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.

Method	AD	EF	Key Category Analysis
T1, T3	NS, M	CS, M, D	**L&** : NO,,x,,, PM,,2.5,,, PM,,10,,, BC

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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel oil	253,892	305,128	324,929	440,663	492,791	518,198	518,957	556,096	589,674	593,962	621,938	641,476	610,293	
Gasoline	1,275,916	1,260,078	1,196,370	958,621	765,478	762,566	718,328	717,580	720,676	684,853	684,954	694,769	668,337	
LPG	138	138	94	2,357	21,823	23,613	23,532	23,077	21,464	18,963	16,799	15,377	13,570	
CNG	0	0	0	1,608	5,361	5,505	5,151	4,389	4,519	4,492	3,603	3,257	3,980	
Biodiesel	0	476	3,600	29,343	37,500	35,842	36,337	32,710	35,928	32,198	32,732	34,022	35,226	
Biogasoline	0	0	0	6,585	29,575	31,257	31,833	30,760	31,340	29,703	29,752	29,291	30,051	
Biogas	0	0	0	0	0	0	736	868	1,139	757	847	1,013	930	
Σ 1.A.3.b i	**1,529,946**	**1,565,820**	**1,524,993**	**1,439,177**	**1,352,529**	**1,376,981**	**1,334,873**	**1,365,479**	**1,404,740**	**1,364,927**	**1,390,625**	**1,419,204**	**1,362,386**	

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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 .

[!– Table 2: selected annual fuel-specific IEF for passenger cars, in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gasoline fuels[1]																		
NH_3	0.66	12.6	23.1	21.3	21.3	20.8	20.0	18.9	17.8	17.1	16.5	15.8	15.3	15.0	15.0	14.9		
NMVOC[2]	731	281	151	106	99.4	94.8	86.5	82.1	78.4	76.0	74.1	72.4	71.3	70.5	70.1	69.5		
NO_x	616	342	217	142	130	119	99.2	87.8	77.6	70.7	64.6	59.3	55.1	51.8	49.1	46.5		
SO_2	11.8	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	4,698	2,340	1,397	1,013	948	911	844	802	763	741	720	700	687	678	677	673		
BC[5]	0.07	0.30	0.44	0.36	0.35	0.34	0.31	0.28	0.25	0.24	0.22	0.20	0.19	0.18	0.18	0.17		
PM[3]	3.67	2.75	2.48	1.87	1.82	1.74	1.60	1.49	1.37	1.31	1.24	1.18	1.14	1.10	1.09	1.07		
TSP[4]	5.58	3.03	2.48	1.87	1.82	1.74	1.60	1.49	1.37	1.31	1.24	1.18	1.14	1.10	1.09	1.07		
Diesel fuels[1]																		
NH_3	0.36	0.37	0.39	0.41	0.40	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42	0.43	0.44	0.44		
NMVOC	45.5	36.8	29.1	18.6	16.5	15.0	13.5	12.5	11.7	11.0	10.4	9.93	9.64	9.62	9.85	10.1		
NO_x	273	274	304	308	302	298	294	293	298	309	320	329	334	332	324	313		
SO_2	80.8	60.5	14.0	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	250	205	152	87.9	78.8	71.5	64.3	59.8	56.3	53.1	50.4	48.3	46.7	45.6	44.6	44.0		
BC[5]	29.6	30.4	28.8	18.3	15.5	13.3	11.2	9.53	8.29	7.19	6.07	5.13	4.35	3.72	3.22	2.80		
PM[3]	48.8	46.1	39.5	23.2	19.6	16.8	14.1	12.1	10.5	9.20	7.86	6.74	5.82	5.09	4.49	4.00		
Liquefied Petroleum Gas - LPG																		
NH_3	0.84	6.92	37.3	32.6	28.6	26.7	23.5	22.1	21.6	21.3	20.9	20.5	20.2	19.9	19.8	19.6		
NMVOC	329	283	49.6	9.73	8.63	8.22	7.50	7.24	7.17	7.10	6.97	6.88	6.82	6.78	6.77	6.75		
NO_x	1,047	906	200	66.1	58.7	56.5	52.6	50.9	49.9	49.3	48.1	46.7	45.6	44.8	44.0	43.2		
SO_2	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41		

CO	2,043	1,812	662	509	452	458	456	456	453	455	452	449	448	447	452	453		
BC[5]	0.24	0.33	0.75	0.56	0.47	0.43	0.36	0.33	0.32	0.31	0.30	0.29	0.29	0.28	0.28	0.28		
PM[3]	0.97	1.31	3.01	2.41	2.05	1.90	1.64	1.53	1.48	1.47	1.43	1.40	1.38	1.37	1.37	1.36		
Compressed Natural Gas (CNG) & Biogas[6]																		
NH_3				10.6	10.6	10.7	10.7	10.7	10.7	10.8	10.8	10.8	11.0	11.1	11.4	11.6		
NMVOC				0.48	0.48	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.50	0.51	0.52	0.52		
NO_x				40.6	40.6	40.6	40.4	40.3	39.6	37.6	35.1	33.3	31.7	30.3	29.3	28.2		
SO_2				0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15		
CO				258	258	262	261	261	259	258	255	252	251	252	255	257		
BC[5]				0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11		
PM[3]				0.67	0.67	0.67	0.67	0.67	0.67	0.68	0.69	0.70	0.71	0.72	0.74	0.75		

[1] due to lack of better information: similar EF are applied for fossil and biofuels
[2] not including NMVOC from gasoline evaporation!
[3] EF($PM_{2.5}$) also applied for PM_{10} and TSP (assumption: > 99% of TSP consists of $PM_{2.5}$)
[4] 1990-1997: including additional TSP from combustion of leaded gasoline
[5] EF(BC) estimated via f(BC)
[6] due to lack of better information: similar EF are applied for CNG and biogas –]

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

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

+ Discussion of emission trends

> **NFR 1.A.3.b ii** is key category for **NO,,x,,**, **PM,,2.5,,**, **PM,,10,,** and **BC**.

++ Nitrogen oxides (NO,,x,,)

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.

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++ Particulate matter (BC, PM,,2.5,,, PM,,10,,, and TSP)

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.

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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**
DIESEL OIL																	
Submission 2021	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 2020	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%	
BIODIESEL																	
Submission 2021	0	0	0	158	314	293	400	577	736	762	778	752	783	771	785	778	
Submission 2020	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%	
GASOLINE																	
Submission 2021	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 2020	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	
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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 2021	0	0	0	158	314	293	400	577	736	762	778	752	783	771	785	778	
Submission 2020	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%	
CNG																	
Submission 2021	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 2020	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%	
BIOGAS																	
Submission 2021	0	0	0	158	314	293	400	577	736	762	778	752	783	771	785	778	
Submission 2020	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%	
LPG																	
Submission 2021	0	0	0	158	314	293	400	577	736	762	778	752	783	771	785	778	
Submission 2020	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 2021	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 2020	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

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bibliography : 1 : Knörr et al. (2019a): 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 1960-2030, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg & Berlin, 2019. : 2 : Keller et al., (2007): 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, 2019. : 3 : 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. : 4 : 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 bibliography

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[1] (bibcite 1)
[2] (bibcite 2)
[3] (bibcite 1)
[4] (bibcite 3)
[5] (bibcite 4)
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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.