

1.A.3.b iii - Transport: Road Transport: Heavy Duty Vehicles and Buses

Short description

In sub-category 1.A.3.b iii - Road Transport: Heavy Duty Vehicles and Buses emissions from fuel combustion in trucks, lorries, buses etc. are reported.

Category Code	Method					AD					EF				
1.A.3.b iii	T1, T3					NS, M					CS, M, D				
	NO _x	NM VOC	SO ₂	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	PB	Cd	Hg	Diox	PAH	HCB
Key Category:	L/T	-/-	-/-	-/-	L/T	L/T	-/-	L/T	-/-	-/-	-/-	-/-	-/-	-/-	-

T = key source by Trend **L** = key source by Level

Methods

D	Default
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model

* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in the group specific chapters.

AD - Data Source for Activity Data

NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential

EF - Emission Factors

D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data
M	Model / Modelled

Methodology

Activity data

Specific consumption data for heavy-duty vehicles (trucks and lorries) and buses are generated within TREMOD ¹⁾. - The following tables provide an overview of annual amounts of fuels consumed by these vehicles in Germany.



Table 1: Annual fuel consumption of trucks and lorries, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
thereof: Buses																
Diesel oil	54,449	46,071	46,040	37,582	43,949	43,549	46,516	47,685	44,800	47,766	49,068	47,777	45,841	47,939	31,448	29,736
Biodiesel		72	510	2,511	3,369	3,039	3,283	2,828	2,753	2,613	2,601	2,551	2,665	2,730	2,612	2,066
CNG				1,147	2,141	1,962	2,152	1,737	1,667	1,576	1,213	1,155	956	1,004	983	983
Biogas							307	344	420	266	285	319	257	408	529	470
Petroleum		610	414													
Σ Buses	54,449	46,143	46,550	41,240	49,459	48,550	52,258	52,594	49,640	52,221	53,167	51,802	49,720	52,082	35,572	33,255
thereof: Trucks & Lorries																
Diesel oil	382,330	507,334	590,322	455,044	509,974	510,920	535,523	550,889	523,710	543,429	549,899	555,099	542,086	552,663	535,871	523,678
Biodiesel		792	6,540	30,409	39,098	35,648	37,795	32,670	32,182	29,726	29,153	29,634	31,511	31,478	44,513	36,381
CNG							393	336	320	272	190	182	164	206	276	444
Biogas							56,2	66,6	80,5	45,8	44,7	50	44	84	148	212
LNG							36,1	41,1	46,7	52,2	63,0	104	192	830	2,511	5,045
Σ Trucks & Lorries	382,330	508,125	596,862	485,453	549,072	546,569	573,767	583,962	556,292	573,472	579,287	584,964	573,805	584,432	580,807	560,715
HDDVs over-all																
Diesel oil	436,779	553,405	636,362	492,626	553,922	554,469	582,039	598,574	568,510	591,195	598,967	602,876	587,927	600,602	567,318	553,414
Biodiesel		863	7,050	32,920	42,467	38,687	41,078	35,498	34,935	32,339	31,754	32,184	34,175	34,209	47,125	38,446
CNG				1,147	2,141	1,962	2,545	2,074	1,986	1,848	1,403	1,337	1,120	1,211	1,259	1,428
Biogas							364	410	501	312	330	369	301	492	677	682
Petroleum		610	414													
LNG							36,1	41,1	46,7	52,2	63,0	104	192	830	2,511	5,045
Σ 1.A.3.b iii	436,779	554,878	643,825	526,693	598,531	595,118	626,061	636,598	605,979	625,745	632,517	636,870	623,716	637,344	618,890	599,016

source: TREMOD ²⁾



For information on mileage, please refer to sub-chapters on emissions from [tyre & brake wear and road abrasion](#).

Emission factors

The majority of emission factors for exhaust emissions from road transport are taken from the 'Handbook Emission Factors for Road Transport' (HBEFA, version 4.1) ³⁾ where they are provided on a tier3 level mostly and processed within the TREMOD software used by the party ⁴⁾.

However, it is not possible to present these tier3 values in a comprehensible way here.

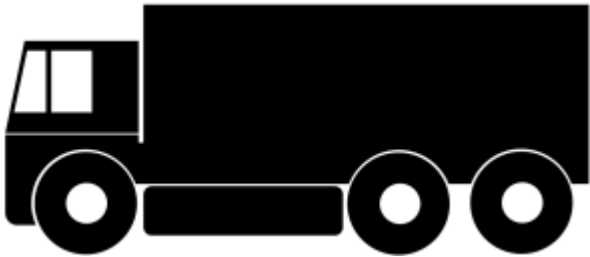


With respect to the country-specific emission factors applied for particulate matter, given the circumstances during test-bench measurements, condensables are most likely included at least partly. ¹⁾

For heavy-metal (other than lead from leaded gasoline) and PAH exhaust-emissions, default emission factors from the 2019 EMEP Guidebook (EMEP/EEA, 2019) ⁵⁾ have been applied. Regarding PCDD/F, tier1 EF from (Rentz et al., 2008) ⁶⁾ are used instead.

Table 2: tier1 EF derived from default values

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	B[a]P	B[b]F	B[k]F	I[...]P	PAH 1-4	PCDD/F
	[g/TJ]									[mg/TJ]				[µg/km]	
Diesel oil	0.012	0.001	0.123	0.002	0.198	0.133	0.005	0.002	0.419	498	521	275	493	1,788	
Biodiesel	0.013	0.001	0.142	0.003	0.228	0.153	0.005	0.003	0.483	575	601	317	569	2,062	
CNG & Biogas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Petroleum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
all fuels: buses															0.000019
all fuels: trucks & lorries															0.000016



Discussion of emission trends

Table 3: Outcome of Key Category Analysis

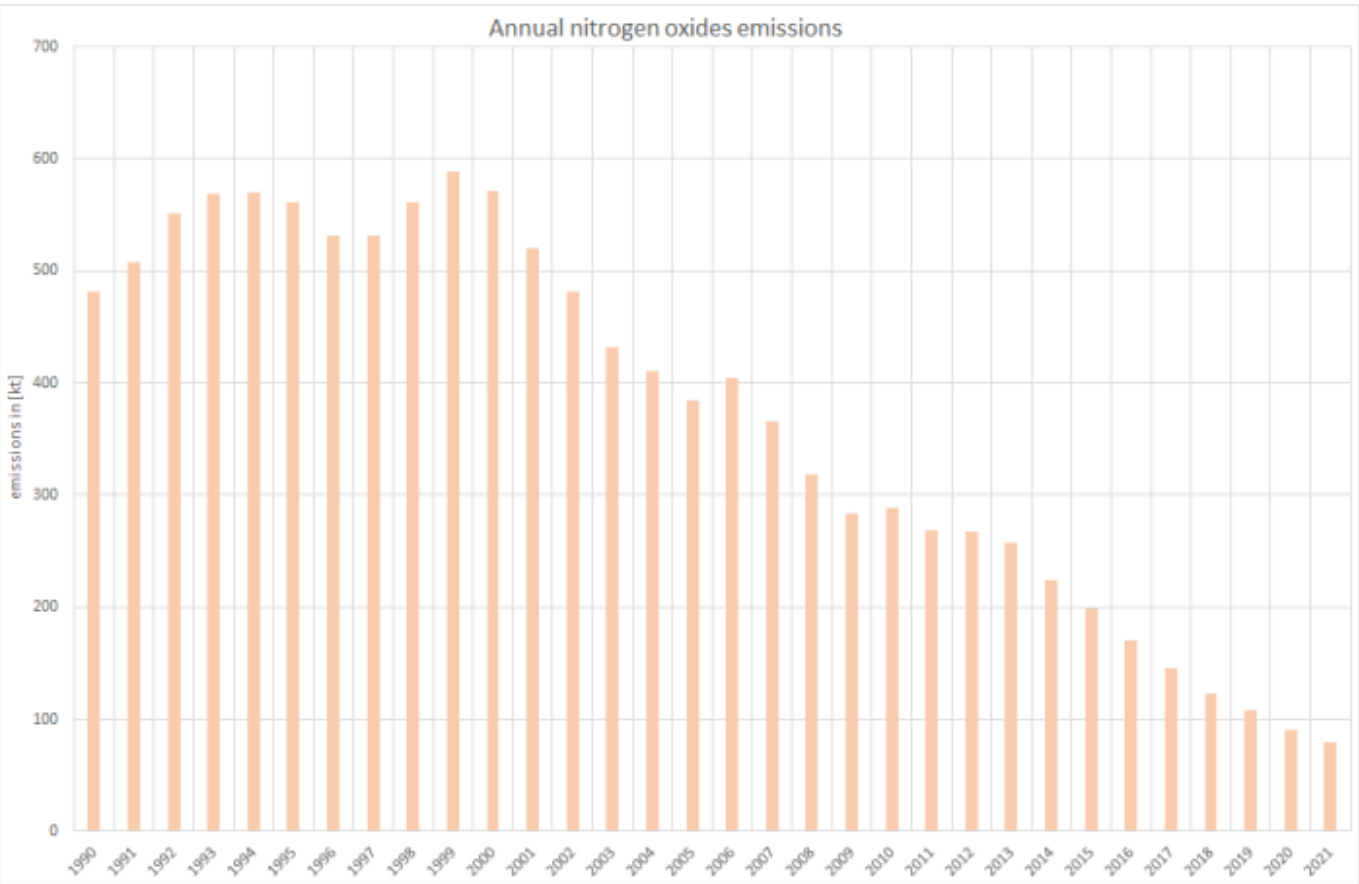
for:	NO_x	BC	PM₁₀	PM_{2.5}
by:	L/T	L/T	L/T	L/T

Nitrogen oxides

Until 2005, NO_x emissions followed mileage and fuel consumption. Since 2006, in contrast to nearly unchanged fuel consumption, emissions have decreased due to controlled catalytic-converter use and engine improvements resulting from continual tightening of emissions laws.

Table 4: EURO norms and their effect on limit values of NO_x emissions from diesel heavy-duty vehicles, in [g/kWh]

	pre-Euro	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
Diesel	14,4	8/9	7	5	3,5	2	0,4 / 0,46

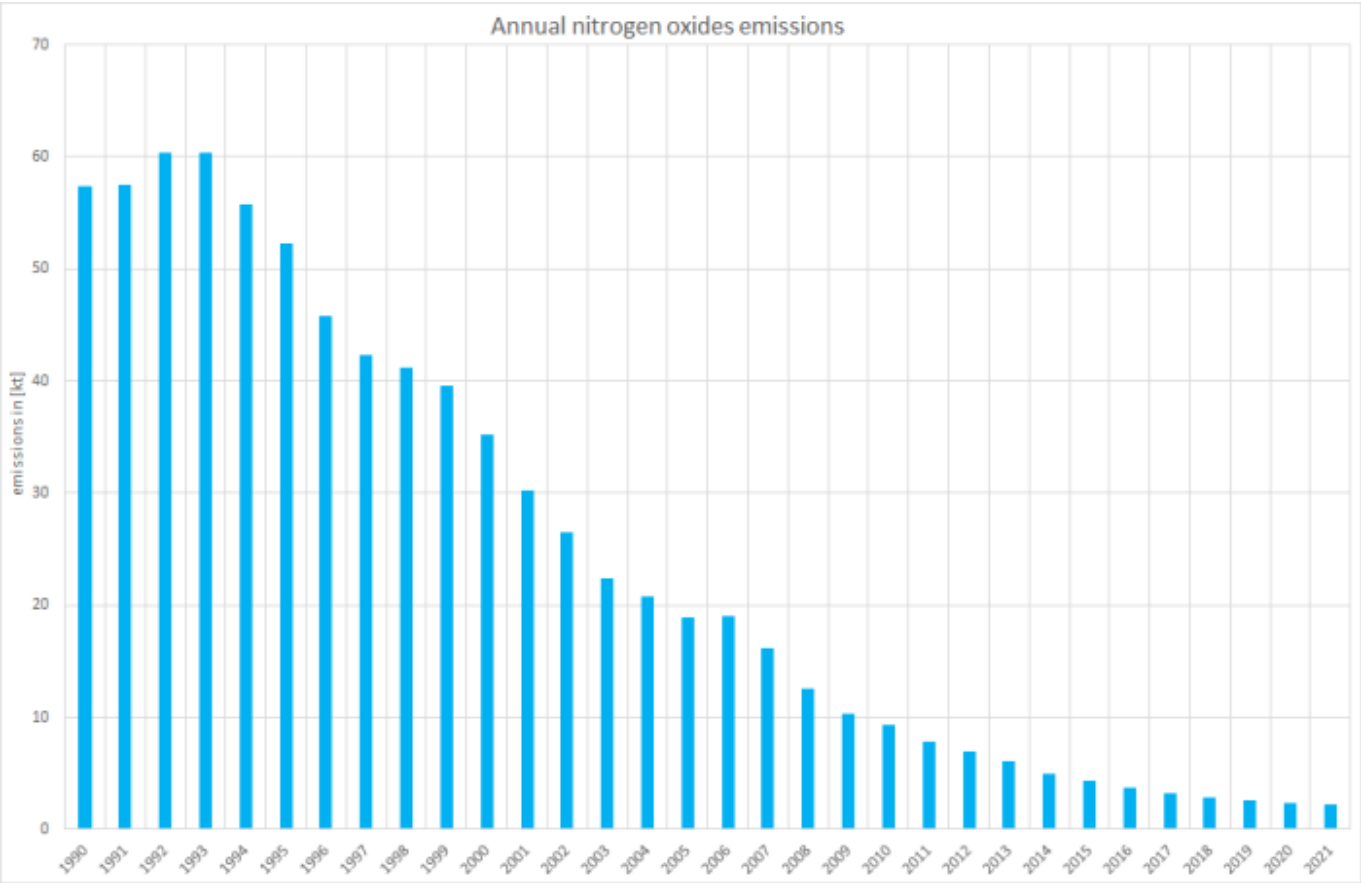


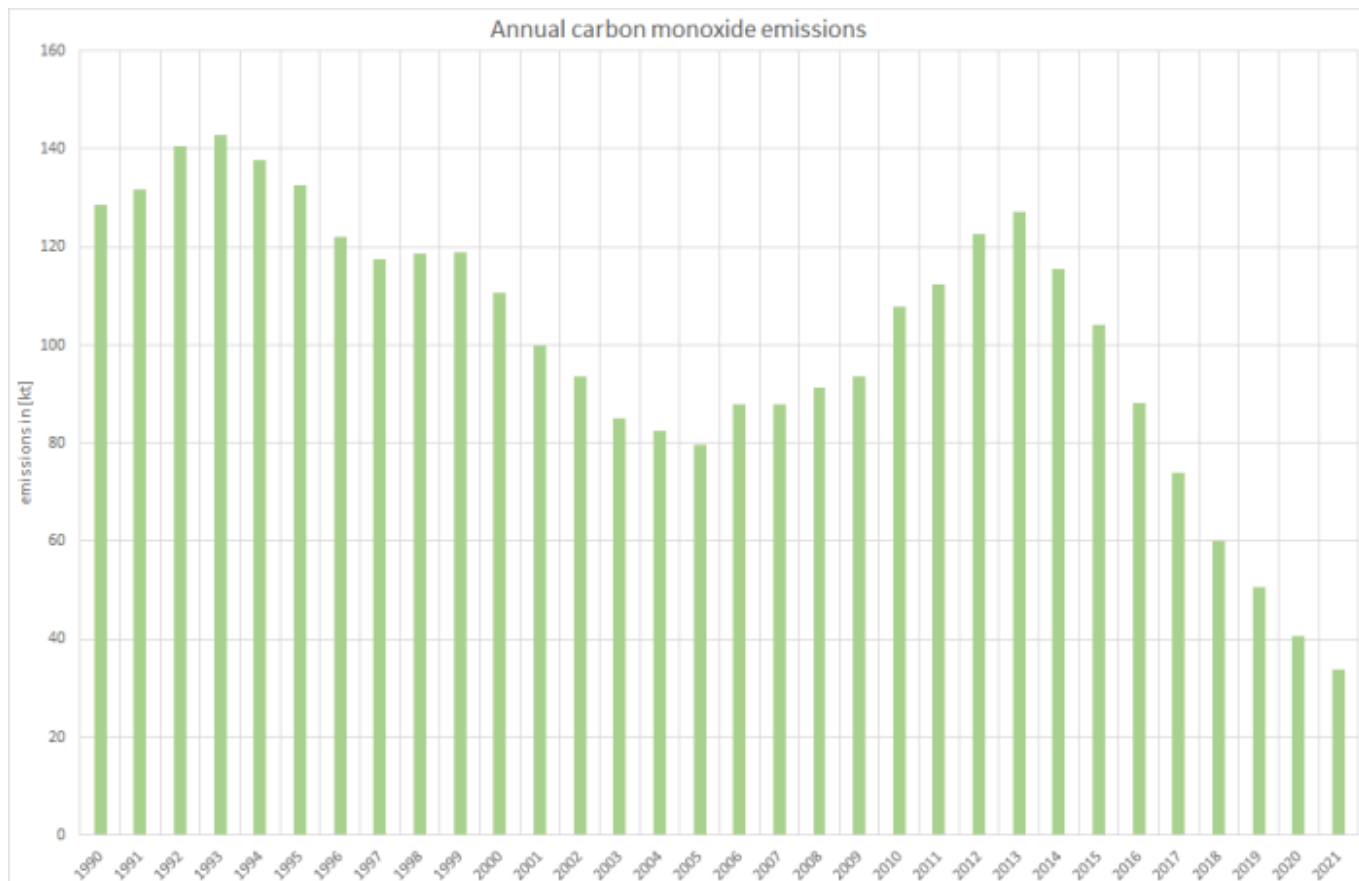
Non-methane volatile organic compounds (NMVOC) and carbon monoxide

Since 1990, exhaust emissions of **NM VOC** and **carbon monoxide** have decreased sharply due to catalytic-converter use and engine improvements resulting from ongoing tightening of emissions laws and improved fuel quality.

Table 4: EURO norms and their effect on limit values of CO emissions from diesel heavy-duty vehicles, in [g/kWh]

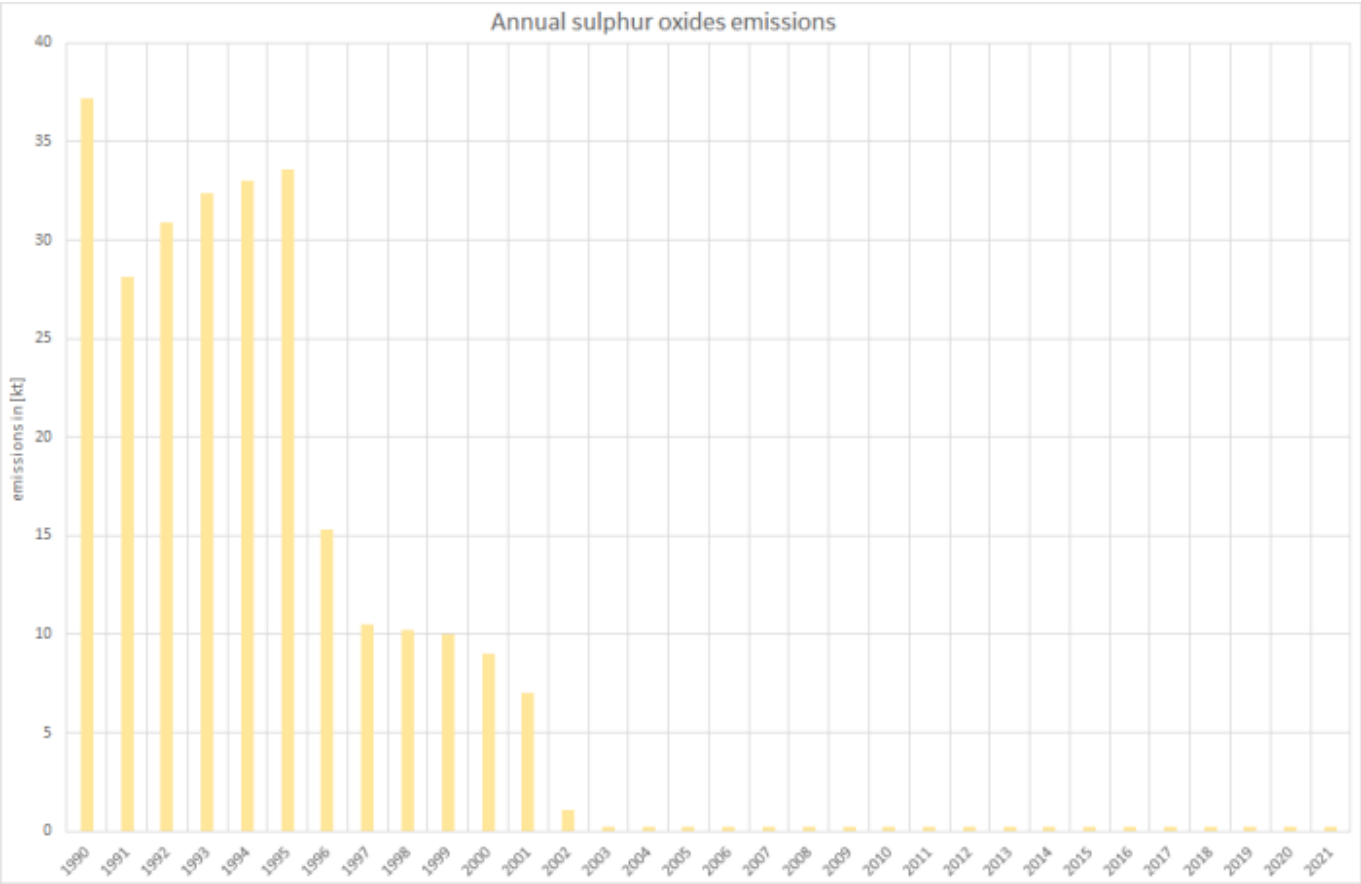
pre-Euro	Euro I	Euro II	Euro III	Euro IV	Euro V	Euro VI
11,2	4,5 / 4,9	4	2,1	1,5	1,5	1,5





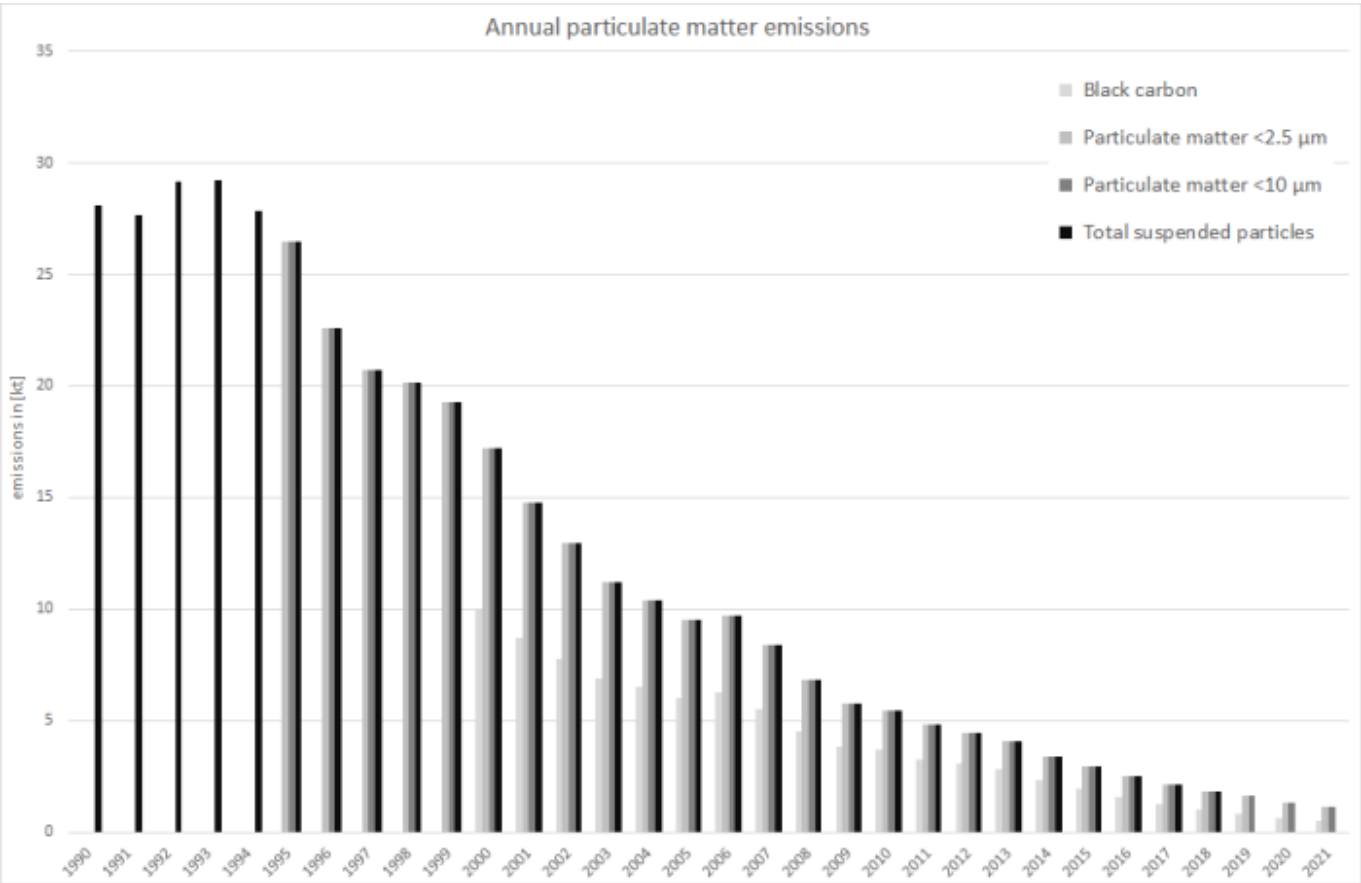
Ammonia and sulphur dioxide

As for the entire road transport sector, the trends for **sulphur dioxide** (SO₂) and **ammonia** (NH₃) exhaust emissions from heavy duty vehicles show characteristics different from those shown above: Here, the strong dependence on increasing fuel qualities (sulphur content) leads to a cascaded downward trend of SO₂ emissions, influenced only slightly by increases in fuel consumption and mileage. For **ammonia** emissions the increasing use of catalytic converters in gasoline driven cars in the 1990s lead to a steep increase whereas both the technical development of the converters and the ongoing shift from gasoline to diesel cars resulted in decreasing emissions in the following years.



Particulate matter & Black carbon

As for all reported exhaust PM emissions from mobile diesel vehicles the Party assumes that nearly all particles emitted are within the PM_{2.5} range, resulting in similar emission values for PM_{2.5}, PM₁₀, and TSP.



Recalculations

Compared to submission 2022, recalculations were carried out due to a routine revision of the TREMOD software and the revision of several National Energy Balances (NEB).

Here, **activity data** were revised within TREMOD due to the provision of the final NEB 2020.

Furthermore, significant re-allocations of consumption shares between the different vehicle types and classes were conducted, effecting the entire time series but with the 1.A.3.b consumption totals remaining unaltered.

Table 4: Revised fuel consumption data, in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DIESEL OIL																		
Submission 2022	459.124	590.259	680.299	526.071	547.742	529.429	535.158	525.222	571.016	571.405	598.290	615.392	585.865	608.497	615.976	619.134	602.053	612.992
Submission 2021	459.124	590.259	680.299	526.071	547.742	529.429	535.158	525.220	571.008	571.389	598.264	615.361	585.893	608.417	615.537	618.619	601.836	613.898
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,07	8,16	16,2	26,4	30,7	-28,5	79,2	439	515	217	-906
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%	0,07%	0,08%	0,04%	-0,15%
BIODIESEL																		
Submission 2022		921	7.537	35.155	66.042	70.833	53.317	42.432	43.778	39.869	42.225	36.496	36.002	33.285	32.656	33.052	34.996	34.915
Submission 2021		921	7.537	35.155	66.042	70.833	53.317	42.432	43.777	39.867	42.223	36.494	36.004	33.281	32.633	33.025	34.984	34.954
absolute change		0,00	0,00	0,00	0,00	0,00	0,00	0,17	0,63	1,13	1,86	1,82	-1,75	4,33	23,3	27,5	12,6	-39,5
relative change		0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%	0,07%	0,08%	0,04%	-0,11%
CNG																		
Submission 2022				1.183	1.682	1.965	2.072	2.255	2.200	2.011	2.552	2.058	1.979	1.866	1.407	1.337	1.125	1.226
Submission 2021				1.183	1.682	1.965	2.072	2.255	2.200	2.011	2.552	2.057	1.967	1.846	1.390	1.173	1.104	1.060
absolute change				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02	1,10	12,0	20,3	17,1	165	21,4	166
relative change				0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,05%	0,61%	1,10%	1,23%	14,04%	1,94%	15,7%
BIOGAS																		
Submission 2022											365	407	499	315	331	370	303	498
Submission 2021											365	407	496	311	327	365	297	485
absolute change											0,00	0,22	3,03	3,43	4,03	4,98	5,77	13,7
relative change											0,00%	0,05%	0,61%	1,10%	1,23%	1,37%	1,94%	2,83%
PETROLEUM																		
Submission 2022		610	414															
Submission 2021		610	414															
absolute change		0,00	0,00															
relative change		0,00%	0,00%															
TOTAL FUEL CONSUMPTION																		
Submission 2022	459.124	591.789	688.249	562.409	615.465	602.227	590.547	569.908	616.994	613.284	643.541	654.470	624.469	644.101	650.529	654.098	638.776	650.539
Submission 2021	459.124	591.789	688.249	562.409	615.465	602.227	590.547	569.906	616.985	613.267	643.403	654.319	624.360	643.855	649.887	653.181	638.221	650.396
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,24	8,79	17,4	138	151	110	245	642	916	556	143
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,02%	0,02%	0,02%	0,04%	0,10%	0,14%	0,09%	0,02%

Due to the variety of highly specific tier3 **emission factors** applied, it is not possible to display any changes in these data sets in a comprehensible way.



For **pollutant-specific information on recalculated emission estimates for Base Year and 2020**, please see the recalculation tables following [chapter 8.1 - Recalculations](#).

Planned improvements

Besides a routine revision of the underlying model, no specific improvements are planned.

FAQs

^{1), 2), 4)} Knörr et al. (2021a): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Fortschreibung des Daten- und Rechenmodells: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2035, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg & Berlin, 2021.

³⁾ Keller et al. (2017): Keller, M., Hausberger, S., Matzer, C., Wüthrich, P., & Notter, B.: Handbook Emission Factors for Road Transport, version 4.1 (Handbuch Emissionsfaktoren des Straßenverkehrs 4.1) URL: <http://www.hbefa.net/e/index.html> - Dokumentation, Bern, 2017.

⁵⁾ EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019; <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view>; Copenhagen, 2019.

⁶⁾ Rentz et al., 2008: Nationaler Durchführungsplan unter dem Stockholmer Abkommen zu persistenten organischen Schadstoffen (POPs), im Auftrag des Umweltbundesamtes, FKZ 205 67 444, UBA Texte | 01/2008, January 2008 - URL: <http://www.umweltbundesamt.de/en/publikationen/nationaler-durchfuehrungsplan-unter-stockholmer>

¹⁾ During test-bench measurements, temperatures are likely to be significantly higher than under real-world conditions, thus reducing condensation. On the contrary, smaller dilution (higher number of primary particles acting as condensation germs) together with higher pressures increase the likeliness of condensation. So over-all condensables are very likely to occur but different to real-world conditions.