1.A.3.b iv - Road Transport: Mopeds & Motorcycles

Short description

In sub-categories *1.A.3.b iv - Road Transport: Mopeds & Motorcycles* emissions from fuel combustion in motorised two-wheelers are reported.

Category Code	Method				AD				EF					
1.A.3.b iv	T1, T3				NS, M				CS, M, D					
Key Category	**SO_2**	**NO_x**	**NH_3**	**NMVOC**	**CO**	**BC**	**Pb**	**Hg**	**Cd**	**Diox**	**PAH**	**HCB**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
1.A.3.b iv	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-	-/-	-/-	-/-

Methodology

Activity data

Specific consumption data for mopeds and motorcycles is generated within the TREMOD model (Knörr, 2020a) [1].

The following table provides an overview of annual amounts of gasoline fuels consumed by motorized two-wheelers in Germany.

Table 1: Annual fuel consumption of mopeds and motorcycles, in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
MOPEDS																		
Gasoline	4.953	3.102	3.133	3.056	3.021	3.169	3.240	3.517	3.298	3.235	3.067	3.152	3.157	3.176	3.191	3.190	3.136	3.195
Biogasoline	0	0	0	21	44	43	62	100	127	133	136	135	137	138	139	134	141	138
Σ Mopeds	**4.953**	**3.102**	**3.133**	**3.077**	**3.065**	**3.212**	**3.302**	**3.617**	**3.426**	**3.368**	**3.203**	**3.287**	**3.294**	**3.313**	**3.330**	**3.324**	**3.278**	**3.333**
MOTORCYCLES																		
Gasoline	16.747	16.206	20.514	19.740	18.888	18.352	17.563	16.613	15.680	15.294	14.426	14.327	14.738	14.516	14.812	15.195	14.565	14.780
Biogasoline	0	0	0	21	44	43	62	100	127	133	136	135	137	138	139	134	141	138
Σ Motorcycles	**16.747**	**16.206**	**20.514**	**19.761**	**18.932**	**18.395**	**17.625**	**16.714**	**15.807**	**15.427**	**14.561**	**14.463**	**14.875**	**14.654**	**14.950**	**15.330**	**14.706**	**14.917**
MOTORIZED 2-WHEELERS: Mopeds & Motorcycles																		
Gasoline	21.700	19.308	23.648	22.796	21.909	21.521	20.803	20.130	18.978	18.530	17.492	17.480	17.894	17.691	18.003	18.385	17.702	17.974
Biogasoline	0	0	0	157	316	291	398	575	733	760	775	749	778	767	782	775	796	775
Σ 1.A.3.b iv	**21.700**	**19.308**	**23.648**	**22.953**	**22.225**	**21.812**	**21.201**	**20.705**	**19.712**	**19.289**	**18.268**	**18.229**	**18.673**	**18.459**	**18.785**	**19.160**	**18.497**	**18.750**

source: TREMOD 6.02 [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 TREMOD [4].

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

[!– the following table provides a set of fuel-specific implied emission factors (ratio of total emissions per pollutant and total annual consumption.

Table 2: Annual country-specific implied emission factors[1], in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH_3	1.21	1.25	1.30	1.33	1.34	1.33	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34		
NMVOC[2]	2,415	1,636	1,456	1,322	1,303	1,315	1,287	1,252	1,200	1,163	1,134	1,086	1,045	1,003	983	954		
NO_x	183	198	186	175	171	179	173	167	163	159	155	151	148	146	143	140		
SO_2	15.11	8.36	3.25	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37		
CO	12,126	12,427	11,872	10,595	10,045	9,817	9,436	9,036	8,693	8,352	8,028	7,695	7,369	7,066	6,766	6,488		
$PM_{2.5}$	NA	63.7	42.7	39.9	38.8	40.0	38.1	36.3	34.2	33.0	32.3	30.7	29.3	27.8	27.0	25.4		
PM_{10}	NA	63.7	42.7	39.9	38.8	40.0	38.1	36.3	34.2	33.0	32.3	30.7	29.3	27.8	27.0	25.4		
TSP[3]	71.0	64.5	42.7	39.9	38.8	40.0	38.1	36.3	34.2	33.0	32.3	30.7	29.3	27.8	27.0	25.4		
BC	NA	NA	4.98	4.75	4.60	4.71	4.54	4.36	4.16	4.05	3.96	3.81	3.67	3.53	3.45	3.30		

[1] due to lack of better information: similar EF are applied for fossil and biofuels
[2] from fuel combustion only!
[3] from 1990 to 1997: also including additional dust from leaded gasoline

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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 3: Overview of applied EMEP/EEA defaults and other tier1 EF

As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	PCDD/F	B[a]P	B[b]F	B[k]F	I[…]P	PAH 1-4
[g/TJ]									[µg/km]	[mg/TJ]				
0.007	0.005	0.145	0.103	0.200	0.053	0.037	0.005	0.758	0.0000027	192.91	215.88	156.17	234.25	799.21

Discussion of emission trends

NFR 1.A.3.b iv is no key category.

Carbon monoxide

Non-methane volatile organic compounds

Since 1990, exhaust emissions of NMVOC have decreased due to technical improvements.

Nitrogen oxides

Sulphur dioxide

As for the entire road transport sector, the trends for **sulphur dioxide** exhaust emissions from two-wheelers shows charcteristics very 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.

Particulate matter & Black carbon

Particle emissions result from the comusbtion of gasoline and bioethanol. Here, due to the assumption that nearly all TSP emitted is formed by particles in the PM,,2.5,, range, similar estimates are provided for all three fractions. (Exception: Until 1997, additional TSP emissions from use of leaded gasoline are included.)

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
GASOLINE																	
Submission 2020	23,131	19,972	24,124	23,030	21,811	21,678	20,902	20,202	19,039	18,591	17,555	17,548	17,996	17,777	18,080	18,456	
Submission 2019	22,049	16,628	19,184	20,151	20,306	17,167	17,492	17,657	17,384	18,033	17,840	18,540	19,289	18,641	18,609	18,809	
absolute change	1,082	3,344	4,940	2,878	1,505	4,511	3,410	2,544	1,655	558	-285	-992	-1,293	-863	-529	-352	
relative change	4,91%	20,1%	25,8%	14,3%	7,41%	26,3%	19,5%	14,4%	9,52%	3,09%	-1,60%	-5,35%	-6,71%	-4,63%	-2,84%	-1,87%	
BIOGASOLINE																	
Submission 2020	0	0	0	158	314	293	400	577	736	762	778	752	783	771	785	778	
Submission 2019	0	0	0	138	293	232	334	504	672	739	791	795	839	808	808	801	
absolute change	0	0	0	20	22	61	65	73	64	23	-13	-43	-56	-37	-23	-23	
relative change	0.00	0.00	0.00	14,3%	7,41%	26,3%	19,5%	14,4%	9,52%	3,09%	-1,60%	-5,35%	-6,71%	-4,63%	-2,84%	-2,82%	
TOTAL FUEL CONSUMPTION																	
Submission 2020	23,131	19,972	24,124	23,188	22,125	21,971	21,302	20,779	19,775	19,354	18,336	18,304	18,783	18,554	18,871	19,242	
Submission 2019	22,049	16,628	19,184	20,290	20,598	17,399	17,827	18,162	18,056	18,773	18,631	19,335	20,128	19,449	19,417	19,609	
absolute change	1,082	3,344	4,940	2,898	1,527	4,572	3,475	2,617	1,719	581	-295	-1,030	-1,345	-895	-545	-368	
relative change	4.91%	20.1%	25.8%	14.3%	7.41%	26.3%	19.5%	14.4%	9.52%	3.09%	-1.58%	-5.33%	-6.68%	-4.60%	-2.81%	-1.88%	

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 2018, 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.

FAQs

[1), 2), 4)] 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.
[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.