

Informative Inventory Report Sweden 2021 - Annexes

Submitted under
the Convention on Long-Range Transboundary Air Pollution



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1 Annex 1: Uncertainties and Key Sources

1.1 Methodology for analysis of Key Sources

The complete analysis of Sweden's key sources and uncertainties are presented in section 1.3. Key sources are reported together with their order of priority. Some important key sources according to level and trend are also discussed in sections 1.3 – 1.4 of the main report.

The analysis has been done for 1990 and 2019 using both the approach 1 and the approach 2 levels and trend assessment according to the 2006 IPCC Guidelines. The approach 1 method assesses the impacts of various source categories on the level and the trend of the national emission inventory. In the approach 2 analyses the uncertainty of the emissions are also considered. The analyses are performed for the following pollutants: As, Cd, CO, Cr, Cu, dioxins/furans, Hg, NH₃, Ni, NMVOC, NO_x, PAH 1-4, Pb, PM_{2.5}, PM₁₀, Se, SO₂, TSP and Zn.

1.1.1 Level assessment, approach 1

For each source category and pollutant, the level assessment (LA) is calculated as:

$$L_{x,t} = E_{x,t} / E_t$$

Key source are those that, for each pollutant, when summed together in descending order of magnitude, add up to over 95 % of the total emission estimates in the inventory for each year.

1.1.2 Level assessment, approach 2

In the approach 2 analysis the uncertainty of the emissions are also taking into account.

$$LU_{x,t} = L_{x,t} \bullet U_{x,t}$$

The key sources are then those that adds up to 90 % of the cumulative value of LU_{x,t}.

1.1.3 Trend assessment, approach 1

The trend is calculated as:

$$T_{x,t} = L_{x,t} \left[\frac{E_{x,t} - E_{x,0}}{|E_{x,0}|} \right] - \frac{\sum_y E_{y,t} - \sum_y E_{y,0}}{\left| \sum_y E_{y,0} \right|}$$

For each pollutant, the percentage contribution to the overall trend (C%) is then calculated for each source as:

$$C\% = \frac{T_{x,t}}{\sum T_{x,t}}$$

Finally the cumulative total of percentage contribution is calculated for each pollutant in the same way as for the level assessment. Key source categories are those that for each pollutant, when summed together in descending order of magnitude, add up to more than 95% of the contribution to trend.

1.1.4 Trend assessment, approach 2

In the same way as for the level assessment, in the approach 2 analysis the uncertainty is also considered.

$$TU_{x,t} = T_{x,t} \times U_{x,t}$$

The approach 2 key sources for trend are then those that add up to 90 % of the cumulative value of $T_{x,t}/\sum T_{x,t}$.

1.2 Methodology for estimation of uncertainties

As a basis for the calculations the 95 % confidence intervals have been assessed for all subcategories and substances. This information is documented in Swedish in “Expert Protocols”, describing how and what sources was used to quantify the individual uncertainty ranges. National references on uncertainty estimates of emission factors are used when available (e.g. emission factors for stationary combustion, emission factors for navigation and fisheries). Most other uncertainty estimates for emission factors derive from expert judgments or information from the EMEP/EEA Guidebook. Uncertainty estimates of activity data are mostly based on expert judgments. The data in the Expert Protocols are then used to calculate the 95 % confidence interval for the aggregated emissions reported in section 1.4. The calculations are made according to the 2006 IPCC guidelines. Lack of completeness, i.e. in this context entire source categories missing (NE), are not taken into consideration when quantifying uncertainties.

1.3 Key Sources and Uncertainty results

In Table A1-1 to Table A1-19 the results are presented for the key sources and uncertainty analyses for the following substances: As, Cd, CO, Cr, Cu, dioxins/furans, Hg, NH₃, Ni, NMVOC, NO_x, PAH 1-4, Pb, PM_{2.5}, PM₁₀, Se, SO₂, TSP and Zn. The identified key sources for the approach 1 and the approach 2 analyses are presented in the tables. In the bottom of the tables information on total emissions and total uncertainty in the inventory are given, both for the level and for the trend. Due to confidentiality reasons some emissions and uncertainty results are shown as C in the tables.

Table A1-1 Summary of the key source and uncertainty analysis of As emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	As	0.02	0.14	1.55	310.13	310.14	48.68	488.43	0.563		2	2		5	1
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	As	0.01	0.00	1.55	77.65	77.67	0.00	-83.87	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	As	0.01	0.06	2.39	718.44	718.45	43.42	455.22	0.500		4	4		8	2
1 A 1 a Public Electricity and Heat Production: Peat	As	0.05	0.01	1.90	95.07	95.09	0.02	-85.46	0.000	7	11				
1 A 1 a Public Electricity and Heat Production: Solid Fuels	As	0.11	0.03	1.41	70.38	70.40	0.08	-76.78	0.000	3	6	10		4	
1 A 1 b Petroleum refining: Liquid Fuels	As	0.00	0.00	10.00	100.00	100.50	0.00	-68.48	0.000						
1 A 2 a Iron and Steel: Biomass	As	0.00	C	5.00	400.00	400.03	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	As	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	As	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	As	0.00	0.00	5.00	100.00	100.12	0.00	-47.99	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	As	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	As	0.00	0.00	5.00	300.00	300.04	0.00	175.27	0.000						
1 A 2 c Chemicals: Liquid Fuels	As	0.00	0.00	5.00	100.00	100.12	0.00	-72.14	0.000						
1 A 2 c Chemicals: Other Fuels	As	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	As	0.00	C	2.00	200.00	200.01	0.00	C	C						

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IPCC Source Category	Substance	Base Year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Biomass	As	0.02	0.02	8.00	400.00	400.08	1.82	23.01	0.018	7	6	6	4	4
1 A 2 d Pulp, Paper and Print: Liquid Fuels	As	0.02	0.00	5.00	100.00	100.12	0.01	-76.57	0.000					
1 A 2 d Pulp, Paper and Print: Other Fuels	As	0.00	0.00					-100.00						
1 A 2 d Pulp, Paper and Print: Solid Fuels	As	0.01	0.00	7.00	100.00	100.24	0.00	-96.29	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	As	0.00	0.00	5.00	400.00	400.03	0.00	350.57	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	As	0.01	0.00	5.00	100.00	100.12	0.00	-93.81	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	As	0.00	0.00					-100.00						
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	As	0.00	0.00	5.00	100.00	100.12	0.00	-95.14	0.000					
1 A 2 f Non-metallic minerals: Biomass	As	0.00	0.00	4.76	219.07	219.12	0.00	2543.48	0.000					
1 A 2 f Non-metallic minerals: Liquid Fuels	As	0.00	C	9.81	49.05	50.02	0.00	C	C					
1 A 2 f Non-metallic minerals: Solid Fuels	As	0.03	C	8.57	43.33	44.17	0.00	C	C	14				
1 A 2 g viii Other: Biomass	As	0.01	C	4.70	141.12	141.19	0.03	C	C	13	12			
1 A 2 g viii Other: Liquid Fuels	As	0.02	C	3.48	20.90	21.18	0.00	C	C					

IPCC Source Category	Substance	Base Year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g viii Other: Solid Fuels	As	0.00	C	4.84	29.06	29.46	0.00	C	C	10	9			
1 A 3 b i Road Transportation, Cars: Biomass	As	0.00	0.00	3.56	71.15	71.24	0.00		0.000					
1 A 3 b i Road Transportation, Cars: Diesel oil	As	0.00	0.00	5.00	100.00	100.12	0.00	870.53	0.000					
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	As	0.00	0.00	5.00	100.00	100.12	0.00		0.000					
1 A 3 b i Road Transportation, Cars: Gasoline	As	0.00	0.00	3.00	100.00	100.04	0.00	-50.53	0.000					
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	As	0.00	0.00	4.88	97.65	97.77	0.00		0.000					
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	As	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000					
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of bio-diesel and biogasoline	As	0.00	0.00	5.00	100.00	100.12	0.00		0.000					
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	As	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000					
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	As	0.00	0.00	3.50	70.07	70.15	0.00	12408.32	0.000					
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	As	0.00	0.00	4.87	97.31	97.43	0.00	-12.98	0.000					

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1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	As	0.00	0.00	3.57	71.44	71.53	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	As	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	As	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	As	0.00	0.00	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	As	0.09	0.04	15.00	100.00	101.12	0.49	-50.67	0.003	5	5	5	3	7 7	
1 A 4 a Commercial/Institutional: Biomass	As	0.00	0.00	10.00	400.00	400.12	0.00	112.34	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	As	0.02	0.00	20.00	100.00	101.98	0.00	-97.97	0.000						
1 A 4 b Residential: Biomass	As	0.02	0.01	10.00	400.00	400.12	0.88	-7.74	0.008		8	8	9	6	6
1 A 4 b Residential: Liquid Fuels	As	0.04	0.00	20.00	100.00	101.98	0.00	-97.71	0.000	9					
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	As	0.00	0.00	10.00	400.00	400.12	0.02	2359.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	As	0.00	0.00	10.46	70.72	71.49	0.00	-54.06	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	As	0.01	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	As	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						

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1 B 2 a Oil	As	0.00	0.00	7.50	90.00	90.31	0.00	-96.00	0.000						
1 B 2 c Venting and flaring	As	0.00	C	17.50	233.00	233.66	0.00	C	C						
2 A 3 Glass Production	As	0.11	0.00	0.00	100.00	100.00	0.00	-98.61	0.000	4		7		2	
2 B 10 Other	As	0.00	0.00	0.00	100.00	100.00	0.00	5127.86	0.000						
2 C 1 Iron and Steel Production	As	0.06	0.01	3.96	39.57	39.76	0.01	-80.05	0.000	6	9				
2 C 7 Other	As	4.71	0.23	4.00	50.00	50.16	3.54	-95.11	0.120	1	1	1	1	3	3
2 G 4 Other	As	0.00	0.00	11.59	648.71	648.81	0.04	-25.58	0.000						
2 H 1 Pulp and paper	As	0.13	0.11	6.94	50.55	51.02	0.90	-13.43	0.008	2	3	3	7	5	5
2 H 3 Other	As	0.04	0.00	0.00	100.00	100.00	0.00	-99.30	0.000	8		13			
5 C 1 Waste Incineration	As	0.00	0.01	58.36	234.40	241.55	0.04	13.44	0.000		15				
5 E Other	As	0.01	0.01	50.00	68.00	84.40	0.01	1.03	0.000		12	11			
Total		5.59	0.74			83.49	100.00	-86.83	11.056						

Table A1-2 Summary of the key source and uncertainty analysis of Cd emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Cd	0.05	0.14	1.52	22.83	22.89	3.78	168.21	0.017	6	1	2	11	2	3
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Cd	0.01	0.00	1.54	76.96	76.97	0.00	-82.39	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Cd	0.02	0.01	2.39	79.83	79.86	0.44	-24.97	0.001	9	9	8	9	7	8
1 A 1 a Public Electricity and Heat Production: Peat	Cd	0.01	0.00	1.90	95.07	95.09	0.00	-99.55	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Cd	0.02	0.00	2.00	100.00	100.02	0.01	-87.80	0.000				8		
1 A 1 b Petroleum refining: Liquid Fuels	Cd	0.00	0.00	10.00	100.00	100.50	0.00	-68.20	0.000						
1 A 2 a Iron and Steel: Biomass	Cd	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Cd	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Cd	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-45.24	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Cd	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Cd	0.00	0.00	5.00	40.00	40.31	0.00	10.65	0.000						
1 A 2 c Chemicals: Liquid Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-71.99	0.000						

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1 A 2 c Chemicals: Other Fuels	Cd	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Cd	0.00	C	2.00	40.00	40.05	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	Cd	0.06	0.04	8.00	40.00	40.79	1.11	-22.55	0.003	5	3	5	6	4	5
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Cd	0.01	0.00	5.00	100.00	100.12	0.01	-75.90	0.000		16		12		
1 A 2 d Pulp, Paper and Print: Other Fuels	Cd	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Cd	0.00	0.00	7.00	40.00	40.61	0.00	-97.98	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Cd	0.00	0.00	5.00	40.00	40.31	0.00	313.01	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-93.27	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Cd	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Cd	0.00	0.00	5.00	40.00	40.31	0.00	-97.66	0.000						
1 A 2 f Non-metallic minerals: Biomass	Cd	0.00	0.00	4.76	19.05	19.64	0.00	1662.3	0.000		14				

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1 A 2 f Non-metallic minerals: Liquid Fuels	Cd	0.00	C	9.56	47.85	48.80	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Cd	0.00	C	8.57	17.32	19.32	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Cd	0.00	0.00	4.97	99.44	99.56	0.01		0.000						
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Cd	0.00	0.00	4.93	98.58	98.70	0.06	47.27	0.000		12	13		11	
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Cd	0.04	C	4.59	18.38	18.94	0.04	C	C	7	7	7			
1 A 2 g viii Other: Liquid Fuels	Cd	0.01	C	3.28	13.11	13.51	0.00	C	C		15				
1 A 2 g viii Other: Solid Fuels	Cd	0.00	C	4.93	19.72	20.33	0.00	C	C						
1 A 3 b i Road Transportation, Cars: Biomass	Cd	0.00	0.00	3.91	78.29	78.39	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Cd	0.00	0.00	5.00	100.00	100.12	0.00	870.53	0.000						
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Cd	0.00	0.00	3.00	100.00	100.04	0.00	-50.53	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Cd	0.00	0.00	4.85	96.90	97.02	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Cd	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of biodiesel and biogasoline	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Cd	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Cd	0.00	0.00	3.45	69.09	69.18	0.00	9430.4 3	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Cd	0.00	0.00	4.87	97.31	97.43	0.00	-12.98	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	Cd	0.00	0.00	3.56	71.10	71.19	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Cd	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Cd	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Cd	0.00	0.00	0.00	75.00	75.00	0.01	28.24	0.000						
1 A 3 c Railways: Liquid Fuels	Cd	0.00	0.00	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Cd	0.00	0.00	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Cd	0.00	0.00	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 3 e Other Transportation: Biomass	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 e Other Transportation: Diesel Oil	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-3.69	0.000						
1 A 3 e Other Transportation: Other Fossil Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Biomass	Cd	0.00	0.00	10.00	150.00	150.33	0.16	109.83	0.001	11	11		9	9	
1 A 4 a Commercial/Institutional: Diesel Oil	Cd	0.00	0.00	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional: Ethanol	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: FAME	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Gasoline	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-14.31	0.000						

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1 A 4 a Commercial/Institutional: Liquid Fuels	Cd	0.01	0.00	20.00	100.00	101.98	0.00	-97.52	0.000						
1 A 4 a Commercial/Institutional: Other Fossil Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Cd	0.12	0.11	9.99	149.78	150.11	91.33	-7.61	0.296	3	2	3	2	1	1
1 A 4 b Residential: Liquid Fuels	Cd	0.02	0.00	6.92	52.30	52.76	0.00	-93.05	0.000	10			7		
1 A 4 b Residential: Other Fossil Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Cd	0.00	0.01	9.21	138.18	138.48	1.32	2146.03	0.007		8	6		3	4
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Cd	0.00	0.00	3.54	70.83	70.92	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Cd	0.00	0.00	5.00	100.00	100.12	0.00	104.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Cd	0.00	0.00	3.56	59.86	59.96	0.02	-19.96	0.000		13				
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Cd	0.01	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Cd	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	Cd	0.00	0.00	7.50	90.00	90.31	0.00	-98.66	0.000						
1 B 2 c Venting and flaring	Cd	0.00	C	17.50	186.00	186.82	0.00	C	C						
2 A 3 Glass Production	Cd	0.00	0.00	0.00	100.00	100.00	0.00	-95.78	0.000						

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2 B 10 Other	Cd	0.00	0.00	0.00	100.00	100.00	0.00	1028.69	0.000						
2 C 1 Iron and Steel Production	Cd	0.45	0.03	4.15	16.61	17.12	0.12	-92.36	0.002	2	5	4	3	10	6
2 C 7 Other	Cd	1.34	0.04	4.00	20.00	20.40	0.23	-97.00	0.045	1	4	1	1	8	2
2 G 4 Other	Cd	0.00	0.00	12.59	697.14	697.25	0.63	-16.18	0.002				10	5	7
2 H 1 Pulp and paper	Cd	0.09	0.03	6.34	45.32	45.76	0.59	-67.06	0.001	4	6	9	4	6	11
2 H 3 Other	Cd	0.03	0.00	0.00	96.22	96.22	0.00	-99.08	0.000	8		10	5		10
5 C 1 Waste Incineration	Cd	0.00	0.00	53.01	279.60	284.58	0.05	10.56	0.000						
5 E Other	Cd	0.00	0.00	50.00	67.00	83.60	0.05	1.01	0.000		10	12			
Total		2.31	0.49			34.46	100.00	-78.62	6.138						

Table A1-3 Summary of the key source and uncertainty analysis of CO emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Trend	Level in 2019 (Approach 2)	Level in base year (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	CO	0.59	5.26	1.51	56.53	56.55	0.22	793.16	0.001	12	11	10	10	
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	CO	0.09	0.08	1.87	27.98	28.04	0.00	-8.27	0.000					
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	CO	0.36	0.06	1.51	30.27	30.31	0.00	-83.75	0.000					
1 A 1 a Public Electricity and Heat Production: Other Fuels	CO	0.12	0.59	2.41	24.12	24.25	0.00	402.33	0.000					
1 A 1 a Public Electricity and Heat Production: Peat	CO	1.64	0.12	1.90	28.52	28.58	0.00	-92.73	0.000					
1 A 1 a Public Electricity and Heat Production: Solid Fuels	CO	0.32	0.09	1.42	21.27	21.32	0.00	-70.97	0.000					
1 A 1 b Petroleum refining: Gaseous Fuels	CO	0.00	0.04	2.00	30.00	30.07	0.00		0.000					
1 A 1 b Petroleum refining: Liquid Fuels	CO	0.34	0.24	10.00	40.00	41.23	0.00	-28.55	0.000					
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	CO	0.04	0.05	5.00	30.00	30.41	0.00	2.40	0.000					
1 A 2 a Iron and Steel: Biomass	CO	0.00	C	5.00	75.00	75.17	0.00	C	C					
1 A 2 a Iron and Steel: Gaseous Fuels	CO	0.00	0.04	5.00	30.00	30.41	0.00	871.02	0.000					

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1 A 2 a Iron and Steel: Liquid Fuels	CO	0.20	C	5.00	35.00	35.36	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	CO	0.04	0.03	2.00	20.00	20.10	0.00	-13.87	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	CO	0.00	0.00	5.00	30.00	30.41	0.00	142.66	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	CO	0.03	0.02	5.00	30.00	30.41	0.00	-24.55	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	CO	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	CO	0.02	0.08	5.00	50.00	50.25	0.00	362.00	0.000						
1 A 2 c Chemicals: Gaseous Fuels	CO	0.03	0.02	5.00	30.00	30.41	0.00	-28.46	0.000						
1 A 2 c Chemicals: Liquid Fuels	CO	0.09	0.07	5.00	40.00	40.31	0.00	-14.51	0.000						
1 A 2 c Chemicals: Other Fuels	CO	0.00	C	10.00	50.00	50.99	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	CO	0.01	C	2.00	30.00	30.07	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	CO	1.24	1.67	8.00	75.00	75.43	0.04	34.72	0.000						
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	CO	0.01	0.02	5.00	30.00	30.41	0.00	66.51	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	CO	0.56	0.12	5.00	30.00	30.41	0.00	-78.68	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	CO	0.01	0.00	10.00	50.00	50.99	0.00	-80.04	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Solid Fuels	CO	0.03	0.00	7.00	30.00	30.81	0.00	-84.86	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	CO	0.02	0.11	5.00	75.00	75.17	0.00	420.05	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	CO	0.04	0.04	5.00	30.00	30.41	0.00	-7.92	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	CO	0.18	0.03	5.00	40.00	40.31	0.00	-85.53	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	CO	0.00	0.00					-100.00						
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	CO	0.01	0.00	5.00	40.00	40.31	0.00	-90.63	0.000					
1 A 2 f Non-metallic minerals: Biomass	CO	0.00	0.32	4.93	39.40	39.71	0.00	11359.31	0.000					
1 A 2 f Non-metallic minerals: Gaseous Fuels	CO	0.01	0.03	3.90	14.13	14.66	0.00	162.66	0.000					
1 A 2 f Non-metallic minerals: Liquid Fuels	CO	0.17	C	9.01	18.10	20.22	0.00	C	C					
1 A 2 f Non-metallic minerals: Other Fuels	CO	0.00	0.03	10.00	30.00	31.62	0.00		0.000					
1 A 2 f Non-metallic minerals: Solid Fuels	CO	0.11	C	8.57	17.33	19.33	0.00	C	C					

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1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	CO	10.10	8.69	2.63	14.68	14.91	0.04	-14.01	0.000	9	9	10			
1 A 2 g viii Other: Biomass	CO	0.72	C	3.59	21.52	21.81	0.00	C	C						
1 A 2 g viii Other: Gaseous Fuels	CO	0.02	0.02	2.63	5.26	5.88	0.00	-9.56	0.000						
1 A 2 g viii Other: Liquid Fuels	CO	0.74	C	2.54	5.08	5.68	0.00	C	C						
1 A 2 g viii Other: Other Fuels	CO	0.00	C	3.58	14.32	14.76	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	CO	0.01	C	4.94	19.75	20.36	0.00	C	C						
1 A 3 a Domestic Aviation: Aviation Gasoline	CO	0.02	0.00	10.00	100.00	100.50	0.00	-90.62	0.000						
1 A 3 a Domestic Aviation: Jet Kerosene	CO	0.82	0.45	10.00	100.00	100.50	0.01	-45.69	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	CO	0.00	3.50	4.51	45.09	45.32	0.06		0.000		15	15			
1 A 3 b i Road Transportation, Cars: Diesel oil	CO	2.87	3.46	5.00	50.00	50.25	0.08	20.63	0.000		16				
1 A 3 b i Road Transportation, Cars: Gasoline	CO	678.50	44.76	3.00	50.00	50.09	12.67	-93.40	0.528	1	4	1	1	2	1
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	CO	0.00	0.05	5.00	50.00	50.25	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	CO	0.86	1.33	5.00	50.00	50.25	0.01	54.81	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	CO	0.00	0.14	5.00	50.00	50.25	0.00		0.000						

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1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	CO	76.81	2.37	3.00	50.00	50.09	0.04	-96.91	0.009	3		5	3		4
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	CO	0.01	0.19	4.31	43.12	43.33	0.00	2704.3	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	CO	15.15	6.61	4.14	41.36	41.56	0.19	-56.40	0.000	6	11			11	
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	CO	0.17	0.04	3.00	50.00	50.09	0.00	-78.11	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	CO	8.52	7.06	3.00	50.00	50.09	0.32	-17.17	0.000	10	10	13		9	11
1 A 3 c Railways: Liquid Fuels	CO	0.54	0.24	5.00	75.00	75.17	0.00	-55.43	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	CO	13.34	19.11	4.87	19.49	20.09	0.37	43.25	0.001	7	5	6		8	9
1 A 3 d Domestic Navigation: Gaseous Fuels	CO	0.00	0.16	10.00	100.00	100.50	0.00		0.000						
1 A 3 d Domestic Navigation: Gasoline	CO	0.00	0.05	5.00	20.00	20.62	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	CO	0.23	0.39	15.00	20.00	25.00	0.00	69.93	0.000						
1 A 3 e Other Transportation: Diesel Oil	CO	0.76	0.25	5.00	20.00	20.62	0.00	-66.57	0.000						
1 A 3 e Other Transportation: Gaseous fuels	CO	0.00	0.00	5.00	30.00	30.41	0.00	40.37	0.000						

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1 A 4 a Commercial/Institutional: Biomass	CO	2.30	0.53	10.00	75.00	75.66	0.00	-76.85	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	CO	0.70	0.56	5.00	20.00	20.62	0.00	-20.40	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	CO	0.04	0.09	10.00	30.00	31.62	0.00	132.21	0.000						
1 A 4 a Commercial/Institutional: Gasoline	CO	59.07	48.50	5.00	20.00	20.62	2.52	-17.89	0.004	4	3	4	4	4	5
1 A 4 a Commercial/Institutional: Liquid Fuels	CO	1.83	0.04	20.00	30.00	36.06	0.00	-97.78	0.000						
1 A 4 b Residential: Biomass	CO	136.66	72.32	10.00	75.00	75.66	75.46	-47.08	0.052	2	1	3	2	1	2
1 A 4 b Residential: Gaseous Fuels	CO	0.04	0.02	10.00	30.00	31.62	0.00	-51.07	0.000						
1 A 4 b Residential: Liquid Fuels	CO	48.21	50.77	3.91	15.62	16.10	1.68	5.31	0.003	5	2	2		5	7
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	CO	0.68	5.26	10.00	75.00	75.66	0.40	678.51	0.001		13	12		7	8
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	CO	0.01	0.00	10.00	30.00	31.62	0.00	-71.10	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	CO	2.73	4.56	5.00	20.00	20.62	0.02	67.30	0.000		14	14			
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	CO	8.44	10.58	2.58	17.02	17.22	0.08	25.41	0.000		8	9		13	
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	CO	0.09	0.00					-100.00							

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1 A 5 b Mobile: Biomass	CO	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	CO	6.02	0.44	4.00	78.68	78.78	0.00	-92.70	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	CO	0.00	0.00	50.00	30.00	58.31	0.00	40.31	0.000						
1 B 2 a Oil	CO	0.03	C	2.46	45.68	45.74	0.00	C	C						
1 B 2 c Venting and flaring	CO	0.01	C	17.49	49.98	52.95	0.00	C	C						
1 D International Aviation: Jet kerosene	CO	0.67	0.86	10.00	100.00	100.50	0.02	29.48	0.000						
2 B 10 Other	CO	0.25	0.15	0.00	52.89	52.89	0.00	-38.91	0.000						
2 C 1 Iron and Steel Production	CO	2.36	2.48	4.80	95.97	96.09	0.14	5.40	0.000		17			12	
2 C 3 Aluminium production	CO	6.74	12.61	2.00	100.00	100.02	4.01	87.00	0.009		7	8		3	3
2 C 7 Other	CO	0.11	0.08	4.00	100.00	100.08	0.00	-25.23	0.000						
2 D 3 Other	CO	0.00	C	10.00	216.00	216.23	0.00	C	C						
2 G 4 Other	CO	0.47	C	14.44	3.85	14.94	0.00	C	C						
2 H 1 Pulp and paper	CO	11.96	15.61	6.63	50.17	50.61	1.57	30.52	0.003	8	6	7		6	6
5 B 1 Composting	CO	0.01	0.13	0.00	92.20	92.20	0.00	1058.5	0.000						
								8							
5 C 1 Waste Incineration	CO	0.52	0.59	69.38	185.68	198.22	0.03	13.84	0.000						
Total		1106.43	336.63			18.71	100.00	-69.57	7.825						

Table A1-4 Summary of the key source and uncertainty analysis of Cr emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Cr	0.58	0.51	1.53	30.52	30.56	0.29	-12.08	0.002	3	3	3		4	4
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Cr	0.01	0.00	1.51	75.30	75.31	0.00	-78.07	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Cr	0.30	0.07	2.39	79.83	79.86	0.04	-76.87	0.000	4	6		4	6	
1 A 1 a Public Electricity and Heat Production: Peat	Cr	0.05	0.02	1.90	38.03	38.08	0.00	-56.38	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Cr	0.25	0.04	2.00	50.00	50.04	0.00	-84.75	0.000	5	10	9			
1 A 1 b Petroleum refining: Liquid Fuels	Cr	0.00	0.00	10.00	100.00	100.50	0.00	-67.30	0.000						
1 A 2 a Iron and Steel: Biomass	Cr	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Cr	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Cr	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-38.18	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Cr	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Cr	0.00	0.00	5.00	40.00	40.31	0.00	56.14	0.000						
1 A 2 c Chemicals: Liquid Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-71.55	0.000						
1 A 2 c Chemicals: Other Fuels	Cr	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Cr	0.01	C	2.00	50.00	50.04	0.00	C	C						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Trend	Level in 2019	Level in 2019 (Approach 2)	Level in base year (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Biomass	Cr	0.12	0.13	8.00	40.00	40.79	0.03	8.76	0.000	4	4				6
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Cr	0.01	0.00	5.00	100.00	100.12	0.00	-77.93	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	Cr	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Cr	0.02	0.00	7.00	50.00	50.49	0.00	-97.13	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Cr	0.00	0.00	5.00	40.00	40.31	0.00	460.62	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-91.75	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Cr	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Cr	0.01	0.00	5.00	50.00	50.25	0.00	-96.48	0.000						
1 A 2 f Non-metallic minerals: Biomass	Cr	0.00	0.01	4.76	19.05	19.64	0.00	2378.26	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Cr	0.00	C	9.86	49.31	50.29	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Cr	0.10	C	8.57	25.98	27.36	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Cr	0.00	0.01	4.97	99.44	99.56	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Cr	0.01	0.02	4.93	98.58	98.70	0.01	47.27	0.000						
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Cr	0.08	C	4.70	18.81	19.39	0.00	C	C	8	8				
1 A 2 g viii Other: Liquid Fuels	Cr	0.01	C	3.21	12.83	13.22	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	Cr	0.01	C	4.90	19.59	20.19	0.00	C	C	11	7				
1 A 3 b i Road Transportation, Cars: Biomass	Cr	0.00	0.00	4.04	80.73	80.83	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Cr	0.00	0.01	5.00	100.00	100.12	0.00	870.53	0.000						
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Cr	0.02	0.01	3.00	100.00	100.04	0.00	-50.53	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Cr	0.00	0.00	4.97	99.40	99.53	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Cr	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of biodiesel and biogasoline	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Cr	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Cr	0.00	0.00	3.63	72.52	72.61	0.00	48710.28	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Cr	0.01	0.01	4.87	97.31	97.43	0.00	-12.98	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	Cr	0.00	0.00	3.64	72.76	72.85	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Cr	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Cr	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Cr	0.00	0.00	0.00	75.00	75.00	0.00	28.34	0.000						
1 A 3 c Railways: Liquid Fuels	Cr	0.00	0.00	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Cr	0.00	0.00	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Cr	0.08	0.04	15.00	100.00	101.12	0.02	-50.67	0.000						
1 A 3 e Other Transportation: Biomass	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						

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1 A 3 e Other Transportation: Diesel Oil	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-3.69	0.000						
1 A 3 e Other Transportation: Other Fossil Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Biomass	Cr	0.00	0.00	10.00	200.00	200.25	0.00	112.72	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	Cr	0.00	0.00	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional: Ethanol	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: FAME	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Gasoline	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-14.31	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Cr	0.02	0.00	20.00	100.00	101.98	0.00	-97.13	0.000						
1 A 4 a Commercial/Institutional: Other Fossil Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Cr	0.12	0.11	9.93	198.53	198.78	0.54	-7.06	0.005	5	5		3	3	3
1 A 4 b Residential: Liquid Fuels	Cr	0.04	0.01	4.65	52.43	52.64	0.00	-88.58	0.000						
1 A 4 b Residential: Other Fossil Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Cr	0.00	0.02	7.44	148.74	148.92	0.01	3311.64	0.000			10			

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Cr	0.00	0.00	3.54	70.83	70.92	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Cr	0.00	0.00	5.00	100.00	100.12	0.00	104.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Cr	0.02	0.02	3.13	60.64	60.72	0.00	-14.08	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Cr	0.02	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Cr	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	Cr	0.01	0.01	7.50	90.00	90.31	0.00	38.66	0.000						
1 B 2 c Venting and flaring	Cr	0.00	C	17.50	233.00	233.66	0.00	C	C						
2 A 3 Glass Production	Cr	0.02	0.00	0.00	100.00	100.00	0.00	-93.44	0.000						
2 B 10 Other	Cr	0.00	0.00	0.00	100.00	100.00	0.00	592.90	0.000						
2 C 1 Iron and Steel Production	Cr	12.61	0.76	4.11	41.08	41.28	1.13	-94.00	0.191	1	2	1	1	2	2
2 C 2 Ferroalloys production	Cr	8.41	3.86	5.00	75.00	75.17	97.67	-54.06	0.312	2	1	2	2	1	1
2 C 7 Other	Cr	0.02	0.05	4.00	45.00	45.18	0.00	104.38	0.000		9	6			
2 G 4 Other	Cr	0.02	0.02	14.01	791.63	791.75	0.23	-2.41	0.002					5	5
2 H 1 Pulp and paper	Cr	0.20	0.07	6.34	45.32	45.76	0.01	-66.36	0.000		7				
2 H 3 Other	Cr	0.02	0.00	0.00	100.00	100.00	0.00	-85.97	0.000						
5 C 1 Waste Incineration	Cr	0.00	0.00	7.17	278.57	278.66	0.00	205.84	0.000						
5 E Other	Cr	0.01	0.01	50.00	70.00	86.02	0.00	1.00	0.000						
Total		23.27	5.99			49.08	100.00	-74.28	7.159						

Table A1-5 Summary of the key source and uncertainty analysis of Cu emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Cu	0.66	1.29	1.52	75.83	75.85	0.16	94.54	0.011	4	2	3		3	5
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Cu	0.04	0.01	1.52	76.08	76.10	0.00	-80.00	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Cu	0.30	0.05	2.39	718.44	718.45	0.02	-85.19	0.025			10	3		3
1 A 1 a Public Electricity and Heat Production: Peat	Cu	0.09	0.04	1.90	95.07	95.09	0.00	-54.56	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Cu	0.25	0.04	2.00	100.00	100.02	0.00	-84.75	0.000						
1 A 1 b Petroleum refining: Liquid Fuels	Cu	0.01	0.00	10.00	100.00	100.50	0.00	-67.76	0.000						
1 A 2 a Iron and Steel: Biomass	Cu	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Cu	0.02	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Cu	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Cu	0.00	0.00	5.00	100.00	100.12	0.00	-41.30	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Cu	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Cu	0.01	0.01	5.00	40.00	40.31	0.00	13.85	0.000						
1 A 2 c Chemicals: Liquid Fuels	Cu	0.01	0.00	5.00	100.00	100.12	0.00	-71.76	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 c Chemicals: Other Fuels	Cu	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Cu	0.01	C	2.00	40.00	40.05	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	Cu	0.34	0.26	8.00	40.00	40.79	0.00	-22.74	0.000	9					
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Cu	0.07	0.02	5.00	100.00	100.12	0.00	-75.78	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	Cu	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Cu	0.02	0.00	7.00	40.00	40.61	0.00	-96.73	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Cu	0.00	0.01	5.00	40.00	40.31	0.00	288.72	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Cu	0.02	0.00	5.00	100.00	100.12	0.00	-92.45	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Cu	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Cu	0.01	0.00	5.00	40.00	40.31	0.00	-96.48	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 f Non-metallic minerals: Biomass	Cu	0.00	0.01	4.76	19.05	19.64	0.00	1662.32	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Cu	0.02	C	9.64	38.56	39.75	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Cu	0.10	C	8.57	17.32	19.32	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Cu	0.00	0.26	4.97	99.44	99.56	0.01		0.002	8	6				
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Cu	0.49	0.73	4.93	98.58	98.70	0.08	47.27	0.004	6	4	5		5	6
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Cu	0.22	C	4.70	18.82	19.40	0.00	C	C						
1 A 2 g viii Other: Liquid Fuels	Cu	0.06	C	3.41	13.66	14.08	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	Cu	0.01	C	4.90	19.59	20.19	0.00	C	C						
1 A 3 b i Road Transportation, Cars: Biomass	Cu	0.00	0.00	3.36	67.18	67.26	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Cu	0.00	0.01	5.00	100.00	100.12	0.00	870.53	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in 2019	Level in base year	Trend	Level in 2019 (Approach 2)	Level in base year (Approach 2)	Trend (Approach 2)
1 A 3 b i Road Transportation, Cars: Fossil part of bio-diesel and biogasoline	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Cu	0.02	0.01	3.00	100.00	100.04	0.00	-50.53	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Cu	0.00	0.00	4.97	99.36	99.49	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Cu	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of biodiesel and biogasoline	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Cu	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Cu	0.00	0.00	3.62	72.46	72.56	0.00	45760.74	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Cu	0.01	0.01	4.87	97.31	97.43	0.00	-12.98	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and bio-gasoline	Cu	0.00	0.00	3.64	72.72	72.82	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Cu	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Cu	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Cu	38.83	32.81	0.00	75.00	75.00	99.05	-15.50	1.054	1	1	2	1	1	1
1 A 3 c Railways: Liquid Fuels	Cu	0.05	0.02	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Cu	0.09	0.13	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Cu	0.17	0.08	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 3 e Other Transportation: Biomass	Cu	0.00	0.04	5.00	100.00	100.12	0.00		0.000						
1 A 3 e Other Transportation: Diesel Oil	Cu	0.10	0.10	5.00	100.00	100.12	0.00	-3.69	0.000						
1 A 3 e Other Transportation: Other Fossil Fuels	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 a Commercial/Institutional: Biomass	Cu	0.00	0.01	10.00	500.00	500.10	0.00	116.11	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	Cu	0.08	0.12	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional: Ethanol	Cu	0.00	0.01	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: FAME	Cu	0.00	0.05	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Gasoline	Cu	0.10	0.08	5.00	100.00	100.12	0.00	-14.31	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Cu	0.09	0.00	20.00	100.00	101.98	0.00	-97.77	0.000						
1 A 4 a Commercial/Institutional: Other Fossil Fuels	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Cu	0.20	0.21	8.70	434.56	434.64	0.13	6.17	0.003				5	4	7
1 A 4 b Residential: Liquid Fuels	Cu	0.31	0.14	3.00	58.90	58.97	0.00	-53.87	0.000						
1 A 4 b Residential: Other Fossil Fuels	Cu	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Cu	0.00	0.22	3.29	92.97	93.03	0.01	21171.03	0.001			7			
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Cu	0.00	0.00	3.54	70.83	70.92	0.00		0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Cu	0.01	0.01	5.00	100.00	100.12	0.00	104.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Cu	0.64	0.58	3.13	62.66	62.74	0.02	-8.85	0.000	5	5	9			
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Cu	0.02	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Cu	0.03	0.02	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	Cu	0.00	0.01	7.50	90.00	90.31	0.00	103.21	0.000						
1 B 2 c Venting and flaring	Cu	0.00	C	17.50	200.00	200.76	0.00	C	C						
2 A 3 Glass Production	Cu	0.00	0.00					-100.00							
2 B 10 Other	Cu	0.00	0.00	0.00	100.00	100.00	0.00	-97.80	0.000						
2 C 1 Iron and Steel Production	Cu	1.78	0.56	4.31	43.11	43.32	0.01	-68.83	0.001	3	6	4			
2 C 7 Other	Cu	18.55	1.06	4.00	50.00	50.16	0.05	-94.31	0.634	2	3	1	2		2
2 G 4 Other	Cu	0.44	0.48	14.98	349.61	349.93	0.45	8.39	0.013	7	7	8	4	2	4
2 H 1 Pulp and paper	Cu	0.43	0.14	6.34	45.32	45.76	0.00	-67.64	0.000	8		11			
2 H 3 Other	Cu	0.10	0.00	0.00	37.00	37.00	0.00	-99.52	0.000						
5 C 1 Waste Incineration	Cu	0.00	0.01	22.68	139.52	141.35	0.00	104.32	0.000						
5 E Other	Cu	0.02	0.02	50.00	68.00	84.40	0.00	0.99	0.000						
Total		64.83	39.87			62.01	100.00	-38.50	13.226						

Table A1-6 Summary of the key source and uncertainty analysis of Dioxin emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	DIOX	7.81	6.16	1.53	228.99	229.00	18.92	-21.13	1.275	3	2	3	4	2	4
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	DIOX	0.00	0.00	1.87	46.63	46.67	0.00	-38.85	0.000						
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	DIOX	0.04	0.00	1.60	40.07	40.11	0.00	-87.31	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	DIOX	3.55	0.85	2.39	239.48	239.49	0.39	-76.20	0.018	6	6	9	8	9	
1 A 1 a Public Electricity and Heat Production: Peat	DIOX	1.20	0.12	1.90	285.21	285.21	0.01	-90.09	0.015	11		13			
1 A 1 a Public Electricity and Heat Production: Solid Fuels	DIOX	3.15	0.04	2.00	50.00	50.04	0.00	-98.78	0.006	7		6			
1 A 1 b Petroleum refining: Liquid Fuels	DIOX	0.02	0.01	10.00	100.00	100.50	0.00	-33.93	0.000						
1 A 2 a Iron and Steel: Biomass	DIOX	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	DIOX	0.00	0.00	5.00	100.00	100.12	0.00	547.35	0.000						
1 A 2 a Iron and Steel: Liquid Fuels	DIOX	0.01	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	DIOX	0.01	0.00					-100.00							

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 b Non-ferrous metals: Gaseous Fuels	DIOX	0.00	0.00	5.00	50.00	50.25	0.00	61.77	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	DIOX	0.00	0.00	5.00	100.00	100.12	0.00	-41.23	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	DIOX	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	DIOX	0.06	0.03	5.00	100.00	100.12	0.00	-48.87	0.000						
1 A 2 c Chemicals: Gaseous Fuels	DIOX	0.00	0.00	5.00	50.00	50.25	0.00	-52.31	0.000						
1 A 2 c Chemicals: Liquid Fuels	DIOX	0.01	0.00	5.00	100.00	100.12	0.00	-71.73	0.000						
1 A 2 c Chemicals: Other Fuels	DIOX	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	DIOX	0.11	C	2.00	100.00	100.02	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	DIOX	4.23	1.32	8.00	100.00	100.32	0.17	-68.79	0.001	4	4				
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	DIOX	0.00	0.00	5.00	50.00	50.25	0.00	11.01	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	DIOX	0.07	0.01	5.00	100.00	100.12	0.00	-81.59	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	DIOX	0.05	0.00					-100.00							

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Solid Fuels	DIOX	0.29	0.00	7.00	100.00	100.24	0.00	-98.38	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	DIOX	0.04	0.05	5.00	100.00	100.12	0.00	14.28	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	DIOX	0.00	0.00	5.00	50.00	50.25	0.00	-38.61	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	DIOX	0.01	0.00	5.00	100.00	100.12	0.00	-91.49	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	DIOX	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	DIOX	0.10	0.00	5.00	100.00	100.12	0.00	-99.06	0.000						
1 A 2 f Non-metallic minerals: Biomass	DIOX	0.01	0.07	4.76	152.38	152.45	0.00	621.06	0.000						
1 A 2 f Non-metallic minerals: Gaseous Fuels	DIOX	0.00	0.00	3.90	21.20	21.55	0.00	75.11	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	DIOX	0.01	C	9.79	19.58	21.89	0.00	C	C						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 f Non-metallic minerals: Solid Fuels	DIOX	1.23	C	8.57	25.98	27.36	0.00	C	C	10		10			
1 A 2 g viii Other: Biomass	DIOX	2.63	C	4.59	91.90	92.01	0.02	C	C	9	9	11			
1 A 2 g viii Other: Gaseous Fuels	DIOX	0.00	0.00	2.74	10.96	11.29	0.00	-40.22	0.000						
1 A 2 g viii Other: Liquid Fuels	DIOX	0.03	C	2.57	10.27	10.58	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	DIOX	0.08	C	4.96	19.86	20.47	0.00	C	C		12	12			
1 A 3 b i Road Transportation, Cars: Diesel oil	DIOX	0.02	0.11	5.00	1000.00	1000.01	0.12	631.27	0.024						
1 A 3 b i Road Transportation, Cars: Gasoline	DIOX	4.11	0.19	3.00	1000.00	1000.00	0.34	-95.42	3.137	5		5	2	10	3
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	DIOX	0.01	0.04	5.00	1000.00	1000.01	0.01	531.04	0.003						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	DIOX	0.25	0.00	3.00	1000.00	1000.00	0.00	-99.15	0.014						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	DIOX	0.14	0.09	4.85	970.58	970.59	0.07	-32.81	0.004						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	DIOX	0.01	0.00	3.00	1000.00	1000.00	0.00	-97.92	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	DIOX	0.01	0.00	3.00	1000.00	1000.00	0.00	-78.89	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	DIOX	0.01	0.01	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	DIOX	0.05	0.02	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 4 a Commercial/Institutional: Biomass	DIOX	0.05	0.11	10.00	1000.00	1000.05	0.11	114.52	0.016						
1 A 4 b Residential: Biomass	DIOX	2.73	2.52	10.00	1000.00	1000.05	60.33	-7.74	5.056	8	3	4	3	1	2
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	DIOX	0.01	0.41	10.00	1000.00	1000.05	1.59	2695.64	0.335		11	8		8	7
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	DIOX	0.01	0.00	5.00	100.00	100.12	0.00	-33.50	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	DIOX	0.17	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	DIOX	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	DIOX	0.24	C	7.42	989.31	989.34	0.25	C	C						
1 B 2 c Venting and flaring	DIOX	0.00	C	17.50	100.00	101.52	0.00	C	C						
2 B 10 Other	DIOX	0.02	0.01	0.00	200.00	200.00	0.00	-10.50	0.000						
2 C 1 Iron and Steel Production	DIOX	26.79	0.71	4.04	808.75	808.76	3.13	-97.35	98.179	1	7	1	1	5	1
2 C 7 Other	DIOX	0.97	0.56	4.00	1000.00	1000.01	3.01	-42.28	0.103	12	8		6	6	

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
2 G 4 Other	DIOX	0.00	0.00	15.00	100.00	101.12	0.00	-58.87	0.000						
2 H 1 Pulp and paper	DIOX	0.80	0.56	6.63	994.13	994.16	2.90	-30.69	0.155		10	14	7	7	
5 C 1 Waste Incineration	DIOX	0.62	0.87	10.96	766.55	766.63	4.27	41.18	0.523		5	7		4	5
5 E Other	DIOX	8.07	8.17	50.00	66.00	82.80	4.35	1.27	0.941	2	1	2	5	3	6
Total		69.87	24.26			133.71	100.00	-65.27	104.79						
									5						

Table A1-7 Summary of the key source and uncertainty analysis of Hg emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Hg	0.23	0.10	1.55	31.03	31.07	1.15	-56.85	0.007	2	1	1	4	2	3
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Hg	0.00	0.00	1.47	73.74	73.75	0.00	-67.39	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Hg	0.13	0.04	2.39	718.44	718.45	97.83	-68.91	0.105	6	3	12	1	1	1
1 A 1 a Public Electricity and Heat Production: Peat	Hg	0.02	0.01	1.90	38.03	38.08	0.01	-63.65	0.000	10	13	21			
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Hg	0.09	0.01	1.97	39.34	39.39	0.03	-87.65	0.001	7	11	8			11
1 A 1 b Petroleum refining: Liquid Fuels	Hg	0.00	0.00	10.00	100.00	100.50	0.00	-65.24	0.000						
1 A 2 a Iron and Steel: Biomass	Hg	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Hg	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Hg	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Hg	0.00	0.00	5.00	100.00	100.12	0.00	-27.04	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Hg	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Hg	0.00	0.00	5.00	40.00	40.31	0.00	36.04	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 c Chemicals: Liquid Fuels	Hg	0.00	0.00	5.00	100.00	100.12	0.00	-70.77	0.000						
1 A 2 c Chemicals: Other Fuels	Hg	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Hg	0.00	C	2.00	40.00	40.05	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	Hg	0.01	0.01	8.00	40.00	40.79	0.04	-8.70	0.001	13	10	10		9	12
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Hg	0.00	0.00	5.00	100.00	100.12	0.00	-80.73	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	Hg	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Hg	0.01	0.00	7.00	40.00	40.61	0.00	-95.71	0.000			24			
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Hg	0.00	0.00	5.00	40.00	40.31	0.00	-19.22	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Hg	0.00	0.00	5.00	100.00	100.12	0.00	-88.77	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Hg	0.00	0.00					-100.00							

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco:	Hg	0.00	0.00	5.00	40.00	40.31	0.00	-96.88	0.000						
Solid Fuels															
1 A 2 f Non-metallic minerals: Biomass	Hg	0.00	0.00	4.76	19.05	19.64	0.00	2543.48	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Hg	0.00	C	9.89	49.47	50.45	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Hg	0.04	C	8.58	17.34	19.34	0.00	C	C	8	17	15			
1 A 2 g viii Other: Biomass	Hg	0.01	C	4.67	18.67	19.24	0.00	C	C		16	17			
1 A 2 g viii Other: Liquid Fuels	Hg	0.00	C	2.87	17.21	17.45	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	Hg	0.00	C	4.89	19.54	20.14	0.01	C	C		12	9			
1 A 3 b i Road Transportation, Cars: Biomass	Hg	0.00	0.00	3.80	75.93	76.02	0.01		0.000		19	19			16
1 A 3 b i Road Transportation, Cars: Diesel oil	Hg	0.00	0.01	5.00	100.00	100.12	0.06	870.53	0.002		14	13		8	9
1 A 3 b i Road Transportation, Cars: Fossil part of bio-diesel and biogasoline	Hg	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Hg	0.03	0.02	3.00	100.00	100.04	0.33	-50.53	0.003	9	7	11	9	3	5

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Hg	0.00	0.00	4.93	98.69	98.82	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Hg	0.00	0.00	5.00	100.00	100.12	0.01	738.49	0.000			22			17
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of biodiesel and biogasoline	Hg	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Hg	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Hg	0.00	0.00	3.57	71.50	71.59	0.01	22266.18	0.000			20			
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Hg	0.01	0.01	4.87	97.31	97.43	0.03	-12.98	0.001		15	16		10	13
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	Hg	0.00	0.00	3.61	72.13	72.22	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Hg	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Hg	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Hg	0.00	0.00	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Hg	0.00	0.00	15.00	100.00	101.12	0.00	40.05	0.000						
1 A 4 a Commercial/Institutional: Biomass	Hg	0.00	0.00	10.00	40.00	41.23	0.00	110.84	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Hg	0.00	0.00	20.00	100.00	101.98	0.00	-96.38	0.000						
1 A 4 b Residential: Biomass	Hg	0.02	0.02	10.00	40.00	41.23	0.07	-7.74	0.001	12	6	7		7	10
1 A 4 b Residential: Liquid Fuels	Hg	0.01	0.00	20.00	100.00	101.98	0.00	-97.40	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Hg	0.00	0.00	10.00	40.00	41.23	0.00	2124.23	0.000			23			
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Hg	0.00	0.00	19.71	98.57	100.52	0.00	-68.60	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Hg	0.01	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Hg	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	Hg	0.00	0.00	7.50	90.00	90.31	0.00	-98.51	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 B 2 c Venting and flaring	Hg	0.00	C	17.50	567.00	567.27	0.00	C	C						
2 A 3 Glass Production	Hg	0.01	0.00	0.00	1000.00	1000.00	0.00	-97.22	0.007				5		2
2 B 10 Other	Hg	0.19	0.01	0.00	35.56	35.56	0.03	-92.72	0.007	4	9	2	3		4
2 C 1 Iron and Steel Production	Hg	0.30	0.06	4.38	17.54	18.08	0.14	-80.62	0.001	1	2	5	6	4	14
2 C 7 Other	Hg	0.19	0.02	4.00	20.00	20.40	0.01	-91.93	0.002	3	8	3	8		8
2 G 4 Other	Hg	0.00	0.00	12.96	146.56	147.13	0.00	-54.67	0.000						
2 H 1 Pulp and paper	Hg	0.01	0.02	6.63	50.17	50.61	0.11	38.31	0.002	14	5	6		6	6
2 H 3 Other	Hg	0.02	0.00					-100.00		11		14	2		
5 C 1 Waste Incineration	Hg	0.18	0.03	4.89	37.40	37.71	0.12	-85.65	0.002	5	4	4	7	5	7
5 E Other	Hg	0.00	0.00	50.00	67.00	83.60	0.02	1.01	0.001		18	18			15
Total		1.55	0.40			72.19	100.00	-74.44	3.785						

Table A1-8 Summary of the key source and uncertainty analysis of NH₃ emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	NH ₃	0.05	0.22	1.52	15.25	15.32	0.00	382.61	0.000		16			
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	NH ₃	0.02	0.01	1.87	37.31	37.35	0.00	-69.42	0.000					
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	NH ₃	0.03	0.00	1.51	30.27	30.31	0.00	-88.09	0.000					
1 A 1 a Public Electricity and Heat Production: Other Fuels	NH ₃	0.01	0.06	2.43	32.39	32.48	0.00	361.67	0.000					
1 A 1 a Public Electricity and Heat Production: Peat	NH ₃	0.02	0.01	1.90	38.03	38.08	0.00	-63.65	0.000					
1 A 1 a Public Electricity and Heat Production: Solid Fuels	NH ₃	0.02	0.01	1.59	15.91	15.99	0.00	-44.24	0.000					
1 A 1 b Petroleum refining: Gaseous Fuels	NH ₃	0.00	0.00	2.00	40.00	40.05	0.00		0.000					
1 A 1 b Petroleum refining: Liquid Fuels	NH ₃	0.06	0.05	10.00	40.00	41.23	0.00	-20.59	0.000					
1 A 2 a Iron and Steel: Biomass	NH ₃	0.00	C	5.00	40.00	40.31	0.00	C	C					
1 A 2 a Iron and Steel: Gaseous Fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	223.67	0.000					
1 A 2 a Iron and Steel: Liquid Fuels	NH ₃	0.02	C	5.00	40.00	40.31	0.00	C	C					

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 0.8 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 a Iron and Steel: Solid Fuels	NH ₃	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Gaseous Fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	-19.11	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	-56.13	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	NH ₃	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	371.69	0.000						
1 A 2 c Chemicals: Gaseous Fuels	NH ₃	0.01	0.00	5.00	40.00	40.31	0.00	-76.05	0.000						
1 A 2 c Chemicals: Liquid Fuels	NH ₃	0.01	0.01	5.00	40.00	40.31	0.00	-50.33	0.000						
1 A 2 c Chemicals: Other Fuels	NH ₃	0.00	C	10.00	50.00	50.99	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	NH ₃	0.00	C	2.00	40.00	40.05	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	NH ₃	0.05	0.06	8.00	40.00	40.79	0.00	34.18	0.000						
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	-44.50	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	NH ₃	0.05	0.01	5.00	40.00	40.31	0.00	-83.19	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Other Fuels	NH ₃	0.00	0.00	10.00	50.00	50.99	0.00	-78.85	0.000					
1 A 2 d Pulp, Paper and Print: Solid Fuels	NH ₃	0.00	0.00	7.00	40.00	40.61	0.00	-83.69	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Bio-mass	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	516.04	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	NH ₃	0.01	0.00	5.00	40.00	40.31	0.00	-69.31	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	NH ₃	0.02	0.00	5.00	40.00	40.31	0.00	-89.38	0.000					
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	NH ₃	0.00	0.00					-100.00						
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	-90.63	0.000					
1 A 2 f Non-metallic minerals: Biomass	NH ₃	0.00	0.00	4.84	19.37	19.96	0.00	4933.0 1	0.000					
1 A 2 f Non-metallic minerals: Gaseous Fuels	NH ₃	0.00	0.00	3.90	14.13	14.66	0.00	-12.45	0.000					

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 f Non-metallic minerals: Liquid Fuels	NH ₃	0.02	C	8.82	8.87	12.51	0.00	C	C						
1 A 2 f Non-metallic minerals: Other Fuels	NH ₃	0.00	0.01	10.00	30.00	31.62	0.00		0.000						
1 A 2 f Non-metallic minerals: Solid Fuels	NH ₃	0.01	C	8.58	17.35	19.35	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	NH ₃	0.00	0.00	4.97	29.82	30.23	0.00	58.13	0.000						
1 A 2 g viii Other: Biomass	NH ₃	0.02	C	4.52	18.08	18.64	0.00	C	C						
1 A 2 g viii Other: Gaseous Fuels	NH ₃	0.00	0.00	2.65	10.61	10.93	0.00	-69.37	0.000						
1 A 2 g viii Other: Liquid Fuels	NH ₃	0.06	C	2.66	5.32	5.95	0.00	C	C						
1 A 2 g viii Other: Other Fuels	NH ₃	0.00	C	3.58	14.32	14.76	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	NH ₃	0.00	C	4.91	19.65	20.25	0.00	C	C						
1 A 3 b i Road Transportation, Cars: Biomass	NH ₃	0.00	0.11	4.27	341.93	341.96	0.16		0.004						12
1 A 3 b i Road Transportation, Cars: Diesel oil	NH ₃	0.00	0.11	5.00	400.00	400.03	0.22	4154.77	0.005					14	10
1 A 3 b i Road Transportation, Cars: Gasoline	NH ₃	1.65	1.14	3.00	400.00	400.01	24.11	-31.03	0.046	9	11	14	1	2	3

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	NH ₃	0.00	0.00	5.00	400.00	400.03	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	NH ₃	0.00	0.03	5.00	400.00	400.03	0.01	3754.88	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	NH ₃	0.00	0.00	5.00	400.00	400.03	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	NH ₃	0.09	0.02	3.00	400.00	400.01	0.00	-83.00	0.002						16
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	NH ₃	0.01	0.07	4.37	349.26	349.29	0.07	695.29	0.001						18
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	NH ₃	0.00	0.00	3.00	400.00	400.01	0.00	-77.85	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	NH ₃	0.00	0.00	3.00	400.00	400.01	0.00	110.19	0.000						
1 A 3 c Railways: Liquid Fuels	NH ₃	0.00	0.00	5.00	75.00	75.17	0.00	-54.73	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	NH ₃	0.00	0.00	3.18	25.46	25.65	0.00	200.59	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 d Domestic Navigation: Gasoline	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	NH ₃	0.00	0.01	15.00	40.00	42.72	0.00	679.04	0.000						
1 A 3 e Other Transportation: Diesel Oil	NH ₃	0.00	0.00	5.00	30.00	30.41	0.00	3.15	0.000						
1 A 3 e Other Transportation: Gaseous fuels	NH ₃	0.00	0.00	5.00	40.00	40.31	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	NH ₃	0.00	0.00	10.00	40.00	41.23	0.00	112.40	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	NH ₃	0.00	0.00	5.00	30.00	30.41	0.00	54.30	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	NH ₃	0.00	0.00	10.00	40.00	41.23	0.00	48.69	0.000						
1 A 4 a Commercial/Institutional: Gasoline	NH ₃	0.00	0.00	5.00	30.00	30.41	0.00	3.24	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	NH ₃	0.07	0.00	20.00	40.00	44.72	0.00	-97.69	0.000						
1 A 4 b Residential: Biomass	NH ₃	0.12	0.11	10.00	40.00	41.23	0.00	-7.74	0.000						
1 A 4 b Residential: Gaseous Fuels	NH ₃	0.00	0.00	10.00	40.00	41.23	0.00	-66.69	0.000						
1 A 4 b Residential: Liquid Fuels	NH ₃	0.16	0.00	16.54	33.20	37.09	0.00	-98.35	0.000			19			

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	NH ₃	0.00	0.01	10.00	40.00	41.23	0.00	2163.44	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	NH ₃	0.00	0.00	10.00	40.00	41.23	0.00	-81.94	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	NH ₃	0.00	0.00	5.00	30.00	30.41	0.00	266.81	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	NH ₃	0.01	0.00	6.28	17.58	18.67	0.00	-60.13	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	NH ₃	0.00	0.00					-100.00							
1 A 5 b Mobile: Biomass	NH ₃	0.00	0.00	5.00	400.00	400.03	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	NH ₃	0.01	0.00	4.06	23.73	24.07	0.00	-75.35	0.000						
1 B 1 b Coke production	NH ₃	0.00	0.00	5.00	170.00	170.07	0.00	-8.50	0.000						
1 B 2 a Oil	NH ₃	0.00	C	2.40	41.94	42.01	0.00	C	C						
1 B 2 c Venting and flaring	NH ₃	0.00	C	17.50	49.99	52.97	0.00	C	C						
2 A 1 Cement Production	NH ₃	0.00	0.03	2.00	400.00	400.00	0.01		0.000						
2 A 3 Glass Production	NH ₃	0.25	0.05	0.00	400.00	400.00	0.05	-78.56	0.012	17			9		5
2 B 10 Other	NH ₃	0.19	0.03	0.00	40.83	40.83	0.00	-86.44	0.000	18					
2 B 2 Nitric Acid Production	NH ₃	0.01	0.00	2.00	5.00	5.39	0.00	-43.57	0.000						
2 C 1 Iron and Steel Production	NH ₃	0.00	0.00	5.00	20.00	20.62	0.00	0.00	0.000						
2 G 4 Other	NH ₃	0.04	0.01	15.00	6.00	16.16	0.00	-58.87	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
2 H 1 Pulp and paper	NH ₃	1.70	2.49	6.99	49.90	50.39	1.83	46.49	0.008	8	8	6	11	9	8
2 H 3 Other	NH ₃	0.21	0.07	0.00	400.00	400.00	0.08	-67.06	0.006						9
3 B 1 Dairy cattle	NH ₃	9.41	3.13	20.00	50.00	53.85	3.29	-66.77	0.207	2	6	1	2	6	1
3 B 1 Non-dairy cattle	NH ₃	6.94	9.66	20.00	50.00	53.85	31.41	39.29	0.290	3	2	2	4	1	2
3 B 3 Swine	NH ₃	4.97	3.23	20.00	50.00	53.85	3.50	-35.14	0.032	5	5	3	5	5	6
3 B 4 Fur-bearing animals	NH ₃	0.61	0.41	20.00	50.00	53.85	0.06	-32.64	0.000			21			
3 B 4 Goats	NH ₃	0.01	0.02	20.00	50.00	53.85	0.00	192.25	0.000						
3 B 4 Horses	NH ₃	2.66	3.00	20.00	50.00	53.85	3.03	12.64	0.023	7	7	9	7	7	13
3 B 4 Poultry	NH ₃	1.55	2.17	14.94	37.35	40.23	0.88	40.19	0.008	10	9	8		11	14
3 B 4 Sheep	NH ₃	0.39	0.67	20.00	50.00	53.85	0.15	72.77	0.002		13	13			
3 D a 1 Inorganic N fertilizers	NH ₃	5.93	4.41	5.00	14.00	14.87	0.50	-25.67	0.003	4	3	7	10	12	
3 D a 2 a Animal manure applied to soils	NH ₃	17.44	14.30	5.00	14.00	14.87	5.24	-18.02	0.029	1	1	4	6	4	
3 D a 2 b Sewage sludge applied to soils	NH ₃	0.15	0.52	5.00	100.00	100.12	0.31	237.52	0.004			12		13	11
3 D a 2 c Other organic fertilizers applied to soils	NH ₃	0.14	1.15	5.00	100.00	100.12	1.53	743.38	0.029		10	5		10	4
3 D a 3 Urine and dung deposited by grazing animals	NH ₃	4.06	4.13	20.00	100.00	101.98	20.59	1.81	0.045	6	4	10	3	3	7
5 B 1 Composting	NH ₃	0.03	0.16	0.00	192.60	192.60	0.10	518.60	0.002			20			17
5 B 2 Anaerobic Digestion at Biogas Facilities	NH ₃	0.00	0.53	10.00	38.00	39.29	0.05	124193.99	0.001		14	11			
5 C 1 Waste Incineration	NH ₃	0.00	0.00	10.00	50.00	50.99	0.00		0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 018 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
5 D 1 Domestic wastewater	NH ₃	0.00	0.00	0.00	102.00	102.00	0.00	0.00	0.000						
5 E Other	NH ₃	0.99	1.09	1.08	141.90	141.91	2.78	10.10	0.003	11	12	15	8	8	15
Total		60.31	53.42			17.38	100.00	-11.43	8.744						

Table A1-9 Summary of the key source and uncertainty analysis of Ni emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Ni	0.60	0.64	1.52	30.41	30.45	2.52	5.98	0.003	11	4	3		5	6
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Ni	2.44	0.24	1.67	83.32	83.33	2.70	-90.10	0.006	4	7	5	4	4	4
1 A 1 a Public Electricity and Heat Production: Other Fuels	Ni	0.30	0.06	2.39	335.27	335.28	2.38	-81.49	0.000	17	16		8	6	18
1 A 1 a Public Electricity and Heat Production: Peat	Ni	0.44	0.02	1.90	38.03	38.08	0.00	-96.37	0.000	14		12			16
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Ni	0.22	0.03	2.00	40.00	40.05	0.01	-86.06	0.000						
1 A 1 b Petroleum refining: Liquid Fuels	Ni	0.56	0.17	10.00	100.00	100.50	1.97	-69.59	0.000	12	10	17	10	8	12
1 A 2 a Iron and Steel: Biomass	Ni	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Ni	0.76	C	5.00	100.00	100.12	1.07	C	C	9	12	19	9	13	15
1 A 2 a Iron and Steel: Solid Fuels	Ni	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Ni	0.09	0.03	5.00	100.00	100.12	0.08	-63.10	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Ni	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Ni	0.00	0.01	5.00	40.00	40.31	0.00	72.32	0.000						
1 A 2 c Chemicals: Liquid Fuels	Ni	0.34	0.09	5.00	100.00	100.12	0.57	-72.85	0.000	16	14		11	15	
1 A 2 c Chemicals: Other Fuels	Ni	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Ni	0.01	C	2.00	40.00	40.05	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Biomass	Ni	0.27	0.31	8.00	40.00	40.79	1.09	14.19	0.001		6	6		12	8
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Ni	3.64	0.83	5.00	100.00	100.12	45.91	-77.21	0.001	2	2	14	2	1	11
1 A 2 d Pulp, Paper and Print: Other Fuels	Ni	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Ni	0.03	0.00	7.00	40.00	40.61	0.00	-96.88	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Ni	0.00	0.01	5.00	40.00	40.31	0.00	272.77	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Ni	0.95	0.03	5.00	100.00	100.12	0.08	-96.32	0.003	8	21	8	7		5
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Ni	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Ni	0.01	0.00	5.00	40.00	40.31	0.00	-95.48	0.000						
1 A 2 f Non-metallic minerals: Biomass	Ni	0.00	0.02	4.76	19.05	19.64	0.00	2543.48	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Ni	0.76	C	9.98	59.90	60.73	1.18	C	C	10	8	15		10	14
1 A 2 f Non-metallic minerals: Solid Fuels	Ni	0.08	C	8.57	17.32	19.32	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Ni	0.00	0.01	4.97	99.44	99.56	0.01		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Ni	0.02	0.03	4.93	98.58	98.70	0.06	47.27	0.000						
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Ni	0.17	C	4.75	18.98	19.57	0.04	C	C	13	11				
1 A 2 g viii Other: Liquid Fuels	Ni	1.75	C	4.53	36.25	36.53	2.30	C	C	6	5	9	7	13	
1 A 2 g viii Other: Solid Fuels	Ni	0.00	C	4.87	19.49	20.09	0.00	C	C			22			
1 A 3 b i Road Transportation, Cars: Biomass	Ni	0.00	0.00	2.98	59.52	59.60	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Ni	0.00	0.00	5.00	100.00	100.12	0.00	870.53	0.000						
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Ni	0.01	0.00	3.00	100.00	100.04	0.00	-50.53	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Ni	0.00	0.00	4.59	91.85	91.97	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Ni	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of bio-diesel and biogasoline	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Ni	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Ni	0.00	0.00	3.18	63.63	63.71	0.00	3604.11	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Ni	0.00	0.00	4.87	97.31	97.43	0.00	-12.98	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	Ni	0.00	0.00	3.56	71.20	71.29	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Ni	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Ni	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Ni	0.00	0.00	0.00	1000.00	1000.00	0.06	28.26	0.000						
1 A 3 c Railways: Liquid Fuels	Ni	0.00	0.00	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Ni	0.03	0.04	3.58	35.84	36.01	0.01	35.81	0.000	20	20				
1 A 3 d Domestic Navigation: Residual Oil	Ni	2.45	1.21	15.00	50.00	52.20	26.54	-50.67	0.022	3	1	2	5	2	3
1 A 3 e Other Transportation: Biomass	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 e Other Transportation: Diesel Oil	Ni	0.00	0.00	5.00	100.00	100.12	0.00	-3.69	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 e Other Transportation: Other Fossil Fuels	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Biomass	Ni	0.00	0.00	10.00	40.00	41.23	0.00	115.36	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	Ni	0.00	0.01	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional: Ethanol	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: FAME	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Gasoline	Ni	0.00	0.00	5.00	100.00	100.12	0.00	-14.31	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Ni	2.23	0.00	20.00	100.00	101.98	0.00	-99.96	0.026	5		4	3		2
1 A 4 a Commercial/Institutional: Other Fossil Fuels	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Ni	0.10	0.09	9.88	39.52	40.73	0.09	-6.60	0.000		15	13			17
1 A 4 b Residential: Liquid Fuels	Ni	1.12	0.01	5.00	52.09	52.33	0.00	-99.34	0.002	7		7	6		7
1 A 4 b Residential: Other Fossil Fuels	Ni	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Ni	0.00	0.02	6.72	35.33	35.97	0.00	4330.84	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Ni	0.00	0.00	3.54	70.83	70.92	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Ni	0.00	0.00	5.00	100.00	100.12	0.00	104.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Ni	0.40	0.18	14.37	74.03	75.42	1.27	-54.26	0.001	15	9	10	12	9	10
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Ni	0.01	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Ni	0.01	0.01	5.00	50.00	50.25	0.00	-35.46	0.000						
1 B 2 a Oil	Ni	0.00	0.01	7.50	90.00	90.31	0.00	52.66	0.000						
1 B 2 c Venting and flaring	Ni	0.00	C	17.50	150.00	151.02	0.00	C	C						
2 A 3 Glass Production	Ni	0.18	0.04	0.00	300.00	300.00	1.03	-77.26	0.000		19			14	
2 B 10 Other	Ni	0.01	0.00	0.00	100.00	100.00	0.00	-98.70	0.000						
2 C 1 Iron and Steel Production	Ni	8.68	0.73	3.07	46.03	46.13	7.47	-91.64	0.030	1	3	1	1	3	1
2 C 2 Ferroalloys production	Ni	0.00	0.02	5.00	75.00	75.17	0.01		0.000						
2 C 7 Other	Ni	0.03	0.04	4.00	53.00	53.15	0.03	28.05	0.000		17	18			
2 G 4 Other	Ni	0.05	0.04	12.09	316.82	317.05	1.16	-20.81	0.001		18	21		11	9
2 H 1 Pulp and paper	Ni	0.47	0.15	6.34	45.32	45.76	0.33	-67.06	0.000	13	11	16		16	
2 H 3 Other	Ni	0.05	0.00	0.00	36.92	36.92	0.00	-94.81	0.000						
5 C 1 Waste Incineration	Ni	0.00	0.00	5.95	405.47	405.51	0.01	114.06	0.000						
Total		29.31	6.18			19.80	100.00	-78.90	3.113						

Table A1-10 Summary of the key source and uncertainty analysis of NMVOC emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Trend	Level in 2019	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	NMVOC	1.57	2.67	1.52	56.89	56.91	0.28	70.13	0.001	12	8		12	10
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	NMVOC	0.02	0.01	1.90	28.48	28.55	0.00	-58.78	0.000					
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	NMVOC	0.05	0.01	1.53	22.99	23.04	0.00	-80.91	0.000					
1 A 1 a Public Electricity and Heat Production: Other Fuels	NMVOC	0.13	0.15	2.41	40.15	40.22	0.00	14.85	0.000					
1 A 1 a Public Electricity and Heat Production: Peat	NMVOC	0.55	0.20	1.90	47.53	47.57	0.00	-63.65	0.000					
1 A 1 a Public Electricity and Heat Production: Solid Fuels	NMVOC	0.25	0.04	1.55	31.01	31.05	0.00	-84.29	0.000					
1 A 1 b Petroleum refining: Gaseous Fuels	NMVOC	0.00	0.00	2.00	30.00	30.07	0.00		0.000					
1 A 1 b Petroleum refining: Liquid Fuels	NMVOC	0.06	0.05	10.00	40.00	41.23	0.00	-21.30	0.000					
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	NMVOC	0.01	0.01	5.00	30.00	30.41	0.00	2.40	0.000					
1 A 2 a Iron and Steel: Biomass	NMVOC	0.00	C	5.00	75.00	75.17	0.00	C	C					
1 A 2 a Iron and Steel: Gaseous Fuels	NMVOC	0.00	0.00	5.00	30.00	30.41	0.00	223.67	0.000					
1 A 2 a Iron and Steel: Liquid Fuels	NMVOC	0.03	C	5.00	50.00	50.25	0.00	C	C					

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 a Iron and Steel: Solid Fuels	NMVOC	0.01	0.01	2.00	50.00	50.04	0.00	-21.12	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	NMVOC	0.00	0.00	5.00	30.00	30.41	0.00	-19.11	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	NMVOC	0.00	0.00	5.00	50.00	50.25	0.00	-40.77	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	NMVOC	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	NMVOC	0.06	0.02	5.00	50.00	50.25	0.00	-63.07	0.000						
1 A 2 c Chemicals: Gaseous Fuels	NMVOC	0.01	0.00	5.00	30.00	30.41	0.00	-76.15	0.000						
1 A 2 c Chemicals: Liquid Fuels	NMVOC	0.01	0.01	5.00	50.00	50.25	0.00	-47.59	0.000						
1 A 2 c Chemicals: Other Fuels	NMVOC	0.00	C	10.00	50.00	50.99	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	NMVOC	0.01	C	2.00	50.00	50.04	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	NMVOC	3.78	0.90	8.00	75.00	75.43	0.06	-76.19	0.000	15	21	22	11		
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	NMVOC	0.00	0.00	5.00	30.00	30.41	0.00	-44.50	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	NMVOC	0.07	0.02	5.00	50.00	50.25	0.00	-73.58	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	NMVOC	0.00	0.00	10.00	50.00	50.99	0.00	-87.44	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	NMVOC	0.03	0.01	7.00	50.00	50.49	0.00	-79.67	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	NM VOC	0.03	0.03	5.00	50.00	50.25	0.00	26.27	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	NM VOC	0.01	0.00	5.00	30.00	30.41	0.00	-69.31	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	NM VOC	0.02	0.00	5.00	50.00	50.25	0.00	-88.10	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	NM VOC	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	NM VOC	0.01	0.00	5.00	50.00	50.25	0.00	-90.63	0.000						
1 A 2 f Non-metallic minerals: Biomass	NM VOC	0.01	0.04	4.76	28.56	28.96	0.00	428.94	0.000						
1 A 2 f Non-metallic minerals: Gaseous Fuels	NM VOC	0.00	0.00	3.90	14.13	14.66	0.00	-12.45	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	NM VOC	0.02	C	9.49	18.99	21.23	0.00	C	C						
1 A 2 f Non-metallic minerals: Other Fuels	NM VOC	0.00	0.01	10.00	30.00	31.62	0.00		0.000						
1 A 2 f Non-metallic minerals: Solid Fuels	NM VOC	0.10	C	8.57	25.98	27.36	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	NM VOC	1.84	1.29	3.91	16.07	16.54	0.01	-29.84	0.000		18	19			
1 A 2 g viii Other: Biomass	NM VOC	2.39	C	4.09	24.56	24.90	0.00	C	C	19		23			
1 A 2 g viii Other: Gaseous Fuels	NM VOC	0.00	0.00	2.65	5.31	5.93	0.00	-69.10	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g viii Other: Liquid Fuels	NMVOC	0.07	C	2.65	5.31	5.93	0.00	C	C						
1 A 2 g viii Other: Other Fuels	NMVOC	0.00	C	3.58	14.32	14.76	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	NMVOC	0.01	C	4.67	18.68	19.26	0.00	C	C						
1 A 3 a Domestic Aviation: Aviation Gasoline	NMVOC	0.00	0.00	10.00	100.00	100.50	0.00	-93.44	0.000						
1 A 3 a Domestic Aviation: Jet Kerosene	NMVOC	0.11	0.04	10.00	100.00	100.50	0.00	-62.03	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	NMVOC	0.00	0.37	4.99	49.92	50.16	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	NMVOC	0.64	0.31	5.00	50.00	50.25	0.00	-51.60	0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	NMVOC	85.23	5.37	3.00	50.00	50.09	0.88	-93.71	0.123	2	8	1	1	9	1
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	NMVOC	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	NMVOC	0.09	0.07	5.00	50.00	50.25	0.00	-21.28	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	NMVOC	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	NMVOC	5.50	0.12	3.00	50.00	50.09	0.00	-97.77	0.001	11		11	12		12
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	NMVOC	0.00	0.01	4.07	40.72	40.92	0.00	452.34	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	NM VOC	5.42	0.20	4.20	42.02	42.23	0.00	-96.23	0.000	12		12			14
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	NM VOC	0.15	0.03	3.00	50.00	50.09	0.00	-78.99	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	NM VOC	1.49	0.70	3.00	50.00	50.09	0.02	-52.70	0.000		22				
1 A 3 b v Road Transportation, Motorcycles: Gasoline	NM VOC	44.97	2.27	3.00	50.00	50.09	0.16	-94.94	0.037	3	13	3	3	14	4
1 A 3 c Railways: Liquid Fuels	NM VOC	0.15	0.05	5.00	75.00	75.17	0.00	-68.93	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	NM VOC	5.22	2.80	4.77	19.09	19.68	0.04	-46.39	0.000	13	11	15			
1 A 3 d Domestic Navigation: Gaseous Fuels	NM VOC	0.00	0.03	10.00	50.00	50.99	0.00		0.000						
1 A 3 d Domestic Navigation: Gasoline	NM VOC	0.00	0.01	5.00	50.00	50.25	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	NM VOC	0.07	0.09	15.00	20.00	25.00	0.00	23.19	0.000						
1 A 3 e Other Transportation: Diesel Oil	NM VOC	0.32	0.09	5.00	20.00	20.62	0.00	-73.01	0.000						
1 A 3 e Other Transportation: Gaseous fuels	NM VOC	0.00	0.00	5.00	30.00	30.41	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	NM VOC	0.33	0.04	10.00	75.00	75.66	0.00	-88.77	0.000						

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1 A 4 a Commercial/Institutional: Diesel Oil	NM VOC	0.29	0.21	5.00	20.00	20.62	0.00	-26.80	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	NM VOC	0.00	0.00	10.00	30.00	31.62	0.00	190.26	0.000						
1 A 4 a Commercial/Institutional: Gasoline	NM VOC	2.47	1.32	5.00	20.00	20.62	0.01	-46.64	0.000	18	17				
1 A 4 a Commercial/Institutional: Liquid Fuels	NM VOC	0.12	0.01	20.00	30.00	36.06	0.00	-94.68	0.000						
1 A 4 b Residential: Biomass	NM VOC	17.57	7.14	10.00	75.00	75.66	3.54	-59.38	0.001	5	5	17	8	7	
1 A 4 b Residential: Gaseous Fuels	NM VOC	0.00	0.00	10.00	30.00	31.62	0.00	-38.84	0.000						
1 A 4 b Residential: Liquid Fuels	NM VOC	4.99	3.84	3.68	14.72	15.18	0.04	-23.07	0.000	14	9	10			
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	NM VOC	0.10	0.65	10.00	75.00	75.66	0.03	572.01	0.000			20			
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	NM VOC	0.00	0.00	10.00	30.00	31.62	0.00	-63.88	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	NM VOC	1.01	0.91	5.00	20.00	20.62	0.00	-10.02	0.000		20	21			
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	NM VOC	3.08	2.01	2.48	16.15	16.34	0.01	-34.57	0.000	16	14	16			
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	NM VOC	0.17	0.00					-100.00							
1 A 5 b Mobile: Biomass	NM VOC	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	NM VOC	0.89	0.04	3.56	66.56	66.65	0.00	-95.89	0.000						

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1 B 1 b Coke production	NMVOC	0.01	0.01	5.00	900.00	900.01	0.00	-8.50	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	NMVOC	0.00	0.00	50.00	30.00	58.31	0.00	40.31	0.000						
1 B 2 a Oil	NMVOC	30.75	C	0.00	51.21	51.21	3.05	C	C	4	2	13	6	8	15
1 B 2 b Natural gas	NMVOC	0.51	0.30	0.00	46.85	46.85	0.00	-41.50	0.000						
1 B 2 c Venting and flaring	NMVOC	0.28	C	17.24	98.52	100.02	0.00	C	C						
1 D International Aviation: Jet kerosene	NMVOC	0.09	0.09	10.00	100.00	100.50	0.00	0.61	0.000						
2 A 3 Glass Production	NMVOC	0.04	0.00	0.00	400.00	400.00	0.00	-90.11	0.000						
2 B 10 Other	NMVOC	5.97	1.83	0.00	38.60	38.60	0.06	-69.37	0.000	10	15		14		
2 C 1 Iron and Steel Production	NMVOC	0.11	0.08	3.92	156.71	156.76	0.00	-27.71	0.000						
2 C 3 Aluminium production	NMVOC	0.01	0.00					-100.00							
2 D 3 Other	NMVOC	89.95	50.8	9.66	9.70	13.69	5.88	-43.48	0.038	1	1	2	5	4	8
2 G 4 Other	NMVOC	0.04	0.02	15.00	100.00	101.12	0.00	-58.87	0.000						
2 H 1 Pulp and paper	NMVOC	6.74	6.19	6.09	100.10	100.28	4.68	-8.11	0.011	9	7	6	9	6	7
2 H 2 Food and beverages industry	NMVOC	0.31	0.51	20.00	200.00	201.00	0.13	64.16	0.000					15	13
2 H 3 Other	NMVOC	0.10	0.05	0.00	400.00	400.00	0.01	-46.87	0.000						
3 B 1 Dairy cattle	NMVOC	14.42	7.34	20.00	200.00	201.00	26.40	-49.14	0.016	6	4	9	2	2	6
3 B 1 Non-dairy cattle	NMVOC	7.11	6.63	20.00	200.00	201.00	21.56	-6.76	0.051	8	6	4	7	3	2
3 B 3 Swine	NMVOC	1.33	0.68	20.00	200.00	201.00	0.23	-48.57	0.000		23		13	13	
3 B 4 Fur-bearing animals	NMVOC	0.32	0.21	20.00	200.00	201.00	0.02	-32.64	0.000						
3 B 4 Goats	NMVOC	0.00	0.01	20.00	200.00	201.00	0.00	192.25	0.000						

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3 B 4 Horses	NMVOC	2.91	3.27	20.00	200.00	201.00	5.26	12.64	0.015	17	10	7	10	5	5
3 B 4 Poultry	NMVOC	0.84	1.51	14.20	142.02	142.72	0.57	79.89	0.002		16	14		10	9
3 B 4 Sheep	NMVOC	0.24	0.42	20.00	200.00	201.00	0.09	72.77	0.000						
3 D a 2 a Animal manure applied to soils	NMVOC	9.51	7.40	5.00	200.00	200.06	26.61	-22.22	0.046	7	3	5	4	1	3
3 D a 2 b Sewage sludge applied to soils	NMVOC	0.02	0.08	5.00	200.00	200.06	0.00	237.52	0.000						
3 D a 3 Urine and dung deposited by grazing animals	NMVOC	0.26	0.26	20.00	200.00	201.00	0.03	0.27	0.000						
3 D e Cultivated crops	NMVOC	1.21	1.08	5.00	150.00	150.08	0.32	-10.51	0.001		19	18		11	11
5 A 1 Managed waste disposal sites	NMVOC	2.16	0.40	55.00	92.00	107.19	0.02	-81.49	0.000	20					
5 C 1 Waste Incineration	NMVOC	0.01	0.02	56.30	159.70	169.33	0.00	31.37	0.000						
5 D 1 Domestic wastewater	NMVOC	0.03	0.03	0.00	167.21	167.21	0.00	-10.79	0.000						
Total		366.83	134.00			21.42	100.00	-63.47	5.873						

Table A1-11 Summary of the key source and uncertainty analysis of NO_x emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	NO _x	2.45	9.93	1.51	37.77	37.80	1.17	305.79	0.014	21	3	4		7	8
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	NO _x	0.51	0.08	1.87	18.65	18.75	0.00	-84.71	0.000						
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	NO _x	2.69	0.27	1.49	14.93	15.01	0.00	-90.15	0.000	20		24			
1 A 1 a Public Electricity and Heat Production: Other Fuels	NO _x	0.61	1.64	2.46	16.40	16.58	0.01	168.96	0.000		18	19			
1 A 1 a Public Electricity and Heat Production: Peat	NO _x	2.08	0.28	1.90	19.01	19.11	0.00	-86.61	0.000	27		26			
1 A 1 a Public Electricity and Heat Production: Solid Fuels	NO _x	6.01	0.26	1.51	15.11	15.18	0.00	-95.74	0.000	8		9			
1 A 1 b Petroleum refining: Gaseous Fuels	NO _x	0.00	0.12	2.00	50.00	50.04	0.00		0.000						
1 A 1 b Petroleum refining: Liquid Fuels	NO _x	2.29	0.64	10.00	50.00	50.99	0.01	-72.05	0.000	24	29	32	18		
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	NO _x	0.50	0.39	5.00	50.00	50.25	0.00	-21.52	0.000		35				
1 A 2 a Iron and Steel: Biomass	NO _x	0.00	C	5.00	50.00	50.25	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	NO _x	0.01	0.10	5.00	50.00	50.25	0.00	645.85	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 a Iron and Steel: Liquid Fuels	NO _x	1.33	C	5.00	50.00	50.25	0.01	C	C	31	31				
1 A 2 a Iron and Steel: Solid Fuels	NO _x	0.36	0.18	2.00	50.00	50.04	0.00	-51.70	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	NO _x	0.01	0.01	5.00	50.00	50.25	0.00	7.85	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	NO _x	0.16	0.08	5.00	50.00	50.25	0.00	-47.81	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	NO _x	0.01	0.00					-100.00							
1 A 2 c Chemicals: Biomass	NO _x	0.07	0.12	5.00	50.00	50.25	0.00	72.70	0.000						
1 A 2 c Chemicals: Gaseous Fuels	NO _x	0.16	0.05	5.00	50.00	50.25	0.00	-68.21	0.000						
1 A 2 c Chemicals: Liquid Fuels	NO _x	0.55	0.32	5.00	50.00	50.25	0.00	-41.28	0.000						
1 A 2 c Chemicals: Other Fuels	NO _x	0.01	C	10.00	50.00	50.99	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	NO _x	0.21	C	2.00	50.00	50.04	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	NO _x	4.92	2.62	8.00	50.00	50.64	0.15	-46.64	0.000	10	14	35	10	13	
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	NO _x	0.07	0.04	5.00	50.00	50.25	0.00	-40.80	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Liquid Fuels	NO _x	3.69	0.47	5.00	50.00	50.25	0.00	-87.14	0.000	14	33	20	12		14
1 A 2 d Pulp, Paper and Print: Other Fuels	NO _x	0.12	0.02	10.00	50.00	50.99	0.00	-82.98	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	NO _x	0.57	0.01	7.00	50.00	50.49	0.00	-97.71	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	NO _x	0.03	0.11	5.00	50.00	50.25	0.00	248.67	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	NO _x	0.27	0.11	5.00	50.00	50.25	0.00	-59.07	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	NO _x	1.09	0.10	5.00	50.00	50.25	0.00	-90.90	0.000			34			
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	NO _x	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	NO _x	0.18	0.01	5.00	50.00	50.25	0.00	-96.55	0.000						
1 A 2 f Non-metallic minerals: Biomass	NO _x	0.01	0.13	4.73	28.41	28.80	0.00	1229.90	0.000						

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1 A 2 f Non-metallic minerals:															
Gaseous Fuels	NO _x	0.07	0.08	3.90	21.20	21.55	0.00	16.74	0.000						
1 A 2 f Non-metallic minerals:															
Liquid Fuels	NO _x	2.23	C	9.33	18.69	20.89	0.00	C	C	25	32	27			
1 A 2 f Non-metallic minerals:															
Other Fuels	NO _x	0.00	0.29	10.00	30.00	31.62	0.00		0.000						
1 A 2 f Non-metallic minerals:															
Solid Fuels	NO _x	4.38	C	9.52	28.59	30.14	0.01	C	C	13	22	23	16		
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	NO _x	12.37	7.83	4.97	19.87	20.49	0.21	-36.71	0.001	4	6	11	9	9	
1 A 2 g viii Other: Biomass	NO _x	2.87	C	4.65	18.62	19.19	0.00	C	C	19	21				
1 A 2 g viii Other: Gaseous Fuels	NO _x	0.12	0.05	2.65	10.61	10.94	0.00	-58.92	0.000						
1 A 2 g viii Other: Liquid Fuels	NO _x	2.91	C	4.08	8.15	9.11	0.00	C	C	18	17	31			
1 A 2 g viii Other: Other Fuels	NO _x	0.00	C	3.58	14.32	14.76	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	NO _x	0.14	C	4.96	19.82	20.43	0.01	C	C		15	14			
1 A 3 a Domestic Aviation:															
Aviation Gasoline	NO _x	0.02	0.00	10.00	100.00	100.50	0.00	-92.74	0.000						
1 A 3 a Domestic Aviation:															
Jet Kerosene	NO _x	0.68	0.29	10.00	100.00	100.50	0.01	-57.97	0.000						

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1 A 3 b i Road Transportation, Cars: Biomass	NO _x	0.00	0.37	4.24	42.40	42.61	0.00		0.000		37				
1 A 3 b i Road Transportation, Cars: Diesel oil	NO _x	2.08	19.69	5.00	50.00	50.25	8.15	848.13	0.116	28	1	3		3	3
1 A 3 b i Road Transportation, Cars: Gasoline	NO _x	67.42	4.59	3.00	50.00	50.09	0.44	-93.19	0.219	1	9	1	2	8	1
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	NO _x	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	NO _x	0.98	9.04	5.00	50.00	50.25	1.72	826.62	0.024		5	5		5	6
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	NO _x	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	NO _x	6.00	0.17	3.00	50.00	50.09	0.00	-97.20	0.002	9		8	7		10
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	NO _x	0.02	0.89	4.60	46.00	46.23	0.01	4029.59	0.000		24	25			
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	NO _x	66.31	9.49	4.03	40.30	40.50	1.23	-85.69	0.090	2	4	2	3	6	4

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1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	NO _x	0.21	0.05	3.00	50.00	50.09	0.00	-77.02	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	NO _x	0.09	0.16	3.00	50.00	50.09	0.00	70.04	0.000						
1 A 3 c Railways: Liquid Fuels	NO _x	1.89	0.58	5.00	100.00	100.12	0.03	-69.30	0.000	29	30		11	17	
1 A 3 d Domestic Navigation: Gas/Diesel Oil	NO _x	2.35	3.54	2.66	5.33	5.96	0.00	50.33	0.000	23	11	10			
1 A 3 d Domestic Navigation: Gaseous Fuels	NO _x	0.00	0.21	10.00	10.00	14.14	0.00		0.000						
1 A 3 d Domestic Navigation: Gasoline	NO _x	0.00	0.00	5.00	10.00	11.18	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	NO _x	4.52	4.15	15.00	10.00	18.03	0.05	-8.24	0.001	11	10	12		15	
1 A 3 e Other Transportation: Diesel Oil	NO _x	2.39	0.69	5.00	20.00	20.62	0.00	-71.14	0.000	22	28	33			
1 A 3 e Other Transportation: Gaseous fuels	NO _x	0.00	0.00	5.00	50.00	50.25	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	NO _x	0.06	0.10	10.00	50.00	50.99	0.00	84.14	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	NO _x	2.09	1.18	5.00	20.00	20.62	0.00	-43.50	0.000	26	20				

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 a Commercial/Institutional: Gaseous Fuels	NO _x	0.06	0.18	10.00	50.00	50.99	0.00	192.04	0.000						
1 A 4 a Commercial/Institutional: Gasoline	NO _x	0.25	0.32	5.00	20.00	20.62	0.00	26.74	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	NO _x	3.20	0.08	20.00	50.00	53.85	0.00	-97.63	0.001	15		18	14		12
1 A 4 b Residential: Biomass	NO _x	3.20	2.88	10.00	50.00	50.99	0.18	-10.00	0.001	16	12	17	15	11	13
1 A 4 b Residential: Gaseous Fuels	NO _x	0.06	0.04	10.00	50.00	50.99	0.00	-37.47	0.000						
1 A 4 b Residential: Liquid Fuels	NO _x	7.36	1.31	3.20	11.69	12.12	0.00	-82.14	0.000	7	19	13	6		
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	NO _x	0.02	0.44	10.00	50.00	50.99	0.00	2548.52	0.000		34	29			
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	NO _x	0.02	0.01	10.00	50.00	50.99	0.00	-63.88	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	NO _x	0.01	0.19	5.00	20.00	20.62	0.00	2338.03	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	NO _x	15.18	4.97	2.93	9.53	9.97	0.02	-67.27	0.000	3	8	15	13		
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	NO _x	0.34	0.00					-100.00							
1 A 5 b Mobile: Biomass	NO _x	0.00	0.00	5.00	50.00	50.25	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	NO _x	4.39	0.95	3.20	50.16	50.26	0.02	-78.34	0.000	12	23	21	8		16

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 B 1 b Coke production	NO _x	0.00	0.00	5.00	400.00	400.03	0.00	-16.17	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	NO _x	0.01	0.00	50.00	20.00	53.85	0.00	-27.08	0.000						
1 B 2 a Oil	NO _x	0.32	C	3.07	23.39	23.59	0.00	C	C						
1 B 2 c Venting and flaring	NO _x	0.06	C	17.50	29.99	34.72	0.00	C	C						
1 D International Aviation: Jet kerosene	NO _x	0.55	0.76	10.00	100.00	100.50	0.05	37.31	0.000	26	28		14	17	
2 A 3 Glass Production	NO _x	0.73	0.00					-100.00							
2 B 10 Other	NO _x	1.28	0.74	0.00	49.62	49.62	0.01	-42.21	0.000	32	27				
2 B 2 Nitric Acid Production	NO _x	1.15	0.11	2.00	5.00	5.39	0.00	-90.75	0.000	33		30	19		
2 C 1 Iron and Steel Production	NO _x	0.99	0.82	2.93	43.92	44.01	0.01	-17.51	0.000		25				
2 C 2 Ferroalloys production	NO _x	0.30	0.04	5.00	75.00	75.17	0.00	-86.00	0.000						
2 C 3 Aluminium production	NO _x	0.01	0.00	2.00	50.00	50.04	0.00	-79.52	0.000						
2 C 7 Other	NO _x	0.39	0.29	4.00	50.00	50.16	0.00	-26.72	0.000						
2 G 4 Other	NO _x	0.02	0.01	14.38	7.15	16.06	0.00	-57.76	0.000						
2 H 1 Pulp and paper	NO _x	10.46	11.05	6.70	10.54	12.49	0.16	5.66	0.002	5	2	6	17	12	11
2 H 3 Other	NO _x	0.00	0.02	0.00	100.00	100.00	0.00		0.000						
3 B 1 Dairy cattle	NO _x	0.50	0.04	20.00	80.00	82.46	0.00	-91.88	0.000						
3 B 1 Non-dairy cattle	NO _x	0.26	0.12	20.00	80.00	82.46	0.00	-53.44	0.000						
3 B 3 Swine	NO _x	0.14	0.02	20.00	80.00	82.46	0.00	-85.51	0.000						
3 B 4 Fur-bearing animals	NO _x	0.04	0.03	20.00	80.00	82.46	0.00	-32.64	0.000						
3 B 4 Goats	NO _x	0.00	0.00	20.00	80.00	82.46	0.00	192.25	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
3 B 4 Horses	NO _x	0.06	0.07	20.00	80.00	82.46	0.00	12.64	0.000						
3 B 4 Poultry	NO _x	0.07	0.14	15.07	60.27	62.13	0.00	107.06	0.000						
3 B 4 Sheep	NO _x	0.01	0.02	20.00	80.00	82.46	0.00	72.77	0.000						
3 D a 1 Inorganic N fertilizers	NO _x	8.98	7.31	5.00	400.00	400.03	71.15	-18.65	0.213	6	7	7	1	1	2
3 D a 2 a Animal manure applied to soils	NO _x	3.09	2.83	5.00	400.00	400.03	10.70	-8.38	0.042	17	13	16	4	2	5
3 D a 2 b Sewage sludge applied to soils	NO _x	0.05	0.16	5.00	400.00	400.03	0.03	237.52	0.000					16	15
3 D a 2 c Other organic fertilizers applied to soils	NO _x	0.07	0.38	5.00	400.00	400.03	0.19	453.67	0.002		36			10	9
3 D a 3 Urine and dung deposited by grazing animals	NO _x	1.73	1.77	20.00	400.00	400.50	4.19	2.54	0.020	30	16	22	5	4	7
5 C 1 Waste Incineration	NO _x	0.09	0.18	13.88	304.46	304.78	0.03	92.06	0.000						
Total		278.64	127.04			27.27	100.00	-54.41	8.668						

Table A1-12 Summary of the key source and uncertainty analysis of PAH 1-4 emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	PAH ₁₋₄	0.27	0.37	1.51	75.67	75.69	0.00	34.42	0.012	6	4	5			
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	PAH ₁₋₄	0.00	0.00					-100.00							
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	PAH ₁₋₄	0.00	0.00	1.48	74.01	74.02	0.00	-64.07	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	PAH ₁₋₄	0.00	0.00	2.39	239.48	239.49	0.00	455.22	0.000						
1 A 1 a Public Electricity and Heat Production: Peat	PAH ₁₋₄	0.03	0.01	1.90	95.07	95.09	0.00	-63.65	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	PAH ₁₋₄	0.00	0.00	2.00	100.00	100.02	0.00	-87.88	0.000						
1 A 1 b Petroleum refining: Liquid Fuels	PAH ₁₋₄	0.00	0.00	10.00	100.00	100.50	0.00	-64.46	0.000						
1 A 2 a Iron and Steel: Biomass	PAH ₁₋₄	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	PAH ₁₋₄	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	PAH ₁₋₄	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	PAH ₁₋₄	0.00	0.00	5.00	100.00	100.12	0.00	-24.23	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 b Non-ferrous metals:															
Solid Fuels	PAH ₁₋₄	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	PAH ₁₋₄	0.01	0.00	5.00	100.00	100.12	0.00	-72.27	0.000						
1 A 2 c Chemicals: Liquid Fuels	PAH ₁₋₄	0.00	0.00	5.00	100.00	100.12	0.00	-70.54	0.000						
1 A 2 c Chemicals: Other Fuels	PAH ₁₋₄	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	PAH ₁₋₄	0.00	C	2.00	100.00	100.02	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	PAH ₁₋₄	0.76	0.14	8.00	100.00	100.32	0.00	-82.07	0.008	4	5	6			
1 A 2 d Pulp, Paper and Print: Liquid Fuels	PAH ₁₋₄	0.01	0.00	5.00	100.00	100.12	0.00	-71.72	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	PAH ₁₋₄	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	PAH ₁₋₄	0.00	0.00	7.00	100.00	100.24	0.00	-60.65	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	PAH ₁₋₄	0.01	0.00	5.00	100.00	100.12	0.00	-4.91	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	PAH ₁₋₄	0.00	0.00	5.00	100.00	100.12	0.00	-87.88	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco:															
Other Fuels	PAH ₁₋₄	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco:															
Solid Fuels	PAH ₁₋₄	0.00	0.00	5.00	100.00	100.12	0.00	-90.63	0.000						
1 A 2 f Non-metallic minerals:															
Biomass	PAH ₁₋₄	0.00	0.01	4.76	47.62	47.86	0.00	296.52	0.000						
1 A 2 f Non-metallic minerals:															
Liquid Fuels	PAH ₁₋₄	0.00	C	8.70	35.06	36.13	0.00	C	C						
1 A 2 f Non-metallic minerals:															
Solid Fuels	PAH ₁₋₄	0.00	C	8.57	43.30	44.14	0.00	C	C						
1 A 2 g viii Other: Biomass	PAH ₁₋₄	0.48	C	3.50	27.98	28.20	0.00	C	C	5	6	7			
1 A 2 g viii Other: Liquid Fuels	PAH ₁₋₄	0.01	C	2.83	16.98	17.22	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	PAH ₁₋₄	0.00	C	4.94	39.52	39.83	0.00	C	C						
1 A 3 b i Road Transportation, Cars: Diesel oil	PAH ₁₋₄	0.03	0.02	5.00	1000.0	1000.01	0.00	-47.39	0.001						
1 A 3 b i Road Transportation, Cars: Gasoline	PAH ₁₋₄	0.11	0.04	3.00	1000.0	1000.00	0.01	-59.74	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	PAH ₁₋₄	0.01	0.00	5.00	1000.0	1000.01	0.00	-43.98	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	PAH ₁₋₄	0.01	0.00	3.00	0	1000.00	0.00	-92.38	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	PAH ₁₋₄	0.06	0.01	4.35	870.25	870.26	0.00	-80.60	0.004						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	PAH ₁₋₄	0.00	0.00	3.00	0	1000.00	0.00	-85.38	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	PAH ₁₋₄	0.00	0.00	3.00	0	1000.00	0.00	20.08	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	PAH ₁₋₄	0.00	0.00	0.00	0	1000.00	0.00	28.19	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	PAH ₁₋₄	0.00	0.00	3.58	35.84	36.01	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	PAH ₁₋₄	0.01	0.00	15.00	50.00	52.20	0.00	-50.67	0.000						
1 A 4 a Commercial/Institutional: Biomass	PAH ₁₋₄	0.18	0.07	10.00	0	1000.05	0.02	-63.34	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	PAH ₁₋₄	0.01	0.00	20.00	100.00	101.98	0.00	-96.26	0.000						
1 A 4 b Residential: Biomass	PAH ₁₋₄	11.00	4.61	10.00	0	1000.05	99.12	-58.07	4.779	1	1	4	1	1	2

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 b Residential: Liquid Fuels	PAH ₁₋₄	0.04	0.00	20.00	100.00	101.98	0.00	-97.38	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	PAH ₁₋₄	0.05	0.41	10.00	0	1000.05	0.80	666.11	4.948	3	3			2	1
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	PAH ₁₋₄	0.00	0.00	7.82	73.58	73.99	0.00	-52.93	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	PAH ₁₋₄	0.09	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	PAH ₁₋₄	0.00	0.00	5.00	50.00	50.25	0.00	-35.46	0.000						
1 B 1 b Coke production	PAH ₁₋₄	0.03	0.02	5.00	100.00	100.12	0.00	-48.85	0.000						
1 B 2 a Oil	PAH ₁₋₄	0.00	0.00	7.50	0	1000.03	0.00	-32.35	0.000						
1 B 2 c Venting and flaring	PAH ₁₋₄	0.00	C	17.50	400.00	400.38	0.00	C	C						
2 C 1 Iron and Steel Production	PAH ₁₋₄	1.17	0.91	4.88	99.57	99.69	0.04	-22.54	0.067	3	2	2			4
2 C 3 Aluminium production	PAH ₁₋₄	3.28	0.01	2.00	100.00	100.02	0.00	-99.57	0.494	2		1			3
2 G 4 Other	PAH ₁₋₄	0.00	0.00	15.00	100.00	101.12	0.00	-58.87	0.000						
2 H 1 Pulp and paper	PAH ₁₋₄	0.01	0.02	6.63	994.01	994.04	0.00	38.31	0.007						
5 C 1 Waste Incineration	PAH ₁₋₄	0.01	0.01	53.01	708.07	710.05	0.00	40.12	0.001						
									32.12						
Total		17.71	6.81			680.68	100.00	-61.56	8						

Table A1-13 Summary of the key source and uncertainty analysis of Pb emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Pb	1.08	1.90	1.52	76.14	76.16	51.04	75.92	0.001	2	2			1	1
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Pb	0.18	0.02	1.60	79.80	79.81	0.01	-87.06	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Pb	0.51	0.20	2.39	79.83	79.86	0.61	-61.13	0.000	8	9			7	7
1 A 1 a Public Electricity and Heat Production: Peat	Pb	0.35	0.01	1.90	95.07	95.09	0.00	-97.73	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Pb	0.63	0.02	2.00	100.00	100.02	0.01	-97.56	0.000						
1 A 1 b Petroleum refining: Liquid Fuels	Pb	0.04	0.01	10.00	100.00	100.50	0.00	-69.06	0.000						
1 A 2 a Iron and Steel: Biomass	Pb	0.00	C	5.00	50.00	50.25	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Pb	0.06	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Pb	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Pb	0.01	0.00	5.00	100.00	100.12	0.00	-54.91	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Pb	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Pb	0.01	0.02	5.00	50.00	50.25	0.00	61.98	0.000						
1 A 2 c Chemicals: Liquid Fuels	Pb	0.03	0.01	5.00	100.00	100.12	0.00	-72.48	0.000						
1 A 2 c Chemicals: Other Fuels	Pb	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Pb	0.02	C	2.00	40.00	40.05	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	Pb	0.62	0.70	8.00	50.00	50.64	3.08	13.96	0.000	3	4			3	4
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Pb	0.27	0.06	5.00	100.00	100.12	0.09	-76.69	0.000	14				10	10
1 A 2 d Pulp, Paper and Print: Other Fuels	Pb	0.01	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Pb	0.06	0.00	7.00	40.00	40.61	0.00	-98.70	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Pb	0.01	0.03	5.00	50.00	50.25	0.00	319.90	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Pb	0.07	0.00	5.00	100.00	100.12	0.00	-95.05	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Pb	0.00	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Pb	0.02	0.00	5.00	40.00	40.31	0.00	-97.78	0.000						
1 A 2 f Non-metallic minerals: Biomass	Pb	0.00	0.04	4.76	28.57	28.97	0.00	2543.48	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Pb	0.06	C	9.82	39.30	40.51	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Pb	0.22	C	8.57	17.32	19.32	0.00	C	C						
1 A 2 g viii Other: Biomass	Pb	0.38	C	4.71	18.84	19.42	0.08	C	C	7	8				
1 A 2 g viii Other: Liquid Fuels	Pb	0.16	C	3.82	22.94	23.25	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	Pb	0.00	C	4.94	19.77	20.38	0.01	C	C	12	12				
1 A 3 a Domestic Aviation: Aviation Gasoline	Pb	0.95	0.09	10.00	100.00	100.50	0.22	-90.08	0.000	11			9	9	
1 A 3 b i Road Transportation, Cars: Gasoline	Pb	264.24	0.00	3.00	15.00	15.30	0.00	-100.00	0.001	1		1	1		2
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Pb	15.82	0.00	3.00	15.00	15.30	0.00	-100.00	0.000	4		6	5		
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Pb	0.40	0.00	3.00	15.00	15.30	0.00	-100.00	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Pb	0.79	0.00	3.00	15.00	15.30	0.00	-100.00	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Pb	6.09	0.46	0.00	75.00	75.00	2.95	-92.39	0.000		6	7	4	4	6
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Pb	0.01	0.01	3.58	71.67	71.76	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Pb	0.02	0.01	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 4 a Commercial/Institutional: Biomass	Pb	0.01	0.02	10.00	50.00	50.99	0.00	111.84	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Pb	0.19	0.00	20.00	100.00	101.98	0.00	-98.73	0.000						
1 A 4 b Residential: Biomass	Pb	0.59	0.54	10.00	50.00	50.99	1.85	-7.74	0.000	5	5		5	5	
1 A 4 b Residential: Liquid Fuels	Pb	0.25	0.00	20.00	100.00	101.98	0.00	-98.03	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Pb	0.00	0.07	10.00	50.00	50.99	0.04	2281.09	0.000	13	13				
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Pb	0.03	0.01	13.81	75.44	76.69	0.00	-56.95	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Pb	0.04	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Pb	1.95	0.01	8.29	84.27	84.67	0.00	-99.55	0.000						
1 B 2 c Venting and flaring	Pb	0.00	C	17.50	200.00	200.76	0.00	C	C						
2 A 3 Glass Production	Pb	1.31	0.02	0.00	50.00	50.00	0.00	-98.85	0.000						
2 B 10 Other	Pb	0.09	0.10	0.00	98.54	98.54	0.24	7.82	0.000	10	11		8	8	
2 C 1 Iron and Steel Production	Pb	23.39	0.58	3.67	35.02	35.21	1.01	-97.54	0.000	3	4		3	6	
2 C 2 Ferroalloys production	Pb	0.03	0.02	5.00	100.00	100.12	0.01	-40.84	0.000						
2 C 7 Other	Pb	52.05	2.51	4.00	50.00	50.16	38.64	-95.18	0.000	2	1	3	2	2	3
2 G 4 Other	Pb	0.00	0.00	15.00	100.00	101.12	0.00	-58.87	0.000						
2 H 1 Pulp and paper	Pb	0.40	0.13	6.34	45.32	45.76	0.09	-67.06	0.000	9	10				
2 H 3 Other	Pb	0.46	0.00	0.00	43.60	43.60	0.00	-99.75	0.000						
5 C 1 Waste Incineration	Pb	0.01	0.01	38.93	239.31	242.45	0.01	37.38	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
5 E Other	Pb	0.00	0.00	50.00	74.00	89.31	0.00	1.03	0.000						
Total		373.90	8.09			25.00	100.00	-97.84	0.506						

Table A1-14 Summary of the key source and uncertainty analysis of PM_{2.5} emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	PM _{2.5}	0.61	0.75	1.51	30.24	30.27	0.41	22.93	0.001	14	5	5	21	8	8
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	PM _{2.5}	0.00	0.00	1.87	93.27	93.29	0.00	-38.85	0.000						
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	PM _{2.5}	0.05	0.02	1.63	32.57	32.61	0.00	-69.14	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	PM _{2.5}	0.11	0.09	2.92	39.00	39.11	0.01	-22.91	0.000		26	30			
1 A 1 a Public Electricity and Heat Production: Peat	PM _{2.5}	0.46	0.00	1.90	38.03	38.08	0.00	-99.13	0.000	17		15	23		16
1 A 1 a Public Electricity and Heat Production: Solid Fuels	PM _{2.5}	0.92	0.02	1.83	36.70	36.74	0.00	-97.33	0.001	10		10	12		11
1 A 1 b Petroleum refining: Gaseous Fuels	PM _{2.5}	0.00	0.00	2.00	100.00	100.02	0.00		0.000						
1 A 1 b Petroleum refining: Liquid Fuels	PM _{2.5}	1.56	0.12	10.00	100.00	100.50	0.12	-92.27	0.012	7	21	7	3	14	1
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	PM _{2.5}	0.07	0.02	5.00	100.00	100.12	0.00	-71.49	0.000						
1 A 2 a Iron and Steel: Biomass	PM _{2.5}	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	100.00	100.12	0.00	547.35	0.000						
1 A 2 a Iron and Steel: Liquid Fuels	PM _{2.5}	0.05	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	PM _{2.5}	0.01	0.00	2.00	100.00	100.02	0.00	-67.81	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	100.00	100.12	0.00	61.77	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	PM _{2.5}	0.01	0.00	5.00	100.00	100.12	0.00	-63.64	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	PM _{2.5}	0.01	0.00					-100.00							

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 c Chemicals: Biomass	PM _{2.5}	0.03	0.01	5.00	100.00	100.12	0.00	-68.28	0.000						
1 A 2 c Chemicals: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	100.00	100.12	0.00	-52.31	0.000						
1 A 2 c Chemicals: Liquid Fuels	PM _{2.5}	0.06	0.01	5.00	100.00	100.12	0.00	-86.69	0.000						
1 A 2 c Chemicals: Other Fuels	PM _{2.5}	0.01	C	10.00	100.00	100.50	0.01	C	C			39			25
1 A 2 c Chemicals: Solid Fuels	PM _{2.5}	0.04	C	2.00	100.00	100.02	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	PM _{2.5}	1.74	0.23	8.00	100.00	100.32	0.44	-86.55	0.010	6	11	9	2	7	2
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	100.00	100.12	0.00	-11.20	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	PM _{2.5}	0.18	0.03	5.00	100.00	100.12	0.01	-82.44	0.000	30		34	20		24
1 A 2 d Pulp, Paper and Print: Other Fuels	PM _{2.5}	0.07	0.01	10.00	100.00	100.50	0.00	-89.55	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	PM _{2.5}	0.11	0.00	7.00	100.00	100.24	0.00	-99.93	0.000			31			22
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	PM _{2.5}	0.01	0.01	5.00	100.00	100.12	0.00	-12.15	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	100.00	100.12	0.00	-38.61	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	PM _{2.5}	0.05	0.00	5.00	100.00	100.12	0.00	-95.27	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	PM _{2.5}	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	PM _{2.5}	0.04	0.00	5.00	100.00	100.12	0.00	-99.96	0.000						
1 A 2 f Non-metallic minerals: Biomass	PM _{2.5}	0.00	0.00	4.08	40.78	40.99	0.00	-77.27	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 f Non-metallic minerals: Gaseous Fuels	PM _{2.5}	0.00	0.00	3.90	42.40	42.58	0.00	75.11	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	PM _{2.5}	0.04	C	9.84	59.07	59.88	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	PM _{2.5}	0.12	C	6.42	28.98	29.68	0.00	C	C			27			
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	PM _{2.5}	0.81	0.52	4.95	29.68	30.09	0.20	-35.29	0.000	12	7	13	13	11	17
1 A 2 g viii Other: Biomass	PM _{2.5}	1.09	C	3.83	30.64	30.88	0.02	C	C	9	19	12	8		15
1 A 2 g viii Other: Gaseous Fuels	PM _{2.5}	0.00	0.00	2.47	19.76	19.91	0.00	-33.65	0.000						
1 A 2 g viii Other: Liquid Fuels	PM _{2.5}	0.18	C	3.47	20.81	21.10	0.00	C	C	32		37			
1 A 2 g viii Other: Other Fuels	PM _{2.5}	0.00	C	3.58	28.63	28.86	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	PM _{2.5}	0.04	C	4.99	39.95	40.26	0.00	C	C						
1 A 3 a Domestic Aviation: Aviation Gasoline	PM _{2.5}	0.00	0.00	10.00	20.00	22.36	0.00	-93.09	0.000						
1 A 3 a Domestic Aviation: Jet Kerosene	PM _{2.5}	0.02	0.01	10.00	20.00	22.36	0.00	-60.01	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	PM _{2.5}	0.00	0.00	4.34	13.01	13.71	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	PM _{2.5}	0.36	0.11	5.00	15.00	15.81	0.00	-69.65	0.000	19	24				
1 A 3 b i Road Transportation, Cars: Gasoline	PM _{2.5}	0.18	0.04	3.00	15.00	15.30	0.00	-75.20	0.000	31					
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	PM _{2.5}	0.00	0.00	5.00	15.00	15.81	0.00		0.000						

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1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	PM _{2.5}	0.23	0.14	5.00	15.00	15.81	0.00	-39.70	0.000	25	20	26			
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	PM _{2.5}	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	PM _{2.5}	0.04	0.00	3.00	15.00	15.30	0.00	-93.86	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	PM _{2.5}	0.00	0.01	4.78	14.33	15.11	0.00	2145.56	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	PM _{2.5}	2.99	0.22	4.22	12.66	13.34	0.01	-92.64	0.001	4	13	2	10		10
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	PM _{2.5}	0.03	0.02	3.00	15.00	15.30	0.00	-28.18	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	PM _{2.5}	0.13	0.17	0.00	15.00	15.00	0.00	28.13	0.000	36	16	18			
1 A 3 b vii Road Transportation: Automobile road abrasion	PM _{2.5}	2.37	3.08	0.00	15.00	15.00	1.70	29.90	0.005	5	2	1	11	3	4
1 A 3 c Railways: Liquid Fuels	PM _{2.5}	0.04	0.02	5.00	10.00	11.18	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	PM _{2.5}	0.35	0.19	2.99	26.31	26.48	0.02	-44.78	0.000	20	14	23		19	
1 A 3 d Domestic Navigation: Gaseous Fuels	PM _{2.5}	0.00	0.00	10.00	40.00	41.23	0.00		0.000						
1 A 3 d Domestic Navigation: Gasoline	PM _{2.5}	0.00	0.00	5.00	40.00	40.31	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	PM _{2.5}	0.55	0.27	15.00	40.00	42.72	0.11	-50.66	0.000	16	9	24	15	16	29
1 A 3 e Other Transportation: Diesel Oil	PM _{2.5}	0.20	0.03	5.00	30.00	30.41	0.00	-85.67	0.000	28		25			

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1 A 3 e Other Transportation: Gaseous fuels	PM _{2.5}	0.00	0.00	5.00	10.00	11.18	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	PM _{2.5}	0.23	0.07	10.00	10.00	14.14	0.00	-71.27	0.000	26	28				
1 A 4 a Commercial/Institutional: Diesel Oil	PM _{2.5}	0.19	0.11	5.00	30.00	30.41	0.01	-41.52	0.000	29	23	38			
1 A 4 a Commercial/Institutional: Gaseous Fuels	PM _{2.5}	0.00	0.00	10.00	10.00	14.14	0.00	190.26	0.000						
1 A 4 a Commercial/Institutional: Gasoline	PM _{2.5}	0.03	0.05	5.00	30.00	30.41	0.00	41.53	0.000			40			
1 A 4 a Commercial/Institutional: Liquid Fuels	PM _{2.5}	0.27	0.00	20.00	10.00	22.36	0.00	-98.84	0.000	23		20			
1 A 4 b Residential: Biomass	PM _{2.5}	12.35	5.10	10.00	65.00	65.76	89.62	-58.72	0.027	1	1	11	1	1	6
1 A 4 b Residential: Gaseous Fuels	PM _{2.5}	0.00	0.00	10.00	65.00	65.76	0.00	-38.84	0.000						
1 A 4 b Residential: Liquid Fuels	PM _{2.5}	0.82	0.16	2.99	17.56	17.82	0.01	-80.28	0.000	11	17	17	9		28
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	PM _{2.5}	0.07	0.48	10.00	30.00	31.62	0.18	620.28	0.001		8	8		12	9
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	PM _{2.5}	0.00	0.00	10.00	30.00	31.62	0.00	-63.88	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	PM _{2.5}	0.02	0.03	5.00	30.00	30.41	0.00	16.12	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	PM _{2.5}	1.16	0.25	2.73	16.57	16.79	0.01	-78.20	0.000	8	10	14	16		26
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	PM _{2.5}	0.06	0.00					-100.00							
1 A 5 b Mobile: Biomass	PM _{2.5}	0.00	0.00	5.00	15.00	15.81	0.00		0.000						

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1 A 5 b Mobile: Liquid Fuels	PM _{2.5}	0.10	0.02	3.28	20.32	20.58	0.00	-82.79	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	PM _{2.5}	0.10	0.04	5.99	19.98	20.86	0.00	-54.82	0.000						
1 B 2 a Oil	PM _{2.5}	0.09	C	6.64	20.61	21.66	0.00	C	C						
1 B 2 c Venting and flaring	PM _{2.5}	0.05	C	17.50	100.00	101.52	0.02	C	C						30
1 D International Aviation: Jet kerosene	PM _{2.5}	0.01	0.02	10.00	20.00	22.36	0.00	73.98	0.000						
2 A 1 Cement Production	PM _{2.5}	0.57	0.05	2.00	30.00	30.07	0.00	-91.28	0.000	15		16	22		20
2 A 2 Lime Production	PM _{2.5}	0.27	0.06	5.36	51.64	51.91	0.01	-77.91	0.000	24	31	29			
2 A 3 Glass Production	PM _{2.5}	0.22	0.04	0.00	100.00	100.00	0.02	-80.11	0.000	27		32	17		23
2 B 10 Other	PM _{2.5}	0.10	0.02	0.00	56.18	56.18	0.00	-82.38	0.000						
2 B 5 Carbide production	PM _{2.5}	0.10	0.05	10.00	50.00	50.99	0.01	-46.00	0.000		33				
2 C 1 Iron and Steel Production	PM _{2.5}	3.68	0.72	4.23	33.82	34.08	0.48	-80.52	0.003	3	6	3	5	6	5
2 C 2 Ferroalloys production	PM _{2.5}	0.06	0.06	5.00	40.00	40.31	0.00	5.68	0.000		29	36			
2 C 3 Aluminium production	PM _{2.5}	0.15	0.05	2.00	40.00	40.05	0.00	-62.41	0.000	35	32				
2 C 7 Other	PM _{2.5}	0.17	0.03	4.00	40.00	40.20	0.00	-84.36	0.000	33		35			
2 D 3 Other	PM _{2.5}	0.00	0.00	10.00	100.00	100.50	0.00	9.15	0.000						
2 G 4 Other	PM _{2.5}	0.28	0.15	10.95	30.53	32.44	0.02	-46.52	0.000	22	18	33		21	
2 H 1 Pulp and paper	PM _{2.5}	6.23	1.90	6.34	18.13	19.20	1.07	-69.42	0.002	2	3	4	4	4	12
2 H 3 Other	PM _{2.5}	0.45	0.19	0.00	87.38	87.38	0.22	-57.80	0.000	18	15		18	10	
3 B 1 Dairy cattle	PM _{2.5}	0.16	0.12	20.00	150.00	151.33	0.26	-23.74	0.000	34	22	22	14	9	14
3 B 1 Non-dairy cattle	PM _{2.5}	0.10	0.10	20.00	150.00	151.33	0.18	3.18	0.000		25	21	24	13	13
3 B 3 Swine	PM _{2.5}	0.12	0.08	20.00	150.00	151.33	0.11	-35.41	0.000		27	41	19	15	21
3 B 4 Fur-bearing animals	PM _{2.5}	0.00	0.00	20.00	200.00	201.00	0.00	-32.64	0.000						
3 B 4 Goats	PM _{2.5}	0.00	0.00	20.00	200.00	201.00	0.00	192.25	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
3 B 4 Horses	PM _{2.5}	0.02	0.02	20.00	200.00	201.00	0.02	12.64	0.000					20	27
3 B 4 Poultry	PM _{2.5}	0.04	0.06	13.72	116.30	117.10	0.04	61.07	0.000	30	28			18	19
3 B 4 Sheep	PM _{2.5}	0.00	0.00	20.00	200.00	201.00	0.00	72.77	0.000						
3 D c Farm-level agricultural operations	PM _{2.5}	0.30	0.23	20.00	150.00	151.33	0.98	-22.59	0.002	21	12	19	7	5	7
5 A Solid waste disposal	PM _{2.5}	0.00	0.00	10.00	385.00	385.13	0.00	-62.15	0.000						
5 C 1 Waste Incineration	PM _{2.5}	0.04	0.05	66.70	184.79	196.46	0.06	13.12	0.000					17	18
5 E Other	PM _{2.5}	0.80	0.80	50.00	67.00	83.60	3.61	1.12	0.021	13	4	6	6	2	3
Total		45.35	17.66			20.05	100.00	-61.05	2.962						

Table A1-15 Summary of the key source and uncertainty analysis of PM₁₀ emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	PM ₁₀	0.80	1.11	1.51	30.25	30.29	0.34	38.62	0.001	15	6	9	21	9	13
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	PM ₁₀	0.00	0.00	1.87	93.27	93.29	0.00	-38.85	0.000						
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	PM ₁₀	0.11	0.02	1.63	32.63	32.67	0.00	-83.77	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	PM ₁₀	0.11	0.09	2.92	39.00	39.11	0.00	-24.62	0.000						
1 A 1 a Public Electricity and Heat Production: Peat	PM ₁₀	0.60	0.00	1.90	38.03	38.08	0.00	-99.34	0.000	21		19			16
1 A 1 a Public Electricity and Heat Production: Solid Fuels	PM ₁₀	1.04	0.02	1.83	36.70	36.74	0.00	-97.66	0.001	12		11	15		12
1 A 1 b Petroleum refining: Gaseous Fuels	PM ₁₀	0.00	0.00	2.00	100.00	100.02	0.00		0.000						
1 A 1 b Petroleum refining: Liquid Fuels	PM ₁₀	1.58	0.12	10.00	100.00	100.50	0.05	-92.25	0.013	8		7	6		5
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	PM ₁₀	0.10	0.03	5.00	100.00	100.12	0.00	-75.36	0.000						
1 A 2 a Iron and Steel: Biomass	PM ₁₀	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	100.00	100.12	0.00	547.35	0.000						
1 A 2 a Iron and Steel: Liquid Fuels	PM ₁₀	0.07	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	PM ₁₀	0.01	0.00	2.00	100.00	100.02	0.00	-74.52	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	100.00	100.12	0.00	61.77	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 b Non-ferrous metals: Liquid Fuels	PM ₁₀	0.01	0.00	5.00	100.00	100.12	0.00	-63.60	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	PM ₁₀	0.01	0.00					-100.00							
1 A 2 c Chemicals: Biomass	PM ₁₀	0.04	0.01	5.00	100.00	100.12	0.00	-70.05	0.000						
1 A 2 c Chemicals: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	100.00	100.12	0.00	-52.31	0.000						
1 A 2 c Chemicals: Liquid Fuels	PM ₁₀	0.07	0.01	5.00	100.00	100.12	0.00	-86.01	0.000						
1 A 2 c Chemicals: Other Fuels	PM ₁₀	0.01	C	10.00	100.00	100.50	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	PM ₁₀	0.05	C	2.00	100.00	100.02	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	PM ₁₀	2.36	0.31	8.00	100.00	100.32	0.30	-86.68	0.022	7	14	6	3	10	4
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	100.00	100.12	0.00	-11.20	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	PM ₁₀	0.22	0.04	5.00	100.00	100.12	0.00	-82.43	0.000	35		27			20
1 A 2 d Pulp, Paper and Print: Other Fuels	PM ₁₀	0.07	0.01	10.00	100.00	100.50	0.00	-89.56	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	PM ₁₀	0.13	0.00	7.00	100.00	100.24	0.00	-99.92	0.000						23
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	PM ₁₀	0.02	0.01	5.00	100.00	100.12	0.00	-12.04	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	100.00	100.12	0.00	-38.61	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	PM ₁₀	0.06	0.00	5.00	100.00	100.12	0.00	-95.42	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	PM ₁₀	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	PM ₁₀	0.04	0.00	5.00	100.00	100.12	0.00	-99.96	0.000						
1 A 2 f Non-metallic minerals: Biomass	PM ₁₀	0.01	0.00	4.08	40.78	40.98	0.00	-77.24	0.000						
1 A 2 f Non-metallic minerals: Gaseous Fuels	PM ₁₀	0.00	0.00	3.90	42.40	42.58	0.00	75.11	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	PM ₁₀	0.04	C	9.86	49.28	50.26	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	PM ₁₀	0.14	C	6.40	28.96	29.66	0.00	C	C			29			
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	PM ₁₀	0.85	0.55	4.95	29.68	30.09	0.08	-35.29	0.000	13	11	28	19	14	
1 A 2 g viii Other: Biomass	PM ₁₀	1.48	C	3.99	31.94	32.19	0.01	C	C	10	21	10	11		11
1 A 2 g viii Other: Gaseous Fuels	PM ₁₀	0.00	0.00	2.47	19.76	19.91	0.00	-33.65	0.000						
1 A 2 g viii Other: Liquid Fuels	PM ₁₀	0.19	C	3.56	21.36	21.65	0.00	C	C			30			
1 A 2 g viii Other: Other Fuels	PM ₁₀	0.00	C	3.58	28.63	28.86	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	PM ₁₀	0.04	C	5.00	39.97	40.28	0.00	C	C						
1 A 3 a Domestic Aviation: Aviation Gasoline	PM ₁₀	0.00	0.00	10.00	20.00	22.36	0.00	-93.09	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 a Domestic Aviation: Jet Kerosene	PM ₁₀	0.02	0.01	10.00	20.00	22.36	0.00	-60.01	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	PM ₁₀	0.00	0.00	4.34	13.01	13.71	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	PM ₁₀	0.36	0.11	5.00	15.00	15.81	0.00	-69.65	0.000	23		25			
1 A 3 b i Road Transportation, Cars: Gasoline	PM ₁₀	0.18	0.04	3.00	15.00	15.30	0.00	-75.20	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	PM ₁₀	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	PM ₁₀	0.23	0.14	5.00	15.00	15.81	0.00	-39.70	0.000	33	25				
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	PM ₁₀	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	PM ₁₀	0.04	0.00	3.00	15.00	15.30	0.00	-93.86	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	PM ₁₀	0.00	0.01	4.78	14.33	15.11	0.00	2145.56	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	PM ₁₀	2.99	0.22	4.22	12.66	13.34	0.00	-92.64	0.001	5	17	5	14		14
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	PM ₁₀	0.03	0.02	3.00	15.00	15.30	0.00	-28.18	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	PM ₁₀	0.64	0.83	0.00	15.00	15.00	0.05	28.13	0.000	19	8	14			

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b vii Road Transportation: Automobile road abrasion	PM ₁₀	11.85	15.39	0.00	15.00	15.00	16.08	29.90	0.040	2	1	1	5	3	1
1 A 3 c Railways: Liquid Fuels	PM ₁₀	0.05	0.02	5.00	10.00	11.18	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	PM ₁₀	0.36	0.20	2.95	26.33	26.50	0.01	-44.21	0.000	24	20				
1 A 3 d Domestic Navigation: Gasoline	PM ₁₀	0.00	0.00	5.00	40.00	40.31	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	PM ₁₀	0.61	0.30	15.00	40.00	42.72	0.05	-50.67	0.000	20	15		18		
1 A 3 e Other Transportation: Diesel Oil	PM ₁₀	0.21	0.03	5.00	30.00	30.41	0.00	-85.67	0.000			26			
1 A 3 e Other Transportation: Gaseous fuels	PM ₁₀	0.00	0.00	5.00	10.00	11.18	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	PM ₁₀	0.24	0.07	10.00	10.00	14.14	0.00	-71.30	0.000	31					
1 A 4 a Commercial/Institutional: Diesel Oil	PM ₁₀	0.20	0.12	5.00	30.00	30.41	0.00	-41.52	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	PM ₁₀	0.00	0.00	10.00	10.00	14.14	0.00	190.26	0.000						
1 A 4 a Commercial/Institutional: Gasoline	PM ₁₀	0.04	0.05	5.00	30.00	30.41	0.00	41.53	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	PM ₁₀	0.30	0.00	20.00	10.00	22.36	0.00	-98.94	0.000	29		21			
1 A 4 b Residential: Biomass	PM ₁₀	13.01	5.37	10.00	65.00	65.76	37.60	-58.72	0.046	1	2	3	1	1	2
1 A 4 b Residential: Gaseous Fuels	PM ₁₀	0.00	0.00	10.00	65.00	65.76	0.00	-38.84	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 b Residential: Liquid Fuels	PM ₁₀	0.85	0.17	2.99	17.58	17.83	0.00	-79.83	0.000	14	23	20	13		
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	PM ₁₀	0.07	0.51	10.00	30.00	31.62	0.08	628.65	0.001		12	13		15	15
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	PM ₁₀	0.00	0.00	10.00	30.00	31.62	0.00	-63.88	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	PM ₁₀	0.02	0.03	5.00	30.00	30.41	0.00	16.12	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	PM ₁₀	1.22	0.27	2.75	16.55	16.78	0.01	-78.24	0.000	11	16	16	20		
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	PM ₁₀	0.12	0.00					-100.00							
1 A 5 b Mobile: Biomass	PM ₁₀	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	PM ₁₀	0.10	0.02	3.29	20.76	21.02	0.00	-82.39	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	PM ₁₀	0.33	0.20	6.00	19.99	20.87	0.01	-39.14	0.000	26	19				
1 B 2 a Oil	PM ₁₀	0.10	C	6.97	19.71	20.91	0.00	C	C						
1 B 2 c Venting and flaring	PM ₁₀	0.05	C	17.50	100.00	101.52	0.01	C	C						
1 D International Aviation: Jet kerosene	PM ₁₀	0.01	0.02	10.00	20.00	22.36	0.00	73.98	0.000						
2 A 1 Cement Production	PM ₁₀	0.71	0.06	2.00	30.00	30.07	0.00	-92.03	0.000	17		18			18
2 A 2 Lime Production	PM ₁₀	0.30	0.07	5.36	51.64	51.91	0.00	-77.91	0.000	28		22			
2 A 3 Glass Production	PM ₁₀	0.26	0.06	0.00	100.00	100.00	0.01	-78.82	0.000	30		24	17		19
2 B 10 Other	PM ₁₀	0.11	0.02	0.00	82.60	82.60	0.00	-82.12	0.000						

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
2 B 5 Carbide production	PM ₁₀	0.11	0.06	10.00	50.00	50.99	0.00	-46.00	0.000						
2 C 1 Iron and Steel Production	PM ₁₀	4.33	0.90	3.85	30.76	31.00	0.23	-79.26	0.005	4	7	4	7	11	8
2 C 2 Ferroalloys production	PM ₁₀	0.08	0.09	5.00	40.00	40.31	0.00	5.68	0.000						
2 C 3 Aluminium production	PM ₁₀	0.32	0.12	2.00	40.00	40.05	0.01	-62.41	0.000	27					
2 C 7 Other	PM ₁₀	0.22	0.03	4.00	40.00	40.20	0.00	-86.14	0.000	34		23			
2 D 3 Other	PM ₁₀	0.02	0.02	10.00	97.00	97.51	0.00	8.14	0.000						
2 G 4 Other	PM ₁₀	0.33	0.20	10.63	32.35	34.05	0.01	-38.55	0.000	25	18				
2 H 1 Pulp and paper	PM ₁₀	8.62	2.41	6.34	18.13	19.20	0.65	-72.03	0.005	3	3	2	4	8	9
2 H 3 Other	PM ₁₀	1.52	1.32	0.00	120.30	120.30	7.55	-13.28	0.007	9	5	12	8	4	6
3 B 1 Dairy cattle	PM ₁₀	0.24	0.18	20.00	150.00	151.33	0.23	-23.71	0.000	32	22		16	12	22
3 B 1 Non-dairy cattle	PM ₁₀	0.15	0.15	20.00	150.00	151.33	0.16	3.12	0.000		24		22	13	17
3 B 3 Swine	PM ₁₀	0.66	0.42	20.00	150.00	151.33	1.21	-36.22	0.000	18	13		9	7	21
3 B 4 Fur-bearing animals	PM ₁₀	0.00	0.00	20.00	200.00	201.00	0.00	-32.64	0.000						
3 B 4 Goats	PM ₁₀	0.00	0.00	20.00	200.00	201.00	0.00	192.25	0.000						
3 B 4 Horses	PM ₁₀	0.03	0.04	20.00	200.00	201.00	0.02	12.64	0.000						
3 B 4 Poultry	PM ₁₀	0.45	0.70	14.42	117.67	118.55	2.06	56.02	0.007	22	10	15	12	5	7
3 B 4 Sheep	PM ₁₀	0.00	0.01	20.00	200.00	201.00	0.00	72.77	0.000						
3 D c Farm-level agricultural operations	PM ₁₀	2.58	2.15	20.00	150.00	151.33	31.77	-16.76	0.034	6	4	8	2	2	3
5 A Solid waste disposal	PM ₁₀	0.00	0.00	10.00	379.00	379.13	0.00	-62.15	0.000						
5 C 1 Waste Incineration	PM ₁₀	0.04	0.05	66.84	184.26	196.01	0.03	13.09	0.000						
5 E Other	PM ₁₀	0.80	0.80	50.00	67.00	83.60	1.37	1.12	0.009	16	9	17	10	6	10
Total		66.36	36.82			15.64	100.00	-44.52	4.419						

Table A1-16 Summary of the key source and uncertainty analysis of Se emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Se	0.03	0.12	1.52	76.21	76.22	0.04	243.62	0.379	8	3	4			4
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Se	0.02	0.00	1.61	80.57	80.59	0.00	-87.86	0.022	12		12			
1 A 1 a Public Electricity and Heat Production: Other Fuels	Se	0.01	0.01	2.39	343.26	343.26	0.01	177.61	0.084		8	17			
1 A 1 a Public Electricity and Heat Production: Peat	Se	0.05	0.00	1.90	95.07	95.09	0.00	-93.54	0.227	6		5			5
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Se	0.08	0.00	2.00	100.00	100.02	0.00	-97.07	0.688	4		3	4		3
1 A 1 b Petroleum refining: Liquid Fuels	Se	0.00	0.00	10.00	100.00	100.50	0.00	-69.19	0.001						
1 A 2 a Iron and Steel: Biomass	Se	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Se	0.01	C	5.00	100.00	100.12	0.00	C	C			20			
1 A 2 a Iron and Steel: Solid Fuels	Se	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00	-56.83	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Se	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Se	0.00	0.00	5.00	40.00	40.31	0.00	-24.35	0.000						
1 A 2 c Chemicals: Liquid Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00	-72.57	0.001						
1 A 2 c Chemicals: Solid Fuels	Se	0.00	C	2.00	40.00	40.05	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Biomass	Se	0.07	0.04	8.00	40.00	40.79	0.00	-51.03	0.031	5	5	6			
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Se	0.03	0.01	5.00	100.00	100.12	0.00	-76.86	0.060	9		9			
1 A 2 d Pulp, Paper and Print: Solid Fuels	Se	0.01	0.00	7.00	40.00	40.61	0.00	-98.18	0.001	17		18			
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Se	0.00	0.00	5.00	40.00	40.31	0.00	168.03	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Se	0.01	0.00	5.00	100.00	100.12	0.00	-95.36	0.006	16		19			
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Se	0.00	0.00	5.00	40.00	40.31	0.00	-97.36	0.000						
1 A 2 f Non-metallic minerals: Biomass	Se	0.00	0.00	4.76	19.05	19.64	0.00	1013.04	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Se	0.01	C	9.88	39.51	40.72	0.00	C	C	18					
1 A 2 f Non-metallic minerals: Solid Fuels	Se	0.03	C	8.57	17.32	19.32	0.00	C	C	10		8			
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Se	0.00	0.00	4.97	99.44	99.56	0.00		0.000						
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Se	0.00	0.00	4.93	98.58	98.70	0.00	47.27	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Se	0.05	C	4.59	18.34	18.90	0.00	C	C	7	7	7			
1 A 2 g viii Other: Liquid Fuels	Se	0.02	C	3.93	23.60	23.92	0.00	C	C	15		14			
1 A 2 g viii Other: Solid Fuels	Se	0.00	C	4.93	19.72	20.33	0.00	C	C		10	16			
1 A 3 b i Road Transportation, Cars: Biomass	Se	0.00	0.00	3.70	73.91	74.01	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Se	0.00	0.00	5.00	100.00	100.12	0.00	870.53	0.000						
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Se	0.00	0.00	3.00	100.00	100.04	0.00	-50.53	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Se	0.00	0.00	4.92	98.41	98.54	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Se	0.00	0.00	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of bio-diesel and biogasoline	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Se	0.00	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Se	0.00	0.00	3.56	71.11	71.20	0.00	18364.11	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Se	0.00	0.00	4.87	97.31	97.43	0.00	-12.98	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of bi-odiesel and biogasoline	Se	0.00	0.00	3.60	71.92	72.01	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Se	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Se	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 c Railways: Liquid Fuels	Se	0.00	0.00	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Se	0.00	0.00	3.58	58.42	58.53	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Se	0.00	0.00	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 3 e Other Transportation: Biomass	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 e Other Transportation: Diesel Oil	Se	0.00	0.00	5.00	100.00	100.12	0.00	-3.69	0.000						
1 A 3 e Other Transportation: Other Fossil Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Biomass	Se	0.00	0.00	10.00	40.00	41.23	0.00	112.34	0.000						

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1 A 4 a Commercial/Institutional: Diesel Oil	Se	0.00	0.00	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional: Ethanol	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: FAME	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional: Gasoline	Se	0.00	0.00	5.00	100.00	100.12	0.00	-14.31	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	Se	0.02	0.00	20.00	100.00	101.98	0.00	-99.05	0.035	14		11			
1 A 4 a Commercial/Institutional: Other Fossil Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Se	0.09	0.08	9.98	39.92	41.15	0.01	-7.56	0.016	3	4	13			
1 A 4 b Residential: Liquid Fuels	Se	0.02	0.00	6.12	51.83	52.19	0.00	-94.15	0.011	11		10			
1 A 4 b Residential: Other Fossil Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Se	0.00	0.01	9.10	36.92	38.03	0.00	2603.14	0.002		9	15			
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Se	0.00	0.00	3.54	70.83	70.92	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Se	0.00	0.00	5.00	100.00	100.12	0.00	104.52	0.000						

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1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Se	0.01	0.00	5.32	57.53	57.78	0.00	-29.33	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Se	0.01	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Se	0.00	0.00	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 1 b Coke production	Se	0.02	0.02	5.00	900.00	900.01	0.12	-8.50	0.090	13	6		3		
2 A 3 Glass Production	Se	0.14	0.26	0.00	500.00	500.00	8.17	91.27	29.683	2	2	2	2	2	2
2 C 1 Iron and Steel Production	Se	0.29	0.49	4.88	879.10	879.11	91.65	67.92	219.912	1	1	1	1	1	1
5 C 1 Waste Incineration	Se	0.00	0.00	21.84	557.01	557.43	0.00	32.31	0.001						
Total		1.01	1.11			407.76	100.00	9.53	158.512						

Table A1-17 Summary of the key source and uncertainty analysis of SO₂ emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	SO ₂	0.77	1.51	1.48	14.79	14.86	2.67	96.18	0.000	27	3	2		7	9
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	SO ₂	0.02	0.00					-100.00							
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	SO ₂	3.45	0.20	1.61	16.14	16.22	0.06	-94.22	0.000	12	19	12	18		25
1 A 1 a Public Electricity and Heat Production: Other Fuels	SO ₂	0.49	0.40	2.87	66.91	66.97	3.84	-18.52	0.000	32	8	14		6	7
1 A 1 a Public Electricity and Heat Production: Peat	SO ₂	2.41	0.26	1.90	19.01	19.11	0.13	-89.10	0.000	17	14	30	23	24	
1 A 1 a Public Electricity and Heat Production: Solid Fuels	SO ₂	8.39	0.16	1.63	16.30	16.38	0.04	-98.09	0.000	2	24	4	10		10
1 A 1 b Petroleum refining: Liquid Fuels	SO ₂	2.50	0.13	10.00	70.00	70.71	0.47	-94.65	0.000	16	26	17	7	17	11
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	SO ₂	0.40	0.15	5.00	70.00	70.18	0.59	-62.08	0.000		25	35		15	24
1 A 2 a Iron and Steel: Biomass	SO ₂	0.00	C	5.00	70.00	70.18	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 2 a Iron and Steel: Liquid Fuels	SO ₂	1.31	C	5.00	70.00	70.18	0.93	C	C	20	20		15	13	
1 A 2 a Iron and Steel: Solid Fuels	SO ₂	0.30	0.23	2.00	70.00	70.03	1.33	-23.75	0.000		18	24		12	18

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 b Non-ferrous metals: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	SO ₂	0.14	0.03	5.00	70.00	70.18	0.02	-80.86	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	SO ₂	0.03	0.00					-100.00							
1 A 2 c Chemicals: Biomass	SO ₂	0.02	0.06	5.00	70.00	70.18	0.08	146.16	0.000						
1 A 2 c Chemicals: Gaseous Fuels	SO ₂	0.01	0.00					-100.00							
1 A 2 c Chemicals: Liquid Fuels	SO ₂	0.66	0.07	5.00	70.00	70.18	0.11	-90.00	0.000	29			21	26	
1 A 2 c Chemicals: Other Fuels	SO ₂	0.02	C	10.00	70.00	70.71	0.69	C	C		22	27		14	21
1 A 2 c Chemicals: Solid Fuels	SO ₂	0.39	C	2.00	70.00	70.03	0.10	C	C					27	
1 A 2 d Pulp, Paper and Print: Biomass	SO ₂	2.05	0.53	8.00	70.00	70.46	7.31	-74.29	0.000	18	6	21	9	4	14
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Liquid Fuels	SO ₂	4.98	0.24	5.00	70.00	70.18	1.50	-95.18	0.001	6	16	9	2	11	4
1 A 2 d Pulp, Paper and Print: Other Fuels	SO ₂	0.27	0.02	10.00	70.00	70.71	0.01	-92.32	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	SO ₂	1.01	0.01	7.00	70.00	70.35	0.00	-98.81	0.000	22		28	17		22
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	SO ₂	0.01	0.03	5.00	70.00	70.18	0.02	180.06	0.000						

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1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	SO ₂	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	SO ₂	1.33	0.03	5.00	70.00	70.18	0.02	-97.92	0.000	19		23	14		17
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	SO ₂	0.03	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	SO ₂	0.35	0.03	5.00	70.00	70.18	0.03	-90.63	0.000						
1 A 2 f Non-metallic minerals: Biomass	SO ₂	0.00	0.00	4.23	25.38	25.73	0.00	-49.19	0.000						
1 A 2 f Non-metallic minerals: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 2 f Non-metallic minerals: Liquid Fuels	SO ₂	0.78	C	9.88	39.53	40.74	0.49	C	C	26	17	31		16	
1 A 2 f Non-metallic minerals: Solid Fuels	SO ₂	0.80	C	4.48	25.24	25.63	0.31	C	C	24	11	25		18	
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	SO ₂	1.04	0.00	4.83	19.34	19.93	0.00	-99.67	0.000	21		26			
1 A 2 g viii Other: Biomass	SO ₂	0.96	C	4.56	27.34	27.72	0.14	C	C	23	21		25	23	
1 A 2 g viii Other: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 2 g viii Other: Liquid Fuels	SO ₂	3.08	C	3.51	14.06	14.49	0.08	C	C	14	12	20		28	
1 A 2 g viii Other: Other Fuels	SO ₂	0.00	C	3.58	21.48	21.77	0.01	C	C						
1 A 2 g viii Other: Solid Fuels	SO ₂	0.33	C	3.62	14.48	14.93	0.07	C	C		15	22			

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1 A 3 a Domestic Aviation: Aviation Gasoline	SO ₂	0.00	0.00	10.00	50.00	50.99	0.00	-90.08	0.000						
1 A 3 a Domestic Aviation: Jet Kerosene	SO ₂	0.05	0.03	10.00	50.00	50.99	0.01	-42.57	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	SO ₂	0.00	0.00	5.00	20.00	20.62	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	SO ₂	0.49	0.01	5.00	20.00	20.62	0.00	-97.92	0.000	33					
1 A 3 b i Road Transportation, Cars: Gasoline	SO ₂	0.80	0.04	3.00	20.00	20.22	0.00	-95.51	0.000	25		33			
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	SO ₂	0.20	0.00	5.00	20.00	20.62	0.00	-98.21	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	SO ₂	0.00	0.00	5.00	20.00	20.62	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	SO ₂	0.05	0.00	3.00	20.00	20.22	0.00	-99.17	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	SO ₂	0.00	0.00	4.61	18.43	19.00	0.00	86383.59	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	SO ₂	4.36	0.01	4.87	19.46	20.06	0.00	-99.81	0.000	8		7	16		15
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	SO ₂	0.00	0.00	3.00	20.00	20.22	0.00	-97.97	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	SO ₂	0.00	0.00	3.00	20.00	20.22	0.00	-79.32	0.000						

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1 A 3 c Railways: Liquid Fuels	SO ₂	0.12	0.00	5.00	20.00	20.62	0.00	-99.93	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	SO ₂	0.67	0.10	3.53	28.21	28.43	0.04	-85.04	0.000	28	30				
1 A 3 d Domestic Navigation: Gaseous Fuels	SO ₂	0.00	0.00	10.00	40.00	41.23	0.00		0.000						
1 A 3 d Domestic Navigation: Gasoline	SO ₂	0.00	0.00	5.00	40.00	40.31	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	SO ₂	3.31	0.16	15.00	40.00	42.72	0.25	-95.11	0.000	13	23	10	11	20	12
1 A 3 e Other Transportation: Diesel Oil	SO ₂	0.22	0.00	5.00	20.00	20.62	0.00	-99.79	0.000						
1 A 3 e Other Transportation: Gaseous fuels	SO ₂	0.00	0.00	5.00	70.00	70.18	0.00	40.37	0.000						
1 A 4 a Commercial/Institutional: Biomass	SO ₂	0.01	0.02	10.00	75.00	75.66	0.01	123.64	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	SO ₂	0.18	0.00	5.00	20.00	20.62	0.00	-99.68	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 4 a Commercial/Institutional: Gasoline	SO ₂	0.01	0.00	5.00	20.00	20.62	0.00	-92.23	0.000						
1 A 4 a Commercial/Institutional: Liquid Fuels	SO ₂	4.01	0.03	20.00	70.00	72.80	0.02	-99.37	0.002	10		8	3		3
1 A 4 b Residential: Biomass	SO ₂	0.42	0.40	10.00	75.00	75.66	4.89	-4.72	0.001		9	13	24	5	5

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1 A 4 b Residential: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 4 b Residential: Liquid Fuels	SO ₂	7.17	0.05	19.48	68.19	70.92	0.07	-99.28	0.005	3		5	1		1
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	SO ₂	0.00	0.09	10.00	75.00	75.66	0.24	4124.18	0.000		31	34		21	23
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	SO ₂	0.00	0.00					-100.00							
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	SO ₂	0.00	0.00	5.00	20.00	20.62	0.00	-81.45	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	SO ₂	2.66	0.11	11.84	41.60	43.25	0.13	-95.72	0.000	15	27	15	20	25	16
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	SO ₂	0.63	0.00					-100.00		30		32	22		
1 A 5 b Mobile: Liquid Fuels	SO ₂	0.33	0.06	3.84	36.17	36.37	0.02	-83.38	0.000						
1 B 1 b Coke production	SO ₂	0.08	0.03	5.00	50.00	50.25	0.01	-63.60	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	SO ₂	0.01	0.01	50.00	50.00	70.71	0.00	-34.75	0.000						
1 B 2 a Oil	SO ₂	3.77	0.48	0.57	46.11	46.12	2.59	-87.27	0.000	11	7	29	8	8	26
1 B 2 c Venting and flaring	SO ₂	0.58	C	17.50	50.00	52.97	1.54	C	C	31	10	19	19	10	19
1 D International Aviation: Jet kerosene	SO ₂	0.04	0.07	10.00	50.00	50.99	0.06	50.63	0.000						
2 A 1 Cement Production	SO ₂	5.26	0.07	2.00	20.00	20.10	0.01	-98.60	0.000	5	33	6	12		13
2 A 2 Lime Production	SO ₂	0.09	0.27	5.07	19.72	20.36	0.16	217.87	0.000		13	18		22	27

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2 A 3 Glass Production	SO ₂	0.26	0.11	0.00	30.00	30.00	0.06	-56.09	0.000		28				
2 B 10 Other	SO ₂	5.92	0.58	0.00	32.96	32.96	1.96	-90.14	0.000	4	5	11	6	9	20
2 C 1 Iron and Steel Production	SO ₂	4.26	0.98	3.40	67.99	68.08	23.68	-76.91	0.000	9	4	16	5	1	8
2 C 2 Ferroalloys production	SO ₂	0.30	0.07	5.00	30.00	30.41	0.03	-75.33	0.000		32				
2 C 3 Aluminium production	SO ₂	0.24	0.11	2.00	30.00	30.07	0.05	-56.22	0.000		29				
2 C 7 Other	SO ₂	4.92	3.12	4.00	20.00	20.40	21.40	-36.56	0.002	7	2	1	13	3	2
2 G 4 Other	SO ₂	0.00	0.00	15.00	50.00	52.20	0.00	8.59	0.000						
2 H 1 Pulp and paper	SO ₂	12.82	3.23	5.73	18.84	19.70	21.43	-74.79	0.001	1	1	3	4	2	6
5 C 1 Waste Incineration	SO ₂	0.05	0.01	7.26	534.28	534.33	0.30	-73.88	0.000					19	
Total		102.60	16.38			8.39	100.00	-84.03	1.293						

Table A1-18 Summary of the key source and uncertainty analysis of TSP emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	TSP	0.86	1.11	1.51	15.12	15.20	0.03	29.14	0.000	16	8	13			
1 A 1 a Public Electricity and Heat Production: Gaseous Fuels	TSP	0.00	0.00	1.87	93.27	93.29	0.00	-38.85	0.000						
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	TSP	0.13	0.02	1.64	16.42	16.50	0.00	-82.06	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	TSP	0.12	0.09	2.92	97.27	97.31	0.01	-26.25	0.000						
1 A 1 a Public Electricity and Heat Production: Peat	TSP	0.71	0.00	1.90	19.01	19.11	0.00	-99.44	0.000	20		16			22
1 A 1 a Public Electricity and Heat Production: Solid Fuels	TSP	1.10	0.02	1.83	18.35	18.44	0.00	-97.79	0.000	13		11			18
1 A 1 b Petroleum refining: Gaseous Fuels	TSP	0.00	0.00	2.00	100.00	100.02	0.00		0.000						
1 A 1 b Petroleum refining: Liquid Fuels	TSP	0.40	0.03	10.00	100.00	100.50	0.00	-92.00	0.001	24		19	15		10
1 A 1 c Manufacture of Solid fuels and Other Energy Industries: Solid Fuels	TSP	0.36	0.05	5.00	100.00	100.12	0.00	-85.61	0.001	25		21	17		13
1 A 2 a Iron and Steel: Biomass	TSP	0.00	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Gaseous Fuels	TSP	0.00	0.00	5.00	100.00	100.12	0.00	547.35	0.000						
1 A 2 a Iron and Steel: Liquid Fuels	TSP	0.13	C	5.00	100.00	100.12	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 a Iron and Steel: Solid Fuels	TSP	0.03	0.00	2.00	50.00	50.04	0.00	-84.08	0.000						
1 A 2 b Non-ferrous metals: Gaseous Fuels	TSP	0.00	0.00	5.00	100.00	100.12	0.00	61.77	0.000						
1 A 2 b Non-ferrous metals: Liquid Fuels	TSP	0.01	0.00	5.00	100.00	100.12	0.00	-63.60	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	TSP	0.01	0.00					-100.00							
1 A 2 c Chemicals: Biomass	TSP	0.04	0.01	5.00	100.00	100.12	0.00	-69.79	0.000						
1 A 2 c Chemicals: Gaseous Fuels	TSP	0.00	0.00	5.00	100.00	100.12	0.00	-52.31	0.000						
1 A 2 c Chemicals: Liquid Fuels	TSP	0.07	0.01	5.00	100.00	100.12	0.00	-86.01	0.000						
1 A 2 c Chemicals: Other Fuels	TSP	0.01	C	10.00	100.00	100.50	0.00	C	C						
1 A 2 c Chemicals: Solid Fuels	TSP	0.05	C	2.00	100.00	100.02	0.00	C	C						
1 A 2 d Pulp, Paper and Print: Biomass	TSP	2.47	0.33	8.00	100.00	100.32	0.12	-86.72	0.025	7	17	8	6	12	5
1 A 2 d Pulp, Paper and Print: Gaseous Fuels	TSP	0.00	0.00	5.00	100.00	100.12	0.00	-11.20	0.000						
1 A 2 d Pulp, Paper and Print: Liquid Fuels	TSP	0.22	0.04	5.00	100.00	100.12	0.00	-82.46	0.000						20
1 A 2 d Pulp, Paper and Print: Other Fuels	TSP	0.07	0.01	10.00	100.00	100.50	0.00	-89.56	0.000						
1 A 2 d Pulp, Paper and Print: Solid Fuels	TSP	0.13	0.00	7.00	100.00	100.24	0.00	-99.92	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	TSP	0.02	0.01	5.00	100.00	100.12	0.00	-12.18	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Gaseous Fuels	TSP	0.00	0.00	5.00	100.00	100.12	0.00	-38.61	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	TSP	0.06	0.00	5.00	100.00	100.12	0.00	-95.42	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	TSP	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	TSP	0.04	0.00	5.00	100.00	100.12	0.00	-99.96	0.000						
1 A 2 f Non-metallic minerals: Biomass	TSP	0.01	0.00	4.08	40.78	40.98	0.00	-77.28	0.000						
1 A 2 f Non-metallic minerals: Gaseous Fuels	TSP	0.00	0.00	3.90	42.40	42.58	0.00	75.11	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	TSP	0.04	C	9.86	59.14	59.96	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	TSP	0.14	C	6.40	28.95	29.65	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	TSP	0.90	0.58	4.95	29.68	30.09	0.03	-35.29	0.000	14	11		19		
1 A 2 g viii Other: Biomass	TSP	1.56	C	4.01	32.08	32.33	0.00	C	C	9		9	12		9
1 A 2 g viii Other: Gaseous Fuels	TSP	0.00	0.00	2.47	19.76	19.91	0.00	-33.65	0.000						
1 A 2 g viii Other: Liquid Fuels	TSP	0.19	C	3.56	21.36	21.65	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g viii Other: Other Fuels	TSP	0.00	C	3.58	28.63	28.86	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	TSP	0.05	C	5.00	39.98	40.29	0.00	C	C						
1 A 3 a Domestic Aviation: Aviation Gasoline	TSP	0.00	0.00	10.00	20.00	22.36	0.00	-93.09	0.000						
1 A 3 a Domestic Aviation: Jet Kerosene	TSP	0.02	0.01	10.00	20.00	22.36	0.00	-60.01	0.000						
1 A 3 b i Road Transportation, Cars: Biomass	TSP	0.00	0.00	4.34	13.01	13.71	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	TSP	0.36	0.11	5.00	15.00	15.81	0.00	-69.65	0.000	26		26			
1 A 3 b i Road Transportation, Cars: Gasoline	TSP	0.18	0.04	3.00	15.00	15.30	0.00	-75.20	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	TSP	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	TSP	0.23	0.14	5.00	15.00	15.81	0.00	-39.70	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gaseous Fuels	TSP	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	TSP	0.04	0.00	3.00	15.00	15.30	0.00	-93.86	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	TSP	0.00	0.01	4.78	14.33	15.11	0.00	2145.56	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	TSP	2.99	0.22	4.22	12.66	13.34	0.00	-92.64	0.001	6	20	5	16		11

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	TSP	0.03	0.02	3.00	15.00	15.30	0.00	-28.18	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	TSP	1.25	1.61	0.00	15.00	15.00	0.06	28.18	0.000	12	6	10			19
1 A 3 b vii Road Transportation: Automobile road abrasion	TSP	23.08	29.99	0.00	15.00	15.00	22.59	29.94	0.065	1	1	1	4	2	2
1 A 3 c Railways: Liquid Fuels	TSP	0.05	0.02	5.00	10.00	11.18	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	TSP	0.36	0.20	2.95	26.33	26.50	0.00	-44.21	0.000	27					
1 A 3 d Domestic Navigation: Gasoline	TSP	0.00	0.00	5.00	40.00	40.31	0.00		0.000						
1 A 3 d Domestic Navigation: Residual Oil	TSP	0.61	0.30	15.00	40.00	42.72	0.02	-50.67	0.000	22	18				
1 A 3 e Other Transportation: Diesel Oil	TSP	0.22	0.03	5.00	30.00	30.41	0.00	-85.67	0.000			27			
1 A 4 a Commercial/Institutional: Biomass	TSP	0.24	0.07	10.00	10.00	14.14	0.00	-71.19	0.000						
1 A 4 a Commercial/Institutional: Diesel Oil	TSP	0.21	0.12	5.00	30.00	30.41	0.00	-41.52	0.000						
1 A 4 a Commercial/Institutional: Gaseous Fuels	TSP	0.00	0.00	10.00	10.00	14.14	0.00	190.26	0.000						
1 A 4 a Commercial/Institutional: Gasoline	TSP	0.04	0.05	5.00	30.00	30.41	0.00	41.53	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 a Commercial/Institutional:															
Liquid Fuels	TSP	0.30	0.00	20.00	10.00	22.36	0.00	-98.94	0.000	32		20			
1 A 4 b Residential: Biomass	TSP	13.27	5.48	10.00	65.00	65.76	14.50	-58.69	0.077	2	2	3	1	4	1
1 A 4 b Residential: Gaseous Fuels	TSP	0.00	0.00	10.00	65.00	65.76	0.00	-38.84	0.000						
1 A 4 b Residential: Liquid Fuels	TSP	0.86	0.18	2.99	17.60	17.85	0.00	-79.14	0.000	17		17	14		
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	TSP	0.07	0.53	10.00	30.00	31.62	0.03	636.95	0.000		12	15			16
1 A 4 c Agriculture/Forestry/Fisheries: Gaseous Fuels	TSP	0.00	0.00	10.00	30.00	31.62	0.00	-63.88	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	TSP	0.02	0.03	5.00	30.00	30.41	0.00	16.12	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	TSP	1.28	0.28	2.75	16.61	16.84	0.00	-78.33	0.000	11	19	12			21
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	TSP	0.24	0.00					-100.00				22			
1 A 5 b Mobile: Biomass	TSP	0.00	0.00	5.00	15.00	15.81	0.00		0.000						
1 A 5 b Mobile: Liquid Fuels	TSP	0.10	0.02	3.29	20.76	21.02	0.00	-82.39	0.000						
1 B 1 c Fugitive emissions from Solid Fuels	TSP	0.78	0.48	6.00	19.99	20.88	0.01	-37.95	0.000	19	13				
1 B 2 a Oil	TSP	0.10	C	7.09	19.55	20.80	0.00	C	C						
1 B 2 c Venting and flaring	TSP	0.05	C	17.50	100.00	101.52	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 D International Aviation: Jet kerosene	TSP	0.01	0.02	10.00	20.00	22.36	0.00	73.98	0.000						
2 A 1 Cement Production	TSP	0.88	0.06	2.00	30.00	30.07	0.00	-92.91	0.000	15		14	20		15
2 A 2 Lime Production	TSP	0.33	0.07	5.36	51.64	51.91	0.00	-77.91	0.000	30		23			
2 A 3 Glass Production	TSP	0.29	0.06	0.00	100.00	100.00	0.00	-78.82	0.000	33		25	18		17
2 B 10 Other	TSP	0.16	0.03	0.00	58.30	58.30	0.00	-84.15	0.000						
2 B 5 Carbide production	TSP	0.12	0.06	10.00	50.00	50.99	0.00	-46.00	0.000						
2 C 1 Iron and Steel Production	TSP	6.07	1.12	3.75	30.00	30.23	0.13	-81.61	0.011	4	7	4	9	11	6
2 C 2 Ferroalloys production	TSP	0.09	0.09	5.00	40.00	40.31	0.00	0.40	0.000						
2 C 3 Aluminium production	TSP	0.34	0.13	2.00	40.00	40.05	0.00	-62.41	0.000	28					
2 C 7 Other	TSP	0.26	0.03	4.00	40.00	40.20	0.00	-87.30	0.000	34		24			
2 D 3 Other	TSP	0.11	0.12	10.00	109.00	109.46	0.02	7.95	0.000						
2 G 4 Other	TSP	0.34	0.21	10.67	28.22	30.17	0.00	-37.18	0.000	29	21				
2 H 1 Pulp and paper	TSP	9.58	2.54	6.34	18.13	19.20	0.27	-73.50	0.008	3	5	2	8	10	7
2 H 3 Other	TSP	3.65	4.00	0.00	131.73	131.73	31.05	9.77	0.058	5	3	6	3	1	3
2 I Wood processing	TSP	0.67	0.41	15.00	900.00	900.12	15.39	-38.20	0.002	21	14		2	3	8
3 B 1 Dairy cattle	TSP	0.52	0.40	20.00	150.00	151.33	0.40	-23.80	0.000	23	15		11	8	
3 B 1 Non-dairy cattle	TSP	0.32	0.33	20.00	150.00	151.33	0.28	2.91	0.001	31	16	28	13	9	14
3 B 3 Swine	TSP	1.47	0.94	20.00	150.00	151.33	2.27	-36.01	0.001	10	9		7	6	
3 B 4 Fur-bearing animals	TSP	0.01	0.00	20.00	200.00	201.00	0.00	-32.64	0.000						
3 B 4 Goats	TSP	0.00	0.00	20.00	200.00	201.00	0.00	192.25	0.000						
3 B 4 Horses	TSP	0.08	0.09	20.00	200.00	201.00	0.03	12.64	0.000						
3 B 4 Poultry	TSP	1.83	2.59	16.55	126.64	127.72	12.19	41.70	0.046	8	4	7	5	5	4

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IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
3 B 4 Sheep	TSP	0.01	0.02	20.00	200.00	201.00	0.00	72.77	0.000						
5 A Solid waste disposal	TSP	0.00	0.00	10.00	377.00	377.13	0.00	-62.15	0.000						
5 C 1 Waste Incineration	TSP	0.05	0.05	66.67	184.77	196.43	0.01	13.00	0.000						
5 E Other	TSP	0.80	0.80	50.00	67.00	83.60	0.51	1.12	0.005	18	10	18	10	7	12
Total		84.90	57.01			16.60	100.00	-32.85	5.515						

Table A1-19 Summary of the key source and uncertainty analysis of Zn emissions 1990 and 2019, submission 2021.

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 1 a Public Electricity and Heat Production: Biomass	Zn	5.47	14.48	1.50	75.09	75.11	0.29	164.88	0.256	7	2	3		3	4
1 A 1 a Public Electricity and Heat Production: Liquid Fuels	Zn	0.15	0.02	1.60	80.01	80.03	0.00	-87.24	0.000						
1 A 1 a Public Electricity and Heat Production: Other Fuels	Zn	0.01	0.06	2.39	638.62	638.62	0.00	455.22	0.000						
1 A 1 a Public Electricity and Heat Production: Peat	Zn	0.33	0.12	1.90	95.07	95.09	0.00	-63.65	0.000						
1 A 1 a Public Electricity and Heat Production: Solid Fuels	Zn	0.32	0.04	2.00	100.00	100.02	0.00	-87.80	0.000						
1 A 1 b Petroleum refining: Liquid Fuels	Zn	0.03	0.01	10.00	100.00	100.50	0.00	-69.10	0.000						
1 A 2 a Iron and Steel: Biomass	Zn	0.00	C	5.00	40.00	40.31	0.00	C	C						
1 A 2 a Iron and Steel: Liquid Fuels	Zn	0.05	C	5.00	100.00	100.12	0.00	C	C						
1 A 2 a Iron and Steel: Solid Fuels	Zn	0.00	0.00					-100.00							
1 A 2 b Non-ferrous metals: Liquid Fuels	Zn	0.01	0.00	5.00	100.00	100.12	0.00	-55.40	0.000						
1 A 2 b Non-ferrous metals: Solid Fuels	Zn	0.00	0.00					-100.00							
1 A 2 c Chemicals: Biomass	Zn	0.23	0.11	5.00	40.00	40.31	0.00	-51.05	0.000						
1 A 2 c Chemicals: Liquid Fuels	Zn	0.02	0.01	5.00	100.00	100.12	0.00	-72.51	0.000						
1 A 2 c Chemicals: Other Fuels	Zn	0.00	C					C	C						
1 A 2 c Chemicals: Solid Fuels	Zn	0.01	C	2.00	700.00	700.00	0.00	C	C						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 d Pulp, Paper and Print: Biomass	Zn	15.13	4.39	8.00	40.00	40.79	0.01	-71.00	0.002	5	6	8			
1 A 2 d Pulp, Paper and Print: Liquid Fuels	Zn	0.23	0.05	5.00	100.00	100.12	0.00	-76.86	0.000						
1 A 2 d Pulp, Paper and Print: Other Fuels	Zn	0.03	0.00					-100.00							
1 A 2 d Pulp, Paper and Print: Solid Fuels	Zn	0.03	0.00	7.00	700.00	700.03	0.00	-91.93	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Biomass	Zn	0.11	0.16	5.00	40.00	40.31	0.00	44.80	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Liquid Fuels	Zn	0.06	0.00	5.00	100.00	100.12	0.00	-95.13	0.000						
1 A 2 e Food Processing, Beverages and Tobacco: Other Fuels	Zn	0.01	0.00					-100.00							
1 A 2 e Food Processing, Beverages and Tobacco: Solid Fuels	Zn	0.01	0.00	5.00	700.00	700.02	0.00	-90.63	0.000						
1 A 2 f Non-metallic minerals: Biomass	Zn	0.03	0.22	4.76	19.05	19.64	0.00	560.87	0.000						
1 A 2 f Non-metallic minerals: Liquid Fuels	Zn	0.05	C	9.89	39.56	40.78	0.00	C	C						
1 A 2 f Non-metallic minerals: Solid Fuels	Zn	0.12	C	8.57	311.76	311.88	0.00	C	C						
1 A 2 g vii Off-road vehicles and other machinery: Biomass	Zn	0.00	0.16	4.97	99.44	99.56	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 2 g vii Off-road vehicles and other machinery: Liquid Fuels	Zn	0.29	0.43	4.93	98.58	98.70	0.00	47.27	0.000						
1 A 2 g vii Off-road vehicles and other machinery: Other Fossil Fuels	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 2 g viii Other: Biomass	Zn	9.57	C	4.50	17.98	18.54	0.00	C	C	6	8	7			
1 A 2 g viii Other: Liquid Fuels	Zn	0.13	C	3.85	23.09	23.41	0.00	C	C						
1 A 2 g viii Other: Solid Fuels	Zn	0.01	C	4.68	234.04	234.08	0.00	C	C						
1 A 3 b i Road Transportation, Cars: Biomass	Zn	0.00	0.07	3.79	75.79	75.89	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Diesel oil	Zn	0.00	0.02	5.00	100.00	100.12	0.00	870.53	0.000						
1 A 3 b i Road Transportation, Cars: Fossil part of biodiesel and biogasoline	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 3 b i Road Transportation, Cars: Gasoline	Zn	0.13	0.06	3.00	100.00	100.04	0.00	-50.53	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Biomass	Zn	0.00	0.00	4.93	98.54	98.67	0.00		0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Diesel oil	Zn	0.00	0.01	5.00	100.00	100.12	0.00	738.49	0.000						
1 A 3 b ii Road Transportation, Light duty trucks: Fossil part of bi-diesel and biogasoline	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 b ii Road Transportation, Light duty trucks: Gasoline	Zn	0.01	0.00	3.00	100.00	100.04	0.00	-90.83	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Biomass	Zn	0.00	0.01	3.56	71.29	71.38	0.00	19988.42	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Diesel oil	Zn	0.02	0.02	4.87	97.31	97.43	0.00	-12.98	0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Fossil part of biodiesel and biogasoline	Zn	0.00	0.00	3.60	72.01	72.10	0.00		0.000						
1 A 3 b iii Road Transportation, Heavy duty trucks: Gaseous Fuels	Zn	0.00	0.00	3.00	100.00	100.04	0.00	-77.57	0.000						
1 A 3 b iv Road Transportation, Motorcycles: Gasoline	Zn	0.00	0.00	3.00	100.00	100.04	0.00	128.03	0.000						
1 A 3 b vi Road Transportation: Automobile tyre and brake wear	Zn	15.40	19.79	0.00	1000.00	1000.00	97.51	28.46	54.781	4	1	2	1	1	1
1 A 3 c Railways: Liquid Fuels	Zn	0.03	0.01	5.00	95.00	95.13	0.00	-54.04	0.000						
1 A 3 d Domestic Navigation: Gas/Diesel Oil	Zn	0.04	0.06	3.58	35.84	36.01	0.00	35.81	0.000						
1 A 3 d Domestic Navigation: Residual Oil	Zn	0.17	0.08	15.00	100.00	101.12	0.00	-50.67	0.000						
1 A 3 e Other Transportation: Biomass	Zn	0.00	0.02	5.00	100.00	100.12	0.00		0.000						
1 A 3 e Other Transportation: Diesel Oil	Zn	0.06	0.06	5.00	100.00	100.12	0.00	-3.69	0.000						

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 3 e Other Transportation:															
Other Fossil Fuels	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional:															
Biomass	Zn	0.28	0.61	10.00	200.00	200.25	0.00	113.10	0.003		10				
1 A 4 a Commercial/Institutional:															
Diesel Oil	Zn	0.05	0.07	5.00	100.00	100.12	0.00	51.78	0.000						
1 A 4 a Commercial/Institutional:															
Ethanol	Zn	0.00	0.01	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional:															
FAME	Zn	0.00	0.03	5.00	100.00	100.12	0.00		0.000						
1 A 4 a Commercial/Institutional:															
Gasoline	Zn	0.06	0.05	5.00	100.00	100.12	0.00	-14.31	0.000						
1 A 4 a Commercial/Institutional:															
Liquid Fuels	Zn	0.15	0.00	20.00	100.00	101.98	0.00	-98.89	0.000						
1 A 4 a Commercial/Institutional:															
Other Fossil Fuels	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 b Residential: Biomass	Zn	15.61	14.41	9.99	199.78	200.03	2.07	-7.64	0.785	3	3	5	3	2	2
1 A 4 b Residential: Liquid Fuels	Zn	0.25	0.08	3.01	58.36	58.44	0.00	-66.53	0.000						
1 A 4 b Residential: Other Fossil Fuels	Zn	0.00	0.00	5.00	100.00	100.12	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Biomass	Zn	0.08	2.27	9.51	190.15	190.38	0.05	2611.16	0.055		7	6			

IPCC Source Category	Substance	Base year emissions or removals (t)	Year 2019 emissions or removals (t)	Activity data uncertainty in 2019 (%)	Emission factor uncertainty in 2019 (%)	Combined uncertainty in 2019 (%)	Contribution to variance in 2019 (%)	Inventory trend for 2019 with respect to base year (%)	Uncertainty introduced into the trend (%)	Level in base year	Level in 2019	Trend	Level in base year (Approach 2)	Level in 2019 (Approach 2)	Trend (Approach 2)
1 A 4 c Agriculture/Forestry/Fisheries: Fossil part of biodiesel and biogasoline	Zn	0.00	0.00	3.54	70.83	70.92	0.00		0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Gasoline	Zn	0.00	0.01	5.00	100.00	100.12	0.00	104.52	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Liquid Fuels	Zn	0.39	0.35	3.11	61.76	61.83	0.00	-10.67	0.000						
1 A 4 c Agriculture/Forestry/Fisheries: Solid Fuels	Zn	0.36	0.00					-100.00							
1 A 5 b Mobile: Liquid Fuels	Zn	0.01	0.01	5.00	100.00	100.12	0.00	-35.46	0.000						
1 B 2 a Oil	Zn	0.01	0.01	7.50	90.00	90.31	0.00	2.78	0.000						
1 B 2 c Venting and flaring	Zn	0.02	C	17.50	208.00	208.73	0.00	C	C						
2 A 3 Glass Production	Zn	0.01	0.00	0.00	50.00	50.00	0.00	-99.50	0.000						
2 C 1 Iron and Steel Production	Zn	78.64	8.11	3.36	52.24	52.35	0.04	-89.69	0.483	1	4	1	2		3
2 C 2 Ferroalloys production	Zn	1.21	0.63	5.00	50.00	50.25	0.00	-47.99	0.000		9				
2 C 7 Other	Zn	33.65	4.74	4.00	50.00	50.16	0.01	-85.91	0.063	2	5	4	4		
2 G 4 Other	Zn	0.28	0.29	14.52	677.21	677.36	0.01	3.07	0.004						
2 H 1 Pulp and paper	Zn	0.80	0.26	6.34	45.32	45.76	0.00	-67.06	0.000						
2 H 3 Other	Zn	1.21	0.02	0.00	38.18	38.18	0.00	-98.69	0.000						
5 C 1 Waste Incineration	Zn	0.17	0.18	69.98	195.39	207.54	0.00	8.33	0.000						
Total		181.56	74.69			268.27	100.00	-58.86	75.123						

2 Annex 2: Detailed discussion of methodology and data for estimating emissions from fossil fuel combustion.

2.1 Sources for activity data in NFR 1A and parts of NFR 1B

Activity data used in the energy sector is mainly based on statistics on fuel consumption. In the sections below, the various energy surveys, produced by Statistics Sweden and other data sources are described. For stationary combustion within the Other sector, activity data from the annual energy balances is used in order to ensure that all activities are covered and no activities are double-counted. The energy balances are based on a number of surveys, which are all described below.

A number of activity data sources are used and the UNFCCC-ERT has asked for the rationale for choosing a certain data source, an explanation of how these sources are deemed accurate or inaccurate, and how time series consistency is ensured. In numerous development projects during the last ten years, several of them quoted in IIR section 3, different data sources have been compared and checked against each other, and in some of these projects industrial facilities have been contacted by phone or e-mail to verify data. Generally, the quarterly fuel statistics is considered to be more complete than the Energy use in manufacturing industry, because the industrial energy survey has not always included all back pressure power. In recent years, the main reason for choosing the quarterly fuel statistics is that the annual industrial energy survey is not ready in time for the emission inventory. On an aggregate level, the final results for the two surveys are very coherent. In a study performed by Statistics Sweden in 2009¹, a detailed comparison between the quarterly fuel statistics, the annual industrial energy survey and the energy balances was made. This study showed some differences between the two surveys, but the differences did not indicate systematic errors in any of the surveys, and hence it gave no reason to believe that the quarterly fuel statistics would not be of sufficient quality.

Environmental reports are often a good source for emission data, but generally they do not contain sufficient activity data for the energy sector, and facilities with small emissions are not obliged to submit environmental reports. The EU ETS system has very good coverage of the trading facilities, but presently it is not possible to use as main data source due to several reasons. Firstly, the database is not adapted

¹ Statistics Sweden, 2009

to automated data processing, and secondly, some facilities only report carbon balances. Furthermore, to produce correct estimates for the non-trading facilities, one must be able to separate trading facilities from non-trading ones in the Quarterly fuel statistics, and this is currently not possible due to different definitions of administrative units in the energy statistics and the EU-ETS, respectively.

For the Other sector, energy balances are used because none of the underlying surveys covers all emission sources in the different sub-sectors, but in the energy balances, complementary calculations are made in order to obtain full coverage and avoid double counting. Data for NFR 1A4 has been verified against the underlying surveys described in the sections below, and the coherence was good for biomass fuels and oils, whereas the coverage of use of e.g. LPG was considered to be better in the energy balances.

2.1.1 Quarterly fuel statistics

Quarterly fuel statistics are used as follows:

- All years for data on stationary combustion in the NRF sector 1A1a, parts of 1A1c 1A2, with the exception of 1A2 for the years 1990-1996 and 2000-2002 (where Energy use in manufacturing industry (ISEN) is used) and for some sub-categories in 1A2g (where the Energy Balances is used).
- 1990-1996 for information on in-house (own-produced) fuels in NRF 1A1b and 1A2 since the statistics on energy use in manufacturing industry did not cover own-produced fuels during these years.
- 2000-2002 for data on fuel combustion for back pressure power in NRF 1A2c-e, both sold and consumed at the producing plant. This is due to that the Energy use in manufacturing industry (which is the main data source for industries 2000-2002) has been found not to cover fuel consumption for back pressure power.

Quarterly fuel statistics are carried out as a web-based sample survey sent to all working units². The sample to the quarterly fuel statistics is based on the sample for the yearly statistics of energy use in manufacturing industry, except for electricity and heat production for which the quarterly fuel statistics is a total survey. Data are collected from all companies in electricity and heat production and all companies in the manufacturing industry with more than nine employees and annual fuel combustion of more than 325 tonne oil equivalents.

The survey should cover all fuel consumption, both own-produced and purchased fuels. However, in some cases it has been noted by the inventory staff that not all in

² A company may consist of several working units, that is could be located in several places (factories).

house fuels are covered. In those cases supplementary data has been collected to assure complete time series. In the survey form, respondents are also asked to specify whether fuels are used as raw materials or for energy purposes.

The sample frame is updated annually based on the latest results of the Energy use in manufacturing industry (ISEN). The response rate to the quarterly fuel statistics is almost 100 % for ISIC 40 (that is, NFR 1A1a) and about 90 % for manufacturing industries. The non-respondents among the industries are often small companies, which means that much more than 90 % of consumed energy is covered in responses to the survey. To compensate for companies not included in the sample and companies not responding to the survey, all fuel consumption is raised with a factor which is produced from information on the line of business, number of employees and business volume from the most recent year when the statistics on energy use in manufacturing industry was a total survey (as discussed above). By definition, the survey does not cover energy consumption in working units with less than ten employees. The energy consumption in these “small industries” is estimated with a calculation model and published in the energy balances. This estimate covers all industrial branches and the fuel consumption and emissions are reported under NFR 1A2g.

The quarterly fuel statistics for each year are compiled and ready for use at approximately the end of March the year after. This gives enough time to process the data for the greenhouse gas inventory.

In the inventory, data on plant level and by fuel type is used. In Table A2-1 and Table A2-2 below, the descriptions of the different data sources and reasons for the choice of certain data sources are summarized.

Table A2-1 Summary of the main activity data sources used in the inventory for stationary combustion.

CRF	Main activity data sources	Comments
1A2	Energy use in the manufacturing industry (ISEN), Quarterly fuel statistics (KvBr) and environmental reports.	1990-1996 and 2000-2002: ISEN. 1997-1999 and 2003 and onwards: KvBr.
1A2g + 1A4	Energy balances.	For the parts of 1A2g and 1A4 that are not covered by regular surveys.
1A1b and 1A2c	Emissions reported to EU ETS.	Parts of 1A2c since 2005/2008.
1A1c + 1A2a	Environmental reports	AD and CO ₂ for the two integrated iron and steel plants (see annex 3.5).

Table A2-2 Summarized properties of activity data sources used in the inventory for stationary combustion.

Activity data source	Description	Comments
Energy use in manufacturing industry (ISEN)	Total survey of industrial facilities with 10 or more employees.	Data for year t finalized in February/March year t+2, which is too late for the inventory. Used as main AD source for 1A2 for earlier years.
Quarterly fuel statistics (KvBr)	Total survey for the energy sector, cut-off sample survey for manufacturing industry (ISEN is the sample frame)	Data for year t finalized in March year t+1. Several studies have shown that this data source is complete and consistent.
Emissions reported to EU ETS	Facilities included in the EU Emission trading scheme 2005-. Emission data is complete, activity data and/or NCVs not always reported.	The definition of "facility" is different from the one used in official energy statistics (KvBr or ISEN). Population definitions changes between trading periods. No standardization of fuel types.
Environmental reports	All operators whose activities have an impact on the environment are obliged to report environmental reports to the authority responsible for the emission permits.	Quality and completeness is very variable. Activity data is not always included. Most of the information is only available in text reports, which means that data cannot be processed in an automatized way. The reports are also used for verification and occasionally for plant specific NCV:s
Energy balances	Includes all supply and use of fuels and other energy types on aggregated levels.	See discussions in later sections.

2.1.2 Annual statistics on energy use in manufacturing industry

The statistics on energy use in manufacturing industry is used for emissions from stationary combustion in the NFR sectors 1A1b, 1A1c and 1A2 1990-1996 and 2000-2002. The Quarterly fuel statistics (KvBr) for these years did not include fuel consumption for back pressure power, because data on that activity was collected via a different survey (Electricity supply, district heating and supply of natural and gasworks gas (AREL)).

Since submission 2005, for calculation of emissions in 2003 and later years, energy use in manufacturing industry statistics is not used as a base for estimating emissions in the inventory. This is, as discussed above, mainly because the inventory must be submitted before the energy use in manufacturing industry statistics is completed. The energy use in manufacturing industry statistics is only used to verify or correct data for single plants if errors are suspected in the quarterly fuel statistics for specific years described before.

The energy use in manufacturing industry statistics is based on an annual survey of manufacturing companies. In 1990-1996, 2000 and from 2004, all companies with

more than 9 employees are included. In 1997-1999 and in 2001-2003 it was conducted as a sample survey to companies with less than 50 and more than 9 employees, and as a total survey to all companies with more than 50 employees. In 1990-1996, only purchased fuels were surveyed but, since 1997, information on all fuel consumption has been collected.

The response rate to the energy use in manufacturing industry statistics in the years for which this survey is used in the GHG emission inventory was about 85 %. To compensate for non-response, fuel consumption is raised with a raising factor based on the line of business, number of employees and business volume. There is no adjustment for manufacturing industries with less than 10 employees.

A special form is sent to electricity producing companies within manufacturing industries, where the amounts of fuels used for electricity production and manufacturing purposes are specified. All manufacturing industries with electricity production are included in the survey every year. In the inventory, all data used are on plant level and by fuel type. An overview of the activity data on energy consumption used in the inventory for 1990-2002 is given in Table A2-3.

Table A2-3 Summarized properties of the Annual statistics on energy use in manufacturing industry used in the inventory

Year	Type of survey	Coverage	Adjustments	Quality
1990-1996	Annual total survey to all companies with more than nine employees	Working units, purchased fuels, quantity and economic value of purchased fuels	Raising to represent all companies with more than 9 employees	Not so good quality for quantity, good quality for economic value
1997-1999	Annual total survey to all companies with at least 50 employees and a stratified sample of companies with 10-49 employees	Working units purchased and own-produced fuels	Raising to represent all companies with more than 9 employees	Good on national level and on coarse branch level, poor for single fuel types and single branches
2000	Annual total survey to all companies with more than nine employees	Working units, purchased and own-produced fuels	No adjustments	Excellent
2001-2002	Annual total survey to all companies with at least 50 employees and a stratified sample of companies with 10-49 employees	Working units, purchased and own-produced fuels	Raising to represent all companies with more than 9 employees	Good

2.1.3 One- and two-dwelling statistics

One- and two-dwelling statistics are, together with holiday cottages statistics and multi-dwelling statistics, the main data sources for biomass combustion in households in the energy balances, which in turn are used to calculate emissions from stationary combustion in households, NFR 1A4b i.

This sample survey is conducted every second or third year to collect data on the use of electricity and heat for a total of 7,000 one- and two-dwellings. The years in between, the energy use is modelled based on changes in temperature between the years. Until 1999, the survey has a random sample from a real estate assessment, which includes all dwellings with a value higher than 50,000 SEK (about 5,600 €). From 2000, all dwellings used as permanent dwelling are included in the sample. Every third year, a postal survey collects data from agricultural properties. The sample in this sector is 3,000 objects. Activity data in the inventory is taken from annual reports prepared by Statistics Sweden³. Data is on national level by fuel type and considered to be of relatively good quality. To make sure that all emissions from households are included and that no double-counting occurs, activity data is taken from the annual energy balance sheets. However, the fuel consumption reported under the household category in the energy balance is based on the surveys described here.

2.1.4 Holiday cottages statistics

Holiday cottages statistics, together with one- and two-dwelling statistics and multi-dwelling statistics, is used to calculate emissions from stationary combustion in households, NFR 1A4b. As described above, an aggregate from the energy balances is used as activity data for stationary combustion in NFR 1A4b i.

Holiday cottages are defined as residences with no permanent residents. Energy consumption in holiday cottages has been surveyed with large time intervals, i.e. in 1976, 2001 and 2012. In 2012, Statistics Sweden carried out a stratified sample survey to house owners, covering 4,500 of the 589,525 objects in the sample frame. The net sample, excluding over coverage, included 4024 objects and the response rate was 44%. Because of difficulties regarding classification, houses with type codes other than recreational dwellings were also included in the sample frame. The questionnaire form used in 2012 was based on the one used in 2002. Results show that electricity and biomass combustion are the two predominating heating sources in holiday cottages, both in 2001 and 2011⁴.

2.1.5 Multi-dwelling statistics

Multi-dwelling statistics, together with one- and two-dwelling statistics and holiday cottages statistics, is used to calculate emissions from stationary combustion of biomass in households, NFR 1A4b.

This is a sample survey carried out every second or third year, sent to the owners of 7,000 multi-dwelling buildings, covering the use of electricity and heat. For the years in between, the energy use is modelled based on changes in temperature be-

³ Statistics Sweden EN20SM, 1990-2017.

⁴ Statistic Sweden ES, 2012:03.

tween the years. The survey is based on a random sample from a real estate assessment. The real estate assessment includes all dwellings with an economic value higher than 50,000 SEK (about 5,600 €). Data is on national level by fuel type and of relatively good quality. Statistics on biomass consumption in multi-dwelling buildings was not included in the survey until 2001. However, the time series for 1A4b indicates that this data gap does not lead to any significant under-estimation as biomass use in multi-dwellings is sparse compared to the consumption in one- and two-dwellings.

2.1.6 Premises statistics

Premises statistics are used to calculate emissions from stationary combustion in the commercial and institutional sector, NFR 1A4a i.

This survey is a sample survey carried out each second or third years, covering the use of electricity, heat and fuel combustion for heat production of about 8,000 premises. For the years in-between, the energy use is modelled based on change in temperature between the years. Premises situated in an industrial area are not covered in the dataset. Some of these premises are covered in the Annual statistics on energy use in manufacturing industry as well as in the quarterly fuel statistics and are reported in Manufacturing Industries and Construction (NFR 1A2). To get full coverage, supplementary corrections are made for under or over coverage based on the assumption that these are distributed on over and under cover are as in the answers in the energy balance⁵. Data is on national level by fuel type and of relatively good quality. Statistics on biomass consumption in premises was not included in the survey until 2001.

2.1.7 Monthly fuel gas and inventory statistics

Statistics on supply and delivery of petroleum products⁶ has in previous submission (until submission 2019) been one of the sources used to estimate the emissions from mobile combustion in NFR 1A2gii, 1A3a-e, 1A4b-c ii, 1A4ciii and 1A5b. Data from the survey is used at a national level and by fuel type.

The survey is also the data source for stationary combustion of heating oils in households and premises reported in the energy balances, which is used as activity data source for CRF 1.A.4.a and 1.A.4.b, stationary. The data from the survey is also used for reference approach in CRF 1Ab for all fuels except biomass, waste and peat

Data in the survey is collected from all oil companies and other sellers who keep stocks of petroleum products, biofuels and coal. The survey also collects stock data

⁵ Statistics Sweden EN20SM, 1990-2010, and Swedish Energy Agency (2011 and later)

⁶ Monthly fuel, gas and inventory statistics. <https://www.scb.se/en/finding-statistics/statistics-by-subject-area/energy/energy-supply-and-use/monthly-fuel-gas-and-inventory-statistics/>

from companies with a large consumption of oil in the manufacturing industries and energy industries. The survey covers around 70 companies.

A revised version of the survey was introduced in 2018 (submission 2020) and some uncertainties regarding the quality of the statistics were identified, resulting in the use of an alternative data source. As the same oil companies covered by the survey are obliged to collect and report fuel data under the “Swedish fuel quality act”, this data source was used for diesel, gasoline and liquid biofuels in 2018-2019. The amount of diesel and gasoline collected and reported by the “Monthly fuel, gas and inventory” survey and the “Swedish fuel quality act” has only differed around 1 percent for the last 3-4 years. So, despite the change of data source for 2018-2019, the activity data used in submission 2021 is considered to be consistent and of good quality.

2.1.8 Statistics on the delivery of gas products

Statistics on the delivery of gas products are used to calculate emissions from natural gas and biogas from road transport (NFR 1A3b), pressure levelling losses of natural gas (NFR 1A5a) and transfer losses of gas works gas (NFR 1B2avi). Annual questionnaires are sent to all companies in Sweden that deliver natural gas, biogas and gasworks gas (less than ten companies). Consumption purposes are specified in the survey. Results of this survey are published by Statistics Sweden⁷.

2.1.9 Other statistics from Statistics Sweden

Data used in the inventory for stationary fuel consumption in the construction sector, in all companies with less than 10 employees (NFR 1A2g) and stationary combustion in NFR 1A4a-1A4c is taken from the annual energy balances⁸. Data is on national level and by fuel type. Total consumption for these sectors is checked against fuel deliveries, so that possible errors only occur in the allocation between these sectors.

Data on fuel consumption for the construction sector 1990-2003 is based on a survey from 1985⁹, adjusted according to the number of working hours for each year. The fuel consumption for the construction sector 2004 and later is based on a survey from 2005¹⁰. Data on fuel consumption in the agricultural sector is based on two intermittent surveys, for gardening¹¹ and agriculture¹². The first survey is a sample survey that collects data on energy use in greenhouses and has been carried

⁷ Statistics Sweden. *Deliveries of motor fuel gas*. http://www.scb.se/en_/Finding-statistics/Statistics-by-subject-area/Energy/Energy-supply-and-use/Deliveries-of-motor-fuel-gas/

⁸ Statistics Sweden 1990-2012, EN0202

⁹ Statistics Sweden, 1986

¹⁰ Statistics Sweden, 2005

¹¹ Statistics Sweden JO36SM, 1991, 94, 97, 2000, 2003, 2006, 2010

¹² Statistics Sweden JO63SM, 1995, 2003, 2008

out for 1990, 1993, 1996, 1999, 2002 and 2008. Data for intermediate years is estimated using number of working hours. The second sample survey collects data for energy use in the other parts of the agricultural business and has been performed for 1994, 2002 and 2007 (fuel consumption in households in the agricultural sector is not included here but is included in the one- and two-dwellings statistics). Data for intermediate years is estimated using annual changes in value added.

Fuel consumption in the forestry sector has been studied thoroughly in 1985 and 2007¹³. Estimates for the years before 2005 are upgraded from the 1985 study with available statistics on the annual felling volume 1990-1995 and from 1996 value added are used.

Fuel consumption in small companies (9 employees or less) reported in the annual energy balances is estimated using a model for the years 1990-2010. Fuel consumption for companies with 10-49 employees is taken from Annual statistics on energy use in manufacturing industry and the average use of fuel per employee is calculated. The two information sources are combined to estimate the fuel consumption in small companies. In 2012, the annual statistics on energy use in manufacturing industries (ISEN) for the reference year 2011 included a sample survey to small companies as well. The results were not published in ISEN but in the annual energy balance for 2011, which was published in 2013 and used in submission 2014 as activity data source for small enterprises.

2.1.10 European Union Emission Trading System (EU-ETS)

Data from the EU Emission Trading System (EU-ETS) is used, since submission 2007 and emission years 2005 and later, for oil refineries (CRF 1.A.1.b, 1.B.2.a and 1.B.2.C.2.1), as a SMED study during 2006¹⁴ showed that this is the most accurate data source for these facilities. In addition, EU-ETS data is used for the three cement producing facilities for 2008 and onwards, one plant in CRF 1.A.2.e for 2006 and one plant in CRF 1.A.2.c for 2008 and onwards, since the EU-ETS data contains more detailed information on fuel types for these facilities. EU-ETS data is also used for verification of other data sources, e.g. Quarterly fuel statistics and environmental reports. For example, Quarterly fuel statistics for large facilities within the chemical industry and the steel producing industry are regularly compared with ETS data, and if major differences should be discovered, further investigations are made. As mentioned above, for technical reasons, it is not possible to use EU-ETS data as major source of activity data for stationary combustion. Another reason not to use EU-ETS data, for stationary combustion, as the main data source is that in some facilities, only some of the installations within the facility are included in the trading scheme, and the definition of which installations that should be included has changed between the first and second trading periods.

¹³ ER 2007:15. Energianvändningen inom skogsbruket 2005

¹⁴ Backman & Gustafsson, 2006

2.1.11 Environmental reports

Before the EU-ETS was launched, data on fuel consumption in refineries, NFR 1A1b and 1B2, was often collected from environmental reports in cases when the data sources mentioned above (i.e. various energy surveys) were not considered to be accurate. For one refinery, environmental reports are the only data source for the years 2002-2007. For earlier years, environmental reports are also an important data source for fuel consumption in chemical industries, NFR 1A2c. For 2007, environmental report data was partly used for one plant in the primary steel industry, NFR 1A2a. NMVOC emissions from gasoline handling and storage reported in NFR 1B2av are based on environmental reports as well.

2.1.12 Contacts with operators

For earlier years, i.e. 2005 and before, data on fuel consumption in refineries, NFR 1A1b, and chemical industries, NFR 1A2c, was in many cases collected by means of direct contacts with the operators, as activity data was not sufficiently covered in regular surveys or administrative sources. Operators are sometimes also contacted to verify or correct data that is suspected to contain errors. Since submission 2010, the largest iron and steel company has been involved in the improvements in methodology and data for these sectors (1A1c, 1A2a, 1B1b, 1B1c, 2C1). The operator of the gas transmission pipeline and storage in Sweden is contacted each year for information on amounts of vented and flared natural gas (NFR 1B2c) as well as on number of facilities included in the transmission and storage network (NFR 1B2b). They also provide us with information regarding the amount of gas combusted for transportation of natural gas in pipelines (NFR 1A3ei).

2.1.13 Data sources for navigation

The fuel consumption for both national and international navigation, except for leisure boats, has in previous submissions (prior to submission 2019) been based on the monthly survey on supply and delivery of petroleum products¹⁵. But it has been problematic for the suppliers of fuel to separate the fuel used by national respectively international navigation. As the monthly survey of fuel supply statistics was revised¹⁶, the fuel for national and international navigation was no longer split up in the survey. Instead, the result from the survey showed the total supply of fuel in Sweden for both national and international navigation.

The fuel consumption for domestic navigation¹⁷ is estimated by the Shipair model as from submission 2020. Shipair is developed by the Swedish meteorological and hydrological institute (SMHI) and collects AIS data (Automatic Identification System), which is used by the ships to transmit identity and position information and

¹⁵ Statistic Sweden. Monthly fuel, gas and inventory statistics. See annex 2 for more information regarding different surveys.

¹⁶ The revised monthly survey of fuel supply statistics was implemented in January 2018.

¹⁷ Excluding leisure boats.

shows how the ships move between Swedish ports. Information regarding the ships, such as size, engine power and type of vessel is also collected. This enables the Shipair model to estimate the energy consumption and the amount of fuel.

Beside the Shipair model, the energy consumption from domestic navigation is based on a survey of the largest shipping actors for national navigation, with the exception for cargo ships.¹⁸ The survey asks for the fuel consumption by fuel type since Shipair does not have any specific information regarding which type of fuel is used. The difference between the energy consumption estimated by Shipair and by the survey, is assumed to be the energy consumption by cargo ships.

The consumption of LNG (liquid natural gas) by navigation was included in submission 2021 for year 2019. The data is based on a survey, which took place in 2020 and aimed to map the consumption of LNG by both national and international navigation¹⁹. The emission factors for LNG are based on a study from 2020.²⁰

The fuel consumption of international navigation is estimated as the difference between the total supply of fuel for navigation in the monthly survey of fuel supply statistics and the estimated energy consumption for national statistics.

2.1.14 Other data sources for mobile combustion

Beside using statistics on supply and delivery of petroleum products²¹, data reported according to the Swedish fuel quality act, data from the Shipair model (SMHI) and the survey of the largest shipping actors for national navigation, the following sources are used:

- Swedish Transport Administration (emission data for road traffic and railways),
- the Swedish Transport Agency (emission data for aviation),
- the Swedish Energy Agency (net calorific values and emission factors),
- the Swedish Armed Forces (fuel consumption),
- the Swedish Biogas Association (consumption of biogas)
- and several official reports.

2.2 Net calorific values

Unless otherwise stated, NCVs for each fuel type are produced by Statistics Sweden based on information from energy surveys. All NCVs refer to net calorific val-

¹⁸ EN0118, Transportsektorns energianvändning (inrikes sjöfart). Eklund, V. et al. 2019. Analys och implementering av data från nya MåBra.

¹⁹ Eklund, et al. 2020. Sjöfartens förbrukning av LNG.

²⁰ Hult, C. et al. 2020. Emission factors for methane engines on vehicles and ships

²¹ Monthly fuel, gas and inventory statistics. <https://www.scb.se/en/finding-statistics/statistics-by-subject-area/energy/energy-supply-and-use/monthly-fuel-gas-and-inventory-statistics/>

ues (NCV) as recommended by the IPCC Guidelines. All NCVs are showed in Table A2-4. Most NCVs are calculated on basis of chemical qualities and are considered to be of good quality.

In the inventory, activity data for 1990-2006 on many fuel types are reported in tonne oil equivalents (toe), which is an energy unit. For these fuels the conversion factor of 41.87 GJ/toe is applied. In the energy surveys done by Statistics Sweden, these fuels are reported in mass unit/volume unit as well as the energy content (due to that the NCV often varies a lot for these fuel types). To facilitate data processing, Statistics Sweden calculates the energy content in toe from this information and the result is then used in the greenhouse gas inventory. This implies that the energy content of fuels concerned is very precise.

For 2007 and later years, energy data are taken directly from the Quarterly fuel statistics bases, enabling the use of facility specific NCVs in the GHG inventory without performing the calculation of toe. NCVs for 2007 and later years are considered to be of excellent quality. The time series is considered to be consistent, since the conversions to toe made 2006 and earlier, made use of the same information that is used to calculate energy amounts 2007 and onwards. The only difference is that prior to 2007, the energy statistics department made these calculations, and 2007 and later, the calculations are made by the GHG inventory staff.

Fuels that are standardized products, such as for instance residual fuel oil or liquefied petroleum gas (LPG) have calorific values that do not change between years. In submission 2010 some revisions were made. In earlier submissions, the NCV for biogas used for transports (this amount increases each year) was not known and therefore the NCV for natural gas was used for this fuel. In a SMED study²² performed in 2009, a correct NCV for biogas was provided from the biogas supplier AGA. The same study also resulted in revision of the NCVs for ethanol (new NCV taken from Handbook of Chemistry and Physics) and Fatty Acid Methyl Ester (FAME).

An overview of NCVs used is shown below in Table A2-4. For all mobile combustion, and for standard fuels for stationary combustion, national emission factors are used. For non-standard fuels, median, maximum and minimum NCVs are shown.

²² Paulrud et al. 2010

Table A2-4 Thermal values (NCV) used in submission 2021.

Fuel type	Unit	Me- dian	Min	Max	Remark
Blast furnace gas	GJ/1000m ³	2.86	2.73	3.36	
Coke	GJ/tonne	28.05	28.05	28.05	
Coke oven gas	GJ/1000m ³	17.39	17.28	17.48	
Coking coal	GJ/tonne	27.22	24.84	29.24	
Diesel Oil	GJ/m ³	35.29	35.29	35.29	
Domestic Heating Oil	GJ/m ³	35.82	35.82	36.05	
Gas works gas	GJ/1000m ³	16.75	16.75	16.75	Gas works gas 1990-2010, based on naphtha
Gas works gas	GJ/1000m ³	20.8	20.8	20.8	Gas works gas 2011 and later, based on LNG
Kerosene	GJ/m ³	34.5	34.5	34.5	
LPG	GJ/tonne	46.04	46.04	46.05	
Landfill gas	GJ/1000m ³	22.54	11.19	39.78	
Natural Gas	GJ/1000m ³	*	*	*	Year specific NCV:s, see separate table
Other biomass	GJ/m ³	29.88	2.67	39.72	
Other biomass	GJ/tonne	35.44	7.92	43.92	
Other non-specified	GJ/1000m ³	3.02	2.99	27.61	20-99 observations 1990-2014
Other non-specified	GJ/tonne	19.08	5.55	42.48	
Other petroleum fuels	GJ/m ³	11.07	5.36	39.72	20-99 observations 1990-2014
Other petroleum fuels	GJ/tonne	32.76	12.65	40.79	20-99 observations 1990-2014
Other solid fuels	GJ/tonne	14.4	14.4	14.4	Less than 20 observations 1990-2015
Peat	GJ/tonne	10.76	8.39	17.46	
Petroleum coke	GJ/tonne	34.8	30.09	34.8	20-99 observations 1990-2014
Refinery oil	GJ/m ³	38.16	38.16	38.16	
Refinery oil	GJ/tonne	41.6	35.82	44.5	20-99 observations 1990-2014
Residual Fuel Oil	GJ/m ³	38.34	37.44	38.34	
Solid waste (fossil and biogenic)	GJ/tonne	11,02	6,43	41,87	Observations from the 7 largest incineration plants
Steel converter gas	GJ/1000m ³	7.62	7.07	8.48	20-99 observations 1990-2014
Tall oil	GJ/m ³	37.21	34.13	39.6	
Wooden fuels	GJ/m ³	2.88	0.9	10.12	
Wooden fuels	GJ/tonne	16.92	6.91	18.72	
Gasoline	GJ/m ³	32.78			Mobile combustion, all sources
Biogas	GJ/1000 m ³	35.3			Mobile combustion, all sources
Diesel oil	GJ/m ³	35.28			Railways

Fuel type	Unit	Me- dian	Min	Max	Remark
Diesel oil	GJ/m ³	35.28			Navigation
Marine Gasoil	GJ/m ³	35.868			Navigation
Diesel oil	GJ/m ³	*			Year specific NCV:s, see separate table
Residual fuel oil	GJ/m ³	39.53			Navigation
Ethanol	GJ/m ³	21.20			Road traffic
FAME	GJ/m ³	33.00			Road traffic
HVO	GJ/m ³	33.98			Road traffic
Aviation Gasoline	GJ/m ³	31.45			Aviation
Aviation Kerosene	GJ/m ³	35.28			Aviation
Jet Gasoline	GJ/m ³	32.7			Aviation

Note: refinery gas and petrochemical by product gases are reported in various units and plant specific NCV:s are used.

2.2.1 Liquid fuels

For diesel oil the NCV used in the inventory shows a decreasing trend. In Sweden, this fuel type is separated into three different fuel classes; diesel of environmental classes (EC) 1-3. EC 1 has the best environmental qualities, for instance lower content on aromatic hydrocarbons. EC 1 also has a lower NCV. EC 3 affects the environment most and has a higher NCV²³. In 1990, EC 3 was the most common type of diesel. Over the years, the use of environmental class 3 has decreased and instead environmental class 2 and 1 are more common. In the inventory the mix of environmental class 1-3 used each year is taken into account when calculating a NCV, which is appropriate for each year. Year specific NCVs for diesel are shown in Table A2-5.

Table A2-5 Thermal values (NCV) for diesel except navigation and railways.

Years	NCV (GJ/m ³)
1990	35.82
1991	35.69
1992	35.55
1993	35.40
1994	35.43
1995	35.44
1996	35.36
1997	35.34
1998	35.33
1999-2000	35.31
2001-2015	35.29
2016-2019	35.28

NCVs for different oils (except oils used in navigation) are based on information from the Swedish Petroleum and Biofuel Institute (SPBI), which in turn is based on

²³ <http://www.spi.se/produkter.asp?art=48> , 2005-10-17.

information from oil companies and is crosschecked with Swedish standards for calculating NCVs. NCVs for marine diesel oil, marine gas oil and residual fuel oil used for navigation are based on SMED study from 2004²⁴.

NCVs for refinery gases and other oils in refineries are specific for each operator and fuel. Data on consumption of fuels in t (or sometimes m³) and corresponding NCVs are collected. Activity data for these fuels, used by refineries and chemical industries, is for 2007 and later mainly taken from the EU ETS system, and in most cases plant specific NCVs of excellent quality are also reported and used in the GHG inventory. In other cases, NCVs from the environmental reports are used.

In submission 2010, the NCVs for gasoline, aviation kerosene and aviation gasoline were revised following a SMED Study. The conclusion of the study was that NCVs used for these fuels before submission 2010 were not well documented. NCVs according to the 2006 IPCC Guidelines are now used, since the NCVs used earlier for these fuels were concluded to be of questionable quality. There is no indication that carbon content or NCV for aviation kerosene and aviation gasoline in Sweden should differ from international standards. The properties of aviation fuels are normally the same in all countries, and hence it is appropriate to use the values recommended by IPCC. The NCV for gasoline used since submission 2010 is from SPBI and relies on fuel analyses²⁵.

The NCV for petroleum coke is based on information from consumers taken from the different energy surveys done by Statistics Sweden and is therefore considered to be of good quality. The NCV for diesel used for stationary combustion is according to SPI likely approximately the same mix of environmental classes as mobile diesel for each year. Using the same NCVs as for mobile diesel therefore give correct time series.

In 1990-2010, naphtha was used as raw material for production of gas works gas. Since 2011, liquefied natural gas is used instead. However, the gas is mixed with air and the quality of the gas delivered to the transmission net (in terms of methane content and NCV) is stated to be similar to how it was before the change of feed-stock²⁶. Hence, the same NCVs and emission factors are used for gas works gas for 2011 as for earlier years. Since natural gas liquids are allocated to liquid fuels in the CRF reporter in table 1.Ab, we have chosen to allocate the gas works gas consumed in 2011 to liquid fuels also in the sectoral approach.

²⁴ Cooper & Gustafsson, 2004.

²⁵ Paulrud et al. 2010

²⁶ Stockholm Gas, 2012

2.2.2 Solid fuels and peat

For coke oven gas, blast furnace gas and steel converter gas the NCVs change between years, but there is no trend in the changes, just annual fluctuations due to the quality of used primary fuels each year. NCVs used in the inventory are based on annual information from the consumers (quite few) on actual energy content, and the quality of the NCV is considered to be very good.

For carbon products such as coal and coke, it is difficult to establish the NCV due to lack of information on energy content in imported fuels. For 2007, NCVs reported from the consumers are used when available. Slightly more than half of the reported observations of combusted coal in the Quarterly fuel statistics include specific NCVs. For coke, this share is about 75 %.

Where no NCV is reported, the standard NCV provided from the Swedish Energy Agency is used.

2.2.3 Gaseous fuels

Natural gas is a non-processed primary fuel, and hence the NCV changes between years, however without any trend. All natural gas consumed in Sweden is imported from Denmark, except for LNG which is imported from Norway and northern Europe.

Since submission 2019, Sweden uses the same NCVs for the natural gas imported from Denmark as reported in Denmark's National Inventory²⁷. The NCVs used are shown in Table A2.6. The NCV used for LNG is based on values from the Swedish Energy Agency.

²⁷ Energistyrelsen, 2020-12-09 (https://ens.dk/sites/ens.dk/files/CO2/standardfaktor_for_2019.pdf)

Table A2.6. Net calorific values (NCV) for natural gas, all consumption.

Years	NCV CNG (GJ/1000 m ³)	NCV LNG (GJ/m ³)
1990-1992	39	-
1993-1996	39.3	-
1997	39.6	-
1998	39.9	-
1999	40	-
2000	40.15	-
2001	39.97	-
2002	40.03	-
2003	39.94	-
2004	39.77	-
2005	39.67	-
2006	39.54	-
2007	39.59	-
2008	39.49	-
2009-2016	39.46	-
2017	39.62	-
2018	39.60	-
2019	39.60	22.194

2.2.4 Biomass

Data for 2006 and earlier for wood, black liquor, tall oil, landfill gas and other biomass, other petroleum fuels, other solid fuels and other not specified fuels is reported to Statistics Sweden by surveyed consumers in toe, and the conversion factors are thereby set to 41.87 GJ/toe for these fuels. For 2007 and later years, this is true for NFR 1.A.4. For the other sectors, only black liquor is reported in toe. Other biomass is reported in several different units, e.g. t, m³ or MWh, and thermal values are often reported together with the quantity. These NCVs are considered to be accurate.

net calorific value for ethanol is provided by SPBI²⁸ and is 21.2 GJ/m³ or 26.9 MJ/kg. The net calorific values for ETBE (25.992 GJ/m³) and HVO (33.984 GJ/m³) are based on information from the Swedish Energy Agency²⁹. The net calorific value for FAME (25.992 GJ/m³) is based on a SMED report (33 GJ/m³)³⁰.

2.2.5 Other fuels

Data for waste and other not specified fuels is reported to Statistics Sweden through a survey to consumers in toe, and the conversion factors are thereby set to 41.87 GJ/toe for these fuels. In 2007 and later, waste was combusted within NFR

²⁸ Swedish Petroleum and Biofuel Institute. www.spbi.se

²⁹ <http://www.energimyndigheten.se/statistik/den-officiella-statistiken/statistikprodukter/varmevarden-och-densiteter/>

³⁰ Paulrud, S, Fridell, E, Stripple, H, Gustafsson, T. 2010. *Uppdatering av klimatrelaterade emissionsfaktorer*. SMED report 92:2010

1A1a only and the reporting units used were t and MWh. The NCVs for waste reported by the consumers are considered to be accurate, and thus these thermal values were used for 2007 and later. For other not specified fuels the reporting units vary, and reported NCVs are used (sometimes, the fuel quantities are reported in an energy unit, e.g. MWh).

2.3 Emission factors

Emission factors for SO₂ depend on the content of sulphur in the fuels and on the efficiency of existing emission abatement equipment, for instance if scrubbers are used.

Other emission factors depend on area of consumption and/or the combustion technique used. The efficiency of emission control in the plant is also important. Therefore, these emission factors change over the years as ovens, combustion techniques and emission control used becomes better. All emission factors used in stationary combustion in submission 2016 are published on Swedish EPA's website³¹.

The spread sheets also contain implied emission factors for mobile combustion. Emission factors for selected substances and years are also shown in tables in the following section.

2.3.1 Stationary combustion and fugitive emissions

National emission factors are mainly used for all years. The values of the emission factors have been continuously developed and updated since 2004^{32, 33}. The emission factors are based on results of measurements and national studies as well as studies of international emission factors and judgements of their relevance to national conditions. Emission factors depend on the type of fuel, and the type of plant and abatement equipment. Often and in cases where information is available, the emission factors are updated for the whole time series in order to avoid inconsistencies.

For some fuels, no specific emission factors are available and thus emission factors from similar, more common fuels are used. Fuels concerned are specified in Table A2-7. For all substances, the emission factors for combustion of solid waste are the same for the biogenic and the fossil fraction.

³¹ www.naturvardsverket.se

³² Boström et al., 2004

³³ Nyström & Skårman, 2006

Table A2-7 Fuel types for which specific emission factors are not available in the inventory.

Fuel type	Emission factor used
Kerosene	Gas/diesel oil
Landfill gas	Natural gas
Other biomass	Wood
Other petroleum fuels	Swedish default for "other fuels"
Other solid fuels	Swedish default for "other fuels"
Other not specified fuels	Swedish default for "other fuels"
Refinery gases	Swedish default for "other fuels" except for SO ₂ and NO _x where national values are used

In submission 2017, a major revision of the emission factors was initiated for NFR 1A1A that was completed in submission 2018. Briefly, the completion of the revision in NFR 1A1a includes several fuel types and recalculations were in general made for certain periods or years and not whole time series.

In submission 2018, a larger revision of emission factors for several fuel types was made for sector NFR 1A2³⁴. In general, most emission factors were lowered and revised for the entire time series, decreasing over time. However, emission factors for dioxin and particles were raised for the early years and lowered for the latter part of the time series. Moreover, the increased emissions of NO_x in NFR 1A2 in submission 2018 are primarily related to a reallocation of emissions between NFR 1 and NFR 2 and not an effect of the revised emission factors.

2.3.1.1 NMVOC

Emission factors for stationary combustion within the energy sector for 1990 to 2001 were derived and used together with activity data from the official national Quarterly fuel statistics to calculate emissions and are based on knowledge on the technical development and the general effects of that³⁵. The known effects of this general development has been combined with information from companies legal Environmental Reports, where actual emission factors can be derived, and information from trade associations where experts have contributed their specific knowledge on the different sectors where combustion occurs. These emission factors have been used since submission 2003. Emission factors used in submission 2018 are shown below in Table A2-8 (selected years). Emission factors for small scale biomass combustion in households are additionally described in a separate table (Table A2-17).

³⁴ Mawdsley & Strippel, 2017

³⁵ Kindbom et al., 2003.

Table A2-8 Emission factors for NMVOC (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Blast furnace gas	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Charcoal	Other consumption (1A4)	0.100	0.100	0.100	0.100
Coke	Industry (1A2)	0.008	0.008	0.008	0.008
Coke	Other consumption (1A4)	0.1	NO	NO	NO
Coke oven gas	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Coal	District heating (1A1a)	0.008	0.008	0.008	0.008
Coal	Publ. electricity and power plants (1A1a)	0.005	0.005	0.005	0.005
Coal	Industry (1A2)	0.008	0.008	0.008	0.008
Coal	Other consumption (1A4)	0.1	0.1	NO	NO
Diesel Oil	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Domestic heating oil	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Domestic heating oil	Other consumption (1A4)	0.003	0.006	0.006	0.006
Gas works gas	All consumption (1A1, 1A2, 1A4)	0.002	0.001	0.001	0.001
Kerosene	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
LPG	District heating (1A1a)	0.002	0.001	0.001	0.001
LPG	Industry (1A2)	0.002	0.001	0.001	0.001
LPG	Other consumption (1A4)	0.001	0.001	0.001	0.001
LPG	Publ. electricity and power plants (1A1a)	0.002	0.002	NO	NO
Landfill gas	District heating (1A1a)	NO	0.001	0.001	0.001
Landfill gas	Industry (1A2)	NO	0.001	0.001	0.001
Landfill gas	Publ. electricity and power plants (1A1a)	NO	0.002	0.002	0.002
Landfill gas	Other consumption (1A4)	NO	NO	0.001	0.001
Methane etc.	Industry (1A2)	0.002	0.001	0.001	0.001
Natural gas	District heating (1A1a)	0.002	0.001	0.001	0.001
Natural gas	Industry (1A2)	0.002	0.001	0.001	0.001
Natural gas	Other consumption (1A4)	0.001	0.001	0.001	0.001
Natural gas	Publ. electricity and power plants (1A1a)	0.002	0.002	0.002	0.002
Other biomass	All consumption (1A1, 1A2, 1A4)	0.1	0.02	0.02	0.02
Other non specified	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Other petroleum fuels	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Other solid fuels	Power plants, distr.heating, industry (1A1-2)	0.002	0.002	0.002	0.002
Peat	Power plants, distr.heating, industry (1A1-2)	0.05	0.05	0.05	0.05
Petroleum coke	Industry (1A2)	0.008	0.008	0.008	0.008
Refinery gas	Industry (1A1b)	0.002	0.002	0.002	0.002
Refinery oil	Industry (1A1b)	0.003	0.003	0.003	NO
Residual fuel oil	Other consumption (1A4)	0.006	0.006	0.006	0.006
Residual fuel oil	Power plants, distr.heating, industry (1A1,1A2)	0.003	0.003	0.003	0.003
Steel converter gas	Power plants, distr.heating (1A1)	NO	0.002	0.002	0.002
Steel converter gas	Power plants and district heating (1A1a)	NO	002	002	0.002
Solid waste	District heating (1A1a)	0.025	0.005	0.005	0.005
Solid waste	Industry (1A2)	0.025	0.01	NO	NO
Solid waste	Publ. electricity and power plants (1A1a)	0.005	0.005	0.005	0.005
Tall oil	Power plants, distr.heating, industry (1-2)	0.003	0.003	0.003	0.003
Wooden fuels	District heating (1A1a)	0.1	0.02	0.02	0.02
Wooden fuels	Industry (1A2)	0.1	0.02	0.02	0.02
Wooden fuels	Publ. electricity and power plants (1A1a)	0.05	0.02	0.02	0.02
Wooden fuels	Other consumption: Boilers: pellets	0.017	0.017	0.017	0.017
Wooden fuels	Other consumption: Boilers: wood chips	0.059	0.059	0.059	0.059
Wooden fuels	Other consumption: Boilers: wood logs Modern	0.087	0.087	0.087	0.087
Wooden fuels	Other consumption: Boilers: wood logs Traditional	0.552	0.552	0.552	0.552
Wooden fuels	Other consumption: Stoves: pellets	0.004	0.004	0.004	0.004
Wooden fuels	Other consumption: Stoves: wood logs Modern	0.084	0.084	0.084	0.084

Fuel type	Sector	1990	2000	2010	2019
Wooden fuels	Other consumption: Stoves: wood logs Traditional	0.199	0.199	0.199	0.199
Wooden fuels	Other consumption: Open fire places	0.22	0.22	0.22	0.22

2.3.1.2 EMISSION FACTORS FOR SO₂, NO_x AND PARTICLES WITHIN THE PULP AND PAPER INDUSTRY (NFR 1A2D)

Normally, national emission factors for SO₂, NO_x and particles are used for stationary combustion of all fuels in NFR 1A1 and 1A2, see Table A2-9 and Table A2-10. For the pulp and paper industry, however, a study performed in 2009 showed that these emission factors give systematic overestimations of the emissions of SO₂, NO_x and particles in this industry. The study covered the years 2001-2007 and plants accounting for 80-90% of the emissions within NFR 1A2d. As there was not enough information to trace the overestimation to certain fuels, it was decided to apply “reduction factors” calculated in the study for emissions of SO₂, NO_x and particles from the pulp and paper industry for emission years 2000 and later. These reduction factors are used for all fuels and calculated as the average ratio between total combustion-related emissions from environmental reports and the corresponding emissions calculated with national emission factors. The average ratios over the period 2002-2007 are used since submission 2010 for all years 2000 and later³⁶. However, when implementing the revised emission factors for NFR 1A2³⁷ in submission 2018, these reduction factors were adjusted accordingly, in order to not underestimate the emissions.

Emission factors for SO₂ and NO_x, emission factors are developed for 1990 to 2004³⁸ for refinery gas and refinery oil and for 2005³⁹ and later for SO₂ for refinery gas and NO_x refinery oil. These revised values are used since submission 2007 and 2010.

In submission 2021, the emission factors for NO_x and SO₂ for refinery gas and domestic heating oil were revised⁴⁰ for the combustion within the refineries (1a1b). Regarding NO_x the EF for domestic heating oil was in submission 2021 decreased from 0.090 (kg/GJ) to 0.060 (kg/GJ) for the whole time series. For the refinery gas, the emission factors for NO_x decreased from 0.040 (kg/GJ) to 0.024 (kg/GJ). The emission factors for SO₂ increased for domestic heating oil from 0.15 (kg/GJ) to 0.20 (kg/GJ).

³⁶ The study was never published but the results were documented in Excel files submitted to SEPA in 2009.

³⁷ Mawdsley & Stripple, 2017

³⁸ Nyström & Skårman, 2006

³⁹ Skårman et al., 2008

⁴⁰ Yaramenka, K., Josefsson Ortiz, C. Mawdsley, I. 2020. Förbättring av utsläppsrapporering från Sveriges raffinaderier – fokus på luftföroreningar och Non-Energy Use (NEU). SMED PM.

The effect of the revision on NFR 1a1b led to a decrease of around 30% of the NO_x emissions and for SO₂ the emissions increase. The overall effect on the total emissions are for NO_x a decrease of 0.3% and for SO₂ an increase of 0.53%.

Table A2-9 Emission factors for NO_x (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Charcoal	Other consumption (1A4)	0.1	0.1	0.1	0.1
Coke	All consumption	0.15	0.12	0.09	0.07
Coal	Industry (1A2)	0.2	0.12	0.09	0.07
Coal	Lime production (part of 1A2g)	0.2	0.2	0.2	0.2
Coal	Mining industry (part of 1A2g)	NO	0.6	0.55	0.55
Coal	Other consumption (1A4)	0.2	0.15	NO	NO
Coal	Power plants and district heating (1A1a)	0.2	0.04	0.03	0.03
Domestic heating oil	All consumption except Gas turbines	0.07	0.05	0.05	0.05
Domestic heating oil	Gas turbine/diesel Power generation (part of 1A1a)	0.6	0.2	0.2	0.2
Domestic heating oil	Power plants and district heating (part of 1A1a)	0.07	0.07	0.07	0.07
Domestic heating oil	Industry(1A1b,1A2)	0.07	0.09	0.09	0.09
Gas works gas	Other consumption (1A4)	0.05	0.05	0.05	0.05
Gas works gas	Power plants, district heating (1A1)	0.07	0.04	0.02	NO
Gas works gas	Industries (1A2)	0.07	0.06	0.047	0.04
Hydrogen	Industry (1A2)	NO	NO	NO	NO
Kerosene	Power plants, district heating and industries (1A1, 1A2)	0.07	0.07	0.07	0.07
LPG	Other consumption (1A4)	0.05	0.05	0.05	0.05
LPG	Power plants, district heating (1A1)	0.07	0.07	0.02	0.015
LPG	Industries (1A2)	0.07	0.06	0.047	0.04
Landfill gas	Other consumption	NO	NO	0.054	0.05
Landfill gas	Power plants, district heating (1A1)	NO	0.05	0.05	0.05
Landfill gas	Industries (1A2)	NO	0.06	0.047	0.04
Methane etc.	Industry (1A2)	0.06	0.05	0.047	0.05
Natural gas	Power- and heating plants and industries (1A1, 1A2)	NO	NO	0.05	0.05
Other biomass	Other consumption (1A4)	NO	NO	0.11	0.11
Other biomass	Industry (1A2)	0.12	0.073	0.065	0.06
Other biomass	Power plants, district heating (1A1)	NO	0.07	0.11	0.11
Other non specified	All consumption	0.1	0.1	0.1	0.1
Other petroleum fuels	All consumption	0.1	0.1	0.1	0.1
Other solid fuels	All consumption	0.1	0.1	0.1	0.1
Peat	Industry (1A2)	0.19	0.08	0.07	0.06
Peat	Power plants, district heating (1A1)	0.19	0.08	0.07	0.07
Petroleum coke	All consumption	0.15	0.12	0.12	NO
Refinery gas	All consumption	0.076	0.06	0.047	0.024
Refinery oil	Industry	0.06	0.09	0.09	NO
Residual fuel oil	Gas turbine/diesel Power generation (part of 1A1a)	0.3	NO	NO	NO
Residual fuel oil	Mining industry (part of 1A2g)	0.17	0.09	0.65	0.65
Residual fuel oil	Other Power- and heating plants and industries (1A1, 1A2)	0.17	0.07	0.06	0.06
Residual fuel oil	Other consumption (1A4)	0.17	0.1	0.1	0.1
Solid waste	Industry (1A2)	0.09	0.06	NO	NO
Solid waste	Power plants and district heating (1A1a)	0.09	0.06	0.05	0.05
Tall oil	Industry (1A2)	0.1	0.09	0.08	0.08
Tall oil	Power plants and district heating (1A1a)	NO	0.09	0.08	0.13

Fuel type	Sector	1990	2000	2010	2019
Waste	Power plants and district heating (1A1a)	0.09	0.06	0.05	0.05
Waste	Industry (1A2)	0.09	0.06	NO	NO
Wooden fuels	Industry (1A2)	0.12	0.073	0.065	0.06
Wooden fuels	Other consumption (1A4)	0.08	0.08	0.08	0.08
Wooden fuels	Power plants and district heating (1A1a)	0.12	0.07	0.06	0.06
Wooden fuels	Other consumption: Boilers: pellets	NO	0.065	0.065	0.065
Wooden fuels	Other consumption: Boilers: wood chips	0.08	0.08	0.08	0.08
Wooden fuels	Other consumption: Stoves: pellets	NO	0.065	0.065	0.065
Wooden fuels	Other consumption: Stoves: wood chips	NO	0.08	NO	NO
Wooden fuels	Other consumption: Open fire places	0.08	0.08	0.08	0.08

Table A2-10 Emission factors for SO₂ (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Charcoal	Other consumption (1A4)	NO	NO	0.04	0.04
Coke	Other consumption (1A4)	0.48	NO	NO	NO
Coke	Power plants, district heating and industries (1A1, 1A2)	0.36	0.36	0.36	0.36
Coal	Lime production (part of 1A2g)	0.1	0.05	0.05	0.05
Coal	Mining industry (part of 1A2g)	NO	0.12	0.12	0.04
Coal	Other consumption (1A4)	0.36	0.2	NO	NO
Coal	Other industries, Power plants and district heating (1A1, 1A2)	0.36	0.10	0.10	0.10
Diesel oil	All consumption	0.047	0.002	0.0005	0.0005
Domestic heating oil	Gas turbine/diesel Power generation (part of 1A1a)	0.15	0.05	0.05	0.05
Domestic heating oil	Other Power- and heating plants and industries (1A1, 1A2)	0.04	0.025	0.025	0.025
Domestic heating oil	Other consumption (1A4)	0.08	0.025	0.025	0.025
Kerosene	All consumption	0.014	0.014	0.014	0.014
Landfill gas	Power plants and district heating	NO	0.008	0.008	0.008
Methane etc.	Industry (1A2)	0.002	NA	NA	NA
Natural gas	All consumption	0.002	NA	NA	NA
Other biomass	All consumption	0.04	0.04	0.04	0.04
Other non specified	All consumption	0.24	0.15	0.15	0.15
Other petroleum fuels	All consumption	0.24	0.15	0.15	0.15
Other solid fuels	All consumption	0.24	0.15	0.15	0.15
Peat	Power plants and district heating	0.22	0.12	0.084	0.066
Peat	All consumption	0.22	0.15	0.1	0.07
Petroleum coke	All consumption	0.22	0.12	NO	NO
Refinery gas	All consumption	0.011	0.002	0.002	0.002
Refinery oil	All consumption	0.53	0.24	0.15	NO
Residual fuel oil	All consumption except Gas turbines and lime production	0.24	0.12	0.09	0.09
Residual fuel oil	Gas turbine/diesel Power generation (part of 1A1a)	0.48	NO	NO	NO
Residual fuel oil	Lime production (part of 1A2f)	NO	NO	0.15	0.15
Solid waste	Industry (1A2)	0.025	0.025	NO	NO
Solid waste	Power plants and district heating (1A1a)	0.025	0.025	0.01	0.002
Tall oil	All consumption	0.14	0.1	0.073	0.06
Wooden fuels	Other consumption (1A4)	0.01	0.01	0.01	0.01
Wooden fuels	Power plants, district heating and industries (1A1, 1A2)	0.04	0.018	0.013	0.01

2.3.1.3 PARTICLES, METALS, DIOXIN

The emission factors developed by SMED for calculation of emissions of particles, metals, dioxin from stationary combustion are based on information from many different sources⁴¹. The emission factors for 1990-2003 are based on knowledge on the general effects of technical development combined with information from companies' environmental reports (where actual emission factors can be derived), and information from trade associations where experts on different sectors have contributed with their specific knowledge. The emission factors from 2004 are derived through extrapolation of the 2003 values.

From approximately 1990, emissions have decreased for most stationary sources due to the technical development of abatement measures in combination with regulations and requirements from authorities. Installation of electrostatic precipitator or bag house filters, as an example, has become standard on large combustion sources. This primarily reduces the TSP emissions. Combustion of MSW also became strictly regulated, and as a consequence of that, flue gas cleaning equipment of different types was installed to reduce emissions primarily of dioxins and mercury. In the district heating sector, installation of flue gas condensation equipment has become common since the beginning of the 1990's to increase the heat output, but it also reduces emissions to air of many substances.

Reporting of BaP emissions was introduced in the Swedish inventory for 1990 and later years in submission 2008. Emission factors were developed by SMED⁴² and are applied to the Quarterly fuel statistics since submission 2008.

Emission factors for TSP and PM_{2.5} for refinery oil 1990 and later years, and emission factors for TSP, PM₁₀ and PM_{2.5} for refinery gas for 1998 and later years were revised in submission 2010⁴³. The emission factors used since submission 2010 are the default factors from EMEP/EEA air pollutant emission inventory guidebook, 2009.

In submission 2021, the emission factor for refinery combustion of refinery gas was revised⁴⁴. The emission factor for TSP decreased from 0.005 (kg/TJ) to 0.001 (kg/TJ) for the whole time series.

Emission factors for TSP, PM₁₀ and PM_{2.5} used for stationary combustion are shown in Table A2-11 to Table A2-13. Emission factors for small scale biomass combustion in households are additionally shown in a separate table (Table A2-17).

⁴¹ Boström et al., 2003

⁴² Paulrud et al., 2010

⁴³ Skårman et al., 2008

⁴⁴ Yaramenka, K., Josefsson Ortiz, C. Mawdsley, I. 2020. Förbättring av utsläppsrapporering från Sveriges raffinaderier – fokus på luftföroreningar och Non-Energy Use (NEU). SMED PM.

Table A2-11 Emission factors for TSP (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Coke	Industry (1A2)	0.045	0.03	0.03	0.0002
Coke	Other consumption (1A4)	0.14	NO	NO	NO
Coal	Industry (1A2)	0.045	0.03	0.01	0.0002
Coal	Other consumption (1A4)	0.14	0.10	NO	NO
Coal	Power plants and district heating	0.035	0.02	0.007	0.0002
Diesel Oil	All consumption	0.006	0.002	0.002	0.002
Domestic heating oil	Other consumption (1A4)	0.007	0.003	0.003	0.003
Domestic heating oil	Power plants, district heating	0.006	0.003	0.003	0.003
Domestic heating oil	Industry	0.006	0.002	0.002	0.002
Gas works gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Gas works gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Kerosene	All consumption	0.006	0.002	0.002	0.002
LPG	Other consumption (1A4)	0.0002	0.0002	0.0002	0.0002
LPG	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Landfill gas	Power plants, district heating and industries	NO	0.0001	0.0001	0.0001
Methane etc.	Industry (1A2)	0.0001	0.0001	0.0001	0.0001
Natural gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Natural gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Other biomass	Industry (1A2)	0.065	0.043	0.020	0.009
Other biomass	Power plants and district heating	NO	0.034	0.015	0.010
Other biomass	Other consumption (1A4)	NO	NO	0.04	0.04
Other non specified	All consumption	0.06	0.035	0.035	0.035
Other petroleum fuels	All consumption	0.06	0.035	0.035	0.035
Other solid fuels	All consumption	0.06	0.035	0.035	0.035
Peat	Power plants, district heating and industries, Industry (1A2)	0.065	0.030	0.008	0.001
Petroleum coke	Industry (1A2)	0.045	0.03	0.01	0.0002
Refinery gas	Industry (1A1b)	0.06	0.05	0.005	0.005
Refinery oil	Industry (1A1b)	0.03	0.03	0.03	NO
Residual fuel oil	Other consumption (1A4)	0.015	0.015	0.015	0.015
Residual fuel oil	Power plants and district heating	0.009	0.009	0.009	0.009
Residual fuel oil	Industry	0.01	0.01	0.01	0.01
Solid waste	Industry (1A2)	0.005	0.0012	NO	NO
Solid waste	Power plants and district heating	0.005	0.0012	0.0005	0.0002
Tall oil	All consumption	0.006	0.002	0.002	0.002
Wooden fuels	Industry (1A2)	0.065	0.043	0.020	0.009
Wooden fuels	Power plants and district heating	0.06	0.034	0.015	0.009
Wooden fuels	Other consumption: Boilers: pellets	NO	0.043	0.043	0.043
Wooden fuels	Other consumption: Boilers: wood chips	0.063	0.063	0.063	0.063

Fuel type	Sector	1990	2000	2010	2019
Wooden fuels	Other consumption: Boilers: wood logs Modern	NO	0.039	0.039	0.039
Wooden fuels	Other consumption: Boilers: wood logs Traditional	0.404	0.404	0.404	0.404
Wooden fuels	Other consumption: Stoves: pellets	NO	0.118	0.118	0.118
Wooden fuels	Other consumption: Stoves: wood chips	NO	0.099	NO	NO
Wooden fuels	Other consumption: Stoves: wood logs Modern	NO	0.099	0.099	0.099
Wooden fuels	Other consumption: Stoves: wood logs Traditional	0.204	0.204	0.204	0.204
Wooden fuels	Other consumption: Open fire places	0.204	0.204	0.204	0.204

Table A2-12 Emission factors for PM₁₀ (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Coke	Industry (1A2)	0.043	0.029	0.010	0.00019
Coke	Other consumption (1A4)	0.07	0.05	NO	NO
Coal	Industry (1A2)	0.043	0.029	0.010	0.00019
Coal	Other consumption (1A4)	0.07	0.05	NO	NO
Coal	Power plants and district heating	0.0333	0.019	0.0065	0.0002
Domestic heating oil	Other consumption (1A4)	0.007	0.003	0.003	0.003
Domestic heating oil	Power plants, district heating	0.006	0.003	0.003	0.003
Domestic heating oil	Industry (1A2)	0.006	0.002	0.002	0.002
Ethanol	Industry (1A2)	NO	NO	NO	0.0344
Gas works gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Gas works gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Kerosene	All consumption	0.006	0.002	0.002	0.002
LPG	Other consumption (1A4)	0.0002	0.0002	0.0002	0.0002
LPG	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Landfill gas	Power plants, district heating and industries	NO	0.0001	0.0001	0.0001
Methane etc.	Industry (1A2)	0.0001	0.0001	0.0001	0.0001
Natural gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Natural gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Other biomass	Industry (1A2)	0.062	0.040	0.019	0.0086
Other biomass	Power plants and district heating	NO	0.032	0.015	0.010
Other biomass	Other consumption (1A4)	NO	NO	0.034	0.034
Other non specified	All consumption	0.06	0.035	0.035	0.035
Other petroleum fuels	All consumption	0.06	0.035	0.035	0.035
Other solid fuels	All consumption	0.06	0.035	0.035	0.035
Peat	Power plants, district heating	0.055	0.027	0.007	0.001
Peat	Industry (1A2)	0.059	0.035	0.012	0.0009
Petroleum coke	Industry (1A2)	0.043	0.029	0.010	0.00019
Refinery gas	Industry (1A1b)	0.06	0.05	0.005	0.005
Refinery oil	Industry (1A1b)	0.01	0.01	0.01	0.01
Residual fuel oil	Other consumption (1A4)	0.015	0.015	0.015	0.015
Residual fuel oil	Power plants, district heating	0.007	0.007	0.004	0.004
Residual fuel oil	Industry (1A2)	0.01	0.01	0.01	0.01
Solid waste	Industry (1A2)	0.005	0.0012	NO	NO
Solid waste	Power plants and district heating	0.0045	0.0011	0.0005	0.0002
Tall oil	All consumption	0.006	0.002	0.002	0.002
Wooden fuels	Industry (1A2)	0.062	0.040	0.019	0.0086
Wooden fuels	Power plants and district heating	0.056	0.032	0.015	0.009
Wooden fuels	Other consumption: Boilers: pellets	NO	0.042	0.042	0.042
Wooden fuels	Other consumption: Boilers: wood chips	0.062	0.062	0.062	0.062
Wooden fuels	Other consumption: Boilers: wood logs Modern	NO	0.038	0.038	0.038

Fuel type	Sector	1990	2000	2010	2019
Wooden fuels	Other consumption: Boilers: wood logs Traditional	0.396	0.396	0.396	0.396
Wooden fuels	Other consumption: Stoves: pel- lets	NO	0.116	0.116	0.116
Wooden fuels	Other consumption: Stoves: wood chips	NO	0.097	NO	NO
Wooden fuels	Other consumption: Stoves: wood logs Modern	NO	0.097	0.097	0.097
Wooden fuels	Other consumption: Stoves: wood logs Traditional	0.200	0.200	0.200	0.200
Wooden fuels	Other consumption: Open fire places	0.200	0.200	0.200	0.200

Table A2-13 Emission factors for PM_{2.5} (kg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Coke	Industry (1A2)	0.037	0.025	0.0084	0.00017
Coke	Other consumption (1A4)	0.035	NO	NO	NO
Coking coal	Power plants, district heating	0.029	0.017	0.0056	0.0002
Coking coal	Industry (1A2)	0.037	0.025	0.0084	0.00017
Coking coal	Other consumption (1A4)	0.035	0.025	NO	NO
Coal	Industry (1A2)	0.037	0.025	0.0084	0.00017
Coal	Other consumption (1A4)	0.035	0.025	NO	NO
Coal	Power plants and district heating	0.029	0.017	0.0056	0.0002
Domestic heating oil	Power plants, district heating	0.006	0.003	0.003	0.003
Domestic heating oil	Other consumption (1A4)	0.007	0.003	0.003	0.003
Domestic heating oil	Industry (1A2)	0.007	0.002	0.002	0.002
Gas works gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Gas works gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Kerosene	All consumption	0.006	0.002	0.002	0.002
LPG	Other consumption (1A4)	0.0002	0.0002	0.0002	0.0002
LPG	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Landfill gas	All consumption	NO	0.0001	0.0001	0.0001
Methane etc.	Industry (1A2)	0.0001	0.0001	0.0001	0.0001
Natural gas	Other consumption (1A4)	0.0005	0.0005	0.0005	0.0005
Natural gas	Power plants, district heating and industries	0.0001	0.0001	0.0001	0.0001
Other biomass	Industry (1A2)	0.0455	0.030	0.014	0.0063
Other biomass	Power plants and district heating	NO	0.024	0.011	0.007
Other biomass	Other consumption (1A4)	NO	NO	0.028	0.028
Other non specified	All consumption	0.06	0.035	0.035	0.035
Other petroleum fuels	All consumption	0.06	0.035	0.035	0.035
Other solid fuels	All consumption	0.06	0.035	0.035	0.035
Peat	Power plants, district heating	0.042	0.021	0.005	0.001
Peat	Industry (1A2)	0.046	0.028	0.001	0.0007
Petroleum coke	Industry (1A2)	0.037	0.025	0.0084	0.00017
Refinery gas	Industry (1A1b)	0.06	0.05	0.005	0.005
Refinery oil	Industry (1A1b)	0.005	0.005	0.005	NO
Residual fuel oil	Other consumption (1A4)	0.0125	0.0125	0.0125	0.0125
Residual fuel oil	Power plants, district	0.003	0.003	0.003	0.003
Residual fuel oil	Industry (1A2)	0.0083	0.0083	0.0083	0.0083
Solid waste	Industry (1A2)	0.004	0.0011	NO	NO
Solid waste	Power plants and district heating	0.004	0.0011	0.0005	0.0002
Tall oil	All consumption	0.006	0.002	0.002	0.002
Wooden fuels	Industry (1A2)	0.0455	0.030	0.014	0.0063
Wooden fuels	Power plants and district heating	0.042	0.024	0.011	0.006
Wooden fuels	Other consumption: Boilers: pellets	NO	0.040	0.040	0.040
Wooden fuels	Other consumption: Boilers: wood chips	0.059	0.059	0.059	0.059
Wooden fuels	Other consumption: Boilers: wood logs Modern	NO	0.036	0.036	0.036

Fuel type	Sector	1990	2000	2010	2019
Wooden fuels	Other consumption: Boilers: wood logs Traditional	0.376	0.376	0.376	0.376
Wooden fuels	Other consumption: Stoves: pellets	NO	0.110	0.110	0.110
Wooden fuels	Other consumption: Stoves: wood logs Modern	NO	0.092	0.092	0.092
Wooden fuels	Other consumption: Stoves: wood logs Traditional	0.190	0.190	0.190	0.190
Wooden fuels	Other consumption: Open fire places	0.190	0.190	0.190	0.190

2.3.1.4 EMISSION FACTORS FOR BLACK CARBON

An inventory of emissions of black carbon in Sweden was made for the first time in 2014. Emissions are reported for the years 2000 and later. BC emissions from stationary combustion were estimated according to the EMEP/EEA guidebook⁴⁵ throughout the sectors 1.A.1, 1.A.2 and 1.A.4. The general approach is to multiply the emission factor for PM_{2.5} with a fraction as specified in the guidebook⁴⁶.

2.3.1.5 EMISSIONS FACTORS FOR PCB, HCB AND PAH

Emission factors for PAHs were estimated according to the sum of PAH1-4⁴⁷. The sum of PAH-4 and benzo(a)pyrene was fractionised in benzo(b)fluorathene, benzo(k)fluorathene and indeno(1,2,3-cd)pyrene according to the EMEP/EEA guidebook⁴⁸. Thus, the emissions for the total PAHs will be the same as reported before but the fraction is now enabled. Emission factors for PCB and HFC were taken from the EMEP/EEA guidebook.

Emission factors for PCB are found in Table A2-14. New emission factors for HCB are found in Table A2-15. Emission factors for PAHs in submission 2019 are found in Table A2-16.

⁴⁵ EEA, 2013

⁴⁶ Skårman et.al., 2014

⁴⁷ Allerup et al., 2015

⁴⁸ EEA, 2013

Table A2-14 Emission factors for PCB (µg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Coke	Industry	170	170	170	170
Coking coal	Industry	170	170	170	170
Coking coal	Power pl. and district heating	0.033	0.033	0.033	0.033
Other biomass	Industry	0.06	0.06	0.06	0.06
Other biomass	Power pl. and district heating	NA	3.5	3.5	3.5
Other biomass	Small scale combustion	NA	NA	0.06	0.06
Other non specified	Industry	0.00034	0.00034	0.00034	0.00034
Other non specified	Power pl. and district heating	0.00034	0.00034	0.00034	0.00034
Other non specified	Small scale combustion	NA	NA	0.00034	NA
Other solid fuels	Industry	0.00034	0.00034	0.00034	NA
Other solid fuels	Power pl. and district heating	NA	NA	0.00034	0.00034
Peat	Industry	170	170	170	170
Peat	Power pl. and district heating	0.033	0.033	0.033	0.033
Tall oil	Industry	0.06	0.06	0.06	0.06
Tall oil	Power pl. and district heating	NA	3.5	3.5	3.5
Waste	Industry	0.00034	0.00034	NA	NA
Waste	Power pl. and district heating	0.00034	0.00034	0.00034	0.00034
Wooden fuels	Industry	0.06	0.06	0.06	0.06
Wooden fuels	Power pl. and district heating	3.5	3.5	3.5	3.5
Wooden fuels	Household combustion	0.06	0.06	0.06	0.06

Table A2-15 Emission factors for HCB (µg/GJ), stationary combustion.

Fuel type	Sector	1990	2000	2010	2019
Coke	Industry	0.62	0.62	0.62	0.62
Coking coal	Industry	0.62	0.62	0.62	0.62
Coking coal	Power plants and district heating	6.7	6.7	6.7	6.7
Other biomass	Industry	5	5	5	5
Other biomass	Power plants and district heating	NA	5	5	5
Other biomass	Small scale combustion	NA	NA	5	5
Other non specified	Industry	4.52	4.52	4.52	4.52
Other non specified	Power plants and district heating	4.52	4.52	4.52	4.52
Other non specified	Other combustion	NA	NA	4.52	4.52
Other solid fuels	Industry	4.52	4.52	NA	NA
Other solid fuels	Power plants and district heating	NA	NA	4.52	4.52
Peat	Industry	0.62	0.62	0.62	0.62
Peat	Power plants and district heating	6.7	6.7	6.7	6.7
Tall oil	Industry	5	5	5	5
Tall oil	Power plants and district heating	NA	5	5	5
Waste	Industry	4.52	4.52	NA	NA
Waste	Power plants and district heating	4.52	4.52	4.52	4.52
Wooden fuels	Industry	5	5	5	5
Wooden fuels	Power plants and district heating	5	5	5	5
Wooden fuels	Other combustion	5	5	5	5

Table A2-16 Emission factors for PAH (µg/GJ), stationary combustion.

Fuel type	Sector	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k)fluoranthene	Indenopyrene	PAH_1_4
Coke	Industry	0.7	37	29	1.1	67.8
Coking coal	Industry	0.7	37	29	1.1	67.8
Coking coal	Power pl. and district heating	0.7	37	29	1.1	67.8
Other biomass	Industry	1000	1280	400	320	3000
Other biomass	Power pl. and district heating	1000	896	323	780	3000
Other biomass	Small scale combustion	1000	896	323	780	3000
Other non sp.	Industry	NA	NA	NA	NA	NA
Other non sp.	Power pl. and district heating	NA	NA	NA	NA	NA
Other non sp.	Small scale combustion	NA	NA	NA	NA	NA
Other solid fuels	Industry	NA	NA	NA	NA	NA
Other solid fuels	Power pl. and district heating	NA	NA	NA	NA	NA
Peat	Industry	1000	1280	400	320	3000
Peat	Power pl. and district heating	1000	897	323	780	3000
Tall oil	Industry	250	160	50	40	500
Tall oil	Power pl. and district heating	250	112	40.4	98	50
Waste	Industry	NA	NA	NA	NA	NA
Waste	Power pl. and district heating	0.8	1.7	0.9	1.1	4.5
Wooden fuels	Industry	1000	1280	400	320	3000
Wooden fuels	Power pl. and district heating	1000	897	323	780	3000
Wooden fuels	Other consumption: Boilers: pellets	10	16	5	4	40
Wooden fuels	Other consumption: Boilers: wood chips	20	32	10	8	70
Wooden fuels	Other consumption: Boilers: wood logs Modern	10	16	5	4	40
Wooden fuels	Other consumption: Boilers: wood logs Traditional	121	111	42	71	300
Wooden fuels	Other consumption: Stoves: pellets	10	16	5	4	40
Wooden fuels	Other consumption: Stoves: wood logs Modern	10	16	5	4	40
Wooden fuels	Other consumption: Stoves: wood logs Traditional	121	111	42	71	300
Wooden fuels	Other consumption: Open fire places	121	111	42	71	300

2.3.1.6 EMISSION FACTORS FOR COMBUSTION OF BIOMASS IN HOUSEHOLDS

In submission, 2006 a revision of emission factors for combustion of biomass in households was made to replace single one emission factor for each gas for combustion of biomass in households including all technologies and all biomass fuel types.

Time series of activity data and CH₄ emission factors were reviewed and updated in submission 2016⁴⁹. New methane emission factors for small scale combustion of wood log, pellets and wood chips/sawdust were determined and an improved method was used to calculate the emissions. In order to match the activity data categories, the emission factors were grouped by heating system category and fuel type.

In addition, emission factors for NO_x, CO, NMVOC, SO₂, NH₃, total suspended particles (TSP), PM₁₀, PM_{2.5}, dioxins, PAH and metals 1990-2004 for small scale combustion of biomass were reviewed and occasionally revised⁵⁰. For N₂O emission factors, no new measurement studies were carried out and no new information from the literature was found, and thus no adjustments were made. For NO_x emission factors, data from mainly six Swedish studies was used. The emission of NO_x for pellets varied between 30-80 mg/MJ and for wood logs between 20-120 mg/MJ. The emission factors for CO were mainly based on measured emission data from Swedish residential biomass combustion experiments in the field as well as in the laboratory.

In Swedish emission inventories 2005 and earlier, the SO₂ emission factors were based on an S-content of (0.07 wt % dry fuel) and the assumption that a majority of the sulphur is bound to the ash. In the 2006 study, a lower S-content was applied (0.01 wt %), but with the assumption that no sulphur is bound in the ash.

The NH₃ emissions from wood combustion are generally low and since no new information on NH₃ emission factors was found, the emission factors for NH₃ were not revised.

The emission factors for dioxin from small scale combustion are based on the results from two Swedish and six international studies. The chemical content, for example the chlorine content of the fuel, is a parameter of major significance. It is assumed that most wood boilers and stoves in Sweden are fired with local wood, i.e. uncontaminated wood. The emission factors for PCDD/F varied in the range of 0.012-2.6 ng/MJ for the wood log boilers, 0.02-1.18 ng/MJ for the wood log stoves, 0.002-0.84 ng/MJ for the pellets burners, 0.003-0.11 for the wood chips boilers and 0.005-4.5 for the open fire places. Some of the combustion experiments

⁴⁹ Paulrud et al., 2005

⁵⁰ Paulrud et al., 2006

with pellets showed surprisingly high values. There were no explanations for these high values and in the study it was assumed that combustion of pellets in general have more similar levels of PCDD/F as wood log boilers.

Emission factors for PCB and HCB are default values from the EMEP/EEA guide-book.

In submission 2019, a revision of the emission factors for CO, NMVOC, particles, metals and PAHs for small scale wooden combustion was made, according to Table A2-17 below. The new emission factors were updated and enhanced a new division of modern and traditional technology for stoves and boilers⁵¹.

Table A2-17 Emission factors for 1990-2019 from small scale combustion of wood logs, pellets and wood chip using different combustion technologies.

Technology	Unit	Boiler - pellets	Boiler - wood	boiler - wood Traditional	Modern boiler - wood	lets Stove - pellets	Stove - wood chips	Traditional stove - wood	Modern stove - wood	Open fire- place
CO	g/GJ	339	430	3842	1189	208	208	2371	1740	2610
NMVOC	g/GJ	17	59	552	87	4	4	199	83	220
TSP (total particles)	g/GJ	43	63	404	39	118	118	204	99	225
PM ₁₀ (total particles)	g/GJ	42	62	395	38	116	116	200	97	220
PM _{2.5} (total particles)	g/GJ	40	59	376	36	110	110	190	92	210
BC (based on total particles)	g/GJ	6	2	26	6	11	11	74	22	82
Pb	mg/GJ	15	15	15	15	15	15	15	15	15
Cd	mg/GJ	3	3	3	3	3	3	3	3	3
Hg	mg/GJ	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
As	mg/GJ	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Cr	mg/GJ	3	3	3	3	3	3	3	3	3
Cu	mg/GJ	5	5	5	5	5	5	5	5	5
Ni	mg/GJ	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Se	mg/GJ	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2
Zn	mg/GJ	400	400	400	400	400	400	400	400	400
Benzo(a)pyrene	mg/GJ	10	20	121	10	10	10	121	10	121
Benzo(b)fluoranthene	mg/GJ	16	32	111	16	16	16	111	16	111
Benzo(k)fluoranthene	mg/GJ	5	10	42	5	5	5	42	5	42
Indeno(1,2,3-cd)pyrene	mg/GJ	4	8	71	4	4	4	71	4	71
PAH	g/GJ	0.035	0.07	0.345	0.035	0.035	0.035	0.345	0.035	0.345

⁵¹ Helbig et al., 2018

2.3.1.7 EMISSION FACTORS FOR COMBUSTION OF BIOMASS IN THE
COMMERCIAL/INSTITUTIONAL SECTOR AND
AGRICULTURE/FORESTRY/FISHERY SECTOR

In submission 2020, new calculations of emissions from combustion of biomass in the commercial/institutional sector (NFR 1A4a) and agriculture/forestry/fishery sector (NFR 1A4c) have been developed for particulate matter, CO, NMVOC, PAHs NFR1A4c. The calculations are based on technology-specific emission factors from a previous project in 2018. In order to apply these technology-specific emission factors, shares of fire wood, wood chips and wood pellets in total wood fuel amount were calculated per subsector and across the entire time series. As implemented for the household sector (NFR 1A4b), emissions from firewood are calculated by considering different shares of modern and traditional combustion units over time. The effect of these recalculations are lower emission and a more stable time series with lower year-by-year variation⁵².

⁵² Helbig et al., 2019

Table A2-18. Emission factors for particulate matter, CO, NMVOC, PAHs determined - combustion of wood logs, pellets and wood chip using different combustion technologies for Commercial/Institutional sector and Agriculture/Forestry/Fishery sector.

Technology	Unit	1A4a COMMERCIAL/INSTITUTIONAL				1A4c AGRICULTURE/FORESTRY/FISHERY			
		Boiler - pel- lets	Boiler - wood chips	Tradi- tional boiler - wood	Mod- ern boiler - wood	Boiler - pel- lets	Boiler - wood chips	Tradi- tional boiler - wood	Modern boiler - wood
CO	g/GJ	339	430	3842	1189	339	430	3842	1189
NMVOC	g/GJ	17	59	552	87	17	59	552	87
CH ₄	g/GJ	6	6	88	15	6	6	88	15
TSP (total particles)	g/GJ	43	63	404	39	43	63	404	39
PM ₁₀ (total particles)	g/GJ	42	62	395	38	42	62	395	38
PM _{2.5} (total particles)	g/GJ	40	59	376	36	40	59	376	36
BC (based on total particles)	g/GJ	6	2	26	6	6	2	26	6
Pb	mg/GJ	15	15	15	15	15	15	15	15
Cd	mg/GJ	3	3	3	3	3	3	3	3
Hg	mg/GJ	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
As	mg/GJ	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cr	mg/GJ	3	3	3	3	3	3	3	3
Cu	mg/GJ	5	5	5	5	5	5	5	5
Ni	mg/GJ	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Se	mg/GJ	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Zn	mg/GJ	400	400	400	400	400	400	400	400
Benzo(a)pyrene	mg/GJ	10	20	121	10	10	20	121	10
Benzo(b)fluoranthene	mg/GJ	16	32	111	16	16	32	111	16
Benzo(k)fluoranthene	mg/GJ	5	10	42	5	5	10	42	5
Indeno(1,2,3-cd)pyrene	mg/GJ	4	8	71	4	4	8	71	4
PAH	g/GJ	0.035	0.07	0.345	0.035	0.035	0.07	0.345	0.035

2.3.2 Mobile combustion

Emission factors used for mobile combustion calculations are both country-specific and default values from IPCC Guidelines and EMEP/EEA air pollutant emission inventory guidebook. These emission factors are further described in IIR section 3.2.

In submission 2021, the HBEFA model version 4.1 was implemented and several emission factors, such as NMVOC, NO_x, particles, BC, etc. were updated regarding for all vehicle categories.

2.3.3 Inclusion/exclusion of the condensable component from PM₁₀ and PM_{2.5} emission factors

The size of PM_{2.5} and PM₁₀ emissions depends on whether combustion emissions are measured in hot or cold flue gases, where measurements in cold flue gases include the condensable component and measurements in hot flue gases do not. Information on whether the emission factors used in the Swedish emission inventory include the condensable component is presented in the table below. In many cases it is not known for certain whether the measurements that the emission factors are based on include the condensable component.

Table A2-19 Inclusion /exclusion of the condensable component from PM_{2.5} and PM₁₀ in emission factors.

NFR	Source/sector name	The conden- sable compo- nent is:	The conden- sable compo- nent is:	The conden- sable compo- nent is:	EF reference	Comment
		Included	Excluded	Uncertain		
1A1a	Public electricity and heat production	X				
1A1b	Petroleum refining	X				
1A1c	Manufacture of solid fuels and other energy industries	X				
1A2g, 1a3e, 1A4a, 1A4b, 1A4c	Non-road mobile machinery			X	National model for Non-Road Mobile Machinery	
1A3b	Road Transportation	X			HBEFA,	
1A3c	Railways			X	EMEP/EEA Guidebook 2016, threshold values	
1A3d	Domestic navigation	X			Country specific emission values produced by IVL Swedish Environmental Research Institute.	
1A4a, 1A4b, 1A4c	Other stationary combustion	X			Country-specific emission factors based on measurements from NKL project	
1B excluding 1B1c			X*		1B2A1, 1B2C21, 1B2C22 – national EF	
1B1c	COG flaring		X*		1B2A4 – env. reports	
					Emissions from env. reports (no EF)	

NFR	Source/sector name	The conden- sable compo- nent is:	The conden- sable compo- nent is:	The conden- sable compo- nent is:	EF reference	Comment
		Included	Excluded	Uncertain		
1B1c	Handling of solid fuels					No condensable component exists (no combustion). Total PM=filterable PM
2A excluding 2A5a and 2A5b	Mineral products		X*		2A1 – TSP emissions from env. reports (no EF), PM fractions – from personal communication with the company. 2A2 – national EF 2A3 – emissions from env. reports (no EF)	
2A5a	Quarrying and mining of minerals other than coal					No condensable component exists (no combustion). Total PM=filterable PM
2A5b	Construction and demolition					No condensable component exists (no combustion). Total PM=filterable PM
2A5c	Mineral wool production		X*		Env. reports	
2B5	Carbide production		X*		Env. reports	
2B10	Other chemical industry			X	Env. reports and EMEP/EEA Guidebook 2016	Some emissions may include condensable component and some not.
2C	Metal production		X*		TSP emissions from env. reports (no EF)	
2D3b	Other solvent and product use – Road paving		X		EF from EMEP/EEA Guidebook 2016	According to EMEP/EEA, EF represents filterable PM emissions.

NFR	Source/sector name	The conden- sable compo- nent is:	The conden- sable compo- nent is:	The conden- sable compo- nent is:	EF reference	Comment
		Included	Excluded	Uncertain		
2D3c	Other solvent and product use – As-phalt roofing					No condensable component exists (no combustion). Total PM=filterable PM
2G4	Other product use			X	EF from EMEP/EEA Guidebook 2016	
2H1	Pulp and paper industry		X*		Env. reports	
2I	Wood processing					No condensable component exists (no combustion). Total PM=filterable PM (TSP only)
5C1bii	Incineration of hazardous waste		X*		Env. reports	
5C1bv	Cremation, carcasses			X	EF from EMEP/EEA Guidebook 2016	
5E	House and car fires			X	EF from EMEP/EEA Guidebook 2016	

* Condensable component is most likely excluded since emission factors/estimates in general are based on measurements in the flue stack, i.e. not in diluted flue gases.

2.3.4 References

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2.4 Allocation of fuels for mobile combustion

This section describes the allocation and distribution of the delivered amount of fuels on subsectors.

2.4.1 Gasoline

Data on the delivered amounts of gasoline at a national level is provided by the national statistics on supply and delivery of petroleum products for 1990-2017 and data reported under the Swedish fuel quality act is used for 2018 (see chapter 2.1.7).

National total delivered amounts of gasoline includes low blended ethanol and ETBE. To separate biofuel emissions from fossil fuel emissions, all ethanol used by road traffic is reported as biomass under CRF 1.A.3.b. But a small part of ETBE is considered fossil and the energy consumption and the emissions of CO₂ from the fossil part are included in the national total of CO₂.

Ethanol has been used by buses since 1990, but low blended ethanol started in 2000 and increased significantly in 2003. The gasoline sold at gas stations today is an admixture of about 95 % gasoline and 5 % ethanol. The total amount of ethanol reported as biomass includes, besides low blended ethanol, the volume of ethanol used by E85 vehicles, by ethanol buses and ethanol used by the Swedish armed forces (2007-2014).

The allocation of gasoline to different subsectors takes place in three steps and is illustrated in figure A2.1 below.

1. In the first step, the low blended ethanol/ETBE in gasoline is subtracted from the total delivered amounts of gasoline at a national level.
2. In the next step, the gasoline consumption by domestic navigation, military road traffic and military navigation⁵³ as well as the estimated consumption by road traffic (HBEFA data) and off road vehicles (model estimated) is subtracted.
3. The remaining volume of gasoline is proportionally distributed to civil road traffic and to off-road vehicles.

⁵³ Data from the Swedish Armed Forces.

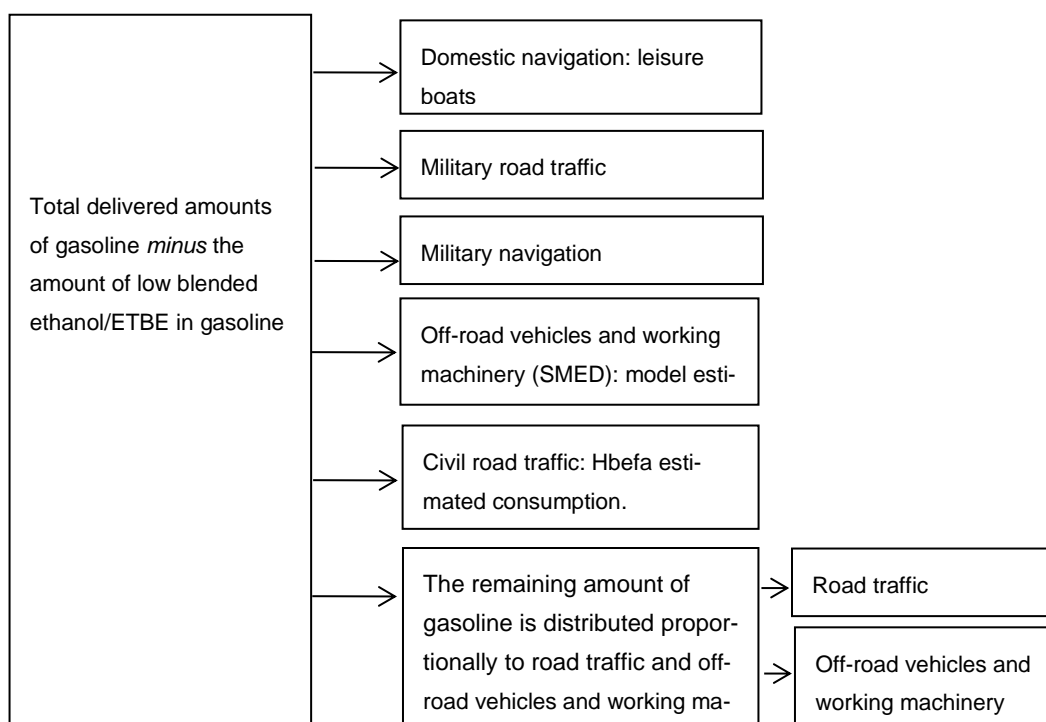


Figure A2-1 Gasoline distribution by subsector and source.

The gasoline consumption by road traffic is estimated by the European road vehicle emission model HBEFA (see chapter 2.5). The gasoline consumption by off-road vehicles (CRF 1.A.2.gvii, 1.A.3.eii, 1.A.4.aai, 1.A.4.bii and 1.A.4.cii) is estimated using a model based on a study carried out in 2008 (see chapter 2.6)⁵⁴. The amount of gasoline consumed by military road transport and navigation (CRF 1.A.5.b) is provided by the Swedish Armed Forces.

The consumption of gasoline by domestic navigation only consists of the consumption by leisure boats and is based on three surveys. Neither domestic ferries nor bigger ships run on gasoline.

The estimated gasoline consumption by leisure boats in Sweden 1990-2004 is based on a survey from 2004⁵⁵ and a study carried out by SMED in 2005⁵⁶. The leisure boat survey from 2010⁵⁷ was assessed by SMED in 2014⁵⁸ and revised in 2018, which resulted in an increased gasoline consumption for 2010. In 2015 there was a third leisure boat study, which was assessed by SMED in 2018⁵⁹ and also resulted in an increased consumption of gasoline for 2015 and the following years.

⁵⁴ Fridell, Jernström & Lindgren, 2008

⁵⁵ Statistics Sweden, 2005a.

⁵⁶ Gustafsson, 2005.

⁵⁷ Transportstyrelsen (2010). Båtlivsundersökningen, 2010.

⁵⁸ Eklund V. 2014.

⁵⁹ Fridell, E., Mawdsley, I., Wisell T. 2017.

The consumption of gasoline in 2005-2009 and in 2010-2014 was estimated by interpolation, based on the assessed consumption in each survey.

A comparison between the volume of gasoline allocated to the civil road traffic sector through this top-down approach and the volume of gasoline consumed according to the bottom-up HBEFA road emission model, used by the Swedish Transport Administration, indicates a good correspondence between the two estimates. The bottom-up approach estimates a slightly higher consumption in the early 90's but the difference in estimated gasoline consumption between the top-down and bottom-up approach is decreasing by time.

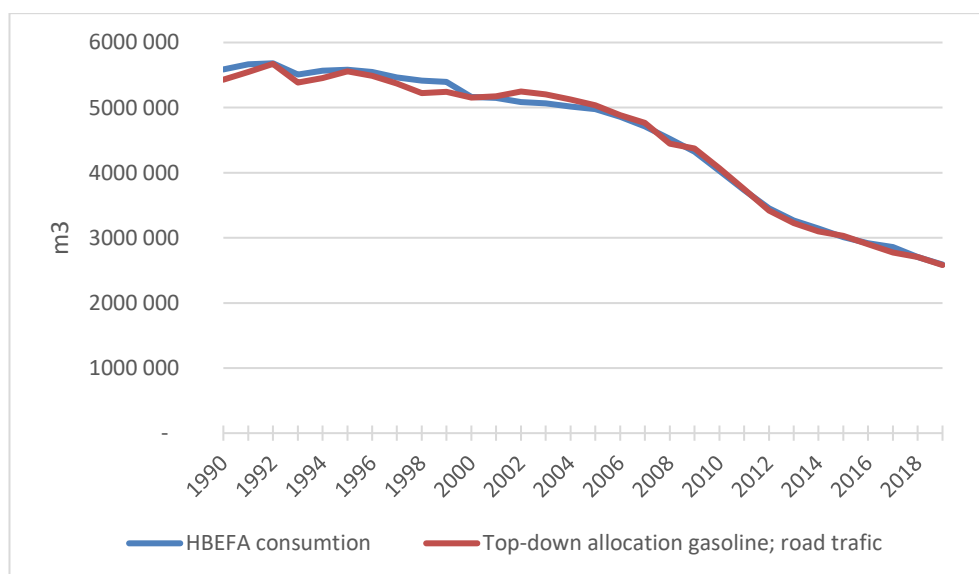


Figure A2-2 Bottom-up estimated gasoline fuel consumption versus top-down allocated gasoline consumption in submission 2021.

The approximate distribution of gasoline deliveries allocated to the civil road traffic to subsectors in 2019 is shown in Figure A2-3. Civil road traffic accounts for almost all gasoline consumption, followed by off-road vehicles and other machinery. Gasoline consumption by domestic navigation and military activities is relatively low.

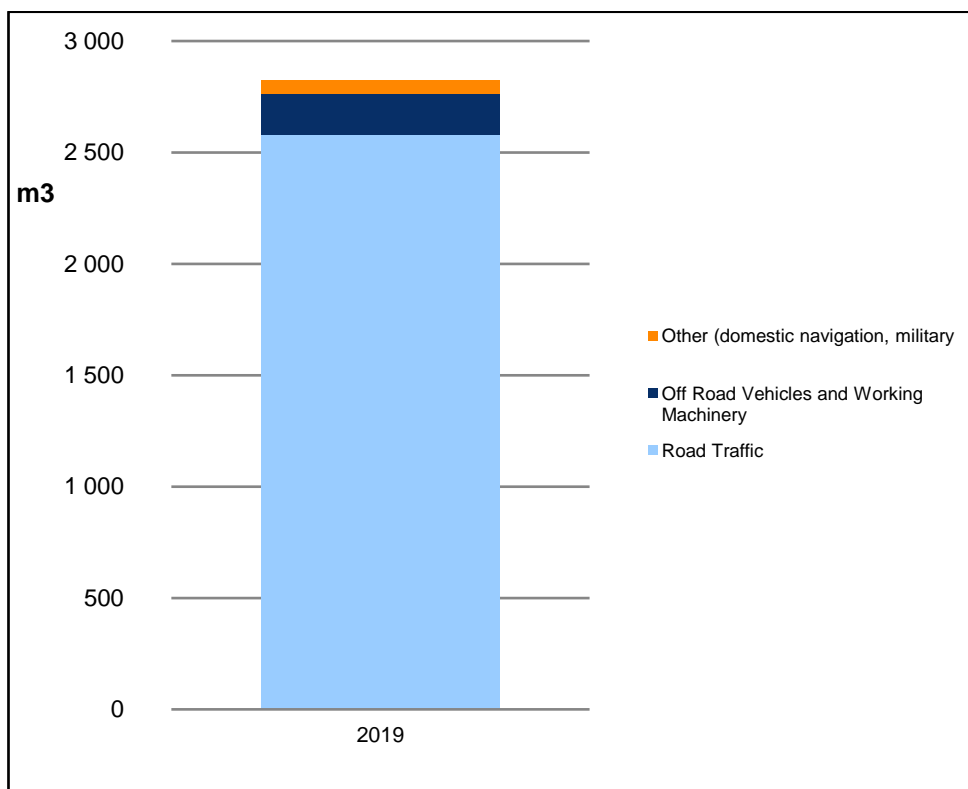


Figure A2-3 Distribution of gasoline by subsector in 2019.

2.4.2 Diesel

Data on the total amount of diesel oil delivered at a national level is provided by the statistics on supply and delivery of petroleum products⁶⁰ for 1990-2017 while data reported under the Swedish fuel quality act is used for 2019 Section 2.1.7). The use of diesel by international bunkers is specified as discussed in IIR section 3.2.9.

The diesel for national consumption is distributed to different subsectors following a three-step process and is illustrated in figure A2.4 below.

1. *In the first step*, the diesel used for stationary combustion and the low blended FAME/HVO is subtracted from the total delivered amounts of diesel.
 - The total volume of HVO is reported as biomass under CRF 1.A.3.b, but a small part of FAME is considered fossil and the emissions of CO₂ from the fossil part of FAME is included in the national emissions of GHG.
2. *In the second step*, the diesel consumption by road traffic (HBEFA data), off road vehicles (model estimated), railways, domestic navigation including leisure boats as well as military road traffic and navigation is subtracted.

⁶⁰ Statistic Sweden. Monthly fuel, gas and inventory statistics. <http://www.scb.se/en/Finding-statistics/Statistics-by-subject-area/Energy/Energy-supply-and-use/Monthly-fuel-gas-and-inventory-statistics/>

3. *In the third and last step*, the remaining volume of diesel is proportionally distributed to subsectors with a more uncertain consumption of diesel: road traffic, off-road vehicles and fisheries. The allocation is made in proportion to the estimated consumption of diesel in each subsector.

The consumption estimates of each subsector is based on the sources according to table A2.20.

Table A2.20. Subsectors with a diesel consumption that is subtracted in the *second step*.

Subsector	CRF	Estimation of amount of diesel consumed
Road traffic	1A3b	HBEFA: road emission model 4.1
Working machinery	1A2gvii, 1A3eii, 1A4aii-1A4cii	Model for off road vehicles
Railway	1A3c	Survey by the Swedish Energy Agency
Domestic navigation	1A3d	Shipai (SMHI) and survey of fuel consumption for domestic navigation the Swedish Energy Agency.
Leisure boats	1A3d	SMED report, 2005. SMED PM, 2014. SMED Report No 9 2017
Military road transport	1A5b	Exact amount given by the Swedish Armed Forces
Military navigation	1A5b	Exact amount given by the Swedish Armed Forces
Military abroad	1D2	Exact amount given by the Swedish Armed Forces

Figure A2.4 gives a brief overview of the distribution of diesel among different subsectors.

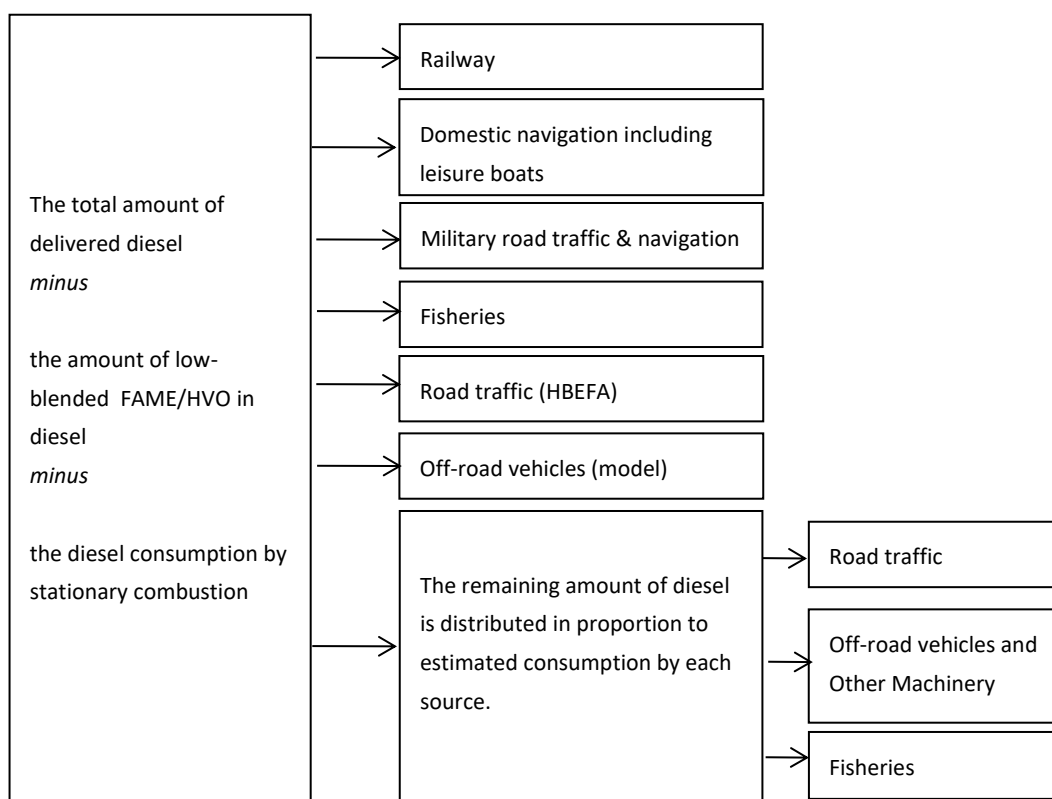


Figure A2-4 Model for allocating the total amount of delivered diesel on subsectors.

The diesel consumption from civil road traffic is estimated by the European road vehicle emission model HBEFA (Section 2.5). A comparison between the estimated diesel consumption according to the bottom-up emission model HBEFA and the top-down adjusted diesel delivery statistics approach gives a higher consumption for the top-down approach for most years (Figure A2.5) estimates.

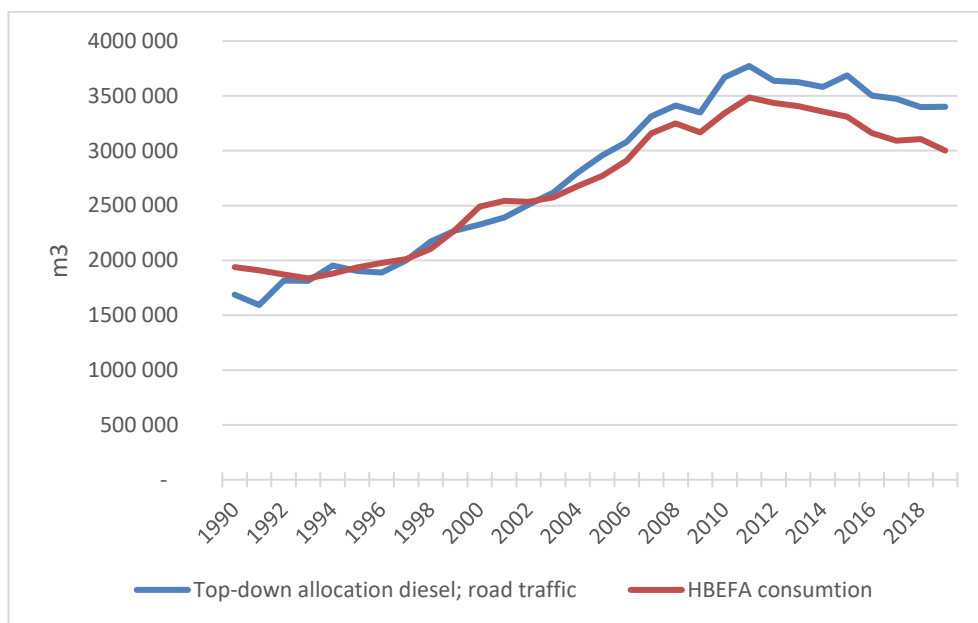


Figure A2-5 Bottom-up estimated diesel consumption versus top-down allocated diesel in submission 2021.

The diesel consumption by off-road vehicles and other machinery is estimated by a model, which is based on a SMED study from 2008⁶¹, and was implemented in submission 2009. The model has been updated with new data and improved by each submission. See section 2.6 for more information.

The estimate for diesel consumption from domestic navigation⁶² (also called marine diesel oil) was before submission 2020 provided by the statistics on supply and delivery of petroleum products⁶³. As from submission 2020, the energy consumption from domestic navigation is based on a model called Shipair, developed by the Swedish meteorological and hydrological institute (SMHI), and information collected from the largest shipping actors for domestic navigation⁶⁴. See section 2.4.3 below for more information.

The fuel consumption by leisure boats was reviewed in 2005, 2014 and 2018. The diesel consumption by leisure boats in Sweden 1990-2004 is based on a survey from 2004⁶⁵ and a study carried out by SMED in 2005⁶⁶. In 2010, there was a new

⁶¹ Fridell, Jernström & Lindgren 2008

⁶² Except for leisure boats.

⁶³ Statistic Sweden. Monthly fuel, gas and inventory statistics. <http://www.scb.se/sv/Hitta-statistik/Statistik-efter-amne/Energi/Tillforsel-och-anvandning-av-energi/Manatlig-bransle--gas--och-lagerstatistik/>

⁶⁴ Eklund, V. et al. 2019. Analys och implementering av data från nya MåBra.

⁶⁵ https://www.transportstyrelsen.se/globalassets/global/sjofart/dokument/2004_batlivsundersokningen.pdf

⁶⁶ Gustafsson, 2005.

leisure boat survey⁶⁷, which is the base for the diesel consumption by leisure boats in 2010-2014. An assessment of the survey was carried out by SMED in 2014⁶⁸ and revised in 2018. In 2015, there was a third leisure boat study⁶⁹, which was assessed by SMED in 2018⁷⁰ and is the base for the diesel consumption in 2015 and the following years. The consumption of diesel in 2005-2009 and 2010-2014 was estimated by interpolation, based on the assessed consumption in each survey.

The estimated consumption of diesel by the Swedish fishing fleet in 2005, is based on a survey to the fishing industry carried out by Statistics Sweden⁷¹. The estimated fuel consumption for 2005 serves as a reference year. The fuel consumption in 1995-2004 and 2006-2018 are adjusted relative to the total installed effect for each year. Information of the Swedish fishing fleet's installed effect is provided by the Swedish Agency for Marine and Water Management (SwAM). The installed effect is available from 1995 and for the years prior to 1995, it is estimated through extrapolation. The amount of diesel consumed by military road transport and navigation, NFR 1A5b, is provided by the Swedish Armed Forces.

Figure A2-6 shows the approximate distribution of the delivered amount of diesel oil in 2018. As for gasoline, diesel from civil road traffic accounts for the majority of the consumption. However, diesel from off-road vehicles and other machinery also contributes to a considerable amount (22 %) of the total diesel consumption.

⁶⁷ https://www.transportstyrelsen.se/globalassets/global/sjofart/dokument/fritidsbatar1/batlivsundersokningen_2010.pdf

⁶⁸ Eklund V. 2014.

⁶⁹ <https://www.transportstyrelsen.se/globalassets/global/sjofart/dokument/fritidsbatar1/transportstyrelsen-batlivsundersokning-2015-rapport-v-2-160307.pdf>

⁷⁰ Fridell, E., Mawdsley, I., Wisell T. 2017.

⁷¹ Statistics Sweden 2006

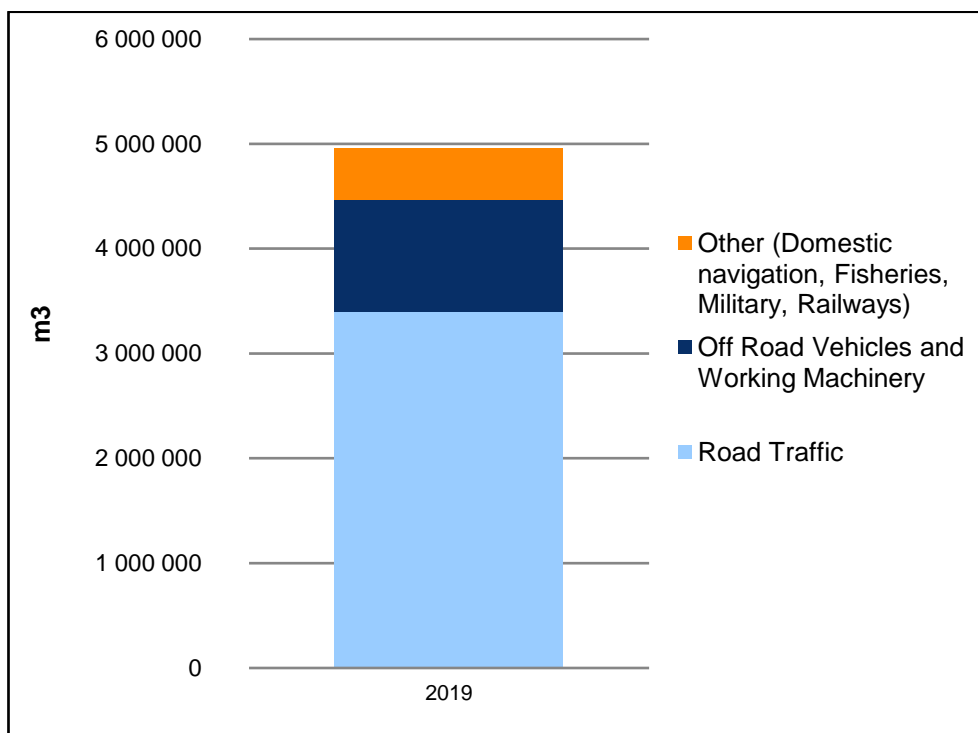


Figure A2-6 Distribution of diesel oil by subsector in 2019.

2.4.2.1 ENVIRONMENTAL CLASSES OF DIESEL OIL

Diesel oil is refined into three categories; so called environmental classes 1-3. These have been gradually introduced from 1991. Today, environmental class 1 diesel accounts for about 99 % of the total delivered amount of diesel. The shift in consumption of diesels of different environmental classes has a significant impact on the emissions.

Table A2-22 shows the characteristics for environmental class 1-3 regarding thermal values. Information on the diesel distribution on environmental classes has been collected from the Swedish National Road Administration for the years 1990-1993 and from Statistics Sweden for 1994 and later years. The Swedish Petroleum and Biofuel Institute (SPBI) have assisted with information regarding thermal values⁷². SMED has calculated yearly averages of thermal values and emission factors.

Information on the diesel distribution on environmental classes has been collected from the former Swedish National Road Administration for the years 1990-1993 and from Statistics Sweden for 1994 and later years. The Swedish Petroleum and Biofuel Institute (SPBI) has assisted with information regarding NCVs and emission factors for CO₂⁷³. SMED has calculated yearly averages of NCVs and emission factors.

⁷² Swedish Petroleum Institute, www.spi.se. August 2005.

⁷³ Swedish Petroleum Institute, www.spi.se. August 2005.

Table A2-22 Impact from different environmental class diesel on NCV and emission factors for CO₂.

Diesel	NCV (GJ/m ³)	Emission factor CO ₂ (t/TJ)	Weight 1990 (%)	Weight 2000 (%)	Weight 2013 (%)
Environmental class 1	35.28	72.00	0	94	99
Environmental class 2	35.28	72.56	0	0	0
Environmental class 3	35.82	74.26	100	6	1
Average 1990	35.82	74.26			
Average 2000	35.31	72.13			
Average 2010	35.28	72.01			
Average 2018	35.28	72.01			

2.4.3 Marine distillate fuel

Marine distillate fuel is a group name covering marine diesel oil and marine gas oil used for navigation. Emissions from these fuels are reported as gas/diesel oil in the NFR. The source for the activity data (AD) used for national navigation changed in submission 2020. In previous submissions, the AD was based on the monthly survey on supply and delivery of petroleum products⁷⁴. As from submission 2020, the energy consumption from domestic shipping is mainly based on a methodology called Shipair, which was developed by the Swedish meteorological and hydrological institute (SMHI). The Shipair model collects data from AIS (Automatic Identification System), which ships use to continuously transmit identity and position information. The AIS data shows how the ships move between Swedish ports. Information regarding the ships, such as size, engine power and type of vessel is also collected. This enables the Shipair model to estimate the amount of energy needed for the ships to move and the amount of fuel consumed.

Beside the Shipair model, the energy consumption from domestic navigation is based on information collected from the largest shipping actors for national navigation, with the exception for cargo ships.⁷⁵ Information regarding the fuel consumption, by fuel type, is collected as Shipair only estimate the energy consumption. Shipair does not know which fuel types are used and the amount of fuel by fuel type. The difference between the energy consumption estimated by Shipair and from collected data, is assumed to be the energy consumption by cargo ships

The diesel consumption by leisure boats is based on three different surveys regarding leisure boats from 2004, 2010 and 2015⁷⁶ and three different studies by

⁷⁴ Statistic Sweden. Monthly fuel, gas and inventory statistics. See annex 2 for more information regarding different surveys.

⁷⁵ Eklund, V. et al. 2019. Analys och implementering av data från nya MåBra.

⁷⁶ Statistics Sweden, 2005. Transportstyrelsen. 2010. Transportstyrelsen 2015.

SMED⁷⁷. Marine diesel oil for domestic navigation is discussed under the diesel section, 2.4.2. The statistics on marine distillate fuels are reported separately for domestic and international navigation and the split is based on the information provided by the respondents to the survey on supply and delivery of petroleum products.

The amount of marine distillate fuel used for domestic navigation and leisure boats (CRF 1.A.3.d) is shown in figure A2.7. The stricter rules regarding the sulphur content in marine fuels, which took effect in January 2015, led to a shift from heavy oil fuel oil to lighter oil products with a lower sulphur content in 2015. But in 2018 there were a shift to heavy marine oils again but with a reduced sulphur content, so called “hybrid oils”. This can be seen in figure A2-7 and A2-8.

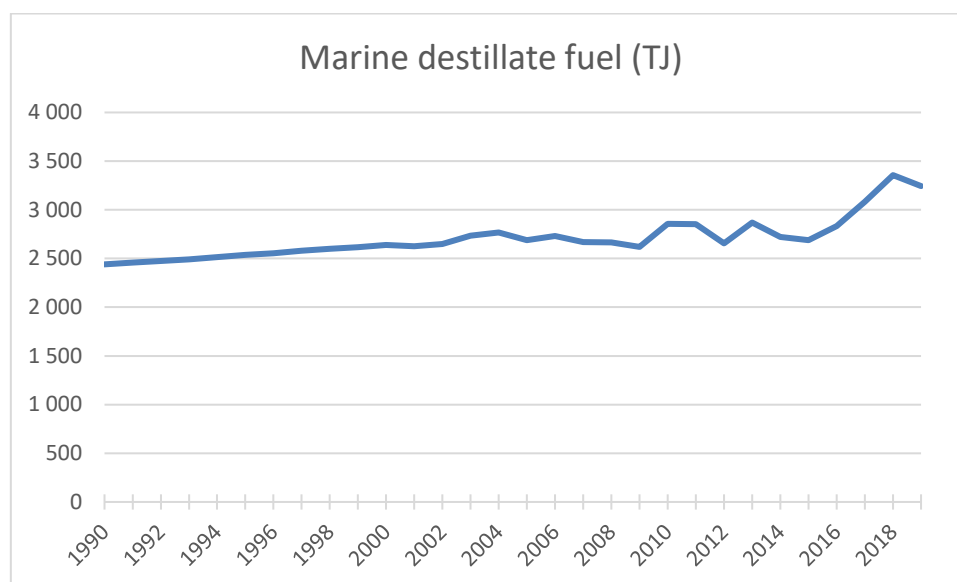


Figure A2-7. National fuel deliveries of marine diesel oil and marine gas oil (marine distillate fuel) 1990-2019.

⁷⁷ Gustafsson, T. 2005. Eklund, V. 2014. Fridell, E., Mawdsley, I., Wisell T. 2017

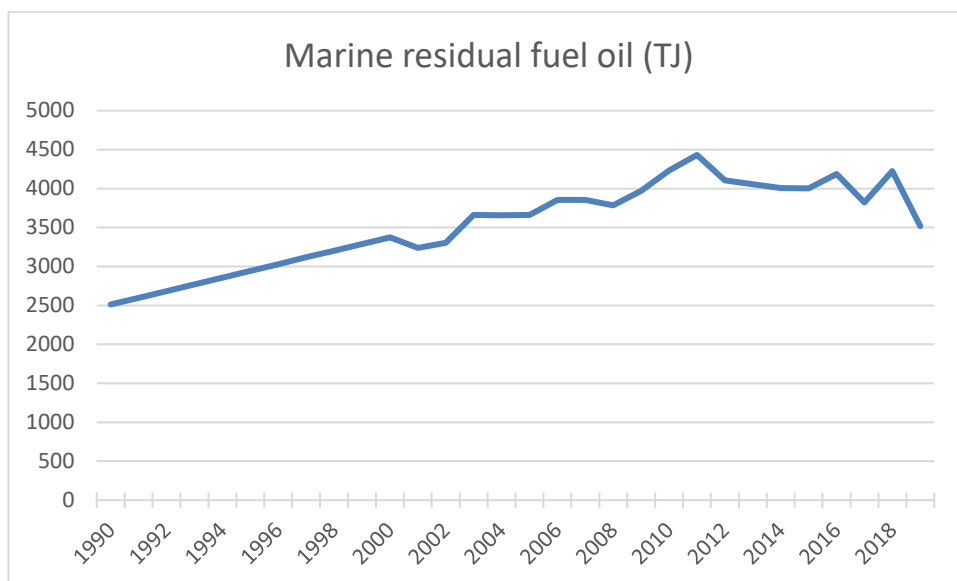


Figure A2-8. National fuel deliveries of marine Residual fuel (m3) for 1990-2019.

2.4.4 Residual fuel oils

As from submission 2020, the energy consumption from domestic shipping is mainly based on a methodology called Shipair and the fuel consumption by fuel type collected from the largest shipping actors for national navigation, with the exception for cargo ships.⁷⁸ See section 2.4.3 and figure A2.8 above for more information.

2.4.5 Jet kerosene, jet gasoline and aviation gasoline

All jet kerosene, jet gasoline and aviation gasoline are assumed to be used for aviation. Delivered amounts of these fuels are provided at national level by the statistics on supply and delivery of petroleum products. Delivered amounts of jet kerosene and aviation gasoline are distributed between military and civil aviation. The information on military consumption of aviation fuels provided by the Swedish Armed Forces is assumed to be correct and the remaining amounts are allotted to civil aviation. Jet gasoline is only used by the military and has not been used after 1993.

2.4.6 Natural Gas and biofuels

Other fuels used for transport are ethanol, FAME, natural gas and biogas. All consumption is assumed to be in the road traffic sector, NFR 1A3b.

Ethanol and FAME are partly used as admixtures in gasoline and diesel, and partly used in more pure forms in bi-fuel vehicles. Information on delivered amounts of ethanol and FAME are provided at national level by the statistics on supply and delivery of petroleum products. Data on delivered amount of natural gas for transport is provided by the statistics on the delivery of gas products (see above). Data on the

⁷⁸ Eklund, V. et al. 2019. Analys och implementering av data från nya MåBra.

consumption of biogas from 1996 is provided by the Swedish Biogas Association. Data for 1990-1995 is not available.

2.4.7 References

Gustafsson, T., 2005. Update of gasoline consumption and emissions from leisure boats in Sweden 1990-2003 for international reporting. SMED report 73 2005.

Eklund, V., 2014. Justering av småbåtars bränsleförbrukning. SMED PM 2014.

Fridell, E., Jernström, M., Lindgren, M., 2008. Arbetsmaskiner – Uppdatering av metod för emissionsberäkningar. SMED Report 2008.

Fridell E., Mawdsley I., Wisell T. 2017: Development of new emission factors for shipping. SMED Report No 9 2017.

Statistics Sweden, 2005: Båtlivsundersökningen 2004 (Leisure boats survey 2004).

Statistics Sweden, 2006: Energy consumption in the fishery sector 2005. Official Statistics of Sweden.

Swedish Petroleum Institute, www.spi.se. August 2005.

Transportsstyrelsen, 2010. Båtlivsundersökningen 2010 (Swedish leisure boat survey 2010).

2.5 The HBEFA road model

The road emission model HBEFA⁷⁹ is used to estimate the emissions from road traffic in Sweden. In submission 2016 there was a transition from HBEFA 3.1 to HBEFA 3.2. In submission 2018 to 2020 HBEFA 3.3 was used and in submission 2021 there was a transition to HBEFA 4.1. The HBEFA model is based on the former ARTEMIS road model, which was used in earlier submissions (submission 2006 to submission 2011). To a large extent the two models are the same, since the HBEFA 3.1 road model was developed from a merging of the ARTEMIS road model and the former version of HBEFA – 2.1. The most prominent difference in HBEFA compared to the Artemis model, is the inclusion of the latest exhaust emission control technology.

HBEFA provides emission factors and emissions for segments and sub-segments of six main vehicle categories - passenger cars (PC), light commercial vehicles (LCV), heavy goods vehicles (HGV), urban busses, coaches, and motorcycles in-

⁷⁹ HBEFA: Handbook of Emission Factors

cluding mopeds (MC) - for a large number of traffic situations, as well as for average speeds⁸⁰. A segment is defined as a group of vehicles of similar size (e.g. rigid trucks with weight between 14 and 20 t) and similar technology (e.g. petrol engines, diesel engines, biofuel, CNG/petrol engines), whereas sub-segments are defined as groups of vehicles of similar size, technology and emission concept (e.g. pre-Euro, Euro 1, 2, 3, etc.)

The emission factors are based on emission measurements according to different sets of real-world driving cycles, representative for typical European driving conditions⁸¹. The model calculates emissions separated into hot emissions, cold start emissions and evaporative emissions. An overview of the model structure with input and output parameters is given by Figure A2-7.

The model is a bottom-up approach estimate and a basic parameter for the HBEFA-model is the vehicle-km, which is calculated through another model. This second model is based on the mileage driven by the vehicle noted at time of MOT (annual testing of the vehicle)⁸². A passenger car that goes through the MOT in the beginning of 2014 has been driven the most part of 2013. If the development of traffic is without interruption, this issue is not a problem for the calculations. However, if a sudden event occurs such as a drop in the economy, it will not be shown as clearly in the development of vehicle mileage as in statistics on fuel consumption.

HBEFA is yearly updated with new information regarding emission factors, vehicle fleet, composition of the fuel and current traffic work. Beside the yearly updates, the model has undergone other updates over the years.

Submission 2014:

- The method to estimate traffic work with regard to driving distances was updated and improved.
- The distribution of segments was updated with new activity data (AD from 1999-2012 instead of 2004) as well as the driving distance as a function of age. This resulted in a decreased average driving distance for passenger cars running on diesel, as diesel vehicles were not as common in 2004 among people driving shorter distances as they are today.

Submission 2015:

- The model was adjusted with new data regarding the fraction of trucks with trailers and the load factor for trailers. The data is based on a yearly truck survey performed by the Agency for Transport Analysis (TRAFA).

⁸⁰ Keller et al., 2005

⁸¹ André, 2004

⁸² Ministry of Transport test (usually abbreviated to MOT test or simply MOT) is an annual test of vehicle safety, roadworthiness aspects and exhaust emissions.

- The vehicle mileage distribution was also revised, as well as the vehicle fleet composition with regard to type of Euro class.

Submission 2016:

- A transition from HBEFA 3.1 to HBEFA 3.2.
- A change in the allocation of segments⁸³; an average distribution over time in terms of environmental requirements is used for all vehicle types, instead of an annual update.
- A redistribution of the allocation of the daily traffic; such as frequency of trips by trip distance, parking time and travel speed. This reallocation concerns only light duty vehicles (passenger cars, light trucks and motorcycles / mopeds).
- The number of vehicles in circulation is based on an average value over the year instead of previously by December 31st.

Submission 2017:

- HBEFA is on a yearly basis updated regarding number and type of vehicles as well as number of km and fuel type per vehicle.
- Adjustment of the number of km driven by heavy-duty vehicles in different segments, with regard to foreign trucks, which have a different allocation between segments than Swedish trucks.
- An update of the fuel consumption development for passenger cars, by taking into account that the actual development has not gone as fast as declared values.

Submission 2018:

- HBEFA is on a yearly basis updated regarding number and type of vehicles as well as number of km and fuel type per vehicle.
- A transition from HBEFA 3.2 to HBEFA 3.3.
- Update regarding the emissions factor for NO_x and diesel passenger cars euro 4, 5 and 6.
- Adjustment of the segment allocation for heavy-duty vehicles.

Submission 2019:

- HBEFA is on a yearly basis updated regarding number and type of vehicles as well as number of km and fuel type per vehicle.
- Update regarding the traffic distribution on different traffic situations, based on new statistics and modeling of traffic distribution over the road network by the air quality model SIMAIR.

⁸³ A segment is defined as a group of vehicles of similar size (e.g. passenger cars with an engine volume between 1.4 and 2 litres, rigid trucks with weight between 14 and 20 tons etc.) and similar technology (e.g. petrol engines, diesel engines, biofuel, CNG/petrol engines), whereas sub-segments are defined as groups of vehicles of similar size, technology and emission concept (e.g. pre-Euro, Euro 1, 2, 3, etc.)

- Update regarding the distribution of heavy trucks' by segment on highways, urban and rural areas based on a new method with data from the truck survey.
- Update of vehicle kilometer by heavy trucks and motorcycles for 2016 based on new data from Transport Analysis.
- Updated fuel distribution for public transport based on the database called “FRIDA”.

Submission 2020:

- HBEFA is on a yearly basis updated regarding number and type of vehicles as well as number of km and fuel type per vehicle.
- In submission 2020, the mileage distribution for passenger cars by fuel type was also adjusted, based on a new method, which was developed and implemented in submission 2020. The new method reflects better the real mileage for passenger cars' first years and is based on data from www.autouncle.se, which contains data on used vehicles for sale, including used cars of a newer model.
- The mileage for heavy trucks has also been revised by “Transport Analysis” in submission 2020. The revision is due to an overestimation of the mileage for foreign trucks.

Submission 2021:

- HBEFA is on a yearly basis updated regarding number and type of vehicles as well as number of km and fuel type per vehicle.
- In submission 2021, the mileage distribution for passenger cars by fuel type was also adjusted, based on a new method first implemented in submission 2020.
- The mileage for all vehicles in 2018 has been revised by Agency for Transport Analysis. The revision is due to how new EU inspection rules affect the method of estimating annual mileage.

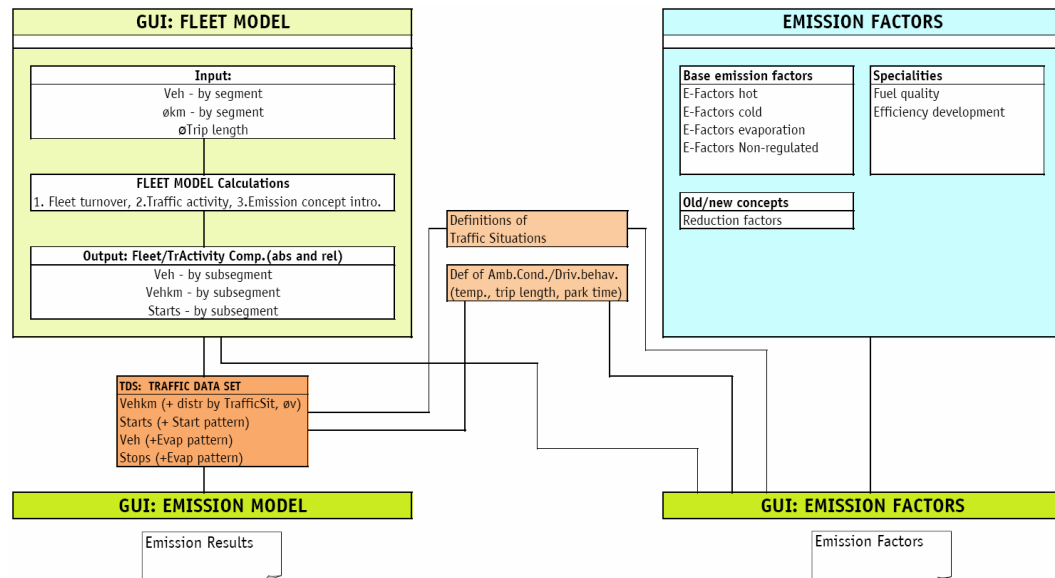


Figure A2-7 HBEFA model structure.

2.5.1 National fleet data

The Swedish road vehicle fleet for each year is described by means of the number of vehicles on category level, along with segment/sub-segment and age distributions, derived from the Swedish national vehicle register. This register is updated with new registrations and scrapped vehicles on a daily basis.

The HBEFA model distinguishes between two types of buses: urban buses, mainly used for urban driving, and coaches, mainly used for rural and motor-way driving. Due to lack of specific information in the national vehicle register, the distinction between urban buses and coaches had to be based on a number of rules. Buses are considered to be urban buses if at least one of the following conditions are fulfilled: 4 axes or more, 3 axes and axis distance of at least 2.5 meters, total length over 14 meters, >60 passengers allowed, >50 passengers allowed whereof >20% standing. Finally, classification is based on the ratio p/w , where p is equal to the maximum allowed number of passengers, and w is equal to the gross vehicle weight, both available from the national vehicle register. Buses with a p/w -value above 3.7 were classified as urban buses, whereas buses with a p/w -value below 3.75 were classified as coaches.

In the HBEFA model, trucks are split into two main categories: with and without trailer, respectively. Since there is no information on the use of trailers in the Swedish national vehicle register, trucks with trailers are described by means of vehicle transformation patterns in the model. A transformation pattern defines the mileage distributions for each weight class, with and without trailer, respectively. The truck category "with trailer" is split further into different sizes of trailers expressed as the maximum permissible weight (i.e. weight range, e.g. 20-28 t) of the truck and

trailer combination. The transformation patterns for Sweden were derived from traffic measurements on Swedish roads. Vehicle fleet data from Statistics Sweden is shown in Figure A2-10.

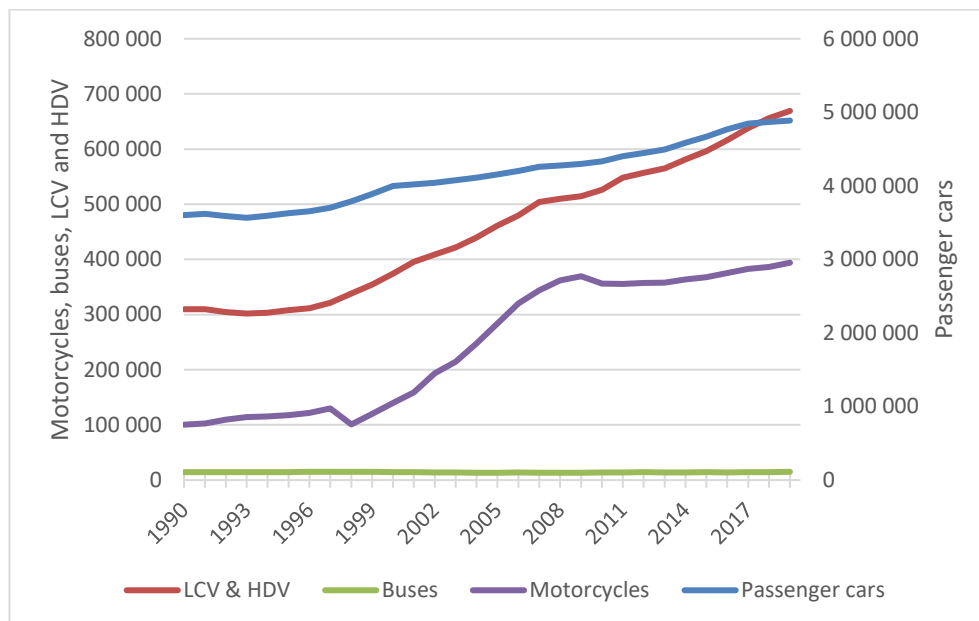


Figure A2-8 Vehicle fleet data by December 31, numbers, 1990-2019 according to the car register available at Statistics Sweden.

2.5.2 Traffic activity data

2.5.2.1 VEHICLE MILEAGES, LOADS, TRIP LENGTHS AND FUELS

The HBEFA model requires yearly mileages per vehicle category. For Sweden these are calculated by means of a national road mileage model⁸⁴. Important inputs to this model are the overall mileage on roads, derived from traffic measurements on Swedish roads, along with the number of vehicles in different categories. The annual mileage per vehicle category is derived by dividing the total mileage per category with the number of vehicles per category. By applying the same number of vehicles together with the derived mileage, the model will provide the same overall national mileage as the national road mileage model.

Yearly mileages per vehicle sub-segment level are used to distribute the total mileage on sub-segments. A method has been developed, which can assign all vehicles in the register an annual mileage, based on yearly odometer readings within the Swedish inspection & maintenance (I/M) programme⁸⁵. This data is used for deriving mileage both per vehicle sub-segment, and as a function of vehicle age.

⁸⁴ Edwards et al., 1999

⁸⁵ SIKA, 2003

In submission 2021, the mileage distribution for passenger cars by fuel type was adjusted. Passenger cars are normally inspected for the first time after 36 months and then after another 24 months. Only then does an annual inspection take place. To obtain the annual mileage for the mileage database, a model estimate has been used until now. A supplementary method, which better reflects the real mileage for the passenger cars' first years, was first developed and implemented in submission 2020. This new method is based on data from "www.autouncle.se" which contains data on used vehicles for sale, including used cars of a newer model. A comparison between the two methods shows that the former method overestimated the mileage for diesel cars, especially those of newer model years. For petrol cars, the earlier method underestimated instead the mileage.

For heavy commercial vehicles the HBEFA model requires mileage distributions of load factors empty (0% load), half-load (50% load), and fully loaded (100% load), by vehicle segment and vehicle age. This data is derived from a major national survey from 1997 on Swedish domestic road goods transport⁸⁶, including detailed information about both truck and trailer loads.

In order to estimate evaporative and cold start emissions, information on distributions of trip lengths and parking times and on the seasonal and diurnal variation of ambient temperature is needed. Trip lengths and parking times can be derived from surveys, or from data from instrumented cars. For Sweden an average trip length according to surveys is 12 km, and according to instrumented cars 7 km⁸⁷. Instrumented cars provide the trip length from engine start to engine stop. Even if instrumented car data just represents a few vehicles and use in few families, this data set has been considered more representative than the survey data, since the information requested is the distance travelled from engine start to engine stop⁸⁸. Thus, available instrumented vehicle data was used to estimate trip lengths and parking times in Sweden.

⁸⁶ Hammarström and Yahya, 2000

⁸⁷ SNRA 1999

⁸⁸ André et al., 1999

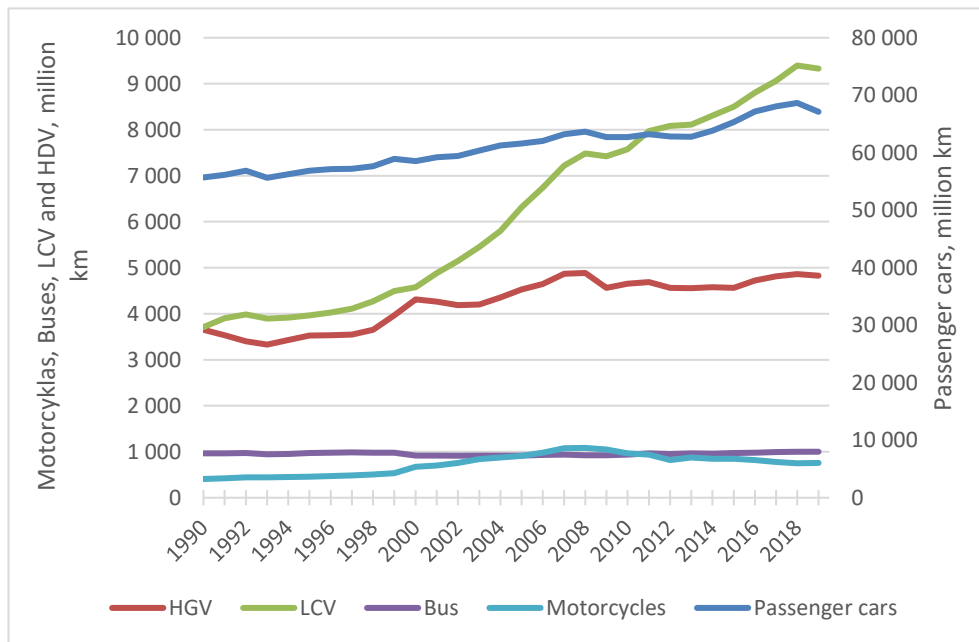


Figure A2-9 Vehicle mileages 1990-2019 according to HBEFA 3.1.

2.5.2.2 TRAFFIC SITUATIONS

The HBEFA model includes 276 traffic situations, i.e. combinations of 69 road categories. For each one of these traffic situations, five-four classes of traffic conditions or "levels of service" is defined, describing how disturbed the traffic is relative to undisturbed traffic - 1) Free Flow, 2) Heavy Traffic, 3) Saturated, and 4) Stop and Go, and 5) Heavy Stop and Go conditions (see Figure A 2.12 and Table A2.22 below). Furthermore, it is possible to add different level of grade; however this is not done for Sweden.

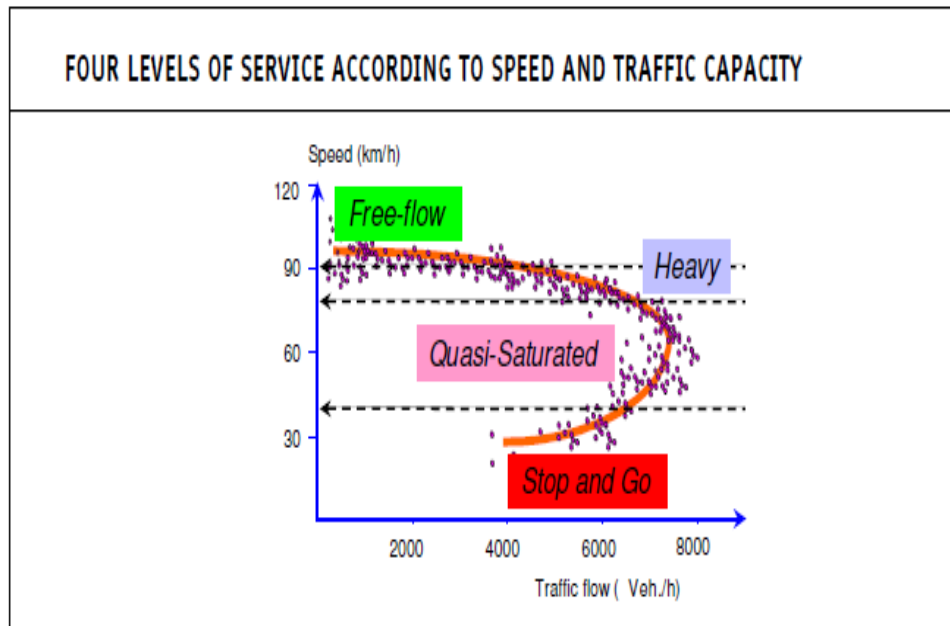


Figure A2-10 Traffic flow

Table A2-23 Definition of the five classes of traffic conditions.

Class	Definition
Freeflow	Free flowing conditions, low and steady traffic flow. Constant and quite high speed. Indicative speeds: 90-120 km/h on motorways, 45-60 km/h on a road with speed limit of 50 km/h. LOS A-B according to HCM.
Heavy	Free flow conditions with heavy traffic, fairly constant speed. Indicative speeds: 70-90 km/h on motorways, 30-45 km/h on a road with a speed limit of 50 km/h. LOS C-D according to HCM.
Saturated	Unsteady flow, saturated traffic. Variable intermediate speeds, with possible stops. Indicative speeds: 30-70 km/h on motorways, 15-30 km/h on a road with speed limit of 50 km/h. LOS E according to HCM.
Stop + go	Stop and go. Heavily congested flow, stop and go or gridlock. Variable and low speed and stops. Indicative speeds: 30-70 km/h on motorways, 15-30 km/h on a road with speed limit of 50 km/h. LOS E according to HCM.
Heavy stop+go	Heavily congested flow. Average speed range from 5.5 km/h to 7.2 km/h

The national vehicle mileages for year 1990, 1995, 1998, 2000 and 2004 were initially estimated by means of the national vehicle mileage model⁸⁹. Procedures were established to allocate the total vehicle mileage over 1) urban and rural roads, 2)

⁸⁹ Edwards et al., 1999

road categories, 3) traffic conditions, and to fit the result to the traffic situations in HBEFA 3.1. Two national GIS road databases were employed. The first, VDB, contains all state road links attached with information about: length, road function, speed limit and ADT (average daily traffic) split on light- and heavy-duty vehicles. The second, NVDB, were used for municipal and private road links. NVDB contains information on road classification and road link length, but lacks information on ADT. Traffic simulations were HBEFA study was able to present new figures on the distribution of the overall vehicle mileage between urban and rural roads in Sweden: 41 % and 59 %, respectively (the distribution used earlier was 35 % and 65 %, respectively). State-owned rural and urban roads together with municipality-owned urban roads accounted for more than 90 % of the overall vehicle mileage in 2004.

Furthermore, a model for distributing the urban vehicle mileage on cities of different size was demonstrated. Cities with inhabitant number exceeding 200,000 - only three in Sweden - accounted for one fourth to almost one third of the overall vehicle mileage on urban roads. Available statistics on hourly flow conditions for different road types⁹⁰ were employed for describing the yearly variation of ADT (monthly, weekly, daily and hourly) on the different road types. The hours over the year were divided into groups based on their share of ADT for different road categories, entitled ranks (categories for rural roads were: share of ADT >0.12, 0.8-1.2, 0.4-0.8 and <0.04, categories for urban roads were: share of ADT >0.1, 0.07-0.1, 0.04-0.07 and <0.04). Using the available statistics, traffic flow and vehicle mileage at different rank-hours was calculated for each link of the state road network.

Similar calculations were carried out for the municipal and private road links in the four regions. The results, traffic flow per lane and hour were related to volume-delay functions, and preliminarily classified into HBEFA 3.1 traffic conditions 1-3. Hypothesis were formulated concerning the distribution of vehicle mileage for "Stop and Go"-conditions. This cannot be estimated from volume delay functions alone, since it is not possible to decide whether a flow occurring between free flow (a) and congested (b) is a case of demand exceeding capacity (Stop and Go) or if it is a lower flow (Heavy Traffic). To overcome this, two assumptions were made: Stop and Go would only occur on road links that had reached their capacity, c; and for these roads it was assumed that Stop and Go constituted a fixed share of the preliminary estimated vehicle mileage in the traffic condition "Heavy Traffic".

By studying flow over the day for individual congested roads (Figure A2-11), it could be seen that a local decrease in flow sometimes occurred within a congested period (i.e. when flow is near the capacity). This period was assumed to be a "Stop and Go"-period and calculations were made accordingly. The calculations finally resulted in a distribution of the vehicle mileage (light- and heavy-duty vehicles) over road categories and traffic conditions for the Swedish road network for the

⁹⁰ Björketun et al., 2005, Jensen, 1997

years 1990, 1995, 1998, 2000 and 2004. Swedish road categories were translated to HBEFA 3.1 traffic situations based on the description of road hierarchy, speed limit, function and design. Then it was possible to sum the vehicle mileage in Sweden over the HBEFA 3.1 traffic situations for different years.

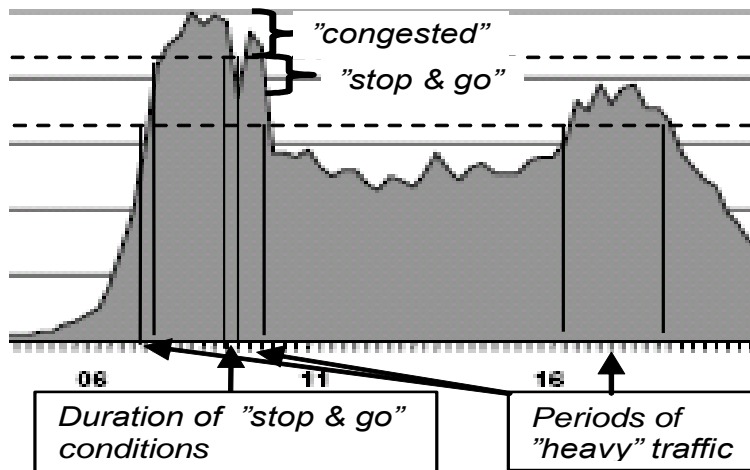


Figure A2-11 Flow over the day for individual congested roads.

Of the 276 traffic situations in HBEFA, were 115 of them identified in Sweden in 2013 representing 53 road categories, for which the traffic conditions "Free Flow" or "Heavy Traffic" were predominant. In fact, as much as 93.6 % of the overall vehicle mileage driven in Sweden was characterised by free flow conditions. The ten most abundant HBEFA 3.1 traffic situations all involved "Free Flow" conditions, and are presented in Table A2-24. The three most common road categories "Rural Distributor" (speed limits 90 and 70 km/h, respectively) and "Rural Motorway" (speed limit 110 km/h) accounted for more than 40% of the national vehicle mileage. Adding also urban road categories "Local Collector" and "Access Residential" (both with speed limit 50 km/h), and "Distributor" (speed limits 70 and 50 km/h, respectively), and two more rural categories ("Local Collector", 70 km/h, and "Trunk Road", 110 km/h), these ten most abundant road categories at free flow conditions accounted for about 66 % of the national vehicle mileage. The share of the HBEFA 3.1 "Stop and Go"-conditions of the overall mileage was as low 0.05%, and only occurred in the three major cities (having more than 200,000 inhabitants). Further details concerning the methodology and the results are reported elsewhere⁹¹.

⁹¹ Larsson and Ericsson, 2006

Table A2-24 The ten most common traffic situations in Sweden in 2013, and their share of the total vehicle mileage.

Description of traffic situations	Vehicle mileage
Rural / Distributor-DistrictConnection / SpLimit:70 / Freeflow	12,9 %
Rural / Motorway / SpLimit:110 / Freeflow	10,5 %
Urban / Distributor-DistrictConnection / SpLimit:60 / Freeflow	9,1 %
Rural / Distributor-DistrictConnection / SpLimit:90 / Freeflow	7,8 %
Rural / Distributor-DistrictConnection / SpLimit:80 / Freeflow	6,8 %
Rural / TrunkRoad / SpLimit:100 / Freeflow	5,0 %
Urban / Distributor-DistrictConnection / SpLimit:50 / Freeflow	4,2 %
Rural / TrunkRoad / SpLimit:90 / Freeflow	3,8 %
Urban / City-TrunkRoad / SpLimit:70 / Freeflow	3,1 %
Urban / Access-residential / SpLimit:40 / Freeflow	2,7 %
Total	65,9 %

Starting at 2008 there has been a change in the speed limit scheme in Sweden. Also 40, 60, 80, 100 and 120 km/h have been implemented in parallel with the old speed limits. In the model the mileage share on the different speed limits and traffic situations have been updated from year 2010. This includes a use of a more updated method to allocating the traffic into different traffic situations.⁹²

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2.6 Methodology for off-road vehicles and working machinery

Fuel consumption and emissions from working machinery are estimated with a model developed by SMED in 2008. The model is considered to correspond to Tier 3. Working machinery in this context means mobile machinery with a combustion engine that is not used on roads, waterways or railways. Included are e.g. construction machinery, hand held garden machines and snow mobiles.

Emissions and fuel consumption are calculated in the model with the equations below:⁹³

$$E = N \times Hr \times P \times Lf \times EF_{adj} \quad (1)$$

- E = Emissions in Gg
- N = number of vehicles,
- Hr = yearly running time in hours,
- P = engine power in kW,
- Lf = load factor, and
- EF_{adj} = adjusted emission factors in g kWh⁻¹ according to equation below (applied for larger off-road vehicles and snow scooters).

$$EF_{adj} = EF_l \times CAF \times TAF \times DF \times FAF \quad (2)$$

- EF_l = emission regulations according to EU legislation in g kWh⁻¹,
- CAF = adjustment factor for difference between regulation and value measured at certification,
- TAF = adjustment factor for transient (i.e. difference between static test cycle and real use of the machine),
- DF = adjustment factor for decline of the motor by increasing age, and
- FAF = adjustment factor for difference between certification fuel and Swedish diesel of type "MK1".

All variables in the equations are described as vectors with data for every model year the last 25 years.

2.6.1 Emission factors

Emissions of SO₂ are estimated using the same emission factors as for diesel and gasoline used for road traffic and are considered to correspond to Tier 2. The emission factors for SO₂ are adjusted according to fuel specifications for each year.

Emission factors for diesel and gasoline machinery are taken from EMEP/EEA Guidebook 2016. An exception is emission factors for snow mobiles that are taken from Winther and Nielsen 2006.⁹⁴ except the emission factors for hydrocarbons, carbon monoxide and particles which are taken from USEPA (2005)^{Error! Bookmark not}

⁹³ Fridell, Jernström and Lindgren, 2008

⁹⁴ Winther, M., Nielsen, O.-K., 2006.

defined. Fuel consumption for snowmobiles were updated to submission 2020 as described in the section Most recent updates.

2.6.2 Vehicle Stocks

The number of diesel machinery 37 – 560 kW of different types is mainly based on a bottom up inventory for the year 2006.⁹⁵ In submission 2014 the model was updated⁹⁶ with new information about number of machines for some of the diesel vehicles in the range of 37 kW – 560 kW. In this update also improved estimates of vehicle lifetime were obtained from the new data and are now used in the model. In submission 2018 the model was updated with sales data for some off-road vehicles for 2005-2016. The sales data was provided by the Swedish trade association for suppliers of mobile machines.⁹⁷ Sales data is from submission 2019 and onwards used annually for updating the model with number of new machineries.

The number of tractors per sector, model year and engine power interval are for most of the years taken from Statistics Sweden's registers. For some years where statistical data is not available, numbers are interpolated (the proportions of different vehicle types are assumed to be constant).

The total number of machines >560 kW is taken from an IVL study conducted in behalf of the Swedish Transport Agency⁹⁸. The total number of machines < 37 kW are based on a bottom up inventory for the year 2002⁹⁹. Number of machines for other years are estimated on e.g. sales data provided by the Swedish trade association for suppliers of garden machinery, estimates of lifetime or set as unchanged from 2002. Different methods are used for different types of machines.

The number of snow mobiles is taken from Statistics Sweden's register for each year.

2.6.3 Other parameters

Yearly running time, engine power and the load factor in equation (1) above are taken from Wetterberg¹⁰⁰ and Flodström¹⁰¹. Load factors for some of the machines are from an IVL study made in 2015¹⁰². The fuel adjustment factor, FAF, and the certification adjustment factor, CAF, for larger vehicles in equation (2) are taken

⁹⁵ Wetterberg C, Magnusson R, Lindgren M, Åström S. 2007.

⁹⁶ Jerksjö, M. 2013.

⁹⁷ Eklund, V., Lidén, M., Jerksjö, M., 2017.

⁹⁸ Transportstyrelsen 2014

⁹⁹ Flodström, E., Sjödin, Å., Gustafsson, T. 2004.

¹⁰⁰ Wetterberg C, Magnusson R, Lindgren M, Åström S. 2007.

¹⁰¹ Flodström, E., Sjödin, Å., Gustafsson, T. 2004.

¹⁰² Jerksjö, M., Fridell, E., Wisell, T. 2015

from Lindgren (2007).¹⁰³ The TAF and DF factors are taken from EMEP/EEA Guidebook 2016.

2.6.4 Allocation to NFR-sectors

Allocation of emissions from working machinery is mainly based on a report by Flodström (et al)¹⁰⁴. This is the most recent Swedish inventory including an allocation of working machinery to the different NFR-sectors. There have also been some changes of the allocation proposed in Flodström *et. al*. Most of these changes have been done by expert judgements in cases where the allocation did not seem to be accurate. Emissions from tractors are allocated to the sector where the machines are used due to the national vehicle register.

Table A2-25 shows emissions of NO_x, PM_{2.5} and NMVOC from all working machinery in 2018, split by sector and fuel type.

Table A2-25 Emissions of NO_x, PM_{2.5} and NMVOC from working machinery 2019.

			NO _x (Gg)	PM _{2.5} (Gg)	NMVOC (Gg)
1A2g vii	Industry	Diesel	7.8	0.5	1.0
1A3e ii	Other Transport	Diesel	0.7	0.03	0.1
1A4a ii	Commercial/institutional	Diesel	1.2	0.1	0.2
1A4b ii	Residential	Diesel	0.4	0.04	0.1
1A4c ii	Agriculture	Diesel	1.9	0.1	0.2
1A4c ii	Forestry	Diesel	1.0	0.1	0.2
1A2g vii	Industry	Gasoline	0.05	0.01	0.3
1A3e ii	Other Transport	Gasoline	0	0	0
1A4a ii	Commercial/institutional	Gasoline	0.3	0.05	1.3
1A4b ii	Residential	Gasoline	0.8	0.1	3.7
1A4c ii	Agriculture	Gasoline	0.2	0.1	2.5
1A4c ii	Forestry	Gasoline	0.2	0.03	0.9
Total	Total	Total	14.4	1.1	9.6

2.6.5 Most recent updates

The model has since 2008 undergone a series of improvements. In this section the most important updates are presented.

¹⁰³ Lindgren M. 2007.

¹⁰⁴ Flodström, E., Sjödin, Å., Gustafsson, T. 2004.

Updates done in 2015 and 2017 are described in Jerksjö *et. al.* (2015¹⁰⁵) and Eklund *et. al.* (2017¹⁰⁶). The updates aimed to further improve the national emission and fuel consumption estimates in several ways.

Updates in 2015 included adding machines with an installed power >560 kW (these were not included in the model before), updated average load factors for some machines, added emission factors for Stage V machines, implementing a function for describing the relationship between engine load and fuel consumption, and some updates concerning allocation of emissions to the different NFR- sectors.

In 2017, the model was updated with sales data for off-road vehicles for 2005-2016, which was provided by the Swedish trade association for suppliers of mobile machines. The allocation table in the model was also updated, as new information regarding the sector distribution was received from both the trade association and the vehicle register. The age of some of the oldest tractors in the model was adjusted as well, as they in previous submissions mistakenly were grouped together in the oldest age category.

Updates for submission 2019 included two major changes and some minor changes. The first major change was an updated age distribution for snow mobiles and all terrain vehicles. Also, the share of these vehicles that are using 2-stroke engines or 4-stroke engines respectively were updated. The other major change was an update of the fuel consumption in g/kWh used for machinery >560kW.

In submission 2020, the model was updated according to the EMEP/EEA Guidebook 2016. Fuel consumption factors and emission factors for CO, NMVOC, NO_x, TSP, PM₁₀, PM_{2.5} and BC for both diesel and gasoline engines have been updated with respect to engine power and emission standards. Moreover, the transient operation adjustment factors (TAF) for diesel engines with emission standard up to EURO IIIA as well as deterioration factors (DF) have been updated, as new information was provided in EMEP/EEA Guidebook 2016. In addition to the changes due to the updates in EMEP/EEA Guidebook 2016, the NMVOC emissions from gasoline evaporation have been included in the emission calculations.

Moreover, fuel consumption factors (in g/kWh) for 4-stroke snow mobiles and modern 2-stroke engines were updated in submission 2020. Also load factors for these machine types were updated. Both types of factors were adjusted partly to data used in Finland's national emission inventory but also to fuel consumption in l/km during real world driving conditions presented by the Swedish snowmobile magazine "Snöskoter". The magazine has done measurements on different snowmobile models during a period of several years.

¹⁰⁵ Jerksjö, M., Fridell, E., Wisell, T. 2015

¹⁰⁶ Eklund, V. Lidén, M. Jerksjö, M. 2017.

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3 Annex 3: Other detailed methodological descriptions for individual sources

Annex 3.1. Methodological issues for emissions from solvent use (in NFR sector 2D3)

In 2016, Swedish Environmental Emissions Data (SMED) in cooperation with the Swedish Chemicals Agency (Skårman et al., 2016¹⁰⁷), has further developed the calculation model for estimating the national emissions of NMVOC and CO₂ from use of solvents in Sweden. The model has been revised in order to meet international reporting requirements according to CLRTAP and UNFCCC as well as to support national needs. The model makes it possible to test different sets of emission factors within the solvent use sector. This function can be used to assess different actions and emission reduction potentials. Furthermore, the model can generate emissions per user category and product group. This information can be used when following-up the Swedish environmental quality objectives.

The calculation model is consumption-based with a product-related approach. Amounts of NMVOC and C in solvents and solvent-based products, produced in, imported to, used in, and exported from Sweden, were derived from the Swedish Product Register hosted by the Swedish Chemicals Agency. Emission factors from the literature have been used as far as possible, but in the case when emission factors are unavailable, country specific emission factors have been developed.

3.1.1 Definition of NMVOC

According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), NMVOCs are defined as:

“any non-methane organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular conditions of use.”

3.1.2 Substance list

A manual selection has been made in order to select each substance with vapour pressure of 0.01 kPa or more at 293.15° K according to the chosen definition of NMVOC. The final substance list for 2013 contains 427 substances defined as NMVOC. The list includes CAS-number, name, molecular formula and carbon share for each substance. The carbon share for each substance has been calculated based on the molecular formula. In some cases a mixture of substances are included in the substance list, and for the mixtures the carbon content has been esti-

¹⁰⁷ Skårman et al., 2016. Swedish method for estimating emissions from Solvent Use. Further development of the calculation model. SMED report 192.

mated by the Swedish Chemicals Agency as 85% of NMVOC, based on information in the Products Register. In cases where the carbon content cannot be derived from the Products Register, the default value of 60%, given in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, has been used

Emission of CO₂ has been calculated with the following equation:

$$\text{Emission (CO}_2\text{)} = C_{\text{quantity}} \times \text{Emission Factor} \times \frac{44}{12}$$

C_{quantity} is the carbon quantity of the solvents. 44 and 12 are the molecular weights of CO₂ and C, respectively.

3.1.3 Activity data

The substance list has been used to extract quantities of NMVOC and C in substances found in the Products Register. Data extractions have been made for each year from 1992. The extractions show for each year:

- The intended use of the product, the product type (functional code)
- Industry to which the product is sold (industry category)
- Quantity NMVOC
- Quantity C
- Number of products

When analysing the extractions from the Products Register, data for 1992-1994 showed not to be reliable to use for quantitative estimates of NMVOC and C emissions. The reason is that during this period the emissions of many substances still were reported as intervals, even if work has been done by the Swedish Chemicals Agency in order to further specify the amounts. There were also changes in the code system during this period. Therefore, data from the Products Register are only used for 1995 and onwards.

Due to the two-year delay in official statistics from the Products Register, activity data for the last year in the reported time series is not published in time to be used in the latest submission and hence Sweden has chosen to equal data for the last year with data for the year before that. Estimated values for last year of one submission will always be updated with official data in the next submission.

Table A3-1 Activity data and emission factors for the individual SNAP codes 060412i (not diluted), 060412i (not diluted, raw material), 060412ii (diluted) and 060412ii (diluted, raw material).

Year	AD 060412i (kt, not diluted)	AD: 060412ii (kt, diluted)	AD 060412i (kt not diluted, raw material)	AD 060412ii (kt, diluted, raw material)	EF 060412i (not diluted)	EF 060412ii (diluted)	EF 060412 (raw material)
1997	11	6	3	0	0.95 ¹	0.275 ²	0.001
1998	13	8	4	0	0.95 ¹	0.275 ²	0.001
1999	12	9	3	0	0.95 ¹	0.275 ²	0.001
2000	12	10	2	0	0.95 ¹	0.275 ²	0.001
2001	13	12	1	0	0.95 ¹	0.275 ²	0.001
2002	16	12	1	0	0.95 ¹	0.275 ²	0.001
2003	18	15	2	0	0.95 ¹	0.275 ²	0.001
2004	19	15	1	0	0.95 ¹	0.275 ²	0.001
2005	19	15	1	0	0.95 ¹	0.275 ²	0.001
2006	21	16	1	0	0.95 ¹	0.275 ²	0.001
2007	21	16	1	0	0.95 ¹	0.275 ²	0.001
2008	22	18	1	0	0.95 ¹	0.275 ²	0.001
2009	21	19	1	0	0.95 ¹	0.275 ²	0.001
2010	23	17	3	0	0.95 ¹	0.275 ²	0.001
2011	26	22	3	0	0.95 ¹	0.275 ²	0.001
2012	26	23	1	0	0.95 ¹	0.275 ²	0.001
2013	26	23	3	0	0.95 ¹	0.275 ²	0.001
2014	29	21	1	0	0.95 ¹	0.275 ²	0.001

Year	AD 060412i (kt, not diluted)	AD: 060412ii (kt, diluted)	AD 060412i (kt not diluted, raw material)	AD 060412ii (kt, diluted, raw material)	EF 060412i (not diluted)	EF 060412ii (diluted)	EF 060412 (raw material)
2015	31	21	<1	0	0.95 ¹	0.275 ²	0.001
2016	25	22	<1	0	0.95 ¹	0.275 ²	0.001
2017	23	21	<1	0	0.95 ¹	0.275 ²	0.001
2018	24	22	<1	0	0.95 ¹	0.275 ²	0.001
2019	24	22	<1	0	0.95 ¹	0.275 ²	0.001

¹ Skårman, T., Danielsson, H., Henningsson, E., Östman, M. 2006. Revised Method for Estimating Emissions of NMVOC from Solvent and Other Product Use in Sweden. SMED Report no 75

² EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.a Domestic solvent use including fungicides.

3.1.4 Allocation

The extractions from the Products Register for 1995 and onwards have been used in order to compile a connection diagram with all combinations of "product codes" and "industry categories". For all combinations, decisions whether to include or exclude from reporting are based on expert judgements in order to avoid double-counting. If the combination should be included, it has been given a specific:

- SNAP-code (according to EMEP/EEA guidebook)
- Industry group (grouping industry categories)
- Product group (grouping of product codes)
- Use category (industry, consumer and other)

Furthermore, it has to be determined if the product is used as raw material or not. Quantities of NMVOC used as raw material have been identified and handled separately from other quantities, since most of the solvents used as raw material will not be emitted but bound in products.

In order to avoid double-counting of reported emissions within other sectors an expert judgement has been made on both industry category and product function. All industrial activities reported in other CRF-codes are excluded from the extractions from the Products Register.

The sold amount of solvent is not always identical to the amount of solvent used, i.e. stock of solvents. Up until submission 2019, activity data has therefore been recalculated using a running average over three years. This led to the need for updating of reported emissions for the latest three years in the time series in every new submission. In submission 2020, the recalculation of activity data has been updated¹⁰⁸ based on the assumption that sold amounts of solvents in a specific year are not used entirely within the same year. For a sold amount of a specific solvent, the amounts of this specific solvent used and the corresponding emissions are distributed over three consecutive years, the first year being the year where the respective solvents are sold. This is done by defining consumption rates of solvents per CRF subcategory sector (see table A3:3.1).

Table A3:3.1 Consumption rates for product groups sold in year X, estimated per NFR category.

NFR category	X	X+1	X+2
2D3a Domestic solvent use including fungicides	70%	20%	10%
2D3d Coating applications	80%	15%	5%
2D3e Degreasing	85%	10%	5%
2D3f Dry cleaning	85%	10%	5%
2D3g Chemical products	85%	10%	5%
2D3h Printing	85%	10%	5%
2D3i Other solvent use	75%	15%	10%

¹⁰⁸ Helbig, T., Danielsson, H. (2019)

When calculating amounts used and emissions from products containing solvents sold in 2016 allocated to domestic solvent use including fungicides, 70 % of these solvents are assumed be used in 2016, 20 % in 2017 and 10 % in 2018. Calculated emissions from usage of these solvents are distributed likewise. Therefore, reported emissions for a certain year after 1996 always include emissions from solvent use from solvents sold within the two previous years. Emissions and activity data for 1995 and 1996 have been interpolated due to the calculation approach suggesting allocating a share of emissions from solvent use in 1993 and 1994 to 1995 and 1996 respectively. However, based on expert judgement it was decided that emissions and activity data for the years 1990-1994 are not changed.

3.1.5 Emission factors

Emission factors given in the literature, for example the EMEP/EEA guidebook (EEA, 2016), EU legislations and other countries IIR's, have been compiled and included in the model. Two emission factors have been developed for each activity; one for solvents used as raw material and one for the remaining quantities. The emission factors for raw material have been set to 0.001 for all SNAP codes, since most of the solvents will end up in the product and will not be emitted during production. A new emission factor for products used diluted in water or removed with water has been introduced in the new model for NFR 2D3a and 2D3i. The new emission factor is set to 0.275 and it has been calculated as average of 0.05 and 0.5 according to the information in the EMEP/EEA Guidebook 2016 for NFR 2D3a section 3.2.4. In the previous estimates these products were not treated separately and consequently the emission factor of 0.95 was used also for water diluted products. The country specific emission factors have been developed in order to adjust to the old time series 1990-2001, developed by SMED in 2002 (Kindbom et. al., 2004). However, for some activities errors have been identified in previously reported data for 1990, and consequently those emissions have been corrected. Furthermore, application techniques, available information in the environmental reports for specific industries, as well as other pathways of release (e.g. water), have been considered when developing the country specific emission factors.

Table A3-2 Country specific emission factors for SNAP codes in NFR 2D3a “Domestic solvent use including fungicides”. Emission factor references given at the end of Annex 3.1. All emissions factors constant throughout the timeseries.

Year	060408ei	060408eii	060408fi	060408fii	060408gi	060408gii	060408hi	060408hii	060408i	060411
1995	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2000	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2010	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2015	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2016	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2017	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2018	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹
2019	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.275 ²	0.95 ¹	0.95 ¹

Table A3-3 Country specific emission factors for SNAP codes in NFR 2D3d “Coating applications”. Emission factor references given at the end of Annex 3.1. EFs in italic are interpolated.

Year	060101	060102	060103	060104	060105	060106	060107	060108	060109
1995	0.95 ¹	0.95 ¹	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.29 ¹	0.95 ¹	0.95 ¹
2000	<i>0.79</i>	<i>0.79</i>	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	<i>0.83</i>	0.95 ¹
2010	<i>0.54</i>	<i>0.54</i>	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	<i>0.59</i>	0.95 ¹
2015	0.45 ³	0.45 ³	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	0.50 ³	0.95 ¹
2016	0.45 ³	0.45 ³	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	0.50 ³	0.95 ¹
2017	0.45 ³	0.45 ³	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	0.50 ³	0.95 ¹
2018	0.45 ³	0.45 ³	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	0.50 ³	0.95 ¹
2019	0.45 ³	0.45 ³	0.95 ¹	0.95 ¹	0.25 ⁴	0.84 ³	0.17 ³	0.50 ³	0.95 ¹

Table A3-4 Country specific emission factors for SNAP codes in NFR 2D3e “Degreasing”, NFR 2D3f “Dry cleaning” and NFR 2D3h “Printing”. Emission factor references given at the end of Annex 3.1. EFs in *italic* are interpolated.

Year	060201	060203	060204	060202	060403
1995	0.61 ⁵	0.61 ⁵	0.61 ⁵	0.30 ⁶	0.65 ¹
2000	0.47 ⁵	0.47 ⁵	0.47 ⁵	0.30 ⁶	<i>0.59</i>
2015	0.19 ⁵	0.19 ⁵	0.19 ⁵	0.30 ⁶	0.30 ³
2016	0.19 ⁵	0.19 ⁵	0.19 ⁵	0.30 ⁶	0.30 ³
2017	0.19 ⁵	0.19 ⁵	0.19 ⁵	0.30 ⁶	0.30 ³
2018	0.19 ⁵	0.19 ⁵	0.19 ⁵	0.30 ⁶	0.30 ³
2019	0.19 ⁵	0.19 ⁵	0.19 ⁵	0.30 ⁶	0.30 ³

Table A3-5 Country specific emission factors for SNAP codes in NFR 2D3g “Chemical products”. Emission factor references given at the end of Annex 3.1. EFs in *italic* are interpolated.

Year	060305	060307	060308	060309	060311	060312	060313	060314
1995	0.30 ¹	0.004 ¹	0.004 ¹	0.004 ¹	0.004 ¹	0.03 ³	0.010 ¹	0.50 ¹
2000	0.27 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.008 ¹	0.29 ¹
2010	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.003 ³	0.20 ¹
2015	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.002 ³	0.20 ¹
2016	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.002 ³	0.20 ¹
2017	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.002 ³	0.20 ¹
2018	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.002 ³	0.20 ¹
2019	0.25 ¹	0.003 ³	0.003 ³	0.003 ³	0.003 ³	0.03 ³	0.002 ³	0.20 ¹

Table A3-6 Country specific emission factors for SNAP codes in NFR 2D3i "Other solvent and product use". Emission factor references given at the end of Annex 3.1. EFs in italic are interpolated.'

Year	060405	060406	060407	060409	060412i	060412ii
1995	0.56 ⁷	0.64 ¹	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2000	0.56 ⁷	<i>0.59</i>	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2010	0.56 ⁷	<i>0.33</i>	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2015	0.56 ⁷	<i>0.22</i> ³	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2016	0.56 ⁷	<i>0.22</i> ³	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2017	0.56 ⁷	<i>0.22</i> ³	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2018	0.56 ⁷	<i>0.22</i> ³	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²
2019	0.56 ⁷	<i>0.22</i> ³	0.95 ¹	0.95 ¹	0.95 ¹	0.275 ²

¹ Skårman, T., Danielsson, H., Henningsson, E., Östman, M. 2006. Revised Method for Estimating Emissions of NMVOC from Solvent and Other Product Use in Sweden. SMED Report no 75

² EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.a Domestic solvent use including fungicides.

³ Environmental reports

⁴ EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.d Coating applications. Table 3-20.

⁵ EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.e Degreasing. Table 3-4. Abatement efficiency from the GAINS model.

⁶ EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.f Dry cleaning. Table 3-3.

⁷ EMEP/EEA air pollutant emission inventory guidebook - 2016. 2.D.3.i, 2.G Other solvent and product use. Table 3-11.

Annex 3.2. Size distribution for PM₁₀ and PM_{2.5} as fraction of TSP

Table A3-7 Size distribution for PM₁₀ and PM_{2.5} as fraction of TSP.

NFR code	Fraction of TSP	
	PM ₁₀	PM _{2.5}
2A1 - Cement production	0.90	0.80
2A2 - Lime production (Carbide production)	0.90	0.80
2A2 - Lime production (Lime production plants)	0.90	0.80
2A2 - Lime production (Sugar industry)	0.90	0.80
2A2 - Lime production (Pulp and paper industry)	IE*	IE*
2A3 - Glass wool production	0.90	0.70
2A3 - Other glass production	0.90	0.80
2A5a - Quarrying and mining of minerals other than coal	0.50	0.07
2A5b - Construction and demolition	0.30	0.03
2A5c - Storage, handling and transport of mineral products	IE**	IE**
2A6 - Mineral wool production	0.90	0.70
2B10a - Other organic chemical production***	1	1
2B10a - Other inorganic chemical production***	0.90	0.80
2B10a - Other inorganic chemical production***	0.38	0.02
2B10a - Other inorganic chemical production***	Based on production of phosphate fertilizers	
2C1 - Iron and steel production (secondary)	0.80	0.70
2C1 - Iron and steel production (primary)	Based on data from producers	
2C1 - Iron and steel production (iron sponge)	0.60	0.47
2C1 - Iron ore mining, dressing and concentration	0.50	0.07
2C1 - Iron ore pellets production	1.00	1.00
2C2 - Ferroalloy production	1.00	0.71
2C3 - Aluminium production	0.95	0.43
2C7c - Other metal production	0.95	0.80
2D3b - Road paving with asphalt	0.18	0.03
2D3c - Asphalt Roofing	0.90	0.85
2G - Other product use (fireworks)	0.91	0.47
2G - Other product use (tobacco smoking)	1.00	1.00
2H1 - Pulp and paper	0.95	0.75

*= Included in 2H1

**= included in respective source category

***= different EFs for different types of production

4 Annex 4: Environmental reports in Sweden

In Sweden, approximately 6,000 “environmental hazardous activities” must have a permit to operate. Such activities are conducted on a real estate and result or may result in discharges or other disturbances to the environment, e.g. water and air pollution or noise. The number includes activities regulated in EC-directives, e.g. under the Industrial Emissions Directive (IED)¹⁰⁹ and Seveso directive¹¹⁰.

According to chapter 9 of the Environmental Code (SFS 1998:808)¹¹¹ permits must be obtained for the establishment, operation and in some cases modification of environmentally hazardous activities on a certain scale. The structures and operations for which permits must be obtained are covered by two ordinances:

- Ordinance on Environmental Assessment (SFS 2013:251)¹¹²
- Ordinance on Environmentally Hazardous Activities and the Protection of Public Health (SFS 1998:899)¹¹³

For permitting procedures the Code divides competence between the regional administrations and the Environmental Courts. Permits are granted by the Environmental Courts and the Environmental Permitting Committees (EPC). The EPC is a special function at the County Administrative Board (CAB). There are 21 EPCs, one in each county, and five Environmental Courts. The allocation of licensing tasks between the EPCs and the Courts is regulated in the Ordinance on Environmental Assessment. For activities that entail a significant environmental impact (classified as A-activities in the list and totalling less than 400), the proponent must apply for a permit to the Court. For activities with less impact on the environment (classified as B-activities in the list and totally around 5,500) the proponent must apply for a permit to the CAB.

Rules on the operator's responsibility for self-monitoring and environmental reports are given in chapter 26 of the Environmental Code. All operations regulated by permit must return an annual environmental report. All activities and measures that require permission or notification are subject to the Ordinance on Operators' self-monitoring (SFS 1998:901)¹¹⁴. The requirements concerning environmental reports

¹⁰⁹ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

¹¹⁰ Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances.

¹¹¹ SFS 1998:808. Miljöbalken

¹¹² SFS 2013:251, Miljöprövningsförförordning

¹¹³ SFS 1998:899, Förförordning om miljöfarlig verksamhet och hälsoskydd

¹¹⁴ SFS 1998:901, Förförordning om verksamhetsutövares egenkontroll

are given in the regulation on environmental reports (NFS 2016:8)¹¹⁵ issued by the Swedish Environmental Protection Agency (Swedish EPA). The environmental report consists of three parts:

- Administrative information about the facility.
- Text section (for example, a description of the facility and the processes, the use of energy, chemicals and raw materials, emissions and conditions in the permit).
- Emission declaration (for example, production data, fuel consumption data, emission data and, information on how emission data have been determined i.e. measured, calculated or estimated).

The data in the environmental reports often originates from measurements or mass balances. The use of default emission factors is limited. Only the operators that exceed the thresholds for the substances listed in Swedish environmental law governing environmental reports are obliged to compile the emission declaration.

All environmental reports have to be submitted electronically via the Swedish Portal for Environmental Reporting (SMP)¹¹⁶.

The environmental reporting system is essential to the credibility of the self-monitoring. The authority checks the operator performance, asks for additional measures and monitoring. The operator is obliged to keep himself informed about the activity's impact on the environment. This is done by initiating studies and measurements, or by other means. The operator should also have routines for responding to new knowledge and new information, e.g. by taking appropriate counter-measures.

¹¹⁵ NFS 2016:8, Naturvårdsverkets föreskrifter om miljörapport <https://www.naturvardsverket.se/Documents/foreskrifter/nfs2016/nfs-2016-8.pdf> 2019-01-30

¹¹⁶ Svenska Miljörapporteringsportalen. <https://smp.lansstyrelsen.se>

4.1 References

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5 Annex 5: Units and Abbreviations

t	1 (metric) tonne = 1 megagram (Mg) = 106 g
g	1 gram
Mg	1 megagram = 106 g = 1 tonne
Gg	1 gigagram = 109 g = 1 kilotonne (kt)
Tg	1 teragram = 1012 g = 1 megatonne (Mt)
TJ	1 terajoule
ARTEMIS	Assessment and Reliability of Transport Emission Models and Inventory Systems
EMIR	Emission database of the County Administrative Boards
CEPMEIP	Coordinated European Programme on Particulate Matter Emission Inventories, Projections and Guidance
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CO	Carbon monoxide
COP	Conference of the Parties
CORINAIR	CORe Inventory of AIR emissions'. EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition
CTMP	Chemo Thermo Mechanical Pulp
CV	Calorific value
EC	European Community
EC	Environmental Class
EEA	European Environment Agency
EF	Emission Factor
EU	European Union
EMV	Emission Model for Road Traffic
EMEP	Co-operative Programme for Monitoring and Evaluation of Long-Range Transmission of Air pollutants in Europe
FAME	Fatty Acid Methyl Ester (earlier called RME)
FMV	Swedish Defence Material Administration
FOI	Swedish Defence Research Agency
FORTV	Swedish Fortification Department
FRA	National Defence Radio Institute
GHG	Greenhouse gases
Good Practice Guidance	Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
	IPCC-NGGIP
HARP	Hasselrot's Reviewed Pollutions
HBEFA	The Handbook Emission Factors for Road Transport
HELCOM	The Helsinki Commission
ICAO	International Civil Aviation Organization
IE	Included Elsewhere'
IEF	Implied emission Factor
IIR	Informative Inventory Report
Industrial statistics	Industrial energy statistics
IPCC	Intergovernmental Panel on Climate Change
IVL	Swedish Environmental Research Institute Ltd
ISEN	Energy use in manufacturing industry
JTI	Swedish Institute of Agricultural and Environmental Engineering

Jernkontoret	Swedish Steel Producers' Association
KEMI	Swedish Chemicals Inspectorate
LD-gas	Steel converter gas
LPG	Liquefied Petroleum Gas
LTO	Landing and Take-Off
MSW	Municipal solid waste
MTC	Motor Test Center
NA	Not Applicable
NACE	Pan-European classification system grouping organisations according to their business activities
NASN	National Administration of Shipping and Navigation
NBF	National Board of Forestry
NE	Not Estimated
NFR	Nomenclature for Reporting
NH ₃	Ammonia
NMVOC	Non methane volatile organic compounds
NO	Not Occurring
NO _x	Nitrogen oxides
O ₃	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
PAH-4	Polycyclic Aromatic Hydrocarbons (4 species as defined in the Reporting Guidelines)
PIANO	Project Interactive Analysis and Optimization
PM ₁₀	Particulate matter less than 10 micrometers
PM _{2.5}	Particulate matter less than 2.5 micrometers
QA/QC	Quality assurance and Quality control
Quarterly fuel statistics	Quarterly fuel statistics
RME	Rapeseed Methyl Ester fuel
RVF	Swedish Association of Waste Management
SCAA	Swedish Civil Aviation Authority
SJV	Swedish Board of Agriculture
SGU	Geological Survey of Sweden
SLU	Swedish University of Agricultural Sciences
SMED	Swedish Environmental Emissions Data
SMHI	Swedish Meteorological and Hydrological Institute
SNRA	Swedish National Road Administration
SO ₂	Sulphur dioxide
SPI	Swedish Petroleum Institute
SVEFF	Swedish Paint and Print Ink Makers Association
Swedish EPA	Swedish Environmental Protection Agency
TEQ	Toxic Equivalents. Used to report the toxicity-weighted masses of dioxins and furans
TIM	Times in Mode
TMP	Thermo Mechanical Pulp
TNO	The Netherlands Organisation for Applied Scientific Research
TSP	Total suspended particulate matter
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VETO	Mechanistic model for simulations on road traffic
VTI	Swedish Road- and Transport Research Institute

