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 commercially and institutionally used mobile sources should be reported.

Within the German inventory, non-road diesel and LPG-driven (forklifters) vehicles used in the commercial and institutional sector are taken into account here.

~ 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, 2019) [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, 2019) [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. (2019b)) [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**

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														
Biodiesel														
LPG														
Σ 1.A.4.a ii														

gallery size="medium" : 1A4aii_AD.png : 1A4aii_AD_bio.png gallery

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**	= **2006**	= **2007**	= **2008**	= **2009**	= **2010**	= **2011**	= **2012**	= **2013**	= **2014**	= **2015**	= **2016**	= **2017**	= **2018**		
< **Diesel fuels**	**1**																		
~ NH,,3,,	> 0.15	> 0.16	> 0.16	> 0.16	> 0.16	> 0.16	> 0.16	> 0.16	> 0.16	> 0.17	> 0.17	> 0.17	> 0.17	> 0.17	> 0.17	> 0.17	> 0.17		
~ NMVOC	> 247	> 223	> 197	> 140	> 129	> 119	> 110	> 101	> 93.3	> 85.9	> 78.8	> 71.5	> 64.6	> 58.6	> 53.8	> 50.0	> 46.9		
~ NO,,x,,	> 999	> 1.026	> 1.004	> 835	> 796	> 756	> 716	> 676	> 636	> 597	> 561	> 526	> 493	> 462	> 430	> 399	> 370		
~ 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	> 0.37	> 0.37	> 0.37		
~ PM	**2**		> 194	> 161	> 134	> 93.8	> 86.3	> 79.7	> 74.0	> 69.1	> 64.6	> 60.3	> 56.1	> 51.6	> 47.0	> 42.8	> 39.2	> 36.4	> 34.1
~ BC	**3**		> 107	> 88.7	> 74.4	> 55.4	> 51.8	> 48.8	> 46.3	> 44.2	> 42.3	> 40.6	> 38.7	> 36.6	> 34.2	> 31.9	> 29.8	> 28.0	> 26.5
~ CO	> 856	> 796	> 726	> 561	> 531	> 502	> 476	> 452	> 429	> 408	> 387	> 368	> 351	> 337	> 328	> 321	> 316		
< **Liquefied Petroleum Gas** (used especially in fork-lifters)																			
~ NH,,3,,	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14	> 0.14		
~ NMVOC	> 150	> 150	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148	> 148		
~ 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	> 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	> 0.41	> 0.41	> 0.41		
~ 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	> 0.84	> 0.84	> 0.84
~ 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	> 0.13	> 0.13	> 0.13
~ CO	> 114	> 114	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112	> 112		

source: (Knörr et al. (2018b)) [6)]

1
2
3

> **NOTE:** 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.footnote 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. footnote

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].

[!–

In contrast, without country-specific information, regarding all **heavy metals** and **POPs**, tier1 values are applied. Here, EF for exhaust HMs and PAHs have been derived from the July 2017 version of the EMEP/EEA air pollutant emission inventory guidebook 2016 (EMEP/EEA, 2016) [8] for road vehicles (chapter ??? , page ??? ff). Regarding heavy metals, separate tier1 default EFs are provided there in tables ??? and ??? for emissions from fuel combustion and engine wear as well as lubricant co-incineration. Heavy-metal emissions from lubricants (as far as not used in 2-stroke mix) are reported under NFR 2.G as emissions from product use. *(Note: Until submission 2017, the EMEP/EEA default EFs provided for NRMM were used in the German inventory. As these EFs do not differentiate between fuel combustion and lubricant co-incineration, the inventory compiler decided to apply the more specific EFs from road transport to NRMM in 1.A.2.g vii, 1.A.4.a ii, b ii and c ii and 1.A.5.b, too.)*

Table 5: Tier1 emission factors for heavy-metal and POP exhaust emissions from fuel combustion and engine wear

=	= **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/TJ]				
~ Diesel oil	> 0.012	> 0.001	> 0.123	> 0.002	> 0.198	> 0.133	> 0.005	> 0.002	> 0.419	> 698	> 1.164	> 801	> 184	> 2,847	> 1.62				
~ Biodiesel	**1**		> 0.013	> 0.001	> 0.142	> 0.003	> 0.228	> 0.153	> 0.005	> 0.003	> 0.483	> 806	> 1.343	> 924	> 212	> 3,284		> 1.62	
~ LPG	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	> 4.35	> 0.00	> 4.35	> 4.35	> 13.04	= NE				
1																			

The tier1 value apllied for **PCDD/F** has been derived from a study carried out by (Rentz et al., 2008) [9] for the German Federal Environment Agency. For **HCB** and **PCBs**, no emission factors are available at the moment.

–]

Discussion of emission trends

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

++ Unregulated pollutants (NH,,3,,, HMs, POPs, ...)

gallery size="medium" : 1A4aii_EM_NH3.PNG : 1A4aii_EM_Cd.PNG gallery

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

++ Regulated pollutants

+++ Nitrogen oxides (NO,,x,,), Sulphur dioxide (SO,,2,,)

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.

gallery size="medium" : 1A4aii_EM_NOx.PNG : 1A4aii_EM_SOx.PNG gallery

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

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 [10], black carbon emissions follow the corresponding emissions of PM,,2.5,,.

gallery size="medium" : 1A4aii_EM_PM.PNG gallery

Recalculations

Activity data hase been revised according to revised annual NEB line 67 shares and the finalized data from the National Energy Balance 2019.

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

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
diesel fuels													
Submission 2021	0,430	0,464	0,470	0,437	0,431	0,434	0,437	0,432	0,435	0,431	0,430	0,429	0,426
Submission 2020	0,423	0,454	0,445	0,402	0,394	0,397	0,400	0,401	0,403	0,398	0,397	0,396	0,394
absolute change	0,01	0,01	0,03	0,04	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,03	0,03
relative change	1,64%	2,11%	5,63%	8,87%	9,35%	9,35%	9,34%	7,74%	8,08%	8,31%	8,29%	8,38%	7,96%
gasoline fuels													
Submission 2021	0,315	0,597	0,551	0,586	0,645	0,644	0,669	0,671	0,669	0,667	0,684	0,681	0,642
Submission 2020	0,315	0,597	0,551	0,584	0,640	0,638	0,663	0,665	0,662	0,659	0,676	0,673	0,673
absolute change	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,01	-0,03
relative change	0,00%	0,00%	0,00%	0,33%	0,73%	0,83%	0,86%	0,95%	1,05%	1,15%	1,19%	1,29%	-4,55%

Table 6: Revised activity data, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
diesel fuels													
Submission 2021	48.078	45.337	44.668	38.177	41.085	42.145	41.684	42.460	44.710	46.075	47.682	48.977	45.594
Submission 2020	47.301	44.401	42.286	33.615	37.154	38.387	37.932	39.357	41.335	42.516	44.012	45.175	41.976
absolute change	776	937	2.382	4.562	3.931	3.758	3.752	3.104	3.375	3.559	3.670	3.802	3.618
relative change	1,64%	2,11%	5,63%	13,57%	10,58%	9,79%	9,89%	7,89%	8,16%	8,37%	8,34%	8,42%	8,62%
gasoline fuels													
Submission 2021	1.420	4.453	4.079	4.302	2.907	2.641	826	815	870	3.471	3.554	3.536	3.263
Submission 2020	1.420	4.453	4.079	4.288	2.886	2.619	819	808	861	3.431	3.512	3.491	3.419
absolute change	0,00	0,00	0,00	13,96	20,98	21,66	7,06	7,67	9,04	39,6	41,8	45,1	-155
relative change	0,00%	0,00%	0,00%	0,33%	0,73%	0,83%	0,86%	0,95%	1,05%	1,15%	1,19%	1,29%	-4,55%
over-all fuel consumption													
Submission 2021	49.497	49.791	48.747	42.478	43.992	44.786	42.510	43.275	45.580	49.546	51.236	52.513	48.857
Submission 2020	48.721	48.854	46.364	37.903	40.040	41.006	38.752	40.164	42.197	45.947	47.524	48.666	45.395
absolute change	776	937	2.382	4.576	3.952	3.780	3.759	3.111	3.384	3.599	3.712	3.847	3.462
relative change	1,59%	1,92%	5,14%	12,07%	9,87%	9,22%	9,70%	7,75%	8,02%	7,83%	7,81%	7,91%	7,63%

With all **emission factors** remaining unrevised, emission values have only been recalculated for 2017 as shown in the following table for the main pollutants.

Table 8: Recalculated emission estimates 2017, in kilotonnes

=	= **NH,,3,,**	= **NMVOC**	= **NO,,x,,**	= **PM**	= **BC**	= **CO**
~ Submission 2020	> 0.00203	> 1.195	> 10.3	> 0.286	> 0.217	> 3.099
~ Submission 2019	> 0.00202	> 1.193	> 10.3	> 0.284	> 0.216	> 3.084
~ absolute change	> 0.00001	> 0.002	> 0.02	> 0.002	> 0.001	> 0.014
~ relative change	> 0.37%	> 0.19%	> 0.17%	> 0.58%	> 0.58%	> 0.47%

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)) [11].

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 [12] 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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