809	2007	2512		
1997	1299	2008	2332		
1998	1138	2009	1566		
1999	2253	2010	1702		
2000	1370	2011	1417		

A summary of calculated NOx, CO, NH3, SOx, NMVOC, particle and heavy metal emissions from “Other product use” are presented in 0.

Table 4.88. Calculated NOx, CO, NH3, SOx, NMVOC, particle and heavy metal emissions from other product use.

Year	NOx (kg)	CO (kg)	NH3 (t)	SOx (t)	NMVOC (t)	TSP (kt)	PM10 (kt)	PM2.5 (kt)	BC (t)
1990	113.1	3142.3	0.042	1.2	0.027	0.153	0.153	0.153	0.0007
1991	128.5	3565.4	0.044	1.4	0.028	0.158	0.158	0.158	0.0007
1992	253.4	6997.2	0.038	2.8	0.025	0.138	0.138	0.138	0.0006
1993	279.4	7711.8	0.037	3.1	0.024	0.135	0.135	0.135	0.0006
1994	456.4	12579.2	0.037	5.2	0.024	0.134	0.134	0.134	0.0006
1995	376.7	10384.4	0.034	4.3	0.022	0.122	0.122	0.122	0.0005
1996	218.8	6042.8	0.035	2.4	0.023	0.127	0.127	0.127	0.0006
1997	346.2	9547.7	0.035	3.9	0.023	0.127	0.127	0.127	0.0006
1998	304.2	8391.5	0.035	3.4	0.023	0.126	0.126	0.126	0.0006
1999	594.1	16364.2	0.034	6.8	0.022	0.124	0.124	0.124	0.0006
2000	364.4	10047.9	0.034	4.1	0.022	0.124	0.124	0.124	0.0006
2001	377.0	10393.1	0.034	4.3	0.022	0.124	0.124	0.124	0.0006
2002	472.4	13016.1	0.035	5.4	0.023	0.126	0.126	0.126	0.0006
2003	403.7	11122.2	0.027	4.6	0.017	0.098	0.098	0.097	0.0004
2004	455.6	12548.7	0.028	5.2	0.018	0.100	0.100	0.100	0.0004
2005	490.2	13500.7	0.028	5.6	0.018	0.102	0.102	0.102	0.0005
2006	570.7	15714.7	0.028	6.6	0.018	0.100	0.100	0.100	0.0005
2007	659.8	18165.7	0.027	7.6	0.018	0.099	0.099	0.099	0.0004
2008	616.9	16996.7	0.044	7.0	0.029	0.158	0.158	0.158	0.0007
2009	413.8	11399.1	0.027	4.7	0.018	0.099	0.099	0.099	0.0004
2010	450.0	12399.1	0.032	5.1	0.020	0.114	0.114	0.114	0.0005
2011	376.7	10386.5	0.035	4.3	0.022	0.125	0.125	0.125	0.0006
2012	488.4	13452.4	0.027	5.6	0.023	0.099	0.099	0.099	0.0004
2013	360.4	9931.0	0.028	4.1	0.024	0.102	0.102	0.102	0.0005
2014	8.7	10725.1	0.025	4.5	0.021	0.091	0.091	0.091	0.0004
2015	9.0	10892.4	0.026	4.5	0.021	0.094	0.094	0.094	0.0004

table 4.89 continues

Year	As (kg)	Cd (kg)	Cr (kg)	Cu (kg)	Hg (kg)	Ni (kg)	Pb (kg)	Zn (kg)
1990	0.53	0.59	6.2	175.7	0.023	11.9	310.3	102.9
1991	0.60	0.67	7.1	201.4	0.026	13.6	355.6	117.9
1992	1.25	1.39	14.7	417.0	0.054	28.2	736.4	244.2
1993	1.38	1.54	16.2	461.8	0.060	31.2	815.4	270.4
1994	2.29	2.55	26.8	764.1	0.098	51.6	1349.3	447.5
1995	1.89	2.10	22.1	629.4	0.081	42.5	1111.4	368.6
1996	1.08	1.20	12.6	359.2	0.046	24.3	634.2	210.3
1997	1.73	1.92	20.3	576.8	0.074	39.0	1018.5	337.8
1998	1.51	1.68	17.8	505.2	0.065	34.1	892.0	295.8
1999	3.00	3.34	35.2	1000.5	0.129	67.6	1766.7	585.9
2000	1.82	2.03	21.4	608.2	0.078	41.1	1074.0	356.2
2001	1.89	2.10	22.1	629.7	0.081	42.5	1111.8	368.7
2002	2.37	2.64	27.8	792.4	0.102	53.5	1399.1	464.0
2003	2.03	2.26	23.8	678.3	0.087	45.8	1197.8	397.2
2004	2.30	2.56	26.9	766.6	0.099	51.8	1353.7	448.9
2005	2.47	2.75	29.0	825.4	0.106	55.8	1457.5	483.4
2006	2.89	3.21	33.8	963.0	0.124	65.1	1700.5	563.9
2007	3.34	3.72	39.2	1115.5	0.144	75.4	1969.7	653.2
2008	3.10	3.45	36.4	1035.2	0.133	69.9	1827.9	606.2
2009	2.08	2.32	24.4	695.3	0.090	47.0	1227.8	407.2
2010	2.26	2.52	26.5	755.5	0.097	51.0	1334.1	442.4
2011	1.89	2.10	22.1	629.1	0.081	42.5	1110.9	368.4
2012	2.47	2.74	28.9	822.8	0.106	55.6	1452.9	481.8
2013	1.81	2.01	21.2	603.7	0.078	40.8	1066.0	353.5
2014	1.96	2.18	23.0	654.5	0.084	44.2	1155.7	383.3
2015	1.99	2.22	23.3	664.5	0.086	44.9	1173.3	389.1

4.39.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.39.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.39.6 Source-specific recalculations including changes made in response to the review process

2017
The calculation of the use of fireworks was revised for the whole time series. In the previous calculations the number of inhabitants was used as acitivty data. In the new calculation the amount of imported fireworks (tonnes) is used as activity data for whole time series (since 1990).

4.39.7 Source-specific planned improvements

Planned for 2018 submission

Tobacco smoking
- The time series will be completed with all relevant emissions from year 1990 onward when the time series are recalculated. The possibility to include emissions from 1980 onward will be investigated.

Fireworks
- There is an error in the calculation sheet concerning SOx emissions from fire works, corrected emissions will be reported in NFR-tables in next submission.

4.40 Other industrial production (NFR 2H)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

4.40.1 Source category description

Other industrial production includes pulp and paper industry and food and beverages industry. NMVOC and particle emissions are typical emissions for these categories. Also sulphur dioxide, ammonia, dioxins and zinc emissions are generated.

Table 4.89. Activities and emissions reported under the other indusrial production.

NFR	Processes	Description	Emissions reported
2H1	Pulp and paper industry	Pulp and paper mills	NMVOC, NH3, TSP, PM10, PM2.5, PCDD/PCDF, SOx
2H2	Food and beverages industry	Food and drink industry	NMVOC, TSP, PM10, PM2,5, Zn
2H3	Other industrial processes	IE, included in 1A2gviii	

Emissions of those plants that report their emissions to the supervising authorities[9] according to the monitoring requirements in the environmental permits are in most cases reported as IE. This is because in most cases the reporting obligations determined in the monitoring programmes are for the total emissions of the plants and not separated between fuel combustion and other processes. Thus it has not been possible to make a complete split between emissions from fuel based and non-fuel based sources. In cases where it has been possible to separate fuel combustion emissions from process emissions, these are reported separately under NFR 2H categories. For those plants that report only total emissions, the split is based on the default emissions calculated on basis of fuel consumption which is reduced from the emissions reported by the plants, and reported under the NFR 1A2gviii.

4.41 Pulp and paper (NFR 2H1)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS

4.41.1 Source category description

<u>Finnish pulp and paper mills</u>

In 2015 there were 19 pulp mills altogether, out of which 17 chemical pulp mills. The number of mills has continuously been decreasing since 1980 while the production volumes significantly increased until 2006-2007 as presented in Figure 4.39 and Table 4.900. Between the years 2006-2009 approximately ten paper machines and pulp mills were closed down. Forest industry production plants in 2015 are presented in 010.

All Finnish chemical pulp mills use sulphate process. The last sulphite based processes were closed in 1991. Typical for the Finnish pulp and paper industry is integrated pulp and paper mills, where the use of energy can be optimized between the energy intensive paper production and energy sources produced in the pulp processes.

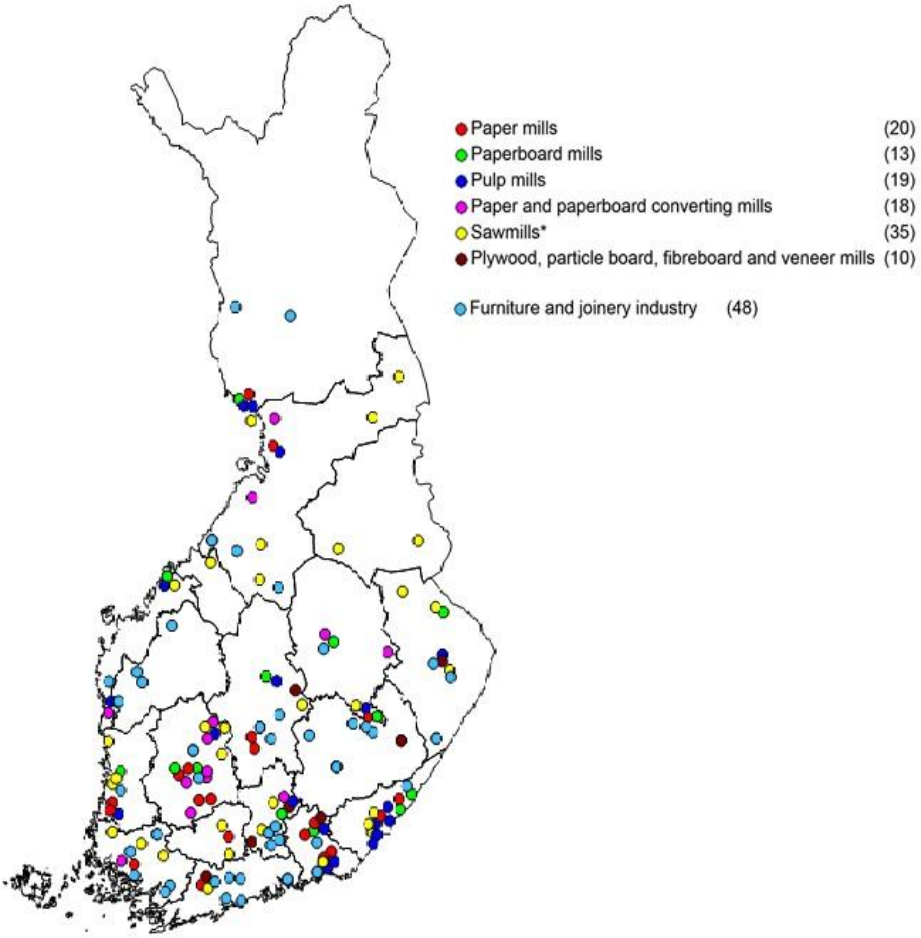


Figure 4.9. Forest industry production plants in Finland 1980-2015, sources Statistics Finland, LUKE, Finnish Forest Industries Federation (2017)

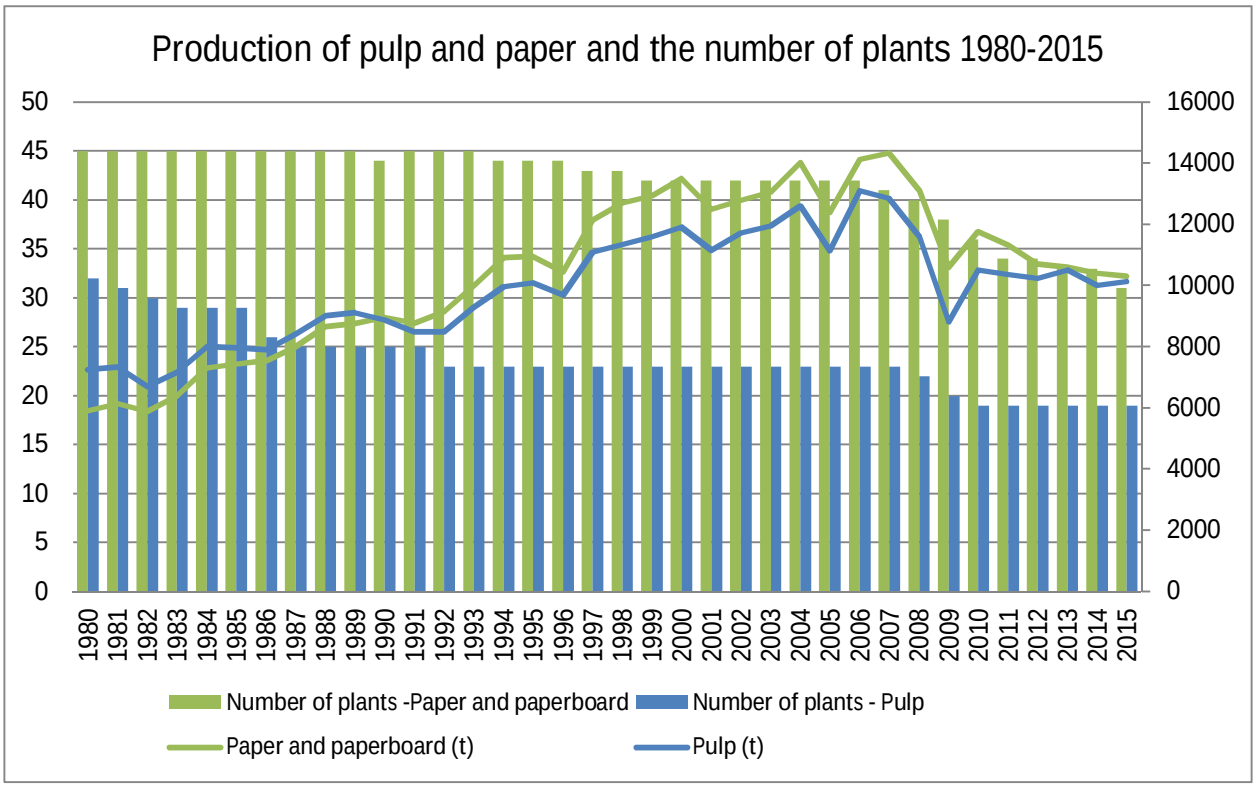


Figure 4.3. Production volumes and number of pulp and paper plants 1980-2015.

Table 4.90. Pulp and paper production since 1988.

Year	Produced pulp (mill t)	Produced mechanical pulp (mill t)	Produced paper (mill t)
1988	5.3	3.2	8.8
1989	5.0	3.8	9.0
1990	4.7	4.1	9.0
1991	4.9	3.6	8.8
1992	4.9	3.6	9.2
1993	5.5	3.9	10.0
1994	5.8	4.1	10.9
1995	5.8	4.4	10.9
1996	5.7	4.0	10.4
1997	6.6	4.5	12.1
1998	6.7	4.6	12.7
1999	7.0	4.6	12.9
2000	7.1	4.8	13.5
2001	6.5	4.6	12.5
2002	7.1	4.6	12.8
2003	7.4	4.6	13.1
2004	7.7	4.8	14.0
2005	6.7	4.4	12.4
2006	13.1	included in produced pulp	14.1
2007	12.9	included in produced pulp	14.3
2008	12.0	included in produced pulp	13.1
2009	8.7	included in produced pulp	10.6
2010	10.7	included in produced pulp	11.9
2011	10.4	included in produced pulp	11.4
2012	10.2	included in produced pulp	10.7
2013	7.1	included in produced pulp	10.6
2014	7.0	included in produced pulp	10.4
2015	10.6	included in produced pulp	11.5

4.41.2 Emission trends

Emissions reported under this NFR category include process based SO2 emissions calculated from reduced sulphur compounds (TRS), ammonia, particle and NMVOC emissions.

The time series has not been recalculated and thus variations in the emission levels do not fully represent actual variations in emissions. This is due to the use of point source data reported by the plants, which cannot be separated for energy and process sources unless energy related emissions are calculated separately and deducted from the total emissions reported. Disaggregated allocation between the NFR sectors 2H1 and 2H3 are available only since 2007 but not yet reported completely consistently in the time series.

At the moment the category includes also other pollutants reported due to the inconsistent allocation of emissions throughout the time series. The allocation will be checked to be consistent over the years when the recalculation of the energy sector emissions is finalized. Since the 2011-2012 submissions CO emissions and most of NOx emissions were allocated to NFR 1A2d.

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.2.

Table 4.91. Contribution of Pulp and paper industry (2H1) to total emissions in 2015. Note: NOx emissions are allocated to 1A2d)

Pollutant	Emissions from pulp and paper industry in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NH3	0.018	31.85	Gg	<0.1	100
NMVOC	1.53	87.76	Gg	1.7	15.9
TSP	0.469	50.02	Gg	0.9	100
PCDD/Fs	0.722	14.25	g I-Teq	5.1	100
PM10	0.414	32.15	Gg	1.3	0
PM2.5	0.355	21.98	Gg	1.6	0
SOx *(as SO2)	1.038	42.06	Gg	2.5	100

4.41.3 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

Nitrogen dioxide
Nitrogen dioxide emissions from the pulp and paper industry are based on data reported by the plants to the supervising authorities[10] according to the monitoring requirements in their environmental permits. NO_2 emissions from the pulp and paper industry are partly allocated in the inventory as fuel based emissions under NFR 1A2d though they include also process emissions of these compounds.

Sulphur emissions reported as SO2
Sulphur dioxide emissions are based on data reported by the plants to the supervising authorities[11] according to the monitoring requirements in their environmental permits. SO_2 emissions are partly allocated in the inventory as fuel based emissions under NFR 1A2d though they may include also process emissions of these compounds. It has not been possible to split all SO_2 emissions between fuel based and non-fuel based due to the fact that the reporting obligations given to the plants are for the total emissions.

The process based emissions include different sulphur compounds such as TRS (total reduced sulphur) and calculated as SO_2 equivalents. Most of the smelly gases are nowadays collected and incinerated due to the requirements for smell abatement in the environmental permits.

Particles
The plants report total suspended particle emissions to the supervising authorities and this data is used in the calculation of PM_{10} and $PM_{2.5}$ particle size fractions with factors 99.3% (PM10) and 86.3 % (PM2.5) for recovery boiler and with factors 98 % (PM10) and 96% (PM2.5) for lime kiln. Size factors for recovery boiler are based on expert estimate, Karvosenja (2001) and factors for lime kiln are taken from USEPA AirChief (1988). Black carbon emissions are calculated using the emission factor 2.6 % of PM2.5 (GB13, EEA 2013).

NMVOC
NMVOC emissions from the pulp and paper industry are partly included in the compliance reporting of the plants and thus available in VAHTI. For plants, which are not obligated to report their NMVOC emissions, these are calculated by using plant specific activity data and emission factor based on information from the Finnish Forest Industries Federation FIFF. The emission factors presented in Table 4.922 are based on the actual levels observed at the plants (Reino Lammi, 2000). Calculated emissions (NMVOC) from pulp and paper sector are presented in 03.

Table 4.92. NMVOC emission factors (Finnish Forest Industries Federation).

Year	chemical pulp	mechanical pulp	paper	Year	chemical pulp	mechanical pulp	paper
1988	0.7	0.2	0.01	2000-2005	0.1	0.2	0.01
1989	0.65						
1990	0.4			2006-2015	0.14		0.01
1991	0.37						
1992	0.34			Pulping:			
1993	0.31			chemical: between 1988-1999 is based on written information by Reino Lammi, FFIF			
1994	0.28						
1995	0.25			Since 2006 chemical and mechanical pulp production statistics have not been available separately. Therefore a combined EF has been used			
1996	0.22						
1997	0.19						
1998	0.16						
1999	0.13						

Table 4.93. Calculated NMVOC emissions from pulp and paper sector

Year	NMVOC (t)	Year	NMVOC (t)	Year	NMVOC (t)
1990	2898	2000	2077	2010	2110
1991	2701	2001	2060	2011	1568
1992	2478	2002	1995	2012	1481
1993	2585	2003	1916	2013	1611
1994	2555	2004	1854	2014	1586
1995	2439	2005	1853	2015	1570
1996	2350	2006	1993		
1997	2269	2007	2805		
1998	2127	2008	2479		
1999	1961	2009	1863		

Activity data
The data collection at the Finnish Forest Industries Federation (FFIF) changed in 2005. Earlier, activity data by pulp types was available but since 2005 the statistics, which is plant specific, covers only the total volume of produced pulp. Pulp and paper production since 1988 is presented in Table 4.90 above.

POP emissions
Pulp and paper industry plants reports also PCDD/F emissions to the supervising authorities.

NH3
Ammonia emissions are reported by some plants to the supervising authorities. These emissions totalled 0.0.018 kt in 2015 are reported under NFR 2H1. For the future inventories, it will be studied, if ammonia is released in all processes and if it is necessary to establish an inventory for ammonia emissions covering all pulp and paper plants.

4.41.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.41.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.41.6 Source-specific recalculations including changes made in response to the review process

None.

4.41.7 Source-specific planned improvements

Not scheduled
For the future inventories, it will be studied, if ammonia is released in all processes and if it is necessary to establish an inventory for ammonia emissions covering all pulp and paper plants.

4.42 Food and beverages industry (NFR 2H2)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 JMP KS
Change in methodology	2017
Other (e.g. language, layout)	April 2017 KS
Recalculations	2017

4.42.1 Source category description

Food and drink industries in Finland include production of coffee, sugar, yeast, dairies, production of wine and beer as well as production of animal feed as summarized in Table 4.944.

Air pollutant emissions from food and drink depend on the production and use volumes over the years. The allocation of activities as well as the methods used to calculate emissions have been changed over the years and thus the time series of emissions is unfortunately not consistent.

Table 4.94. Emissions reported under NFR 2H2

	Number of plants in VAHTI allocated to this sector	Emissions reported by plants	Emissions calculated
Bread, bisquits	-		NMVOC
Wine	-		NMVOC
Beer	-		NMVOC
Spirits	< 5	NMVOC	NMVOC
Sugar production	-		TSP, PM10, PM2.5, NMVOC
Meat, fish etc. frying/curing	-		TSP, PM10, PM2.5
Coffee	-		NMVOC
Yeast	-		NMVOC
Dairies	< 5	TSP	PM10, PM2.5
Animal feed and raw material for animal feed	< 5	TSP, NMVOC	PM10, PM2.5, NMVOC
Food production	< 5	TSP	PM10, PM2.5

The shares of emissions for each air pollutant reported under the NFR category are presented in Table 4.955.

Table 4.95. Contribution of Food and beverages industry (NFR 2H2) to total emissions in 2015.

Pollutant	Emissions from food and drink industry in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NMVOC	1.148	87.76	Gg	1.3	0.3
TSP	0.418	50.02	Gg	0.8	16.7
Zn	<0.001	129.07	Mg	<0.1	100
PM10	0.407	32.15	Gg	1.3	0
PM2.5	0.388	21.98	Gg	1.8	0

4.42.2 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

NMVOC

NMVOC emissions from food industry are calculated with activity data (**Error! Reference source not found.**) and national or EMEP/EEA Guidebook emission factors: for wholemealbread products factor 3 kg/t, for other breads 4.5 kg/t, for cakes bisquits factor 1 kg/t, for roasting of coffee factor 0.6 kg/t, for sugar production factor 1 kg/t, for yeast production factor 18 kg/t, for wine production factor 0.8 kg/m3 and for beer production factor 0.35 kg/m3 are used. All factors except roasting of coffee are from EMEP Guidebook, (2016). Emission factor for roasting of coffee is an expert estimated based on environmental permits (Paulig, 2005). In addition, NMVOC emissions are reported by some plants from the production of spirits and food production to the supervising authorities (VAHTI).

In the 2017 submission NMVOC emissions from bread manufacturing were recalculated for the whole time series. A new more detailed activity data (bread manufacturing statistics) was available provided by Finnish Food and Drink Industries' Federation. In the statistics wholemeal bread and other breads were separated, so also separate emission factors were used. Also in 2017 submission acticity data from cakes, bisquits was updated based on statistics from Finnish Food and Drink Industries' Federation for whole time series.

Fish meal production is included under NFR 2H2 and includes data reported by the plants.
Production volumes used in the calculation of NMVOC emissions are presented in **Error! Reference source not found.**6.

Production of bread and cakes are taken from statistics of Finnish Food and Drink Industries' Federation (ETL), production of coffee from Finnish Coffee Roasters' Association, sugar production from Finnish Food and Drink Industries' Federation (ETL), yeast production from Suomen Hiiva Oy and production fo wine and beer from National Supervisory Authority for Welfare and Health (Valvira).

Table 4.96. Breac, cakes, bisquits production volumes, roasting of coffee and sugar, yeast, wine and beer production (Finnish Food and Drink Indusriries' Federation, Finnish Coffee Roasters' Association, Suomen Hiiva and National Supervisory Authority for Welfare and Healt)

Year	Bread (wholemeal) products (million kg)	Bread (other) products (million kg)	Cakes, bisquits etc (million kg)	Roasting of coffee (t)	Sugar production (t)
1990	52.1*	108.7*	19.9*	50678	168409
1991	52.1*	108.7*	19.9*	49979	149365
1992	52.1*	108.7*	19.9*	50868	146440
1993	52.1*	108.7*	19.9*	50792	142180
1994	52.1	108.7	19.9	46747	154380
1995	52.1*	108.7*	19.9*	40715	160687
1996	52.1*	108.7*	19.9*	47396	133264
1997	57.4	118.9	21.5	44617	183003
1998	57.4*	118.9*	21.5*	47819	126077
1999	57.4*	118.9*	21.5*	47091	166725
2000	57.4*	118.9*	21.5*	44991	153227
2001	57.4*	118.9*	21.5*	47280	146200
2002	57.4*	118.9*	21.5*	46300	162800
2003	95.2	120.9	29.7	47057	136000
2004	95.2*	120.9*	29.7*	47751	148000
2005	95.2*	120.9*	29.7*	46871	179000
2006	95.2*	120.9*	29.7*	48749	130000
2007	95.2*	120.9*	29.7*	48745	101000
2008	95.2*	120.9*	29.7*	49266	69000
2009	95.2*	120.9*	29.7*	48336	88000
2010	94	94	31.7	46442	80300
2011	94*	94*	31.7*	44165	80300
2012	94*	94*	31.7*	43879	80300
2013	91.9	91.9	32	45929	80300
2014	91.9*	91.9*	32*	45030	80300
2015	93.2	93.2	31.2	46000	80300
Year	Yeast production (t)	Wine production (m3)	Beer production (m3)		
1990	7540	18111	413130		
1991	7440	16028	432563		
1992	7620	19938	454064		
1993	8130	24043	458237		
1994	9140	26606	433660		
1995	9610	40383	454468		
1996	10360	42583	464307		
1997	9680	43675	469614		
1998	8810	58964	454751		
1999	7940	67441	464932		
2000	7640	67500	465000		
2001	7642	68000	465000		

2002	8354	18520	400868		
2003	7700	18500	381451		
2004	7700	17380	444500		
2005	7750	66159	456544		
2006	7934	66886	449956		
2007	7942	67271	442342		
2008	8224	68736	433484		
2009	7395	58223	409427		
2010	7897	59008	395072		
2011	10029	51905	397800		
2012	9835	43559	378418		
2013	9416	43559	378418		
2014	8628	18327	388468		
2015	5832	18327	388468		

* for 1990-1993 and 1995, 1996 years 1994 value was used, for 1998-2002 years 1997 value was used, for 2004-2009 years 2003 value, for 2011 and 2012 years 2010 value and for 2014 years 2013 value.

Particles

The plants report total suspended particle emissions according to monitoring requirements in their environmental permits and this data is available in VAHTI. PM_{10} and $PM_{2.5}$ particle size fraction emissions are calculated from TSP emissions with factors 75 % (PM10) and 60 % (PM2.5) from USEPA Air Chief, 1998.

Particle emissions are also calculated from the commercial and residential meat frying and barbeque reported since year 2001. Emission factors are from TNO database (2002) and from McDonald., J etc (2012) and activity data from Finnish Food and Drink Industries' Federation, ETL (Table 4.97). For meat frying emission factor 0.0013 t/t meat consumed is used for TSP, PM10 and PM2.5 as well as for barbeques factor 8.9 kg/ton meat is used for TSP, PM10 and PM2.5.

For the 2017 submission, the emission factors for food heating in barbeques were revise for whole time series. The new emission factors for TSP, PM10 and PM2.5 are more accurate than the old ones as they are based on actual measurements (McDonald, J., etc (2012) (Emissions fron Charbroiling and Grilling of Chicken and Beef, Macdonald., J., Zielinska B., Fujita E., Sagebiel J., Chow J. and Watson J (2012 in Journal of the Air&Waste Management Association)

Activity data

Activity data are presented in Table 4.97. The first figures in brackets in the columns are the amount of meat, while the following persentages with which the amount of meat are multiplied, are representing the following assumptions: It is estimated that from the total meat consumption (beef, pork and poultry) 40% is consumed as pure meat and 60% as processed food. 90% of pure meat is fried and 15% of that in barbeques (Anttonen, ETL, 2000).

Calculated emissions from food and beverages industry are presented in Table 4.98.

Table 4.97. Activity data and for commercial and residential meat frying and barbeque.

Activity data (meat amounts in the first bracket following the persentages of the different treatments)		
Commercial and residential meat frying [1 000 t]		Commercial and residential barbecue's, from food heating [1 000 t]
1990	(306.5) x 40% x 90% x 85%	(306.5) x 40% x 90% * 15%
1991	(306.7) x 40% x 90% x 85%	(306.7) x 40% x 90% * 15%
1992	(299.3) x 40% x 90% x 85%	(299.3) x 40% x 90% * 15%
1993	(287.3) x 40% x 90% x 85%	(287.3) x 40% x 90% * 15%
1994	(287.6) x 40% x 90% x 85%	(287.6) x 40% x 90% * 15%
1995	(313.5) x 40% x 90% x 85%	(313.5) x 40% x 90% * 15%
1996	(317.3) x 40% x 90% x 85%	(317.3) x 40% x 90% * 15%
1997	(319.8) x 40% x 90% x 85%	(319.8) x 40% x 90% * 15%
1998	(336.5) x 40% x 90% x 85%	(336.5) x 40% x 90% * 15%
1999	(337.7) x 40% x 90% x 85%	(337.7) x 40% x 90% * 15%
2000	(168.8 + 99.0 + 68.9) x 40% x 90% x 85%	(168.8 + 99.0 + 68.9) x 40% x 90% * 15%
2001	(167.8 + 92.4 + 75.4) x 40% x 90% x 85%	(167.8 + 92.4 + 75.4) x 40% x 90% * 15%
2002	(165.6 + 92.9 + 80.2) x 40% x 90% x 85%	(165.6 + 92.9 + 80.2) x 40% x 90% * 15%
2003	(171.9 + 95.9 + 82.5) x 40% x 90% x 85%	(171.9 + 95.9 + 82.5) x 40% x 90% * 15%

2004	(176.9 + 99.3 + 83.3) x 40% x 90% x 85%	(176.9 + 99.3 + 83.3) x 40% x 90% * 15%
2005	(175.7 + 97.5 + 84.3) x 40% x 90% x 85%	(175.7 + 97.5 + 84.3) x 40% x 90% * 15%
2006	(180.6 + 97.3 + 82.9) x 40% x 90% x 85%	(180.6 + 97.3 + 82.9) x 40% x 90% * 15%
2007	(184.8 + 99.0 + 93.2) x 40% x 90% x 85%	(184.8 + 99.0 + 93.2) x 40% x 90% * 15%
2008	(187.4 + 96.6 + 98.1) x 40% x 90% x 85%	(187.4 + 96.6 + 98.1) x 40% x 90% * 15%
2009	(183.7 + 95.1 + 93.0) x 40% x 90% x 85%	(183.7 + 95.1 + 93.0) x 40% x 90% * 15%
2010	(187.0 + 99.8 + 97.4) x 40% x 90% x 85%	(187.0 + 99.8 + 97.4) x 40% x 90% * 15%
2011	(187.0 + 99.8 + 97.4) x 40% x 90% x 85%*	(187.0 + 99.8 + 97.4) x 40% x 90% * 15%
2012	(193.0 + 81 + 107) x 40% x 90% x 85%*	(193.0 + 81 + 107) x 40% x 90% x 15%
2013	(195.0 + 81 + 111) x 40% x 90% x 85%*	(195.0 + 81 + 111) x 40% x 90% x 15%
2014	(186.0 + 83 + 113) x 40% x 90% x 85%*	(186.0 + 83+ 113) x 40% x 90% x 15%
2015	(192.0 + 86 + 117) x 40% x 90% x 85%*	(192.0 + 86+ 117) x 40% x 90% x 15%

Table 4.98. Calculated NMVOC and particle emissions from food and beverages industry

Year	NMVOC (t)	TSP	PM10	PM2.5
1990	1027	0.269	0.269	0.269
1991	1002	0.269	0.269	0.269
1992	998	0.263	0.263	0.263
1993	990	0.252	0.252	0.252
1994	1009	0.253	0.253	0.253
1995	1016	0.275	0.275	0.275
1996	986	0.279	0.279	0.279
1997	1093	0.281	0.281	0.281
1998	1035	0.296	0.296	0.296
1999	1080	0.297	0.297	0.297
2000	1074	0.296	0.296	0.296
2001	1074	0.295	0.295	0.295
2002	1094	0.298	0.298	0.298
2003	1202	0.308	0.308	0.308
2004	1185	0.316	0.316	0.316
2005	1244	0.314	0.314	0.314
2006	1191	0.317	0.317	0.317
2007	1163	0.331	0.331	0.331
2008	1109	0.336	0.336	0.336
2009	1121	0.327	0.327	0.327
2010	1094	0.337	0.337	0.337
2011	1099	0.337	0.337	0.337
2012	1103	0.336	0.336	0.336
2013	1013	0.341	0.341	0.341
2014	1011	0.337	0.337	0.337
2015	994	0.349	0.349	0.349

4.42.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.42.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.42.5 Source-specific recalculations including changes made in response to the review process

2017
NMVOC emissions from bread manufacturing and particles from barbeque were recalculated for the whole time series.

4.42.6 Source-specific planned improvements

None.

4.43 Other industrial processes (NFR 2H3)

No emissions are included under NFR 2H3. Other industrial activities not falling under the NFR2 categories are reported under NFR 2L "Other production, consumption, storage, transportation or handling of bulk products".

4.44 Wood processing (NFR 2I)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS
Change in methodology	2017 barbeque + AD for bread
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.44.1 Source category description

Activities reported under NFR 2I include mechanical wood processing, such as saw mills and production of plywood, chipboard and fibreboard.

19 production plants allocated to this sector reported emissions to supervising authorities in 2015.

4.44.2 Emission trends

Mechanical wood processing is a minor source of several air pollutants as presented in Table 4.99.

Table 4.99. Contribution of Mechanical wood processing (NFR 2I) to total emissions in 2015.

Pollutant	Emissions from mechanical wood processing in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
CO	0.035	324.57	Gg	<0.1	100
NMVOC	1.192	87.76	Gg	1.4	43.8
TSP	0.129	50.02	Gg	0.3	100
PM10	0.026	32.15	Gg	<0.1	0
PM2.5	0.001	21.98	Gg	<0.1	0

4.44.3 Methodological issues

NOx and SOx emissions
The plants report NOx and SOx emissions according to monitoring requirements in their environmental permits and this data is available in VAHTI database for the use in inventories. Due to difficulties in separation of fuel and non-fuel based emissions reported by the plants, all the emissions were allocated to NFR 1A2d since the inventory 2011 emissions. The allocation will be checked before next submission.

Particle and CO emissions
The plants report total suspended particle and CO emissions according to monitoring requirements in their environmental permits and this data is available in VAHTI. PM_{10} and $PM_{2.5}$ emissions are calculated from TSP emissions with a fraction factor for PM_{10} of 18% and for $PM_{2.5}$ 0% (zero) according to information from US EPA Air Chief database**.** Due to the separation process of fuel and non-fuel based emissions in the inventory reporting system IPTJ, small part (0.03 kt) of the fuel-based $PM_{2.5}$ emissions was allocated to NFR 2I. The allocation will be checked to the next submission.

NMVOC emissions
NMVOC emissions from mechanical wood industry are calculated with activity data from Finnish Forest Federation (FFIF) and emission factors from NPI and FFIF presented in 0. In addition, NMVOCs are reported by several plants according their monitoring requirements to supervising authorities and available in VAHTI.

Table 4.100. NMVOC emission factors and activity data for wood processing industries in 1988-2015.

Year and sector	Activity data (FFIF yearbook)	Emission factor (reference), emissions (t)
Production of chipboard		0.2 kg/m^3 (NPI; 2002)
1988	650 000 m^3	130
1989	650 000 m^3	130
1990	600 000 m^3	120
1991	385 000 m^3	77
1992	354 000 m^3	71
1993	439 000 m^3	88
1994	477 000 m^3	95
1995	485 000 m^3	97
1996	498 000 m^3	100
1997	475 000 m^3	95
1998	455 000 m^3	91
1999	439 000 m^3	88
2000	462 000 m^3	92
2001	430 000 m^3	86
2002	410 000 m^3	82
2003	400 000 m^3	80
2004	448 000 m^3	90
2005	452 000 m^3	90
2006	400 000 m^3	88
2007	400 000 m^3	80
2008	250 000 m^3	50
2009	170 000 m^3	34
2010	220 000 m^3	44
2011	170 000 m^3	34
2012	100 000 m^3	20
2013	*	*
2014	*	*
2015	*	*
Production of plywood		0.15 kg/m^3 (NPI; 1999)
1988	600 000 m^3	90
1989	600 000 m^3	90
1990	650 000 m^3	98
1991	477 000 m^3	72
1992	462 000 m^3	69
1993	621 000 m^3	93
1994	700 000 m^3	105
1995	778 000 m^3	117
1996	869 000 m^3	130
1997	987 000 m^3	148
1998	992 000 m^3	149
1999	1 076 000 m^3	161
2000	1 167 000 m^3	175
2001	1 140 000 m^3	171
2002	1 240 000 m^3	186
2003	1 300 000 m^3	195
2004	1 350 000 m^3	203
2005	1 305 000 m^3	196
2006	1 400 000 m^3	212
2007	1 410 000 m^3	212
2008	1 265 000 m^3	190
2009	780 000 m^3	117
2010	980 000 m^3	147
2011	1 040 000 m^3	156
2012	1 000 000 m^3	150
2013	1 090 000 m^3	164
2014	1 160 000 m^3	174
2015	1 150 000 m^3	173

Year and sector	Activity data (FFIF yearbook)	Emission factor (reference), emissions (t)
Production of sawn timber		235 g/dry matter t of sawn timber (FFIF, 2005)
1988	3 239 000 t	761
1989	3 239 000 t	761
1990	3 075 000 t	723
1991	2 634 250 t	619
1992	2 984 800 t	701
1993	3 485 000 t	819
1994	4 190 200 t	985
1995	4 042 600 t	950
1996	3 981 100 t	936
1997	4 655 550 t	1094
1998	5 017 170 t	1179
1999	5 210 280 t	1224
2000	5 461 200 t	1283
2001	5 194 700 t	1221
2002	5 453 000 t	1281
2003	5 576 000 t	1310
2004	5 518 600 t	1297
2005	4 997 900 t	1175
2006	4 961 000 t	1170
2007	5 084 000 t	1195
2008	4 018 000 t	944
2009	3 280 000 t	771
2010	3 854 000 t	906
2011	3 977 000 t	935
2012	3 813 000 t	896
2013	4 264 000 t	1 002
2014	4 469 000 t	1 050
2015	4 346 000 t	1 021
Production of fibreboard		1.3 kg/m^3 (NPI; 1999)
1988	90 000 m^3	117
1989	80 000 m^3	104
1990	100 000 m^3	130
1991	69 000 m^3	90
1992	73 000 m^3	95
1993	85 000 m^3	111
1994	86 000 m^3	112
1995	79 000 m^3	103
1996	77 000 m^3	100
1997	88 000 m^3	114
1998	100 000 m^3	130
1999	96 000 m^3	125
2000	100 000 m^3	130
2001	109 000 m^3	142
2002	101 000 m^3	131
2003	100 000 m^3	130
2004	102 000 m^3	133
2005	101 000 m^3	131
2006	100 000 m^3	108
2007	75 000 m^3	98
2008	66 000 m^3	86
2009	46 000 m^3	60
2010	57 000 m^3	74
2011	60 000 m^3	78
2012	60 000 m^3	78
2013	*	
2014	*	
2015	*	

* since 2013 activities of chipboard and fibreboard are in included in the activity of plywood

4.44.4 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.44.5 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.44.6 Source-specific recalculations including changes made in response to the review process

2017
Revision of particle emission factors for barbeque and.
Bread activity data

4.44.7 Source-specific planned improvements

Planned for 2018 submission
Check of consistency of the allocation of emissions between the energy and IPPU sectors over the time series when the recalculation of the energy sector time series has been finalized.

4.45 Production of POPs (NFR 2J)

There is no production of POPs in Finland.

4.46 Consumption of POPs and heavy metals (NFR 2K)

Emissions from consumption of F-gases are available from the Finnish greenhouse gas inventory
http://www.stat.fi/til/khki/index_en.html

4.47 Other industrial production including production, consumption, storage, transportation or handling of bulk products (NFR 2L)

Changes in chapter	
Update of emission figures	March 2017 JMP
Update of text	April 2017 KS
Change in methodology	none
Other (e.g. language, layout)	April 2017 KS
Recalculations	none

4.47.1 Source category description

Activities reported under NFR 2L "Other sector" are presented in 0. This sector includes emissions from tile, light gravel, talc, gypsum products and ceramic household and decorative products manufacturing, quarrying and crushing, manufacturing of electricity distribution and monitoring devices and starch modification. No emissions are reported under NFR 2H3.

Table 4.101. Activites and emissions reported under NFR 2L Other

SNAP code	SNAP	Detailed description	Emissions reported
040617	Other	Light gravel manufacturing	NOx, NMVOC, SOx, NH_3, TSP, PM_{10}, $PM_{2.5}$, PCDD/F
040617	Other	Talc manufacturing	
040617	Other	Ceramic household and decorative products manufacturing	
040617	Other	Tile (brick) manufacturing	
040617	Other	Gypsum product manufacturing	
040617	Other	Quarrying and crushing	
040617	Other	Manufacturing of electricity distribution and monitoring devices	
040617	Other	Starch modification	
		Animal feed production	

The annual variations in the emissions are caused by fluctuation of production or the activity volume over the years. The shares of emissions of total emissions and shares of data reported by the plants are presented in Table 4.102.

Table 4.102. Contribution of Other production, consumption, storage, transportation or handling of bulk products (NFR 2L) to total emissions in 2015.

Pollutant	Emissions from other processes in 2015	Total emissions in 2015	Unit	Share of total emissions %	% reported by the plants
NH3	0.001	31.85	Gg	<0.1	100
NMVOC	0.004	87.76	Gg	<0.1	100
NOx (as NO2)	0.001	139.68	Gg	<0.1	100
TSP	0.016	50.02	Gg	<0.1	100
PCDD/Fz	0.009	14.25	g I-Teq	<0.1	0
PM10	0.009	32.15	Gg	<0.1	0
PM2.5	0.004	21.98	Gg	<0.1	0
SOx (as SO2)	<0.001	42.06	Gg	<0.1	100

4.47.2 Methodological issues

Emissions are mainly reported by the plants according to the monitoring requirements in the environmental permits. When no plant specific data is available emissions has been calculated.

NOx, NMVOC, SOx, particle and carbon monoxide
Emissions are based on emission data reported by the plants and available in VAHTI.

PCDD/F
Emissions from the production of bricks are calculated using the emission factor 87 ng I-TEQ/ t (UNEP, 1999) and activity data presented in Table 4.103. It is assumed that one brick weights 3 kg.

Table 4.103. Activity data for brick production (Confederation of Finnish Construction Industries)

Year	Production of Bricks (t)	Year	Production of Bricks (t)	Year	Production of Bricks (t)
1990	339 000	2000	188 715	2010	111 600
1991	270 000	2001	183 000	2011	108 900
1992	198 000	2002	171 000	2012	100 994
1993	183 000	2003	174 000	2013	100 994*
1994	171 000	2004	177 000	2014	100 994*
1995	156 000	2005	162 000	2015	100 994*
1996	120 000	2006	156 000		
1997	219 270	2007	143 700		
1998	200 145	2008	129 000		
1999	194 430	2009	91 500		

*due the lack of data, years 2012 activity data is used also for years 2013-2015

Calculated emissions dioxin and furines (PCDD/PCDF) from other industrial production sector are presented in 0.

Table 4.104. Calculated PCDD/PCDF emissions from other industrial production

Year	PCDD/PCDF (q I-TEQ)	Year	PCDD/PCDF (q I-TEQ)	Year	PCDD/PCDF (q I-TEQ)
1990	0.0295	2000	0.0164	2010	0.0097
1991	0.0235	2001	0.0159	2011	0.0095
1992	0.0172	2002	0.0149	2012	0.0088
1993	0.0159	2003	0.0151	2013	0.0088
1994	0.0149	2004	0.0154	2014	0.0088
1995	0.0136	2005	0.0141	2015	0.0088
1996	0.0104	2006	0.0136		
1997	0.0191	2007	0.0125		
1998	0.0174	2008	0.0112		
1999	0.0169	2009	0.0080		

4.47.3 Uncertainty and time series' consistency

The results of the uncertainty analysis are presented in Part 3 of the IIR.

4.47.4 Source-specific QA/QC and verification

Normal statistical quality checking related to assessment of magnitude and trends has been carried out. At present, no verification has been carried out for the specific source-sector emissions.

4.47.5 Source-specific recalculations including changes made in response to the review process

None.

4.47.6 Source-specific planned improvements

None.