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	**NMVOC**	**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.	

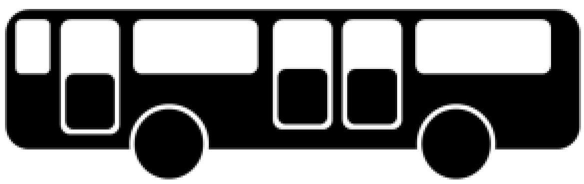
AD - Data Source for Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential

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.



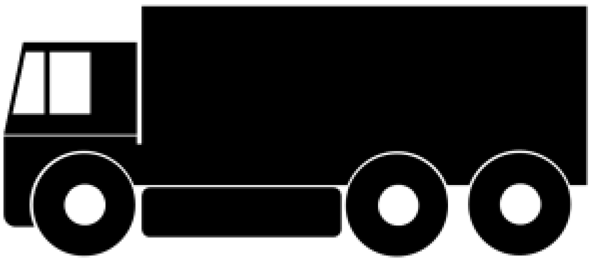


Table 1: Annual fuel consumption of trucks and lorries, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
HDVs: Buses															
Diesel oil	57,322	49,060	49,204	39,890	44,448	44,080	47,336	48,611	46,147	49,428	51,353	50,519	48,606	50,088	38,954
Biodiesel	0	77	545	2,666	3,408	3,076	3,341	2,883	2,836	2,704	2,722	2,697	2,825	2,853	3,236
CNG	0	0	0	1,183	2,200	2,011	2,157	1,720	1,663	1,591	1,213	1,150	955	1,004	1,152
Biogas	0	0	0	0	0	0	308	340	419	268	285	318	257	408	529
Petroleum	0	610	414	0	0	0	0	0	0	0	0	0	0	0	0
Σ Buses	**57,322**	**49,137**	**49,750**	**43,739**	**50,056**	**49,167**	**53,142**	**53,555**	**51,065**	**53,991**	**55,574**	**54,684**	**52,644**	**54,353**	**43,871**
HDVs: Trucks & Lorries															
Diesel oil	401,801	541,198	631,094	486,181	526,568	527,325	550,954	566,780	539,718	559,069	564,622	568,615	553,447	562,904	537,774
Biodiesel	0	844	6,991	32,490	40,370	36,793	38,884	33,613	33,166	30,581	29,933	30,355	32,171	32,062	44,671
CNG	0	0	0	0	0	0	395	338	316	275	194	187	170	222	348
Biogas	0	0	0	0	0	0	56	67	80	46	46	52	46	90	160
Σ Trucks & Lorries	**401,801**	**542,043**	**638,086**	**518,670**	**566,938**	**564,118**	**590,290**	**600,798**	**573,279**	**589,972**	**594,796**	**599,209**	**585,834**	**595,278**	**582,953**
HDVs over all															
Diesel oil	459,124	590,259	680,299	526,071	571,016	571,405	598,290	615,392	585,865	608,497	615,976	619,134	602,053	612,992	576,728
Biodiesel	0	921	7,537	35,155	43,778	39,869	42,225	36,496	36,002	33,285	32,656	33,052	34,996	34,915	47,907
CNG	0	0	0	1,183	2,200	2,011	2,552	2,058	1,979	1,866	1,407	1,337	1,125	1,226	1,500
Biogas	0	0	0	0	0	0	365	407	499	315	331	370	303	498	688
Petroleum	0	610	414	0	0	0	0	0	0	0	0	0	0	0	0
Σ 1.A.3.b iii	**459,124**	**591,179**	**687,835**	**562,409**	**616,994**	**613,284**	**643,432**	**654,353**	**624,344**	**643,963**	**650,370**	**653,893**	**638,477**	**649,631**	**626,824**

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 comprehendible 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 then 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

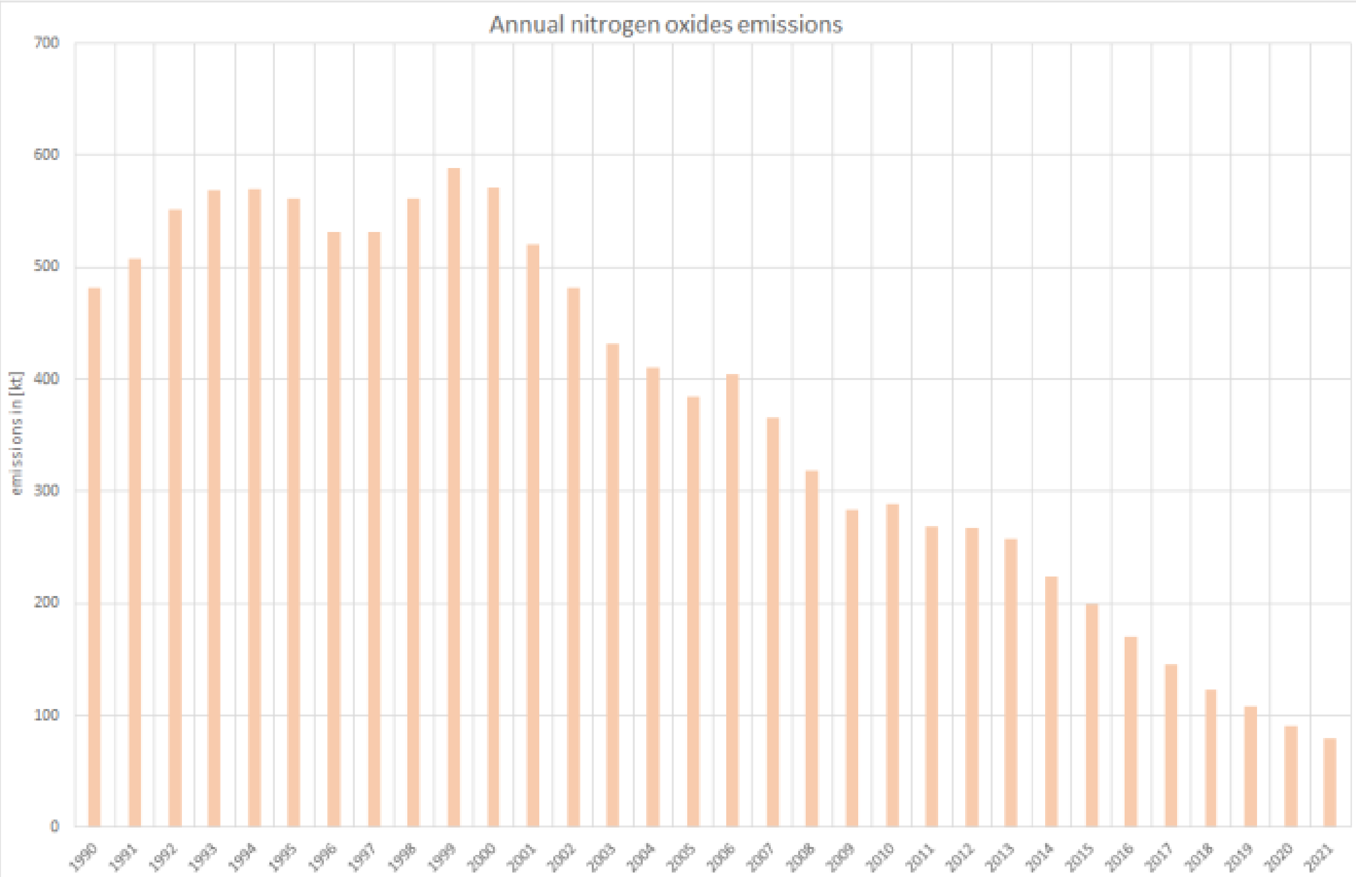
Discussion of emission trends

Table 3: Outcome of Key Category Analysis

for:	**NO_x**	**BC**	**PM_{10}**	**$PM_{2.5}$**
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.



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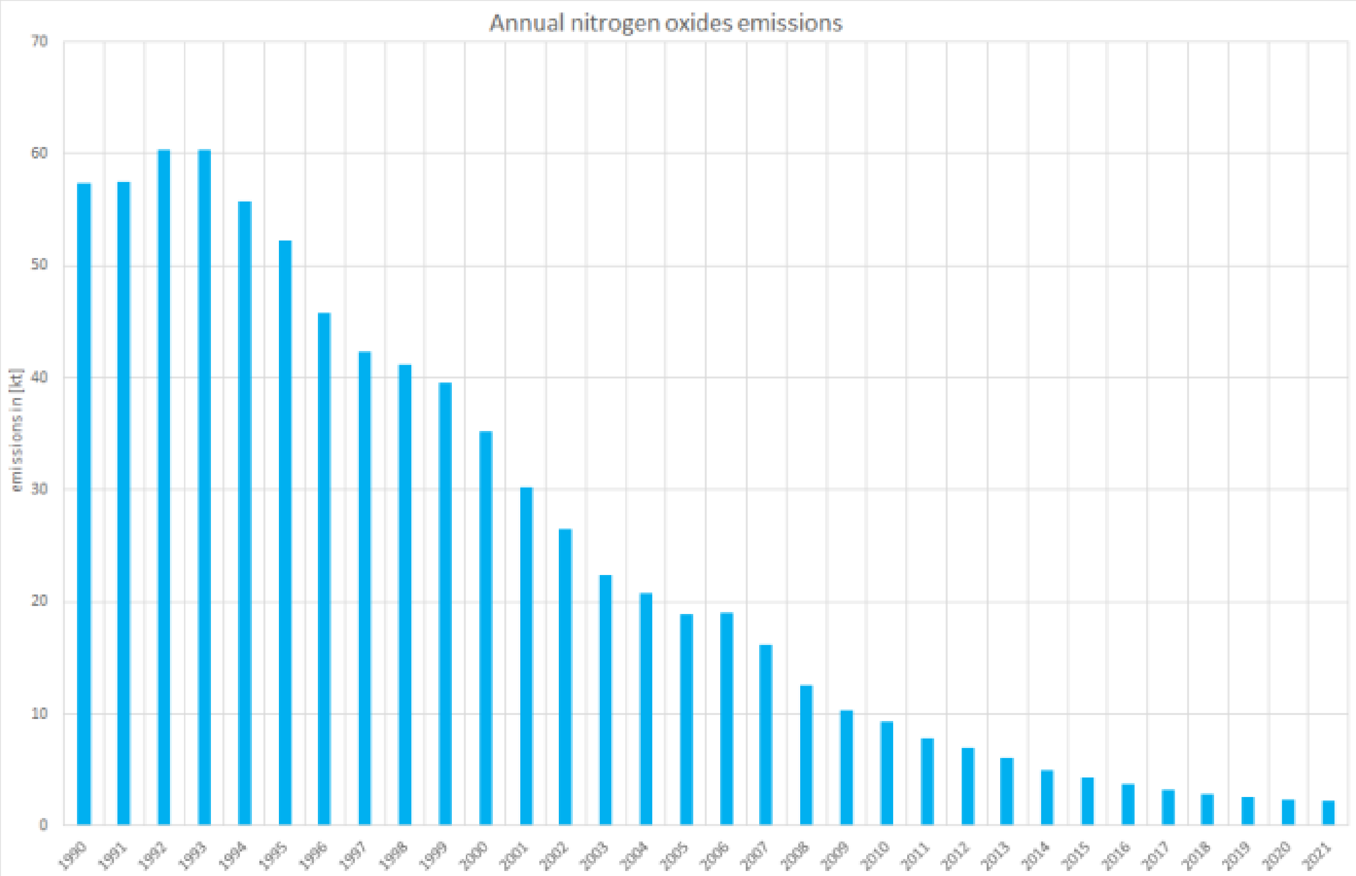
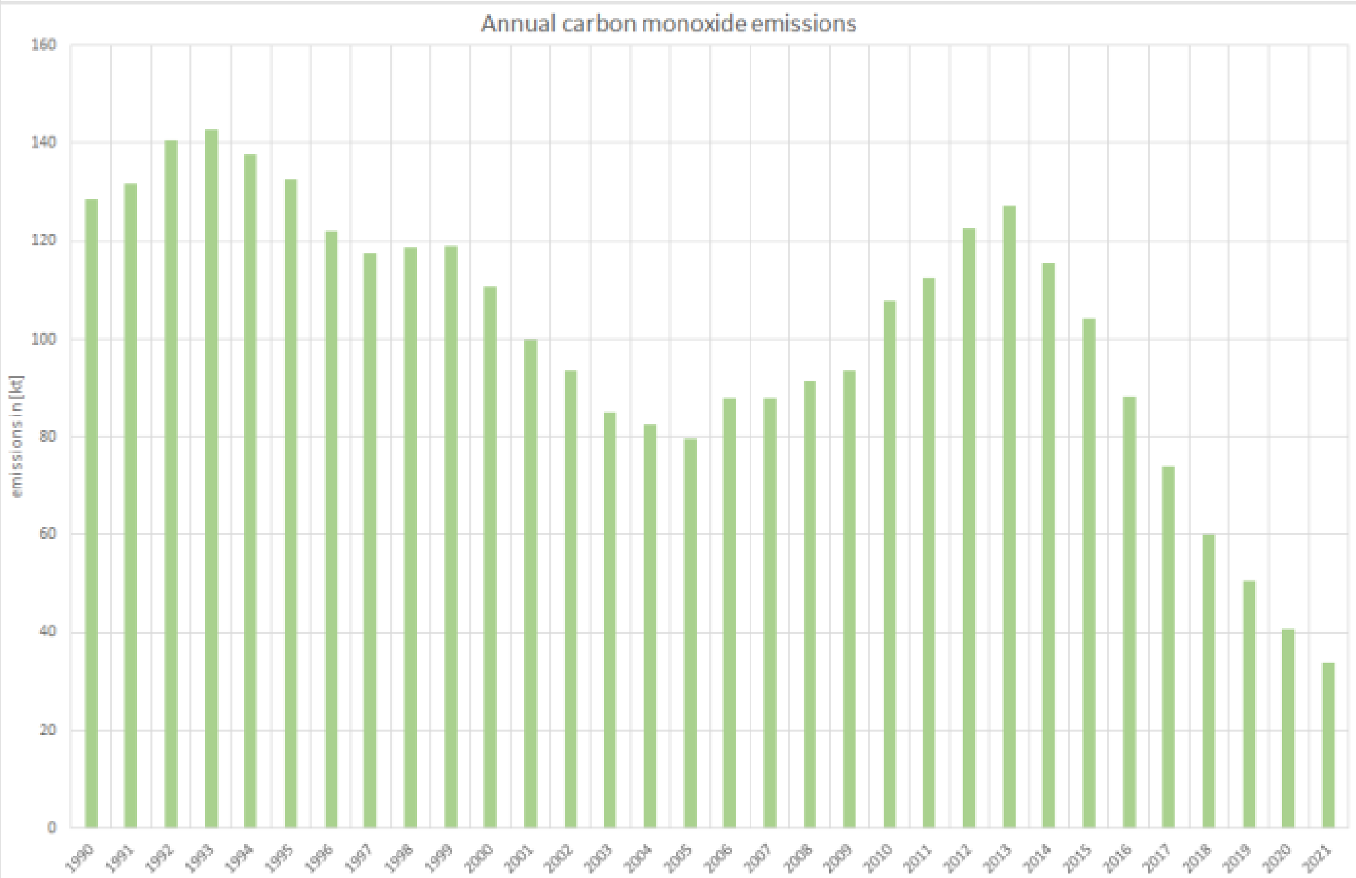
Non-methane volatile organic compounds (NMVOC) and carbon monoxide

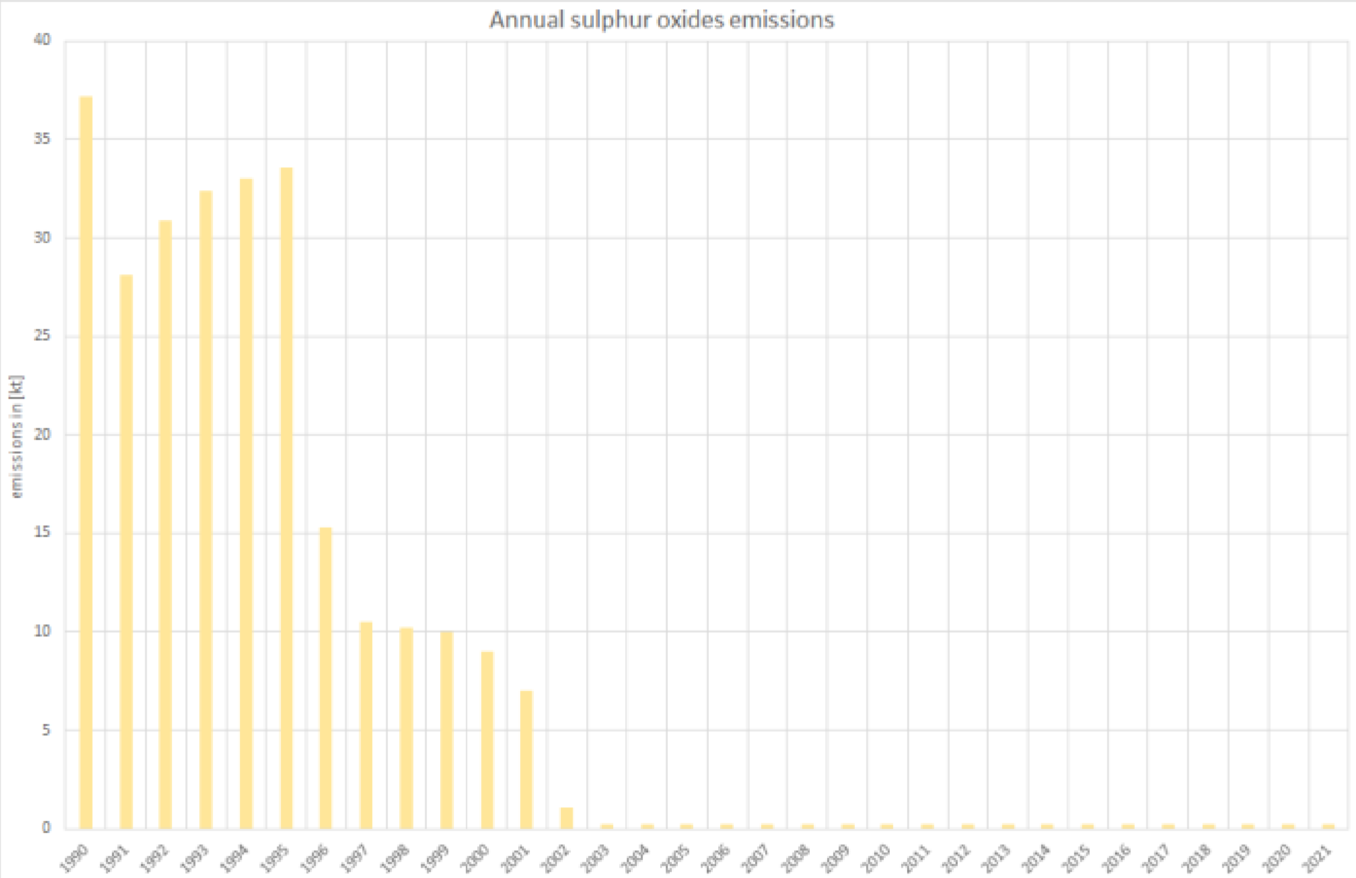
Since 1990, exhaust emissions of **NMVOC** and **carbon monoxide** have decreased sharply due to catalytic-converter use and engine improvements resulting from ongoing tightening of emissions laws and improved fuel quality.





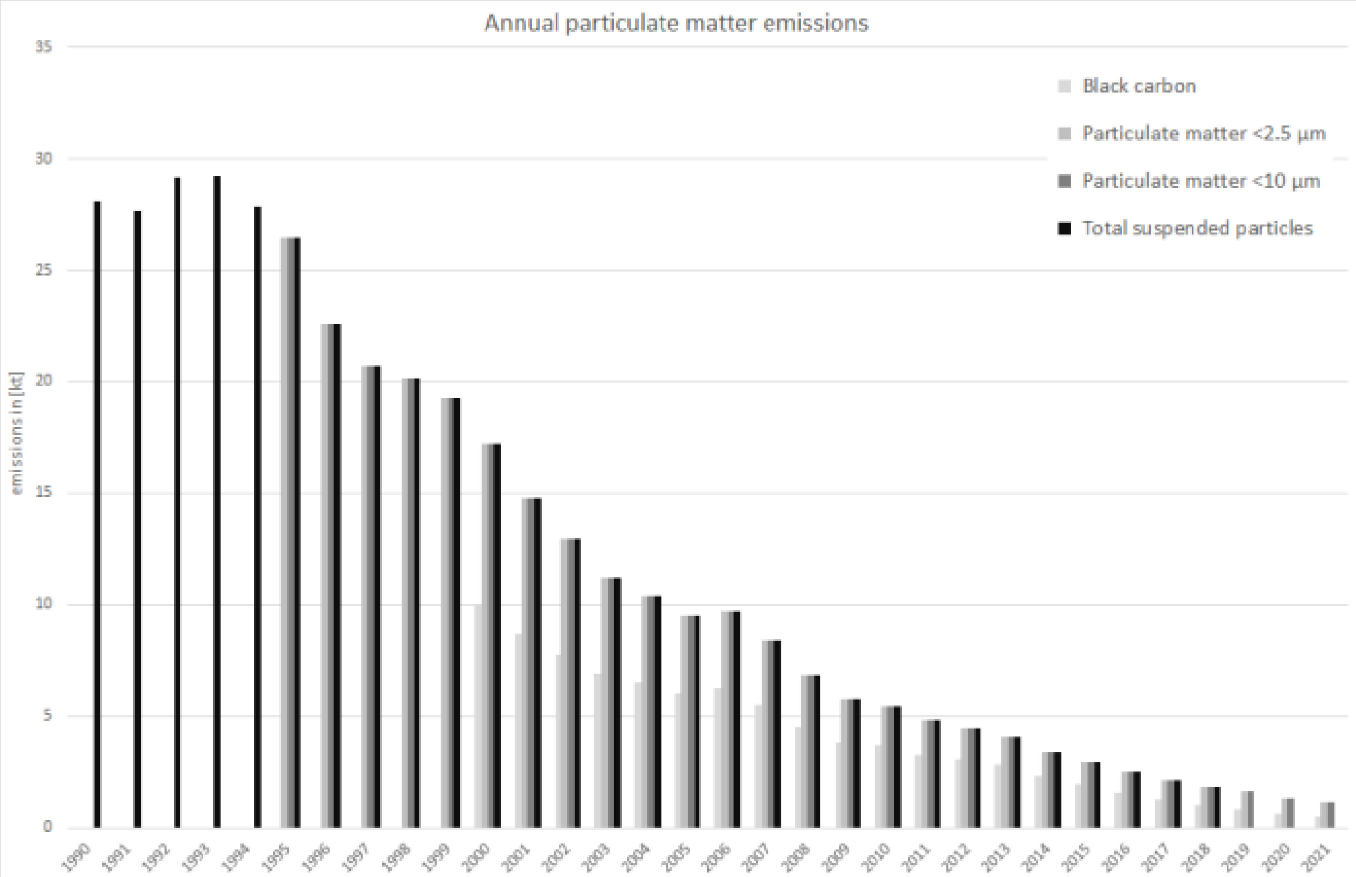
Ammonia and sulphur dioxide

As for the entire road transport sector, the trends for **sulphur dioxide** (SO_2) and **ammonia** (NH_3) exhaust emissions from heavy duty vehicles show charcteristics different from those shown above: Here, the strong dependence on increasing fuel qualities (sulphur content) leads to an cascaded downward trend of SO_2 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 $PM_{2.5}$, PM_{10}, and TSP.



Recalculations

Compared to submission 2020, 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 2019.

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 consumptipon 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																		

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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 comprehendible way.

For **pollutant-specific information on recalculated emission estimates for Base Year and 2019**, 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 dillution (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.