

Emission factors used in the estimations of emissions from combustion

(Last update: 19.01.2018)

In the calculations the numbers are used with the highest available accuracy. In these tables though, they are only shown rounded off.

In the tables, dotted cells indicate combinations of fuel and source without consumption.

CO₂, SO₂ and heavy metals - Stationary and mobile combustion

Table 1. General emission factors for CO₂, SO₂ and heavy metals

	CO ₂ tonne/tonne ²	SO ₂ ¹ kg/tonne ²	Pb g/tonne ²	Cd g/tonne ²	Hg g/tonne ²	As g/tonne ²	Cr g/tonne ²	Cu g/tonne ²
Coal	2.52	16 ³	0.2 ³	0.003 ³	0.05 ³	0.089 ³	0.065 ³	0.087 ³
Coke	3.19	18	0.2 ³	0.003 ³	0.05 ³	0.089 ³	0.065 ³	0.087 ³
Petrol coke	3.59	18	0.2	0.003	0.05	0.089	0.065	0.087
Charcoal	0	0.32	0.8	0.38	0.02	0.01	0.68	0.18
Motor gasoline	3.13	0.010	0.03⁴	0.01	0.0084	0.05	0.05	1.7
Aviation gasoline	3.13	0.4	675.7	0.01	0	0.05	0.05	1.7
Kerosene (heating)	3.15	0.372	0.07	0.01	0.03	0.05	0.04	0.05
Jet kerosene	3.15	0.286	0.07	0.01	0.03	0.05	0.05	0.05
Auto diesel	3.17 ⁵	0.015⁶	0.1	0.01	0.0023	0.05	0.05	1.7
Marine gas oil/diesel	3.17	1.188	0.1	0.01	0.05	0.05	0.04	0.05
Light fuel oils	3.17	0.986	0.1	0.01	0.05	0.05	0.04	0.05
Heavy distillate	3.17	4.586	0.1	0.01	0.05	0.05	0.04	0.05
Heavy fuel oil	3.2	17.94⁷	1	0.1	0.2	0.057	1.35	0.53
Natural gas (1000 Sm ³)	1.99/ 2.34⁸	0	0.00025	0.002	0.001	0.004	0.021	0.016
LPG	3	0	0	0	0	0.004	0.021	0.016
Refinery gas	2.8	0	0	0	0	0.004	0.021	0.016
CO gas	1.571	0	0	0	0	0.004	0.021	0.016
Fuel gas	2.5	0	0	0	0	0.004	0.021	0.016
Landfill gas	0	0.019	0	0	0	0.004	0.021	0.016
Biogas	0	0	0.00025	0.0017	0.001	0.0038	0.021	0.016
Fuel wood	0	0.2	0.05	0.1	0.010244	0.159	0.152	0.354
Wood waste	0	0.37	0.05	0.1	0.010244	0.159	0.152	0.354
Wood pellets	0	0.37	0.05	0.1	0.1	0.159	0.152	0.354
Wood briquettes	0	0.37	0.05	0.1	0.1	0.159	0.152	0.354
Black liquor	0	0.37	0.05	0.1	0.010244	0.159	0.152	0.354
Municipal waste	0.5498⁹	1.4	0.00304	0.00015	0.00016	0.022	0.001	0.000985
Special waste	3.2	9.2	14	0.6	0.2	1	31	25

¹ Applies to 2016 for petroleum products; the factors change yearly, in accordance with changes in the sulphur content in the products.

² For natural gas: 1000 Sm³.

³ Exceptions: Direct-fired furnaces in cement production = 9.1 and small stoves in households = 20.

⁴ From 1997 - considerably higher earlier years. Earlier used factors are not shown in this Appendix.

⁵ From 2006 the emission factor has been corrected for use of bio diesel, which not causes emissions of CO₂: 2006: 3.159, 2007: 3.114, 2008: 3.029, 2009: 3.007, 2010: 2.992, 2011: 3.006, 2012: 2.989, 2013: 2.989, 2014: 3.000, 2015: 2.990, 2016: 2.746.

⁶ Applies to road traffic. Weighted average of duty-free and dutiable auto diesel.

⁷ Stationary combustion.

⁸ Respectively dry gas (domestic use) and rich gas (continental shelf).

⁹ The factor increases through the period, from 0.4874 in 1990. Exact figures can be given at request.

Numbers in italics have exceptions for some sectors, see table 2 and 5. Bold numbers are different for different years, see table B3, B4 and B5. Source: Rosland (1987), (Norwegian pollution control authority (1990), (Sandgren *et al.* (1996), Finstad *et al.* (2001) Finstad *et al.* (2002) and Finstad and Rypdal (2003).

Table 2. Exceptions from the general emission factors for heavy metals: Solid fuels in small stoves (households)

	Pb g/tonne	Cd g/tonne	Hg g/tonne	As g/tonne	Cr g/tonne	Cu g/tonne
Coal	2.5	0.15	0.3	1.2	0.9	1.2
Coke	2.5	0.15	0.3	1.2	0.9	1.2

Table 3. Time series for variable emission factors for SO₂ (kg/tonne)

Years	V11 Motor gasoline	V13 Kerosene (heating)	V14 Jet kerosene	V15 Auto diesel				V17 Marine gas oil/diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil (LS-oil)	V20 Heavy fuel oil (NS-oil)
	General	General	General	General	M.1A3B.1 Passenger cars	M.1A3B.2 Light duty vehicles	M.1A3B.3 Heavy duty vehicles	General	General	General	General	General
1980	1	0.2	0.2	6.6	.	.	.	6.6	6.6	15	19	46
1987	0.7	0.4	0.4	4.4	.	.	.	4.4	4.4	9	19	44
1989	0.6	0.4	0.4	3.4	.	.	.	3.4	3.4	7.6	18.2	40
1990	0.6	0.3	0.3	3.2	.	.	.	3.2	3.2	6	17	39.4
1991	0.6	0.38	0.38	2.8	.	.	.	2.8	2.8	4.6	16.8	43.6
1992	0.6	0.32	0.32	2.6	.	.	.	2.6	2.6	4.4	16.4	42.6
1993	0.6	0.42	0.42	2.2	.	.	.	2.2	2.2	4.4	16.2	45.8
1994	0.6	0.36	0.36	1.4	.	.	.	1.4	1.4	4.2	14.2	44.8
1995	0.24	0.46	0.46	1.4	.	.	.	1.4	1.4	4.6	11.8	43.4
1996	0.22	0.46	0.5	1.2	.	.	.	1.2	1.2	3.8	12.6	46.6
1997	0.16	0.46	0.46	1.2	.	.	.	1.2	1.2	3.8	12.6	47.2
1998	0.16	0.42	0.42	0.8	.	.	.	1.8	1.8	4.2	12.4	42.8
1999	0.22	0.32	0.32	0.6	.	.	.	1.6	1.6	4.4	12.8	39
2000	0.18	0.36	0.36	1.4	0.1174	0.1174	0.1174	1.8	1.8	4.6	14.4	31
2001	0.18	0.46	0.46	0.8	0.0885	0.0885	0.0885	1.8	1.8	4.8	13.2	44.4
2002	0.2	0.32	0.32	0.6	0.0708	0.0708	0.0708	1.6	1.2	4.8	12	43.8
2003	0.1	0.3	0.3	0.8	0.0748	0.0748	0.0748	2	0.8	4.6	14	44.2
2004	0.06	0.3	0.3	0.8	0.0748	0.0748	0.0748	1.8	0.8	5	14.2	44.2
2005	0.01	0.28	0.28	0.8	0.0278	0.0278	0.0278	1.8	0.8	4.6	13.6	39.2
2006	0.01	0.27	0.27	1.38	0.0393	0.0393	0.0393	2	1.38	4.44	10.4	26.2
2007	0.01	0.296	0.296	0.73	0.0244	0.0244	0.0244	1.53	0.73	4.17	17.8	20
2008	0.01	0.286	0.286	0.786	0.0285	0.0285	0.0285	1.562	0.986	3.098	17.5	28.5
2009	0.01	0.302	0.371	0.016	0.016	0.016	0.016	1.069	0.949	4.31	17.4	27.8
2010	0.01	0.324	0.294	0.015	0.015	0.015	0.015	1.184	0.978	4.31	17.5	28
2011	0.01	0.334	0.296	0.015	0.015	0.015	0.015	1.196	0.984	4.32	17.8	28.4
2012	0.01	0.326	0.294	0.015	0.015	0.015	0.015	1.038	0.658	4.295	17.5	27.4
2013	0.009	0.298	0.252	0.014	0.014	0.014	0.014	1.026	0.642	3.957	15.4	26.4
2014	0.01	0.342	0.252	0.014	0.014	0.014	0.014	1.054	0.648	4.263	15.5	27.0
2015	0.01	0.346	0.274	0.015	0.015	0.015	0.015	1.158	0.928	4.375	17.8	28.6
2016	0.009	0.372	0.286	0.015	0.015	0.015	0.015	1.188	0.986	4.586	17.9	29.2

Table 4. Time series for variable emission factors for heavy metals, stationary combustion. g/tonne

Sector	Source	Fuel	1990-1991			1992-		
			Pb	Cd	Hg	Pb	Cd	Hg
General	S.03	V51	0.0085	0.00047	0.00035	0.00304	0.00015	0.00016

Table 5. Exceptions with time series for variable emission factors for natural gas combusted by oil exploration, tonne CO₂/1000 Sm³ natural gas

Sector	Source	Fuel	Component	1990-1994	1995	1996	1997	1998	1999	2000	2001	2002*
230600.1	S.02	V31	CO ₂	2.34	2.29	2.3	2.3	2.31	2.5	2.48	2.47	2.45
230600.1	S.1B2C	V31	CO ₂	2.34	2.42	2.34	2.34	2.34	2.48	2.52	2.42	2.47

*For the years after 2002 reported emissions are used

Aviation - CH₄, N₂O, NO_x, NMVOC, CO, particles and PAH

Table 6. General emission factors for aviation

Source	Fuel	CH ₄ kg/ tonne	N ₂ O kg/ tonne	NO _x kg/ tonne	NMVOC kg/ tonne	CO kg/ tonne	NH ₃ kg/ tonne	TSP, PM ₁₀ , PM _{2.5} kg/tonne	Dioxins µg I- TEQ/ tonne
M.1A3A.111 Jet/turboprop 0-100 m	V14 Jet kerosene	0.129	0.1	12.968	1.164	10.952	0	0.064	0.06
M.1A3A.112 Jet/turboprop 100-1000 m	V14 Jet kerosene	0.129	0.1	12.968	1.164	10.952	0	0.064	0.06
M.1A3A.12 Jet/turboprop cruise	V14 Jet kerosene	0	0.1	14.650	0.707	11.351	0	0.102	0.06
M.1A3A.211 Helicopter 0-100 m	V14 Jet kerosene	3.2	0.1	6.67	28.8	36.6	0	0.025	0.06
M.1A3A.212 Helicopter 100-1000 m	V14 Jet kerosene	3.2	0.1	6.67	28.8	36.6	0	0.025	0.06
M.1A3A.22 Helicopter cruise	V14 Jet kerosene	0	0.1	6.67	32	36.6	0	0.007	0.06
M.1A3A.311 Small aircraft 0-100 m	V12 Aviation gasoline	0.129	0.1	12.968	1.164	10.952	0	0.064	2
M.1A3A.312 Small aircraft 100-1000 m	V12 Aviation gasoline	0.129	0.1	12.968	1.164	10.952	0	0.064	2
M.1A3A.32 Small aircraft cruise	V12 Aviation gasoline	0	0.1	14.650	0.707	11.351	0	0.102	2

Table 6 (cont.). General emission factors for aviation

Source	Fuel	benzo(a)pyrene g/tonne	benzo(b)fluoranthene g/tonne	benzo(k)fluoranthene g/tonne	indeno(1,2,3-cd)pyrene g/tonne
M.1A3A.111 Jet/turboprop 0-100 m	V14 Jet kerosene		NE	NE	NE
M.1A3A.112 Jet/turboprop 100-1000 m	V14 Jet kerosene		NE	NE	NE
M.1A3A.12 Jet/turboprop cruise	V14 Jet kerosene		NE	NE	NE
M.1A3A.211 Helicopter 0-100 m	V14 Jet kerosene		NE	NE	NE
M.1A3A.212 Helicopter 100-1000 m	V14 Jet kerosene		NE	NE	NE
M.1A3A.22 Helicopter cruise	V14 Jet kerosene		NE	NE	NE
M.1A3A.311 Small aircraft 0-100 m	V12 Aviation gasoline	0.005		0.009	0.003
M.1A3A.312 Small aircraft 100-1000 m	V12 Aviation gasoline	0.005		0.009	0.003
M.1A3A.32 Small aircraft cruise	V12 Aviation gasoline	0.005		0.009	0.003

Numbers in italics have exceptions for some sectors, see table 7, and bold numbers are different for different years, see table 8.

In the estimation update for CH₄, NO_x, NMVOC, CO and particles, which was based on the new EEA (2013) factors, no distinction are made between flight phases in 0-100 m altitude and 100-1000 m altitude. Furthermore, emission factors for jet/turboprop and small aircraft are weighted together.

Source: Finstad *et al.* (2001), Finstad *et al.* (2002), EEA (2013). PAHs: Jet keorsone: EEA (2013), Aviation gasoline: Aarhus University (2016)

Table 7. Exceptions from the general factors for aviation

Component	Emission factor		Fuel	Source	Sectors
CH ₄	0.35	V14	Jet kerosene	M.1A3A.111-112, M1A3A.211-212	248422
NO _x	13.51	V14	Jet kerosene	M.1A3A.111, M1A3A.211	248422
NO _x	13.29	V14	Jet kerosene	M.1A3A.112, M1A3A.212	248422
NO _x	11.7	V14	Jet kerosene	M.1A3A.12, M.1A3A.22	248422
NM VOC	7.43	V14	Jet kerosene	M.1A3A.111, M1A3A.211	248422
NM VOC	7.36	V14	Jet kerosene	M.1A3A.112, M1A3A.212	248422
NM VOC	4.3	V14	Jet kerosene	M.1A3A.12, M.1A3A.22	248422
CO	23.67	V14	Jet kerosene	M.1A3A.111, M1A3A.211	248422
CO	23.15	V14	Jet kerosene	M.1A3A.112, M1A3A.212	248422
CO	20.9	V14	Jet kerosene	M.1A3A.12, M.1A3A.22	248422
CH ₄	0.090	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.11x, M1A3A.31x	235100.2N
CH ₄	0	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.12, M1A3A.32	235100.2N
NO _x	12.559	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.11x, M1A3A.31x	235100.2N
NO _x	13.857	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.12, M1A3A.32	235100.2N
NM VOC	0.810	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.11x, M1A3A.31x	235100.2N
NM VOC	0.246	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.12, M1A3A.32	235100.2N
CO	9.903	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.11x, M1A3A.31x	235100.2N
CO	2.547	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.12, M1A3A.32	235100.2N
TSP, PM ₁₀ , PM _{2.5}	0.074	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.11x, M1A3A.31x	235100.2N
TSP, PM ₁₀ , PM _{2.5}	0.142	V12, 14	Aviation gasoline, jet kerosene	M.1A3A.12, M1A3A.32	235100.2N

Table 8. Time series for variable emission factors for aviation. Factors for 1989, 1995, 2000 and 2012 are calculated as given in the table. Factors for 1990-1994, 1996-1999 and 2001-2011 are calculated by linear interpolation. Factors after 2012 are kept constant. In the 2012 calculation source M.1A3A.111 and M.1A3A.112 are weighted together.

Component	Year	General			235100.2N		665100.2
		M.1A3A.111 (LTO 0-100 m)	M.1A3A.112 (LTO 100-1000 m)	M.1A3A.12 (cruise)	M.1A3A.111 (LTO 0-100 m)	M.1A3A.112 (LTO 100-1000 m)	M.1A3A.12 (cruise)
CH ₄	1989	0.086	0.014	0.000	0.041	0.007	0.000
	1995	0.858	0.141	0.000	0.086	0.014	0.000
	2000	0.175	0.029	0.000	0.144	0.025	0.000
	2012	0.129	0.129	0.000	0.090	0.090	0.000
NO _x	1989	6.772	13.049	12.119	7.762	14.958	12.755
	1995	9.296	17.913	11.001	7.745	14.924	11.989
	2000	7.579	14.605	14.032	7.327	14.884	11.750
	2012	12.968	12.968	14.650	12.559	12.559	13.857
NM VOC	1989	0.775	0.127	0.554	0.365	0.060	0.675
	1995	7.725	1.265	0.963	0.773	0.127	3.369
	2000	1.576	0.258	0.507	1.293	0.221	0.366
	2012	1.164	1.164	0.707	0.810	0.810	0.246
CO	1989	19.768	2.145	6.947	14.173	1.538	4.191
	1995	27.204	2.952	12.147	15.118	1.640	8.459
	2000	21.239	2.305	7.808	16.925	2.659	3.866
	2012	10.952	10.952	11.351	9.903	9.903	2.547
TSP, PM ₁₀ , PM _{2.5}	1989	0.039	0.039	0.094	0.048	0.048	0.658
	1995	0.056	0.056	0.102	0.075	0.075	1.325
	2000	0.057	0.057	0.155	0.075	0.075	1.325
	2012	0.064	0.064	0.102	0.074	0.074	0.142

Road traffic - CH₄, N₂O, NO_x, NMVOC, CO, NH₃, particles and PAH

Table 9. General emission factors for road traffic

Source	Fuel	CH ₄ kg/tonne	N ₂ O kg/tonne	NO _x kg/tonne	NMVOC kg/tonne	CO kg/tonne	NH ₃ kg/tonne	TSP, PM ₁₀ kg/tonne	PM _{2.5} kg/tonne	Dioxins µg I-TEQ/tonne
M.1A3B.1 Passenger car	V11 Motor gasoline	0.286	0.029	3.052	5.173	33.969	0.946	0.037	0.037	0.1
	V15 Auto diesel	0.011	0.081	11.509	0.453	2.501	0.019	0.240	0.228	0.1
	V31 Natural gas	0	0	0.871	0.065	1.693	0	0.122	0.122	0.05
	V32 LPG	0	0.045	1.148	0	12.106	0	0.033	0.033	0.06
M.1A3B.2 Other light duty cars	V11 Motor gasoline	0.487	0.072	5.914	9.321	93.276	0.725	0.075	0.075	0.1
	V15 Auto diesel	0.008	0.058	8.950	0.333	2.235	0.013	0.429	0.408	0.1
M.1A3B.3 Heavy duty vehicles	V11 Motor gasoline	0.545	0.042	26.481	15.881	21.082	0.018	0	0	0.1
	V15 Auto diesel	0.007	0.100	10.345	0.286	3.255	0.008	0.172	0.164	0.1
	V31/V37 Natural gas/									
	Biogas	0	0	5.922	0.037	0.849	0.006	0.019	0.019	0.05
M.1A3B.41 Moped	V11 Motor gasoline	23.313	0.049	3.072	102.273	181.252	0.049	0	0	0.1
M.1A3B.42 Motorcycle	V11 Motor gasoline	1.511	0.054	3.786	16.553	174.606	0.054	0	0	0.1

Table 9 (cont.). General emission factors for road traffic

Source	Fuel	benzo(a)pyrene g/tonne	benzo(b)fluoranthene g/tonne	benzo(k)fluoranthene g/tonne	indeno(1,2,3-cd)pyrene g/tonne
M.1A3B.1 Passenger car	V11 Motor gasoline	0.030	0.034	0.024	0.037
	V15 Auto diesel	0.114	0.127	0.100	0.106
	V31 Natural gas	0	0	0	0
	V32 LPG	0.026	0.030	0.021	0.033
M.1A3B.2 Other light duty cars	V11 Motor gasoline	0.029	0.035	0.024	0.038
	V15 Auto diesel	0.114	0.127	0.100	0.106
M.1A3B.3 Heavy duty vehicles	V11 Motor gasoline	0.014	0.083	0.092	0.021
	V15 Auto diesel	0.028	0.169	0.189	0.043
	V31/V37 Natural gas/				
	Biogas	0	0	0	0
M.1A3B.41 Moped	V11 Motor gasoline	0.040	0.040	NE	NE
M.1A3B.42 Motorcycle	V11 Motor gasoline	0.040	0.040	NE	NE

Bold numbers are different for different years, but only the 2016 data are shown here, except for CH₄ (table 10) and N₂O (table 11).
Source: Results from Statistikk Norge's use of HBEFA (INFRAS 2009), Finstad *et al.* (2001). PAH-profile: Aarhus University (2016)

Table 10. Average CH₄ emission factors for road traffic including cold start emissions and evaporation, g CH₄/ kg fuel

	V11 Motor gasoline					V15 Auto diesel		
	Passenger car	Other light duty cars	Heavy duty vehicles	Moped	Motorcycle	Passenger car	Other light duty cars	Heavy duty vehicles
1990	1.592	1.805	0.563	12.571	3.514	0.109	0.097	0.082
1991	1.554	1.810	0.566	12.654	3.344	0.105	0.094	0.081
1992	1.511	1.781	0.568	12.678	3.183	0.095	0.089	0.078
1993	1.466	1.723	0.569	12.716	2.988	0.076	0.074	0.068
1994	1.413	1.652	0.571	12.750	2.834	0.083	0.085	0.073
1995	1.354	1.562	0.574	12.809	2.716	0.080	0.081	0.071
1996	1.231	1.430	0.565	12.606	2.534	0.076	0.076	0.066
1997	1.181	1.384	0.580	12.952	2.759	0.077	0.078	0.066
1998	1.070	1.251	0.564	12.594	2.833	0.073	0.070	0.056
1999	0.984	1.166	0.561	14.084	2.982	0.070	0.066	0.052
2000	0.934	1.113	0.576	17.260	3.105	0.066	0.063	0.049
2001	0.823	0.971	0.552	19.523	2.987	0.056	0.054	0.043
2002	0.750	0.888	0.551	22.722	2.996	0.050	0.049	0.040
2003	0.677	0.821	0.545	24.560	2.895	0.044	0.045	0.037
2004	0.604	0.754	0.537	25.196	2.732	0.038	0.041	0.035
2005	0.572	0.736	0.561	26.359	2.711	0.035	0.038	0.034
2006	0.525	0.691	0.567	26.302	2.520	0.030	0.033	0.032
2007	0.501	0.665	0.583	26.594	2.339	0.026	0.029	0.029
2008	0.469	0.625	0.583	26.163	2.088	0.023	0.024	0.026
2009	0.442	0.593	0.580	25.667	1.963	0.020	0.021	0.022
2010	0.412	0.560	0.571	25.017	1.850	0.017	0.017	0.017
2011	0.396	0.555	0.578	25.177	1.813	0.016	0.015	0.015
2012	0.374	0.539	0.576	24.956	1.766	0.015	0.014	0.013
2013	0.351	0.524	0.572	24.687	1.713	0.014	0.012	0.012
2014	0.323	0.507	0.557	23.982	1.632	0.013	0.011	0.010
2015	0.309	0.504	0.558	23.946	1.593	0.012	0.009	0.008
2016	0.286	0.487	0.545	23.313	1.511	0.011	0.008	0.007

Source: Results from Statistics Norway's use of HBEFA (INFRAS 2009)

Table 11. Average N₂O emission factors for road traffic including cold start emissions and evaporation, g N₂O/ kg fuel

	V11 Motor gasoline					V15 Auto diesel		Heavy duty vehicles
	Passenger car	Other light duty cars	Heavy duty vehicles	Moped	Motorcycle	Passenger car	Other light duty cars	
1990	0.099	0.107	0.043	0.050	0.056	0	0	0.033
1991	0.105	0.107	0.043	0.051	0.056	0	0	0.032
1992	0.110	0.109	0.043	0.051	0.056	0	0	0.031
1993	0.117	0.114	0.043	0.051	0.056	0	0	0.026
1994	0.125	0.121	0.044	0.051	0.056	0	0	0.030
1995	0.135	0.131	0.044	0.051	0.057	0.003	0.005	0.030
1996	0.146	0.139	0.043	0.051	0.056	0.009	0.012	0.030
1997	0.155	0.154	0.044	0.052	0.058	0.018	0.020	0.033
1998	0.153	0.157	0.043	0.051	0.056	0.027	0.026	0.032
1999	0.154	0.164	0.043	0.050	0.056	0.036	0.034	0.033
2000	0.160	0.176	0.044	0.052	0.057	0.046	0.041	0.033
2001	0.156	0.184	0.042	0.050	0.055	0.050	0.043	0.030
2002	0.156	0.199	0.042	0.049	0.055	0.056	0.046	0.029
2003	0.152	0.175	0.042	0.049	0.055	0.062	0.049	0.027
2004	0.148	0.174	0.041	0.048	0.054	0.066	0.052	0.026
2005	0.087	0.164	0.043	0.050	0.057	0.073	0.057	0.026
2006	0.083	0.161	0.043	0.051	0.057	0.076	0.060	0.025
2007	0.082	0.161	0.045	0.052	0.059	0.083	0.064	0.028
2008	0.078	0.152	0.045	0.052	0.059	0.086	0.065	0.032
2009	0.073	0.142	0.044	0.052	0.058	0.086	0.064	0.037
2010	0.067	0.129	0.044	0.051	0.057	0.083	0.060	0.048
2011	0.062	0.123	0.044	0.052	0.058	0.085	0.061	0.064
2012	0.056	0.113	0.044	0.052	0.058	0.087	0.062	0.075
2013	0.049	0.102	0.044	0.051	0.057	0.087	0.062	0.080
2014	0.040	0.090	0.043	0.050	0.056	0.085	0.061	0.091
2015	0.035	0.082	0.043	0.050	0.056	0.084	0.060	0.097
2016	0.029	0.072	0.042	0.049	0.054	0.081	0.058	0.100

Source: Results from Statistics Norway's use of HBEFA (INFRAS 2009)

Navigation - CH₄, N₂O, NO_x, NMVOC, CO, particles and POPs

Table 12. General emission factors for navigation

	CH ₄ kg/ tonne	N ₂ O kg/ tonne	NO _x kg/ tonne	NMVOC kg/tonne	CO kg/ tonne	NH ₃ kg/ tonne	TSP, PM ₁₀ kg/ tonne	PM _{2.5} kg/ tonne	Dioxins µg I- TEQ/ tonne
V17 Marine gas oil/diesel, V18 Light fuel oils	0.23	0.08	43.30	2.4	2.9	0	1.6	1.5	4
V19 Heavy distillate, V20 Heavy fuel oil	0.23	0.08	43.30	2.4	2.9	0	5.4	5.1	4
V31 Natural gas (1000 Sm ³)	48.64	0.07	4.0	0.814	2.143	0	0.032	0.032	0.05

Table 12 (cont.). General emission factors for navigation

	benzo(a)pyrene g/tonne	benzo(b)fluoranthene g/tonne	benzo(k)fluoranthene g/tonne	indeno(1,2,3_cd)pyrene g/tonne
V17 Marine gas oil/diesel	0.006	0.028	0.013	0.051
V19 Heavy distillate	0.003	0.009	0.004	0.009
V20 Heavy fuel oil	0.003	0.008	0.004	0.008
V31 Natural gas (1000 Sm ³)	0.000025	0.000102	0.000039	0.000038

Numbers in italics have exceptions for some sectors, see table 13, and bold numbers are different for different years, see tables 14-16.

Source: Flugsrud and Rypdal (1996), Tormsjø (2001), Finstad *et al.* (2001), Finstad *et al.* (2002b), Finstad *et al.* (2003), Bremnes Nielsen and Stenersen (2010). PAHs: Aarhus University (2016) and EEA (2013).

Table 13. Exceptions from the general factors for navigation

Component	Emission factor (kg/tonne)	Fuel	Sector
CH ₄	0.8	V17	Marine gas oil/diesel 230600.1 -230600.3
CH ₄	1.9	V20	Heavy fuel oil 230600.1 -230600.3
N ₂ O	0.02	V17	Marine gas oil/diesel 230600.1 -230600.3
NO _x	36.60	V17, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 230310.N
NO _x	54	V17, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, Heavy fuel oil 230600.1 -230600.3
NO _x	46.58	V17, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 248422
NM VOC	1.4	V17, 18, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 230310.N
NM VOC	2.3	V17, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 248422
NM VOC	5	V17	Marine gas oil/diesel, light fuel oils 230600.1 -230600.3
NM VOC	5	V19, 20	Heavy distillate, heavy fuel oil 230600.1 -230600.3
CO	7.9	V17, 18, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 230310.N
CO	1.6	V17, 18, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 230600.1
CO	7	V17, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 230600.1 -230600.3
CO	2.3	V17, 19, 20	Marine gas oil/diesel, light fuel oils, heavy distillate, heavy fuel oil 248422

Table 14. Time series for variable emission factors for navigation. NO_x

Sector	Fuel	1990-1999	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999			
General	V17-20		56.85	56.80	56.89	56.77	56.82	56.68	57.23	57.47	57.41	56.82			
			2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
General	V17-20		57.82	55.90	55.55	54.61	53.25	51.90	50.54	49.18	47.83	46.47	45.11	43.76	43.30
230310. N	V17, 19, 20	52.11	52.12	51.58	51.48	50.93	49.90	47.41	45.17	43.64	43.36	40.94	37.97	36.60	36.60
248422	V17, 19, 20	50.17	49.82	48.74	48.52	48.31	48.09	47.88	47.66	47.44	47.23	47.01	46.80	46.58	46.58

Source: (Flugsrud *et al.* 2010)

Table 15. Time series for variable emission factors for navigation. CH₄

Sector	Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013-16
General	V31	31.43	31.43	31.43	49.99	52.71	54.55	54.43	36.81	38.83	41.65	42.73	40.59	46.83	48.64

Table 16. Time series for variable emission factors for navigation. NMVOC and CO

Sector	Fuel	NMVOC						CO	
		1980-1990	1980-1997	1980-1998	1991-	1998-	1999-	1980-1997	1998-
General	V17-20							3.1	2.9
230310.N	V17-20			1.5			1.4		
230600.1	V17-20							2	1.6
230600.1,230910	V19,20	6.4			5				
230600.1,230910	V 20								
248422	V17-20		2.2			2.3			

Other mobile sources including railways - CH₄, N₂O, NO_x, NMVOC, CO, NH₃, particles and POPs

Table 17. General emission factors for other mobile sources

		CH ₄ kg/ tonne	N ₂ O kg/ tonne	NO _x kg/ tonne	NM VOC kg/ tonne	CO kg/ tonne	NH ₃ kg/ Tonne	TSP, PM ₁₀ kg/ tonne	PM _{2.5} kg/ tonne	Dioxins µg I- TEQ/ tonne
M.1A3C Railway	V01 Coal	0.28	0.04	3	1.1	3	0	1.6/1.14	0.82	1.6
	V15 Auto diesel	0.18	1.2	47	4	11	0.007	3.8	3.8	0.1
M.1A3E.21 Small boats 2 stroke	V11 Motor gasoline	5.1	0.02	6	240	415	0	8	8	0.1
M.1A3E.22 Small boats 4 stroke	V11 Motor gasoline	1.7	0.08	12	40	1 000	0	1	1	0.1
	V15 Auto diesel	0.18	0.03	54	27	25	0	4	4	0.1
M.1A3E.31 Motorized equipment 2 stroke	V11 Motor gasoline	6	0.02	2¹	500	700	0	8	8	0.1
M.1A3E.32 Motorized equipment 4t	V11 Motor gasoline	2.2	0.07	10	110	1 200	0	1	1	0.1
	V15 Auto diesel	0.17	0.139	12.8	1.0	6.1	0.008	0.2	0.2	0.1
	V18 Light fuel oils	0.17	1.3	50	6	15	0.005	7.1	6.75	0.1

Other mobile sources including railways - CH₄, N₂O, NO_x, NMVOC, CO, NH₃, particles and POPs

Table 17 (cont.). General emission factors for other mobile sources

		benzo(a)pyrene g/tonne	benzo(b)fluoranthene g/tonne	benzo(k)fluoranthene g/tonne	indeno(1,2,3-cd)pyrene g/tonne
	V01 Coal	0.007	0.01	0.004	0.003
M.1A3C Railway	V15 Auto diesel	0.030	0.050	0	0
M.1A3E.21 Small boats 2 stroke	V11 Motor gasoline	0.040	0.040	0	0
	V11 Motor gasoline	0.040	0.040	0	0
M.1A3E.22 Small boats 4 stroke	V15 Auto diesel	0.030	0.050	0	0
M.1A3E.31 Motorized equipment 2 stroke	V11 Motor gasoline	0.040	0.040	0	0
	V11 Motor gasoline	0.040	0.040	0	0
	V15 Auto diesel	0.030	0.050	0	0
M.1A3E.32 Motorized equipment 4t	V18 Light fuel oils	0.030	0.050	0	0

M.1A3E.1 Snow scooter has the same emission factors as M.1A3B.41 Moped, see table 9.

Bold numbers are different for different years, but only 2016 figures are presented here.

¹Before 1995 the emission factor was 1.3.

Numbers in italics have exceptions for some sectors, see tables 18–19.

Sources: Bang (1993), Bang *et al.* (1999), Finstad *et al.* (2001), Finstad *et al.* (2002b), Finstad *et al.* (2003), Winther and Nielsen (2006), EEA (2013).

Table 18. Exceptions from the general factors for greenhouse gases and precursors for other mobile sources

Component	Emission factor (kg/tonne)	Fuel	Source	Sectors	
CH ₄	6.2	V11	Motor gasoline	M.1A3E.31 Motorized equipment 2 stroke	230100
CH ₄	3.7	V11	Motor gasoline	M.1A3E.32 Motorized equipment 4 stroke	230100
CH ₄	7.7	V11	Motor gasoline	M.1A3E.31 Motorized equipment 2 stroke	230210
CH ₄	8.1	V11	Motor gasoline	M.1A3E.31 Motorized equipment 2 stroke	330000
CH ₄	5.5	V11	Motor gasoline	M.1A3E.32 Motorized equipment 4 stroke	330000
CH ₄	0.18	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke	330000
N ₂ O	0.08	V11	Motor gasoline	M.1A3E.32 Motorized equipment 4 stroke	230500-233320
N ₂ O	0.132	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke	230100-230210
NO _x	14.4	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke	230100-230210
NO _x	54	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230100
NO _x	52	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230210
NO _x	47	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230710-230892, 234910
NO _x	48	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	232360, 248422
NO _x	46	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	234110-234120
NMVOC	1.8	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke	230100-230200
NMVOC	7.2	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230100

NMVOC	5.7	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230210
NMVOC	4	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230710-230892,234910
NMVOC	4.8	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	232360,248422
NMVOC	3.8	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	234110-234120
CO	9.6	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke	230100-230210
CO	25	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230100
CO	20	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230210
CO	11	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	230710-230892,234910
CO	17	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	234110-234120
CO	18	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke	248422

Bold numbers are different for different years, time series for NO_x are presented in table 20.

Table 19. Exceptions from the general factors for other pollutants for other mobile sources

Component	Emission factor (kg/tonne)	Fuel	Source	Sectors
TSP, PM ₁₀	1.6	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke
TSP, PM ₁₀	3.8	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
TSP, PM ₁₀	4.2	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
TSP, PM ₁₀	5.3	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
TSP, PM ₁₀	5.4	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
PM _{2.5}	1.5	V15	Auto diesel	M.1A3E.32 Motorized equipment 4 stroke
PM _{2.5}	3.61	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
PM _{2.5}	3.99	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
PM _{2.5}	5.04	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke
PM _{2.5}	5.13	V18	Light fuel oils	M.1A3E.32 Motorized equipment 4 stroke

Bold numbers are different for different years, but only 2016 figures are presented here.

Table 20. Time series for NO_x emission factors for use of auto diesel in motorized equipment 4t

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
General	46.3	46.4	46.4	46.4	46.5	46.6	46.7	46.8	46.0	43.9	41.9	40.2	37.8	35.0	31.8
230100-230210	27.1	27.0	26.7	26.5	26.4	26.4	26.5	26.6	26.6	26.5	26.4	26.2	25.8	25.4	24.9

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
General	28.6	24.8	21.6	19.8	18.5	17.1	16.1	15.3	14.5	13.5	13.0	12.78
230100-230210	24.1	23.3	22.3	21.3	20.3	19.3	18.3	17.5	16.8	15.9	15.1	14.37

Source: Winther and Nielsen (2006). Data for 2005 and later are extrapolations.

Table 21. Time series for variable emission factors for other mobile sources

Fuel	Component	1980-1990	1991	1992	1993	1994	1995	1996	1997-
V11 Gasoline	Dioxins	1.32	1.11	0.95	0.69	0.25	0.23	0.11	0.1

CH₄ - Stationary combustion

Table 22. General emission factors, kg CH₄/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood briquettes	V04 Charcoal	V31 Natural gas (1 000 Sm ³)	V33 Refinery gas
S.01 Direct- fired furnaces .	0.0281	0.285	0.105	.	.	.	.	.	5.9	0.1775	0.0486
S.02 Gas turbines ..	.	.	.	.	.	.	.	.	.	0.91	.
S.03 Boilers	8.43	8.55	0.35	.	0.1788	0.0216	0.1901	0.1703	.	0.1775	0.0486
S.04 Small stoves	8.43	8.55	.	6.1463	.	.	5.184	.	6.0	.	.
S.1B2C Flares	.	.	.	.	.	.	.	.	.	0.24	0.28
	V34 CO gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kerosene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
S.01 Direct- fired furnaces	0.0067	.	0.05	.	.	0.431	.	0.431	0.406	.	1.218
S.02 Gas turbines	.	0.251	.	.	.	-	.	.	.	.	.
S.03 Boilers	0.0067	0.251	0.05	0.2305	0.431	0.431	0.431	0.431	0.406	0.345	1.218
S.04 Small stoves	.	.	.	0.2305	0.431	.	0.431	0.431	.	.	.
S.1B2C Flares	.	0.37	0.054.	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 23.

Source: IPCC (2006), Sandgren *et al.* (1996), Karlsvik (1995) and The Norwegian oil industry association (1994).

Table 23. Exceptions from the general factors for CH₄, stationary combustion (kg CH₄/tonne fuel)

Emission factor	Fuel	Source	Sectors
0.1293	V13, V17, V18, V19	Kerosene (heating), marine diesel; light fuel oil, heavy distillate	S.01 Direct fired furnaces, S.03 Boilers
0.1218	V20	Heavy fuel oil	S.01 Direct fired furnaces, S.03 Boilers
0.0461	V32	LPG	S.03 Boilers
0.0403	V31	Natural gas (1000 Sm ³)	S.01 Direct fired furnaces, S.03 Boilers
0.0355	V31	Natural gas (1000 Sm ³)	S.01 Direct fired furnaces, S.03 Boilers
0	V34	CO gas	S.03 Boilers
0.0502	V36	Landfill gas	S.02 Gas turbines, S.03 Boilers
0.4875	V42	Wood waste	S.03 Boilers
4.644	V45	Wood briquettes	S.03 Boilers

N₂O - Stationary combustion

Table 24. General emission factors. kg N₂O/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood briquettes	V04 Char- coal	V31 Natural gas (1000 Sm ³)	V33 Refinery gas
S.01 Direct- fired furnaces .	0.0422	0.0428	0.021	.	.	.	.	.	0.12	0.0036	0.0049
S.02 Gas turbines ..	.	.	.	.	.	.	.	.	.	0.0036	.
S.03 Boilers	0.0422	0.0428	0.021	.	0.065	0.0144	0.0691	0.0619	.	0.0036	0.0049
S.04 Small stoves	0.0422	0.0428	.	0.082	.	.	0.0691	.	0.03	.	.
S.1B2C Flares	.	.	.	.	.	.	.	.	.	0.02	0.024
	V34 Blast furnace gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kero- sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
S.01 Direct- fired furnaces	0.0007	0.005	0.005	.	.	0.0259	.	0.0259	0.0244	.	0.1624
S.02 Gas turbines	.	0.005	.	.	.	0.0259	.	.	.	.	.
S.03 Boilers	0.0007	0.005	0.005	0.0046	0.0259	0.0259	0.0259	0.0259	0.0244	0.046	0.1624
S.04 Small stoves	.	.	.	0.0046	0.0259	.	0.0259	0.0259	.	.	.
S.1B2C Flares	.	0.0015	0.024	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 25.

Source: IPCC (2006), Sandgren *et al.* (1996) and The Norwegian oil industry association (1994).

Table 25. Exceptions from the general factors for N₂O. Stationary combustion (kg N₂O/1000 Sm³ natural gas)

Emission factor	Fuel	Source	Sectors
0.0040	V31 Natural gas	S.01 Direct-fired furnaces, S.02 Gas turbines, S.03 Boilers	230600.1-230600.3, 230910,234950

NO_x - Stationary combustion

Table 26. General emission factors. kg NO_x/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood bri- quettes	V04 Char- coal gas	V31 Natural gas (1000 Sm ³)	V33 Refinery gas
S.01 Direct- fired furnaces ..	16	20	20	.	.	.	.	.	2.68	5.95	5.4
S.02 Gas turbines ...	.	.	.	.	.	.	.	.	.	6.27	.
S.03 Boilers	3	3	3.4	.	0.9	0.9	1.3	1.3	.	2.55	3
S.04 Small stoves	3	3	.	0.988	.	.	1.1	.	1.4	.	.
S.1B2C Flares	.	.	.	.	.	.	.	.	.	12	7
	V34 Blast furnace gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kerosene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
S.01 Direct- fired furnaces	5.4	.	5.4	.	.	70	.	5	5	.	5
S.02 Gas turbines	.	.	.	.	.	16	.	.	.	.	.
S.03 Boilers	3	0.01	3	2.3	3	2.5	2.5	2.5	4.2	1.365	4.2
S.04 Small stoves	.	.	.	2.3	2.5	.	2.5	2.5	.	.	.
S.1B2C Flares	.	0.17	.	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 27, and bold numbers are different for different years, see table 28.

Source: Rosland (1987). Fuel wood factor based on data from annual surveys on use of fuel wood in households.

Table 27. Exceptions from the general factors for NO_x. Stationary combustion. kg NO_x /tonne fuel

Emission factor	Fuel	Source	Sectors
24	V19, 20, 52	Heavy distillate, heavy fuel oil, special waste	S.01 Direct-fired furnaces
6.13	V31	Natural gas (1000 Sm ³)	231910.2, 232350
9.5	V19, 20	Heavy distillate, heavy fuel oil	S.01 Direct-fired furnaces
8.681	V31	Natural gas (1000 Sm ³)	232014
1,4	V31	Natural gas (1000 Sm ³)	S.01 Direct-fired furnaces
3	V17, 18, 19	Fuel oils	S.02 Gas turbines
4.5	V01	Coal	S.1B2C Flares
3.4	V02	Coke	230600.1
5	V20, 52	Heavy fuel oil, special waste	S.03 Boilers
2.9	V35	Fuel gas	S.03 Boilers
0.01	V34	CO gas	S.03 Boilers
6.27	V33	Refinery gas	S.02 Gas turbines
1.4	V01, 02	Coal, coke	S.04 Small stoves

Table 28. Time series for variable emission factors for NO_x. Stationary combustion. kg NO_x /tonne fuel

Sector	Source	Fuel	1980-1990	1991	1992-1994	1995	1996-1998	1999-2004	2005	2006	2007	2008	2009	2010
General	S.04	V41	0.982	0.981	0.982	0.981	0.982	0.981	0.985	0.984	0.987	0.988	0.987	0.988
Sector	Source	Fuel	2011	2012	2013	2014	2015	2016						
General	S.04	V41	0.986	0.985	0.988	0.989	0.988	0.988						
Sector	Source	Fuel	1980-1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000-	
230600.1	S.02	V31	8.223	8.172	8.234	8.444	8.617	8.874	9.128	9.185	9.528	9.087	8.681	

NMVOC - Stationary combustion

Table 29. General emission factors. kg NMVOC/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood bri- quettes	V04 Char coal	V31 Natural gas (1000 Sm ³)	V33 Re finery gas
S.01 Direct-fired furnaces	0	0	0	.	.	.	.	.	8.85	0	0.1
S.02 Gas turbines	.	.	.	.	.	.	.	.	.	0.24	.
S.03 Boilers	1.1	0.6	0.6	.	1.30	.	1.3	1.3	.	0.085	0.1
S.04 Small stoves	1.1	0.6	.	7.0	.	.	6.501	.	10	.	.
S.1B2C Flares .	.	.	.	.	.	.	.	.	.	0.06	13.5
	V34 CO gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kero sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
S.01 Direct-fired furnaces	0	.	0	.	.	5	.	0.3	0.3	.	0.3
S.02 Gas turbines	.	.	.	.	.	0.03	.	.	.	.	.
S.03 Boilers	0.1	0	0.1	0.1	0.4	0.4	0.4	0.4	0.3	0.7	0.3
S.04 Small stoves	.	.	.	0.1	0.4	.	0.4	0.4	.	.	.
S.1B2C Flares	.	0	.	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 30.

Source: Rosland (1987) and Sandgren *et al.* (1996).

Table 30. Exceptions from the general factors for NMVOC. Stationary combustion. kg NMVOC/tonne fuel

Emission factor	Fuel	Source	Sectors
0	V 19, 20, 52	Heavy distillate, heavy fuel oil, special waste	S.01 Direct-fired furnaces 231910.2, 232350
0.1	V34	CO gas	S.01 Direct-fired furnaces 231910.2
0.085034	V31	Natural gas (1000 Sm ³)	S.01 Direct-fired furnaces 232014
0.9	V19, 20	Heavy distillate, heavy fuel oil	S.01 Direct-fired furnaces 232360
0.8	V01	Coal	S.03 Boilers 230500-233320
0	V32, 34, 35, 42	LPG, CO gas, fuel gas, wood waste	230500-233320, 231711, 232011-232050, 233510-233530
0.6	V17, 18, 19	Fuel oils	S.03 Boilers 330000
10	V01	Coal	S.04 Small stoves 330000
0.6	V13	Kerosene (heating)	S.04 Small stoves 330000

CO - Stationary combustion

Table 31. General emission factors. kg CO/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood briquettes	V04 Char coal	V31 Natural gas (1000 Sm ³)	V33 Re finery gas
S.01 Direct- fired furnaces .	0	26.16	0	.	.	.	.	.	16.82.	0	0
S.02 Gas turbines ..	.	.	.	.	.	.	.	.	.	1.7	.
S.03 Boilers	3	26.16	3	.	15	0	15	15	.	0	0
S.04 Small stoves	3	26.16	.	93.9	.	.	2.6	.	100	.	.
S.1B2C Flares	.	.	.	.	.	.	.	.	.	1.5	0
	V34 CO gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kero sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
S.01 Direct- fired furnaces .	0	.	0	.	.	5	.	0.2	0.2	.	0.2
S.02 Gas turbines ..	.	.	.	.	.	0.7	.	.	.	.	.
S.03 Boilers	0	0	0	0.5	2	2	2	2	0.4	2.8	0.4
S.04 Small stoves	.	.	.	0.5	2	.	2	2	.	.	.
S.1B2C Flares	.	0.04	.	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 32, and bold numbers are different for different years, see table 33.

Table 32. Exceptions from the general factors for CO. Stationary combustion. kg CO/tonne fuel

Emission factor	Fuel	Source	Sectors
0	V 19, 20, 52	Heavy distillate, heavy fuel oil, special waste	S.01 Direct-fired furnaces
0.01	V34	CO gas	231910.2, 232350, 232360
0.2	V20, 52	Heavy fuel oil, special waste	S.01 Direct-fired furnaces
0	V32, 42	LPG, wood waste	231910.2
6.5	V17, 18, 19	Fuel oils	S.03 Boilers
100	V01, 02	Coal, coke	230500-233320
6.5	V13	Kerosene (heating)	S.03 Boilers
1.7	V31	Natural gas (1000 Sm ³)	230500-233320, 231711
			S.03 Boilers
			330000
			S.04 Small stoves
			330000
			S.04 Small stoves
			330000
			S.1B2C Flares
			231922

Table 33. Time series for variable emission factors for CO. Stationary combustion. kg CO/tonne fuel

Sector	Source	Fuel	1980- 1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
General	S.04	V41	149.1	148.4	146.3	142.6	137.6	131.0	122.2	111.5	115.5	111.9	110.6	107.9	105.0
Sector	Source	Fuel	2010	2011	2012	2013	2014	2015	2016						
General	S.04	V41	103.3	101.2	99.2	96.1	96.7	93.4	93.9						

NH₃ - Stationary combustion

Table 34. General emission factors. kg NH₃/tonne fuel

Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Black waste	V43 Wood liquor	V44 Wood pellets	V45 Wood bri- quettes	V04 Char- coal	V31 Natural gas (1000 Sm ³)	V33 Re- finery gas	V34 CO gas	V36 Land- fill gas	V35 Fuel gas	V32 LPG	V13 Kero- sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy dis- tillate	V20 Heavy fuel oil	V51 Munici- pal waste	V52 Special waste
S.04 Small stoves	.	.	0.066	.	.	0.066	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
All other sources	0	0	0	.	0	0	0	0	1.09	0	0	0	0	0	0	0	0	0	0	0	0	0

Particulate matter - Stationary combustion

Table 35. General emission factors. kg particle component/tonne fuel

Com- ponent	Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood briquettes	V04 Char coal	V31 Natural gas (1000 Sm ³)	V33 Refinery gas
TSP	S.01 Direct-fired furnaces	1.6	1.6	1.6	.	.	.	.	.	4.43	0.122	0.144
TSP	S.02 Gas turbines	.	.	.	.	.	.	.	.	.	0.122	.
TSP	S.03 Boilers	1.6	1.6	1.6	.	2.69	0	2.69	2.69	.	0.122	0.144
TSP	S.04 Small stoves	4.2	2.85	3.5	17.15	.	.	1.1	.	2.4	.	.
TSP	S.1B2C Flares	.	.	.	.	.	.	.	.	.	0.002	0.144
PM ₁₀	S.01 Direct-fired furnaces	1.14	1.14	1.14	.	.	.	.	.	4.22	0.122	0.144
PM ₁₀	S.02 Gas turbines	.	.	.	.	.	.	.	.	.	0.122	.
PM ₁₀	S.03 Boilers	1.14	1.14	1.14	.	2.52	0	2.52	2.52	.	0.122	0.144
PM ₁₀	S.04 Small stoves	2.8	1.71	2.1	16.81	.	.	1.1	.	2.4	.	.
PM ₁₀	S.1B2C Flares	.	.	.	.	.	.	.	.	.	0.002	0.144
PM _{2.5}	S.01 Direct-fired furnaces	0.82	0.82	0.82	.	.	.	.	.	4.13	0.122	0.144
PM _{2.5}	S.02 Gas turbines	.	.	.	.	.	.	.	.	.	0.122	.
PM _{2.5}	S.03 Boilers	0.82	0.82	0.82	.	2.52	0	2.52	2.52	.	0.122	0.144
PM _{2.5}	S.04 Small stoves	0.86	0.86	1.5	16.29	.	.	1.1	.	2.4	.	.
PM _{2.5}	S.1B2C Flares	.	.	.	.	.	.	.	.	.	0.002	0.144
		V34 CO gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kerosene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
TSP	S.01 Direct-fired furnaces	0.144	.	0.144	.	.	0.286	.	*	*	.	5.68
TSP	S.02 Gas turbines	.	.	.	.	.	0.286	.	.	.	.	.
TSP	S.03 Boilers	0.144	0.144	0.144	0.136	0.296	0.286	0.286	*	*	0.05	5.68
TSP	S.04 Small stoves	.	.	.	0.136	0.3	.	0.3	.	.	.	.
TSP	S.1B2C Flares	.	0.144	.	.	.	.	.	.	.	.	.
PM ₁₀	S.01 Direct-fired furnaces	0.144	.	0.144	.	.	0.143	.	*	*	.	4.87
PM ₁₀	S.02 Gas turbines	.	.	.	.	.	0.143	.	.	.	.	.
PM ₁₀	S.03	0.144	0.144	0.144	0.136	0.148	0.143	0.15	*	*	0.05	4.87

Numbers in *italics* have exceptions for some sectors, see table 37, and bold numbers are different for different years, see table 38.
 * General emission factors for all sources for heavy distillate and heavy fuel oil are given in table 36 for all years.
 Source: Finstad *et al.* (2003). Fuel wood factor based on data from annual surveys on use of fuel wood in households

Fuel	Com-ponent	1990	1991	1992	1993	1994	1995	1996-1997	1998	1999	2000-
V19	TSP	0.803	0.714	0.701	0.701	0.688	0.714	0.663	0.688	0.701	0.714
	PM ₁₀	0.690	0.614	0.603	0.603	0.592	0.614	0.570	0.592	0.603	0.614
	PM _{2.5}	0.450	0.400	0.393	0.393	0.385	0.400	0.371	0.385	0.393	0.400
	TSP	1.350	1.339	1.316	1.304	1.190	1.053	1.098	1.087	1.110	1.201
V20	PM ₁₀	1.161	1.151	1.131	1.121	1.023	0.905	0.944	0.934	0.954	1.033
	PM _{2.5}	0.761	0.754	0.741	0.735	0.671	0.593	0.619	0.613	0.625	0.677

Table 37. Exceptions from the general factors for particles. Stationary combustion

Table 38. Time series for variable emission factors for particles. Stationary combustion. kg particle component
/tonne fuel

[illegible]

POPs (Persistent Organic Pollutants) - Stationary combustion

Table 39. General emission factors for PAH

Component	Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood briquettes	V04 Charcoal	V31 Natural gas (1000 Sm ³)	V33 Refinery gas
benzo(a) Direct- pyrene fired g/tonne ..furnaces	S.01	0.00002	0.00002	0.00002	.	.	.	.	.	0.007	0.00002	0.00003
benzo(a) S.02 pyrene Gas g/tonne ..turbines	S.02	.	.	.	.	.	.	.	.	.	0.00002	.
benzo(a) S.03 pyrene Boilers g/tonne ..Boilers	S.03	0.007	0.007	0.007	.	0.0001	0.0001	0.0001	0.0001	.	0.00002	0.00003
benzo(a) S.04 pyrene Small g/tonne ..stoves	S.04	2.81	2.85	3.5	0.334	.	.	2.091	2.091.	3.5695	.	.
benzo(b) S.01 fluoranth Direct- ene fired g/tonne ..furnaces	S.01	0.001	0.001	0.001	.	.	.	.	.	0.010	0.00003	0.00004
benzo(b) S.02 fluoranth Gas ene turbines g/tonne ..turbines	S.02	.	.	.	.	.	.	.	.	.	0.00003	.
benzo(b) S.03 fluoranth Boilers ene Boilers g/tonne ..Boilers	S.03	0.010	0.010	0.010	.	0.0075	0.0075	0.0075	0.0075	.	0.00003	0.00004
benzo(b) S.04 fluoranth Small ene Small g/tonne ..stoves	S.04	4.777	4.845	5.95	0.530	.	.	1.918	1.918	3.2745	.	.
benzo(k) S.01 fluoranth Direct- ene fired g/tonne ..furnaces	S.01	0.0008	0.0008	0.001	.	.	.	.	.	0.004	0.00003	0.00004
benzo(k) S.02 fluoranth Gas ene turbines g/tonne ..turbines	S.02	.	.	.	.	.	.	.	.	.	0.00003	.
benzo(k) S.03 fluoranth Boilers ene Boilers g/tonne ..Boilers	S.03	0.004	0.004	0.004	.	0.0075	0.0075	0.0075	0.0075	.	0.00003	0.00004
benzo(k) S.04 fluoranth Small ene Small g/tonne ..stoves	S.04	3.653	2.85	3.5	0.124	.	.	0.726	0.726.	1.239	.	.
indeno(1 S.01 ,2,3_cd) Direct- pyrene fired g/tonne ..furnaces	S.01	0.00003	0.00003	0.00004	.	.	.	.	.	0.003	0.00003	0.00004
indeno(1 S.02 ,2,3_cd) Gas pyrene turbines g/tonne ..turbines	S.02	.	.	.	.	.	.	.	.	.	0.00003	.
indeno(1 S.03 ,2,3_cd) Boilers pyrene Boilers g/tonne ..Boilers	S.03	0.003	0.003	0.003	.	0.0002	0.0002	0.0002	0.0002	.	0.00003	0.00004
indeno(1 S.04 ,2,3_cd) Small pyrene Small g/tonne ..stoves	S.04	2.248	2.28	2.8	0.243	.	.	1.227	1.227.	2.0945	.	.

Table 39 (cont.). General emission factors for PAH

Component	Source	V34 Blast furnace gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kero- sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste ¹	V52 Special waste
benzo(a)pyrene	S.01 Direct-fired furnaces	0.00001	.	0.00004	.	.	NE	.	NE	NE	.	0.077
benzo(a)pyrene	S.02 Gas turbines	.	0.00003	.	.	.	NE	.	.	.	.	.
benzo(a)pyrene	S.03 Boilers	0.00001	0.00003	0.00004	2.5816E-08	0.00002	NE	0.00002	NE	NE	0.00001	0.077
benzo(a)pyrene	S.04 Small stoves	.	.	.	2.5816E-08	0.003	.	0.003	.	.	.	.
benzo(b)fluoranthene	S.01 Direct-fired furnaces	0.00003	.	0.00015	.	.	0.00019	.	0.00019	0.00018	.	0.609
benzo(b)fluoranthene	S.02 Gas turbines	.	0.00004	.	.	.	0.00019	.	.	.	.	.
benzo(b)fluoranthene	S.03 Boilers	0.00001	0.00004	0.00015	3.8724E-08	0.00001	0.00003	0.00001	0.00019	0.00018	0.00002	0.609
benzo(b)fluoranthene	S.04 Small stoves	.	.	.	3.8724E-08	0.002	.	0.002	.	.	.	.
benzo(k)fluoranthene	S.01 Direct-fired furnaces	0.00001	.	0.00006	.	.	0.00019	.	0.00019	0.00018	.	0.069
benzo(k)fluoranthene	S.02 Gas turbines	.	0.00004	.	.	.	0.00019	.	.	.	.	.
benzo(k)fluoranthene	S.03 Boilers	0.00001	0.00004	0.00006	3.8724E-08	0.00002	0.00003	0.00002	0.00019	0.00018	0.00001	0.069
benzo(k)fluoranthene	S.04 Small stoves	.	.	.	3.8724E-08	0.003	.	0.003	.	.	.	.
indeno(1,2,3-cd)pyrene	S.01 Direct-fired furnaces	0.00001	.	0.00005	.	.	0.0003	.	0.00030	0.00028	.	0.061
indeno(1,2,3-cd)pyrene	S.02 Gas turbines	.	0.00004	.	.	.	0.0003	.	.	.	.	.
indeno(1,2,3-cd)pyrene	S.03 Boilers	0.00001	0.00004	0.00005	3.8724E-08	0.00005	0.00004	0.00005	0.00030	0.00028	0.00001	0.061
indeno(1,2,3-cd)pyrene	S.04 Small stoves	.	.	.	3.8724E-08	0.007	.	0.007	.	.	.	.

Bold numbers are different for different years, see table 40. NE = Not estimated. ¹Emission factor used for the years after 1995. Emission factors for the years 1990 to 1994 can be given on request.

Source: Finstad *et al.* (2001). Fuel wood factor based on data from annual surveys on use of fuel wood in households. EEA (2013), EEA (2016), . Allerup *et. al* (2015)

Table 40. Time series for variable emission factors for PAH¹. Stationary combustion (g component /tonne fuel)

Component	Source	Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
benzo(a)pyrene	S.04	V41	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.72	0.69	0.66
benzo(b)fluoranthene	S.04	V41	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.16	1.13	1.09	1.03
benzo(k)fluoranthene	S.04	V41	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.26	0.25	0.24
indeno(1,2,3-cd)pyrene	S.04	V41	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.52	0.50	0.47
			2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
benzo(a)pyrene	S.04	V41	0.61	0.54	0.46	0.50	0.47	0.46	0.44	0.42	0.41	0.39	0.38	0.36
benzo(b)fluoranthene	S.04	V41	0.96	0.85	0.73	0.78	0.74	0.73	0.70	0.66	0.64	0.62	0.59	0.59
benzo(k)fluoranthene	S.04	V41	0.22	0.20	0.17	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.14	0.13
indeno(1,2,3-cd)pyrene	S.04	V41	0.44	0.39	0.33	0.36	0.34	0.33	0.32	0.30	0.29	0.28	0.27	0.26
			2014	2015	2016									
benzo(a)pyrene	S.04	V41	0.36	0.31	0.34									
benzo(b)fluoranthene	S.04	V41	0.57	0.49	0.53									
benzo(k)fluoranthene	S.04	V41	0.13	0.12	0.12									
indeno(1,2,3-cd)pyrene	S.04	V41	0.26	0.23	0.24									

Source: Emission factor: Finstad *et al.* (2001). PAH-profile: EEA (2013)

POPs (Persistent Organic Pollutants) - Stationary combustion

Table 41. General emission factors for dioxins

Com- ponent	Source	V01 Coal	V02 Coke	V03 Petrol coke	V41 Fuel wood	V42 Wood waste	V43 Black liquor	V44 Wood pellets	V45 Wood bri- quettes	V04 Char- coal	V31 Natural gas (1000 Sm ³)	V33 Refinery gas
Dioxins S.01 µg I-TEQ/tonne Direct- fired furnaces		1.6	1.6	1.6	.	.	.	.	.	2.95.	0.05	0
Dioxins S.02 µg I-TEQ Gas /tonne turbines		.	.	.	.	.	.	.	.	.	0.05	.
Dioxins S.03 µg I-TEQ Boilers /tonne		1.6	1.6	1.6	.	1	1	1	1	.	0.05	0
Dioxins S.04 µg I-TEQ Small /tonne stoves		10	10	10	5.9	.	.	5.9	.	10	.	.
Dioxins S.1B2C µg I-TEQ Flares /tonne		.	.	.	.	.	.	.	.	.	0.05	0
		V34 CO gas	V36 Landfill gas	V35 Fuel gas	V32 LPG	V13 Kero- sene (heating)	V17 Marine gas oil/ diesel	V18 Light fuel oils	V19 Heavy distillate	V20 Heavy fuel oil	V51 Municipal waste	V52 Special waste
Dioxins S.01 µg I-TEQ Direct- fired furnaces		0	.	0	.	.	4	.	0.1	0.1	.	4
Dioxins S.02 µg I-TEQ Gas /tonne turbines		.	.	.	.	.	4	.	.	.	.	.
Dioxins S.03 µg I-TEQ Boilers /tonne		0	0	1	0.06	0.1	0.1	0.1	0.1	0.1	0.02	4
Dioxins S.04 µg I-TEQ Small /tonne stoves		.	.	.	0.06	0.06	.	0.2	.	.	.	.
Dioxins S.1B2C µg I-TEQ Flares /tonne		.	0	.	.	.	.	.	.	.	.	.

Numbers in italics have exceptions for some sectors, see table 42.

Source: Finstad *et al.* (2002).

Table 42. Exceptions from the general factors for POPs. Stationary combustion

Emission factor (ug dioxin/tonne)	Fuel	Source	Sectors
0.2	V18, 19 Heavy distillate, heavy fuel oil	S.03 Boilers	330000

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