1.A.4.a ii - Commercial / Institutional: Mobile

Short description

In *NFR 1.A.4.a ii - Commercial/institutional: Mobile* fuel combustion activities and emissions from non-road diesel and LPG-driven (forklifters) vehicles used in the commercial and institutional sector are taken into account.

Method	AD	EF	Key Category Analysis
T1, T2	NS, M	CS, D, M	*no key category*

Methodology

Activity data

Sector-specific **diesel** consumption data are included in the primary fuel-delivery data available from NEB line 67: 'Commercial, trade, services and other consumers' (AGEB, 2020) [1].

Table 1: Sources for primary fuel-deliveries data

through 1994	NEB line 79: 'Households and small consumers'
as of 1995	NEB line 67: 'Commercial, trade, services and other consumers'

Following the deduction of diesel oil inputs for military vehicles as provided in (BAFA, 2020) [2], the remaining amounts of diesel oil are apportioned onto off-road construction vehicles (NFR 1.A.2.g vii) and off-road vehicles in commercial/institutional use (1.A.4.a ii) as well as agriculture and forestry (1.A.4.c ii) based upon annual shares derived from (Knörr et al. (2020b)) [3] (cf. NFR 1.A.4 - mobile]).

Table 2: Annual contribution of NFR 1.A.4.a ii to the over-all amounts of diesel oil provided in NEB line 67

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
7,01%	6,65%	6,99%	7,18%	6,52%	6,36%	6,21%	5,96%	5,82%	5,73%	5,83%	5,78%	5,68%	5,59%

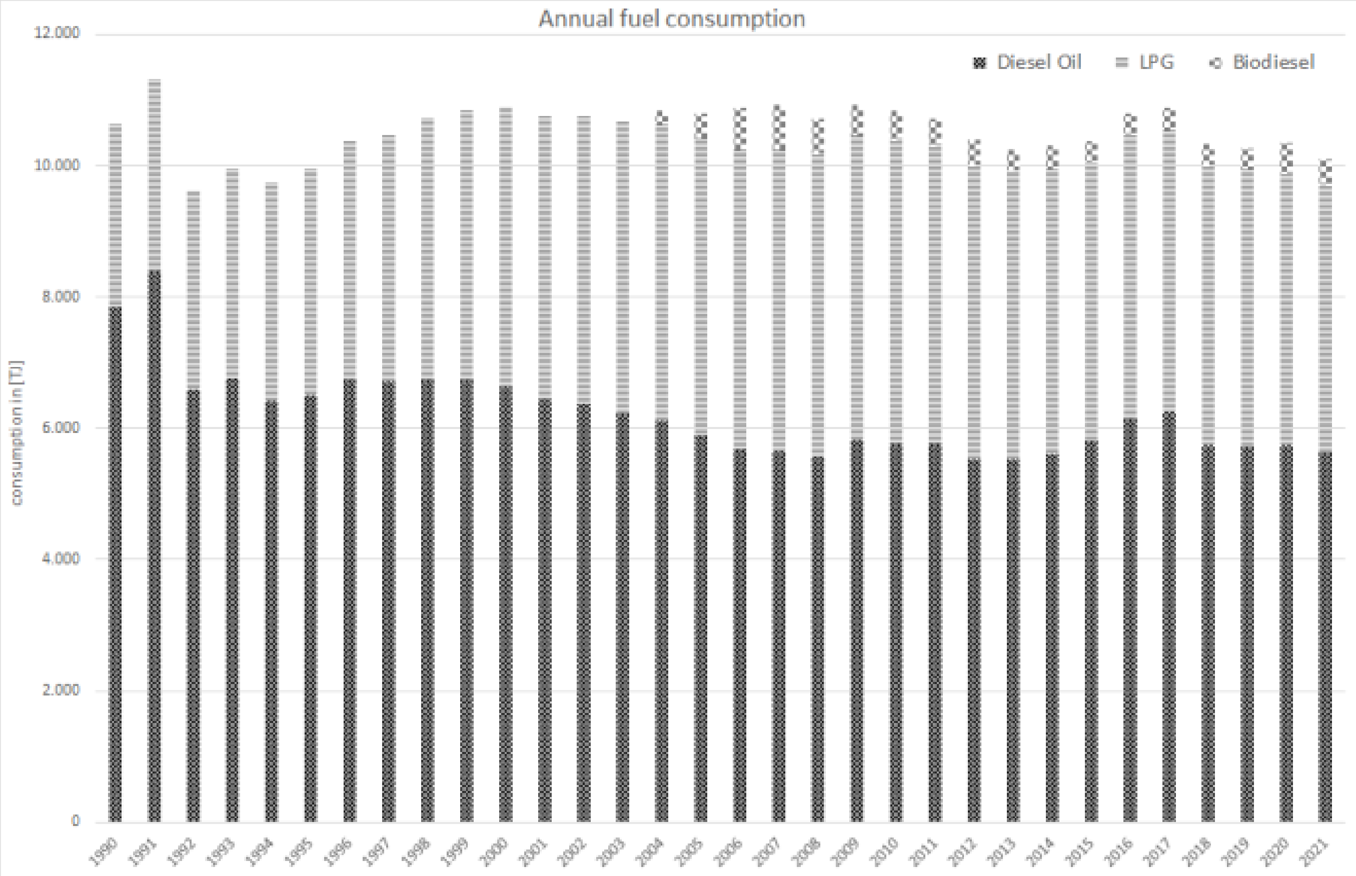
source: (Knörr et al. (2019b)) [4]

As the NEB does not distinguish into specific biofuels, consumption data for biodiesel are calculated by applying Germany's official annual shares of biodiesel blended to fossil diesel oil.

In contrast, for **LPG**-driven forklifters, specific consumption data is modelled in TREMOD-MM. These amounts are then subtracted from the over-all amount available from NEB line 67 to estimate the amount of LPG used in stationary combustion.

Table 3: Annual fuel consumption, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	7.847	6.508	6.646	5.894	5.773	5.770	5.533	5.524	5.629	5.810	6.145	6.257	5.749	5.726
Biodiesel	0.00	0.00	0.00	377	443	403	390	328	346	318	326	334	334	326
LPG	2.787	3.450	4.261	4.533	4.629	4.557	4.484	4.409	4.333	4.256	4.336	4.301	4.264	4.213
Σ 1.A.4.a ii	**10.634**	**9.958**	**10.907**	**10.803**	**10.844**	**10.729**	**10.407**	**10.261**	**10.307**	**10.383**	**10.807**	**10.892**	**10.347**	**10.347**



Emission factors

The emission factors used here are of rather different quality: Basically, for all **main pollutants**, **carbon monoxide** and **particulate matter**, annual IEF modelled within [5)] are used, representing the sector's vehicle-fleet composition, the development of mitigation technologies and the effect of fuel-quality legislation.

As no such specific EF are available for biofuels, the values used for diesel oil are applied to biodiesel, too.

Table 4: Annual country-specific emission factors from TREMOD MM, in kg/TJ

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel fuels[1]														
NH_3	0,15	0,16	0,16	0,16	0,16	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17	0,17
NMVOC	247	223	197	139	93,0	85,7	78,6	71,4	64,6	58,6	53,8	50,0	46,9	44,3
NO_x	1.000	1.026	1.004	833	633	595	560	528	501	477	453	431	410	393
SO_x	79,6	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
BC[3]	107	88,7	74,4	55,3	42,2	40,5	38,7	36,6	34,3	32,1	30,0	28,3	26,8	25,5
PM[2]	194	161	134	93,6	64,4	60,1	56,0	51,6	47,1	43,0	39,5	36,7	34,5	32,7
CO	856	796	725	560	429	407	387	368	351	338	329	322	318	314
LPG														
NH_3	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21
NMVOC	148	147	145	145	145	145	145	145	145	145	145	145	145	145
NO_x	1.346	1.342	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325
SO_x	0,42	0,42	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41
BC[3]	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
PM[2]	0,85	0,85	0,84	0,84	0,84	0,84	0,84	0,84	0,84	0,84	0,84	0,84	0,84	0,84
CO	114	114	112	112	112	112	112	112	112	112	112	112	112	112

[1] due to lack of better information: similar EF are applied for fossil and biofuels
[2] EF($PM_{2.5}$) also applied for PM_{10} and TSP (assumption: > 99% of TSP consists of $PM_{2.5}$)
[3] estimated via a f-BCs as provided in [6)], Chapter 1.A.2.g vii, 1.A.4.a ii, b ii, c ii, 1.A.5.b i - Non-road, note to Table 3-1: Tier 1

emission factors for off-road machinery

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

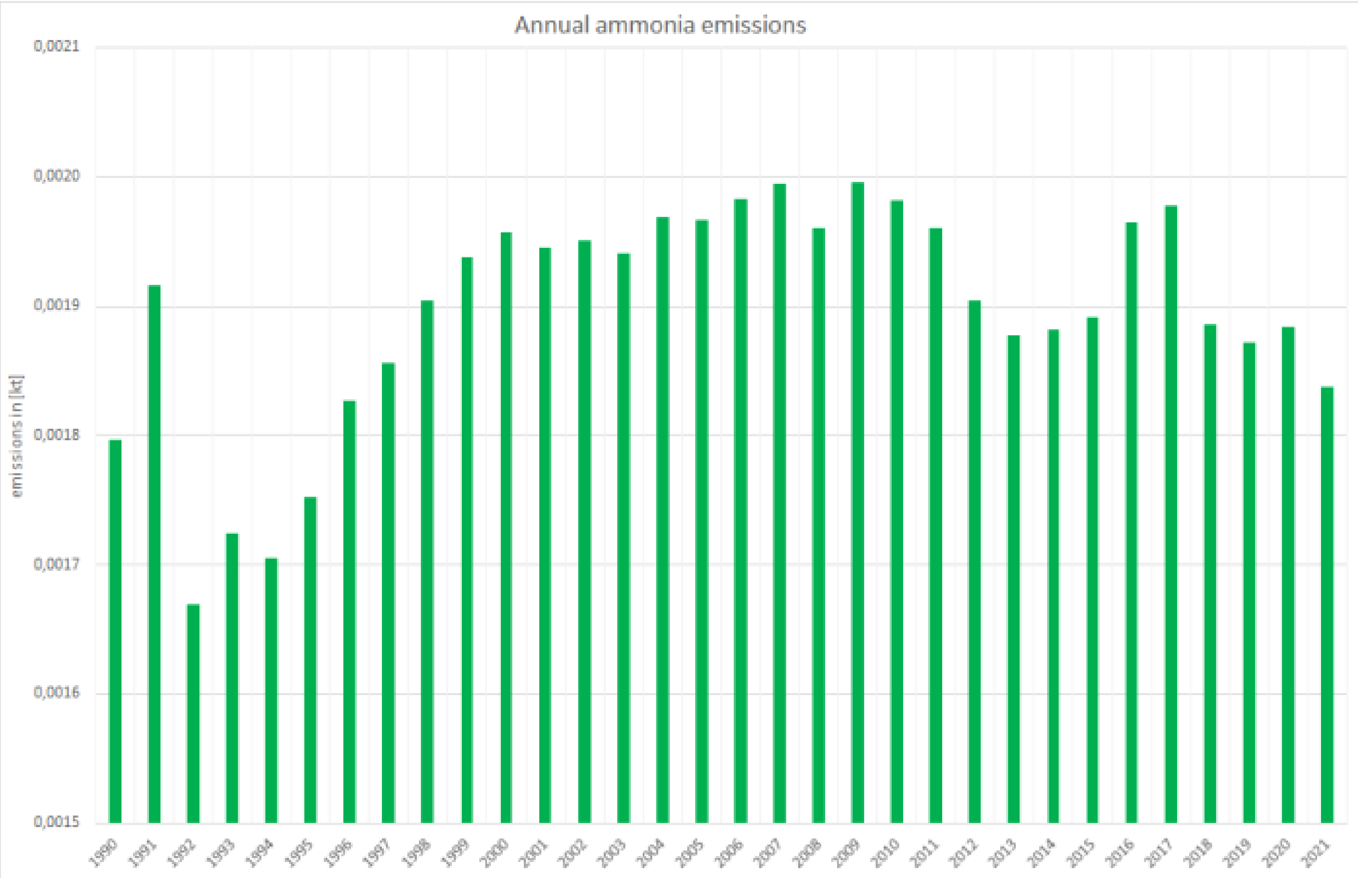
For lead (Pb) from leaded gasoline and corresponding TSP emissions, additional emissions are are calculated from 1990 to 1997 based upon contry-specific emission factors from [7].

For information on the **emission factors for heavy-metal and POP exhaust emissions**, please refer to Appendix 2.3 - Heavy Metal (HM) exhaust emissions from mobile sources] and Appendix 2.4 - Persistent Organic Pollutant (POP) exhaust emissions from mobile sources].

Discussion of emission trends

> **NFR 1.A.4.a ii** is no key source.

Unregulated pollutants

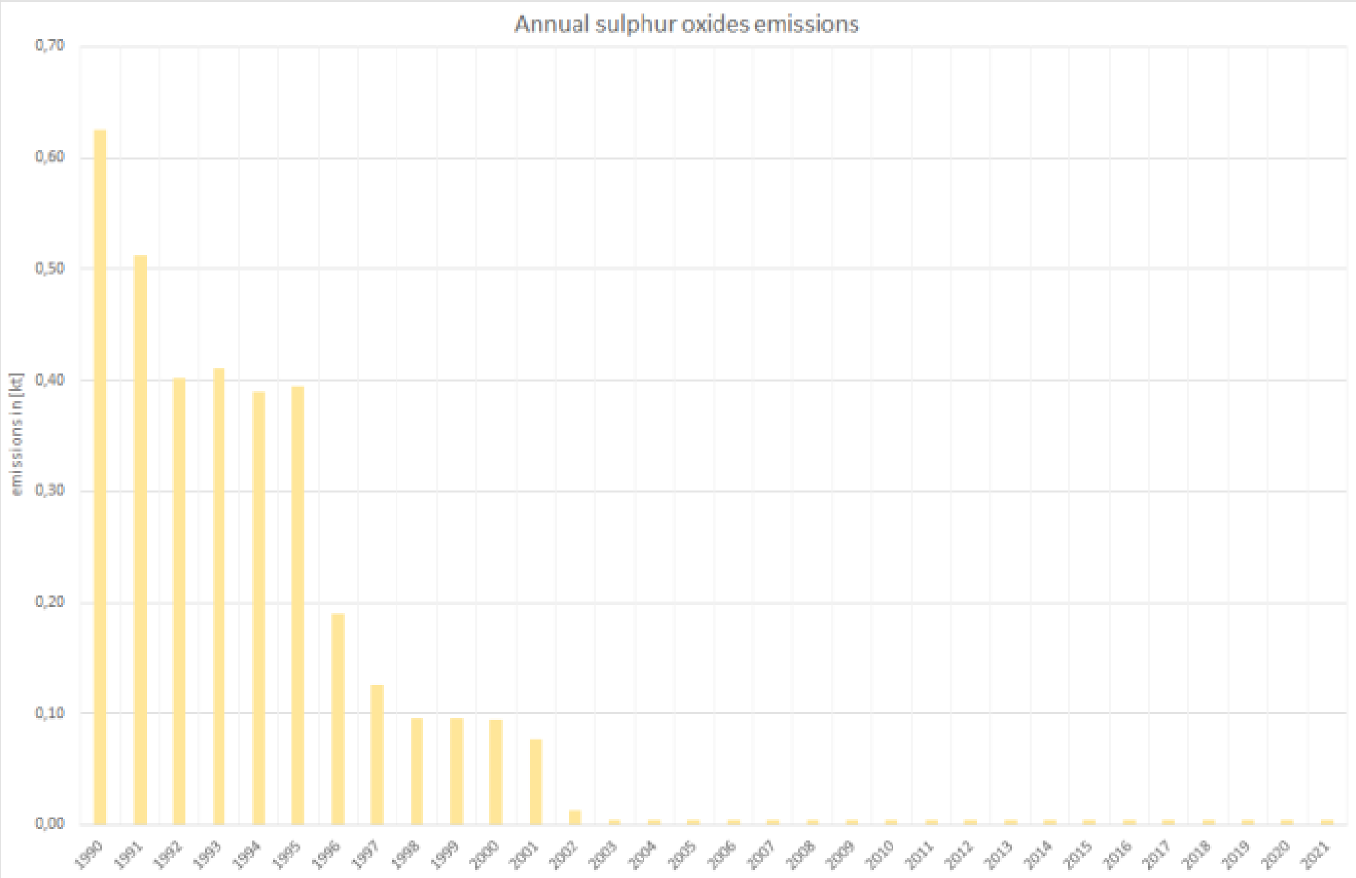


For all unregulated pollutants, emission trends directly follow the trend in fuel consumption.

Regulated pollutants

Nitrogen oxides and Sulphur dioxide

For all regulated pollutants, emission trends follow not only the trend in fuel consumption but also reflect the impact of fuel-quality and exhaust-emission legislation.

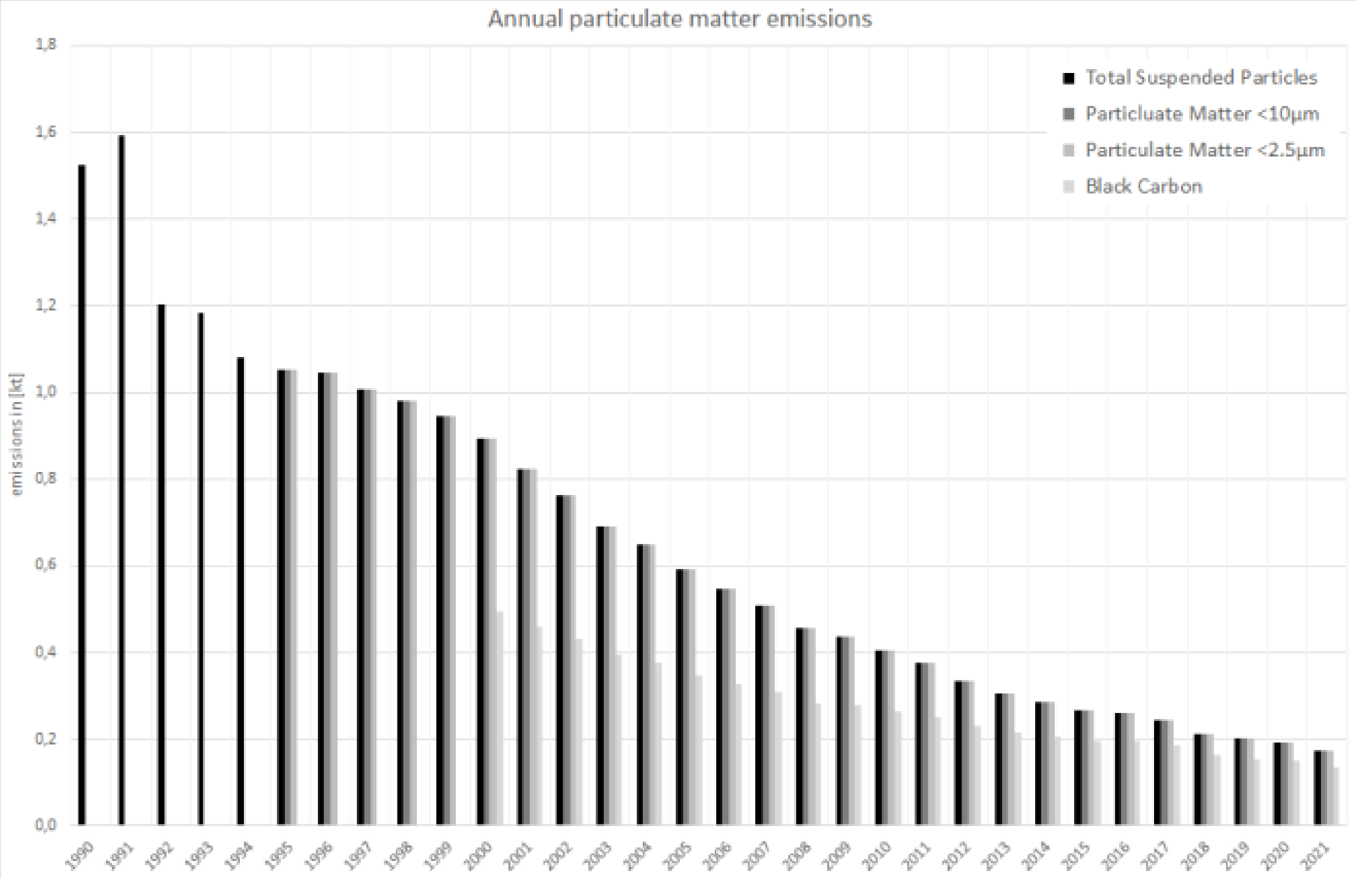


Particulate matter & Black carbon

Over-all PM emissions are by far dominated by emissions from diesel oil combustion with the falling trend basically following the decline in fuel consumption between 2000 and 2005. Nonetheless, the decrease of the over-all emission trend was and still is amplified by the expanding use of particle filters especially to eliminate soot emissions.

Additional contributors such as the impact of TSP emissions from the use of leaded gasoline (until 1997) have no significant effect onto over-all emission estimates.

Here, as the EF(BC) are estimated via fractions provided in the 2019 EMEP Guidebook [8)], black carbon emissions follow the corresponding emissions of $PM_{2.5}$.



Recalculations

Activity data hase been revised according to revised annual NEB line 67 shares and the finalized data from the National Energy Balance 2018.

Table 5: Revised annual contribution of 1.A.4.a ii to over-all diesel oil deliveries provided in NEB line 67

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
Submission 2021	0,070	0,067	0,070	0,072	0,065	0,064	0,062	0,060	0,058	0,057	0,058	0,058	0,057
Submission 2020	0,069	0,066	0,066	0,071	0,070	0,070	0,069	0,068	0,068	0,068	0,068	0,068	0,068
absolute change	0,001	0,001	0,003	0,000	-0,005	-0,006	-0,007	-0,009	-0,010	-0,011	-0,010	-0,010	-0,011
relative change	0,94%	1,48%	5,23%	0,54%	-7,09%	-8,62%	-10,2%	-13,0%	-14,2%	-15,6%	-14,1%	-14,8%	-15,9%

Table 6: Revised activity data, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
Diesel Oil													
Submission 2021	7.847	6.508	6.646	5.894	5.773	5.770	5.533	5.524	5.629	5.810	6.145	6.257	5.749
Submission 2020	7.774	6.413	6.316	5.851	6.213	6.314	6.158	6.348	6.562	6.885	7.153	7.343	6.816
absolute change	73,2	94,7	330	43,2	-440	-544	-625	-824	-933	-1.075	-1.008	-1.085	-1.067
relative change	0,94%	1,48%	5,23%	0,74%	-7,08%	-8,61%	-10,1%	-13,0%	-14,2%	-15,6%	-14,1%	-14,8%	-15,7%
Biodiesel													
Submission 2021	0.00	0.00	0.00	377	443	403	390	328	346	318	326	334	334
Submission 2020	0.00	0.00	0.00	128	403	414	402	368	398	372	376	389	372
absolute change				249	39,6	-11,3	-11,6	-40,0	-52,0	-54,4	-49,9	-55,4	-37,7
relative change				194%	9,83%	-2,72%	-2,88%	-10,9%	-13,1%	-14,6%	-13,3%	-14,2%	-10,1%
LPG													
Submission 2021	2.787	3.450	4.261	4.533	4.629	4.557	4.484	4.409	4.333	4.256	4.336	4.301	4.264
Submission 2020	2.787	3.450	4.261	4.894	5.431	5.441	5.449	5.456	5.462	5.467	5.471	5.474	5.477
absolute change	0,000	0,000	0,006	-361	-802	-884	-966	-1.048	-1.130	-1.211	-1.135	-1.174	-1.214
relative change	0,00%	0,00%	0,00%	-7,39%	-14,8%	-16,2%	-17,7%	-19,2%	-20,7%	-22,2%	-20,7%	-21,4%	-22,2%

over-all fuel consumption													
Submission 2021	10.634	9.958	10.907	10.803	10.844	10.729	10.407	10.261	10.307	10.383	10.807	10.892	10.347
Submission 2020	10.561	9.863	10.577	10.873	12.047	12.169	12.009	12.172	12.422	12.724	13.000	13.206	12.665
absolute change	73,2	94,7	330	-69,6	-1.203	-1.439	-1.602	-1.911	-2.115	-2.341	-2.193	-2.314	-2.319
relative change	0,69%	0,96%	3,12%	-0,64%	-9,98%	-11,8%	-13,3%	-15,7%	-17,0%	-18,4%	-16,9%	-17,5%	-18,3%

For pollutant-specific information on recalculated emission estimates for Base Year and 2018, please see the pollutant specific recalculation tables following chapter 8.1 - Recalculations.

Uncertainties

Uncertainty estimates for **activity data** of mobile sources derive from research project FKZ 360 16 023: "Ermittlung der Unsicherheiten der mit den Modellen TREMOD und TREMOD-MM berechneten Luftschadstoffemissionen des landgebundenen Verkehrs in Deutschland" by (Knörr et al. (2009)) [9].

Uncertainty estimates for **emission factors** were compiled during the PAREST research project. Here, the final report has not yet been published.

Planned improvements

Besides the annual **routine revision** of **TREMOD MM**, no specific improvements are planned.

FAQs

Why are similar EF applied for estimating exhaust heavy metal emissions from both fossil and biofuels?

The EF provided in [10] represent summatory values for (i) the fuel's and (ii) the lubricant's heavy-metal content as well as (iii) engine wear. Here, there might be no heavy metal contained in biofuels. But since the specific shares of (i), (ii) and (iii) cannot be separated, and since the contributions of lubricant and engine wear might be dominant, the same emission factors are applied to biodiesel and bioethanol.

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[1] AGEB, 2020: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen (Hrsg.), AGEB): Energiebilanz für die Bundesrepublik Deutschland; URL: http://www.ag-energiebilanzen.de/7-0-Bilanzen-1990-2018.html, (Aufruf: 29.11.2020), Köln & Berlin, 2020

[2] BAFA, 2020: Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA): Amtliche Mineralöldaten für die Bundesrepublik Deutschland; URL: https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel_amtliche_daten_2018_dezember.html, Eschborn, 2020.

[3], [5], [7] Knörr et al. (2020b): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Aktualisierung des Modells TREMOD-Mobile Machinery (TREMOD MM) 2020, Heidelberg, 2020.

[4] (bibcite 3)

[6], [8], [10] EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook – 2019, Copenhagen, 2019.

[9] Knörr et al. (2009): Knörr, W., Heldstab, J., & Kasser, F.: Ermittlung der Unsicherheiten der mit den Modellen TREMOD und TREMOD-MM berechneten Luftschadstoffemissionen des landgebundenen Verkehrs in Deutschland; final report; URL: https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/3937.pdf, FKZ 360 16 023, Heidelberg & Zürich, 2009.

[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.