1.A3.b ii - Transport: Road Transport: Light Duty Vehicles

Short description

In sub-category *1.A.3.b ii - Road Transport: Light Duty Vehicles* emissions from fuel combustion in Light Duty Vehicles (LDVs) are reported.

Category Code	Method					AD			EF					
1.A.3.b ii	T1, T3					NS, M			CS, M, D					
Key Category	**NO_x**	**NMVOC**	**SO_2**	**NH_x**	**$PM_{2.5}$**	**PM_{10}**	**TSP**	**BC**	**CO**	**PB**	**Cd**	**Hg**	**Diox**	**PAH**	**HCB**
1.A.3.b ii	L/-	-/-	-/-	-/-	L/T	L/T	-/-	L/T	-/-	-/-	-/-	-/-	-/-	-/-	-

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

Methods	
D	Default
RA	Reference Approach
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/CORINAIR Emission Inventory Guidebook - 2007, 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, surveys

EF - Emission Factors	
D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data

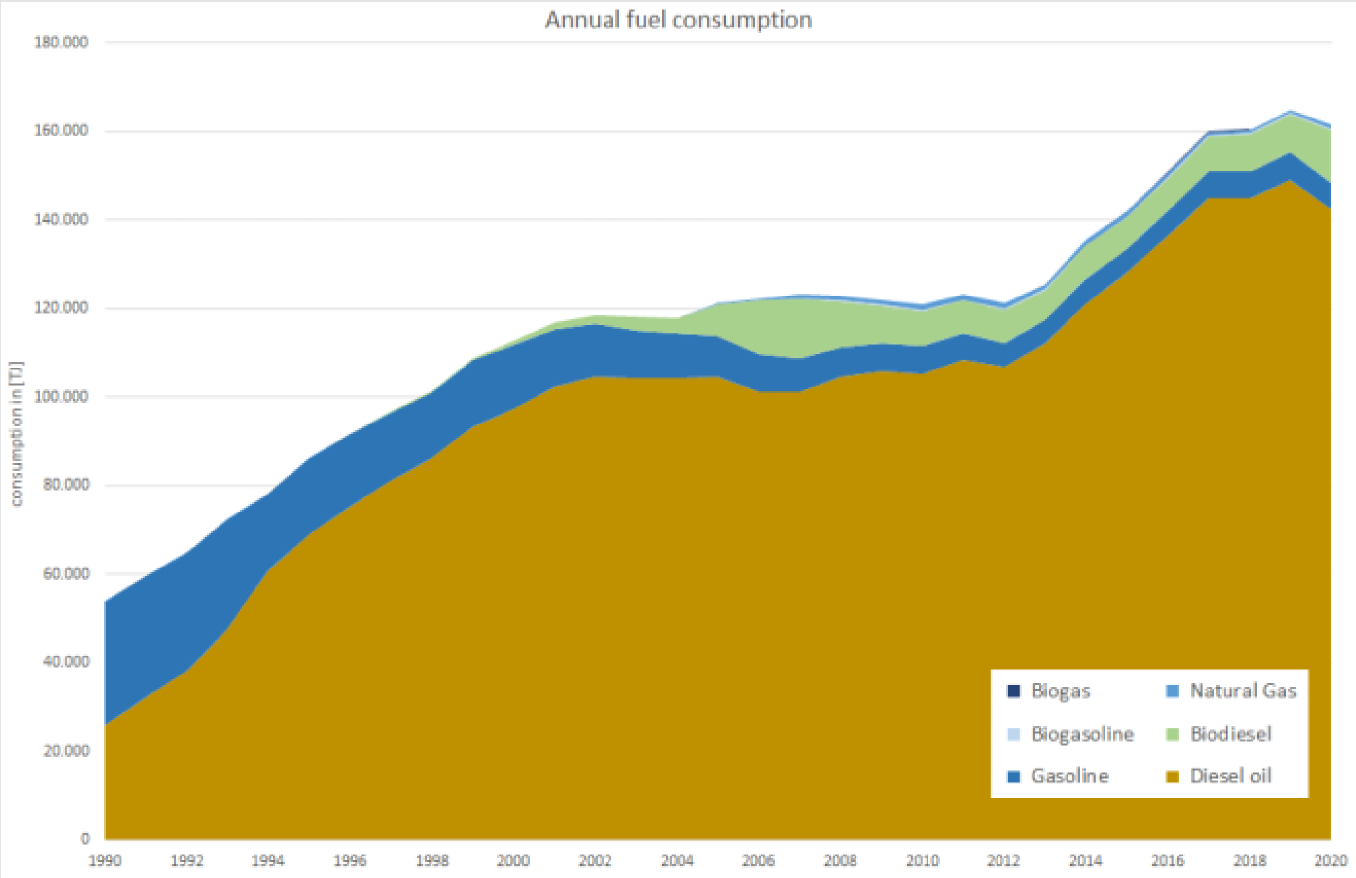
Methodology

Activity data

Specific consumption data for light-duty vehicles (LDV) are generated within TREMOD [1]. - The following table provides an overview of annual amounts of fuels consumed by LDV in Germany.

Table 1: Annual fuel consumption of light duty vehicles, in terajoules

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Diesel oil	25,715	69,182	97,262	104,706	101,229	101,076	104,483	105,776	105,371	108,404	106,814	112,117	121,083	128,168	136,581	145,105	144,960	148,955	142,293
Gasoline	28,187	17,111	14,466	9,216	8,374	7,723	6,825	6,481	6,090	5,877	5,417	5,348	5,599	5,547	5,670	5,919	6,009	6,336	6,251
CNG				340	484	706	927	1,127	1,217	1,266	1,177	953	1,028	1,097	878	888	776	837	1,012
Biodiesel		108	1,078	6,997	12,205	13,523	10,410	8,545	8,078	7,564	7,538	6,649	7,441	7,011	7,241	7,746	8,426	8,484	11,820
Biogasoline				63.3	121	104	130	185	235	241	240	229	243	241	246	250	270	273	285
Biogas											168	188	259	185	207	245	209	340	464
Σ 1.A.3.b ii	**53,902**	**86,401**	**112,806**	**121,322**	**122,412**	**123,133**	**122,776**	**122,115**	**120,992**	**123,351**	**121,355**	**125,484**	**135,654**	**142,248**	**150,823**	**160,154**	**160,651**	**165,225**	**162,126**



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) [2] where they are provided on a tier3 level mostly and processed within the TREMOD software used by the party [3].

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

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) [4] have been applied. Regarding PCDD/F, a tier1 EF from (Rentz et al., 2008) [5] is used instead.

Table 3: tier1 emission factors

	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	B[a]P	B[b]F	B[k]F	I[1,2,3-c,d]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[1]	0.013	0.001	0.142	0.003	0.228	0.153	0.005	0.003	0.483	575	601	317	569	2.062	
Gasoline fuels	0.037	0.005	0.200	0.007	0.145	0.103	0.053	0.005	0.758	96	140	69	158	464	

CNG[2] & biogas[3]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
LPG[4]	NE	NE	NE	NE	NE	NE	NE	NE	NE	4.35	0.00	4.35	4.35	13.0	
all fuels															0.000006

[1] values differ from EFs applied for fossil diesel oil to take into account the specific NCV of biodiesel
[2] no specific default available from [6)]; value derived from CNG powered busses
[3] no specific default available from [7)]; values available for CNG also applied for biogas
[4] no specific default available from [8)]; value derived from LPG powered passenger cars

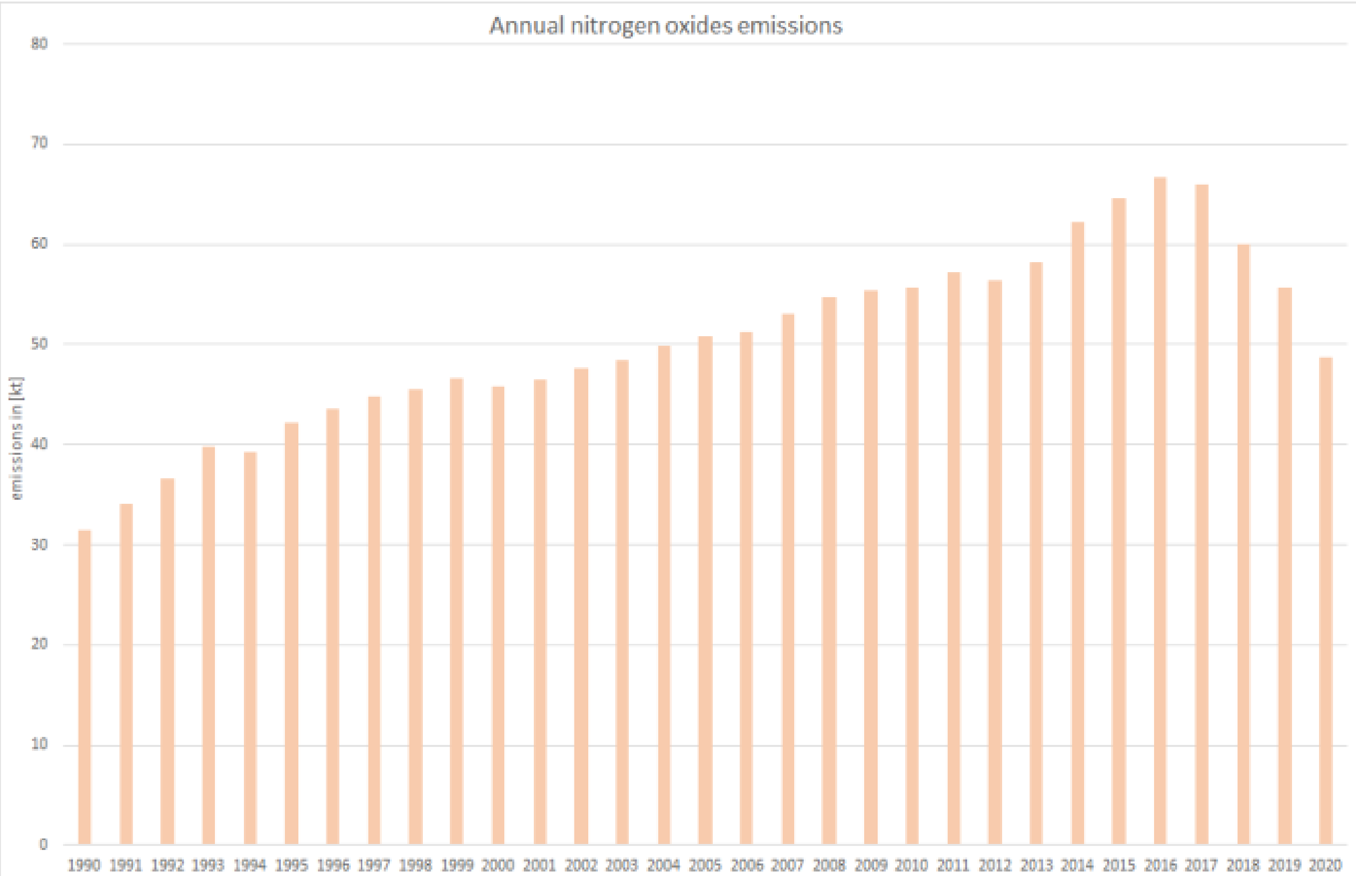
Discussion of emission trends

Table: Outcome of Key Category Analyis

for:	NO_x	BC	PM_{10}	$PM_{2.5}$
by:	Level	Level & Trend	-/T	L/T

Nitrogen oxides

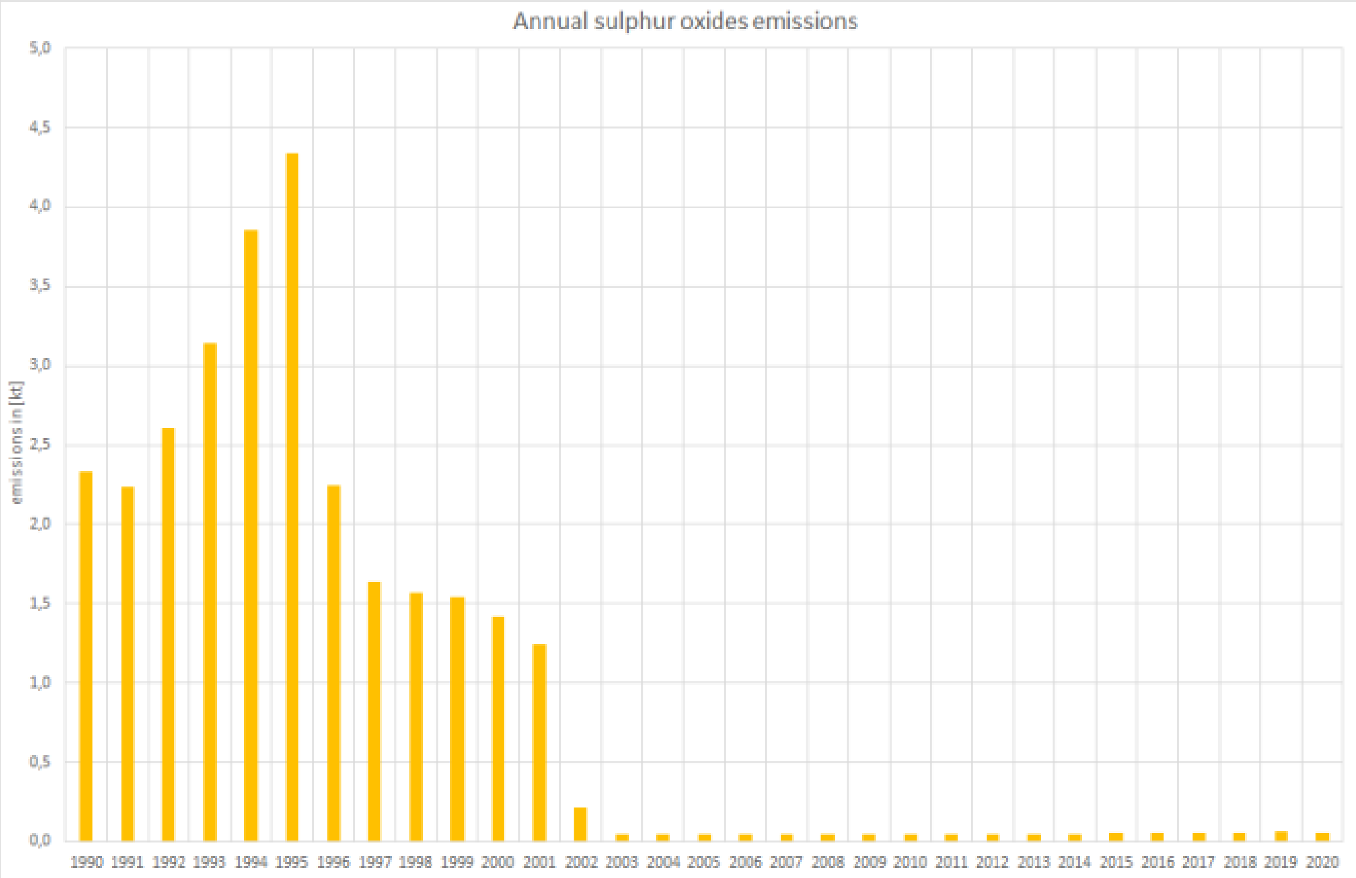
NO_x emissions increased steadily until 2002 following the shift to diesel engines. During the last ten years, emissions decline steadily due to catalytic-converter use and engine improvements resulting from ongoing tightening of emissions laws and improved fuel quality.



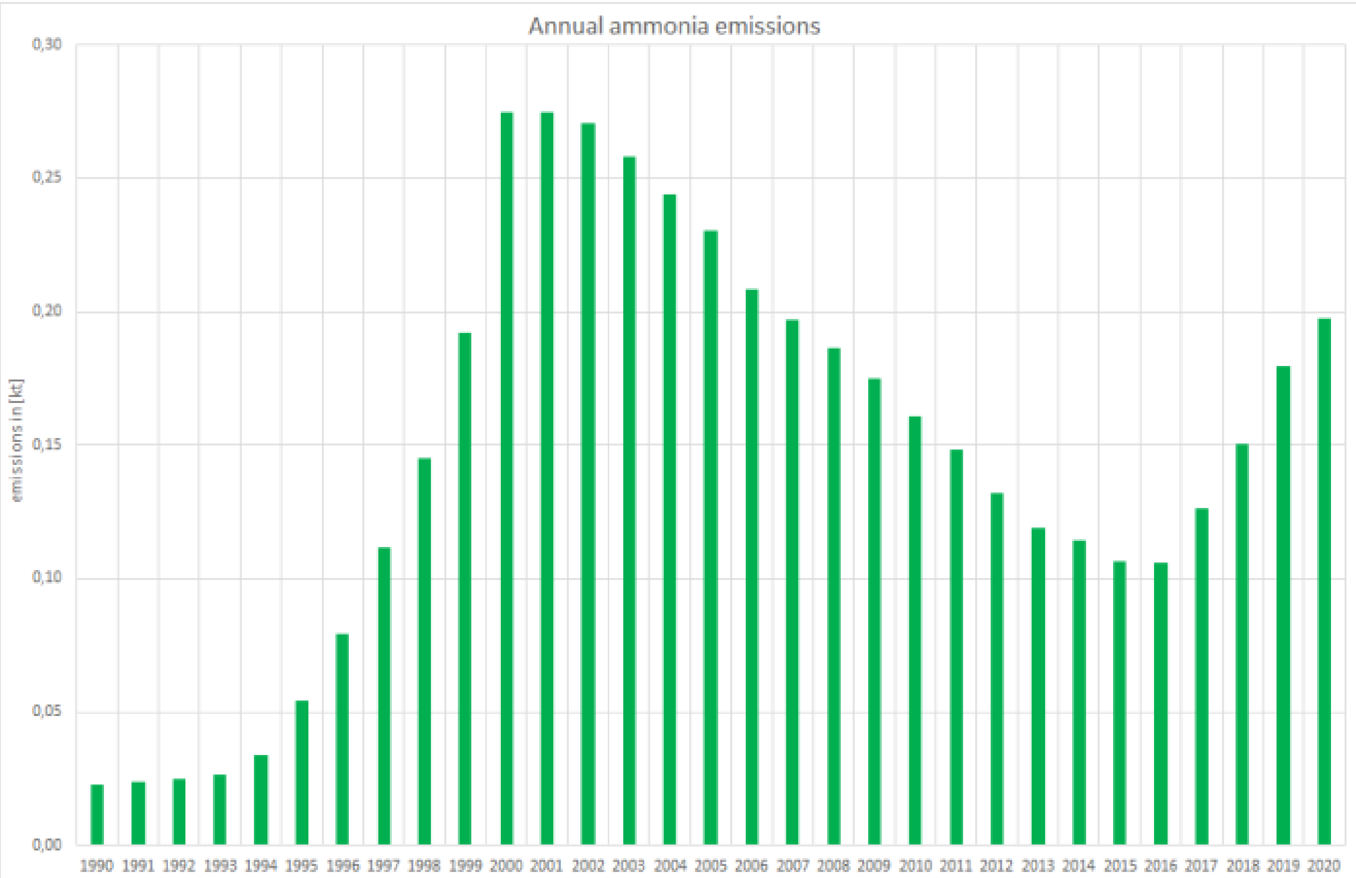
Ammonia and sulphur dioxide

As for the entire road transport sector, the trends for **sulphur dioxide** and **ammonia** exhaust emissions from passenger cars show charcteristics very different from those shown above.

Here, the strong dependence on increasing fuel qualities (sulphur content) leads to an cascaded downward trend of emissions , influenced only slightly by increases in fuel consumption and mileage.

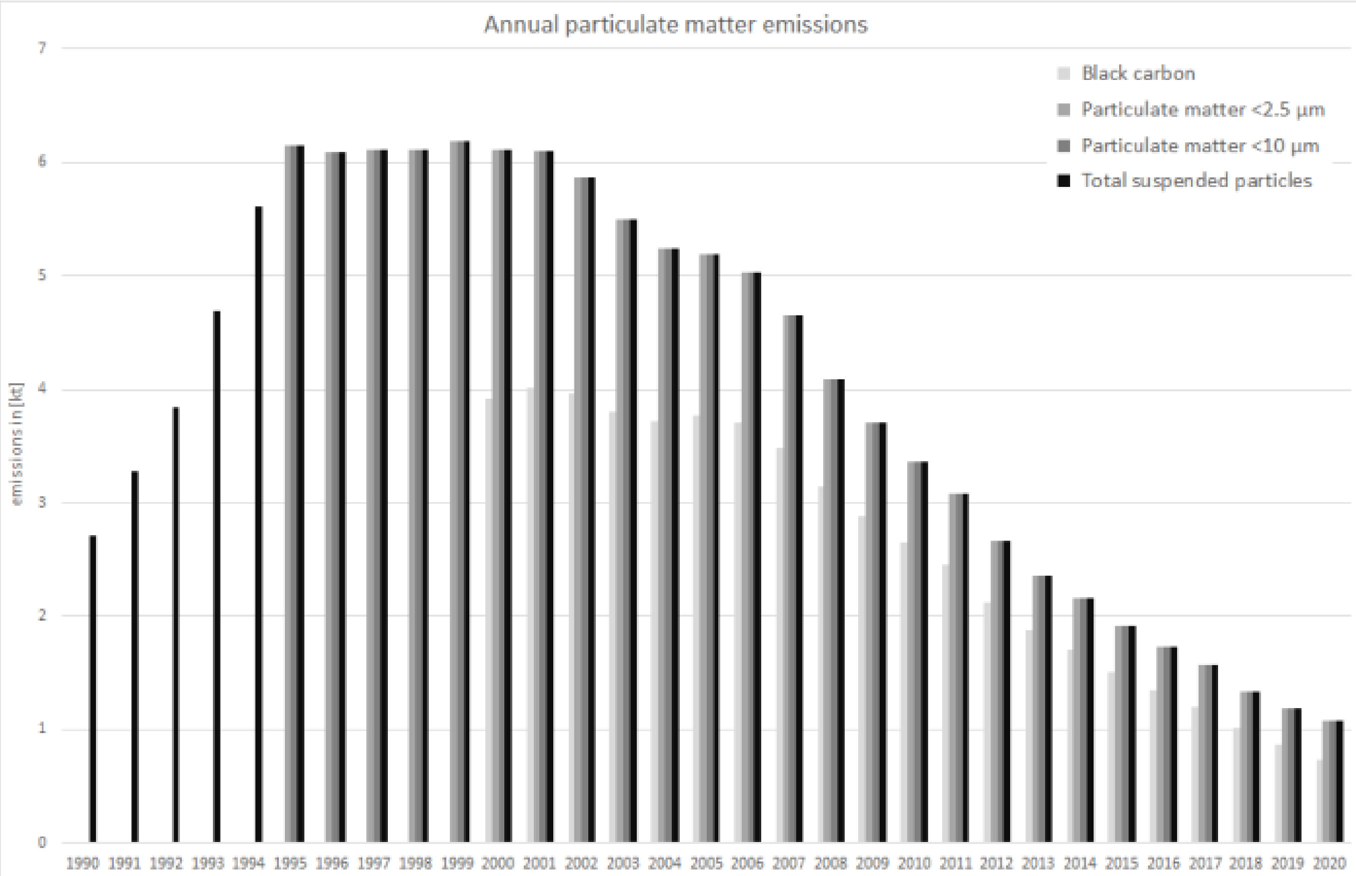


For **ammonia** emissions the increasing use of catalytic converters in gasoline driven cars in the 1990s lead to a steep increase whereas both the technical development of the converters and the ongoing shift from gasoline to diesel cars resulted in decreasing emissions in the following years.



Particulate matter & Black carbon

Starting in the middle of the 1990s, a so-called “diesel boom” began, leading to a switch from gasoline to diesel powered passenger cars. As the newly registered diesel cars had to meet the EURO2 standard (in force since 1996/'97) with a PM limit value less than half the EURO1 value, the growing diesel consumption was overcompensated qickly by the mitigation technologies implemented due to the new EURO norm. During the following years, new EURO norms came into force. With the still ongoing “diesel boom” those norms led to a stabilisation (EURO3, 2000/'01) of emissions and to another strong decrease of PM emissions (EURO4, 2005/'06), respectively. Over-all, the increased consumption of diesel in passenger cars was overastimated by the implemented mitigation technologies.



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.

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																		
current submission	25.715	69.182	97.262	104.706	101.229	101.076	104.483	105.776	105.371	108.404	106.814	112.117	121.083	128.168	136.581	145.105	144.960	144.960
previous submission	25.715	69.182	97.262	104.706	101.229	101.076	104.483	105.776	105.371	108.404	106.812	112.127	121.134	128.288	136.814	145.516	145.785	145.785
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,75	-10,1	-51,4	-120	-233	-411	-825	-825
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	-0,01%	-0,04%	-0,09%	-0,17%	-0,28%	-0,57%	-0,57%
BIODIESEL																		
current submission		108	1.078	6.997	12.205	13.523	10.410	8.545	8.078	7.564	7.538	6.649	7.441	7.011	7.241	7.746	8.426	8.426
previous submission		108	1.078	6.997	12.205	13.523	10.410	8.545	8.078	7.564	7.538	6.650	7.444	7.017	7.253	7.768	8.474	8.474
absolute change		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,12	-0,60	-3,16	-6,59	-12,4	-21,9	-47,9	-47,9

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
relative change		0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	-0,01%	-0,04%	-0,09%	-0,17%	-0,28%	-0,57%	-0,57%
GASOLINE																		
current submission	28.187	17.111	14.466	9.216	8.374	7.723	6.825	6.481	6.090	5.877	5.417	5.348	5.599	5.547	5.670	5.919	6.009	6.009
previous submission	28.187	17.111	14.466	9.216	8.374	7.723	6.825	6.481	6.090	5.877	5.417	5.349	5.602	5.552	5.679	5.936	6.044	6.044
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,09	-0,48	-2,38	-5,21	-9,68	-16,8	-34,2	-34,2
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	-0,01%	-0,04%	-0,09%	-0,17%	-0,28%	-0,57%	-0,57%
BIOGASOLINE																		
current submission				63,3	121	104	130	185	235	241	240	229	243	241	246	250	270	270
previous submission				63,3	121	104	130	185	235	241	240	229	244	241	247	250	272	272
absolute change				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,02	-0,10	-0,23	-0,42	-0,71	-1,54	-1,54
relative change				0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	-0,01%	-0,04%	-0,09%	-0,17%	-0,28%	-0,57%	-0,57%
CNG																		
current submission				340	484	706	927	1.127	1.217	1.266	1.177	953	1.028	1.097	878	888	776	776
previous submission				340	484	706	927	1.127	1.217	1.266	1.177	952	1.022	1.085	868	779	762	762
absolute change				0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,48	6,25	12,0	10,8	109	14,3	14,3
relative change				0,0%	0,0%	0,0%	0,0%	0,0%	0,00%	0,00%	0,0%	0,1%	0,6%	1,10%	1,24%	14,04%	1,87%	1,87%
BIOGAS																		
current submission											168	188	259	185	207	245	209	209
previous submission											168	188	258	183	204	242	205	205
absolute change											0,00	0,10	1,58	2,02	2,53	3,31	3,84	3,84
relative change											0,00%	0,05%	0,61%	1,10%	1,24%	1,37%	1,87%	1,87%

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

For more information on recalculated emission estimates reported for Base Year and 2019, please see the pollutant-specific recalculation tables following chapter 8.1 - Recalculations.

Planned improvements

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

[1], [3] Knörr et al. (2020a): 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, 2020.
[2] 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.
[4], [6], [7], [8] 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.
[5] 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.