1.A.3.b - Transport: Road Transport

Short description

In category *1.A.3.b - Road Transport* emissions from fuel combustion activities as well as abrasive and fugitive emissions are reported within the following categories:

NFR-Code	Name of Category
Emissions from Fuel Combustion in Road Vehicles	
1.A.3.b i	Passenger Cars
1.A.3.b ii	Light Duty Vehicles
1.A.3.b iii	Heavy Duty Vehicles
1.A.3.b iv	Mopeds & Motorcycles
Fugitive Emissions from Road Vehicles	
1.A.3.b v	Gasoline Evaporation
Emissions from Tyre and Brake Wear & Road Abrasion	
1.A.3.b vi	Automobile Tyre and Brake Wear
1.A.3.b vii	Automobile Road Abrasion

Abbreviations used below as well as in the following chapters on road transport for the different types of vehicles: * **PCs** - Passenger Cars * **LDVs** - Light Duty Vehicles * **HDVs** - Heavy Duty Vehicles (if not reported separatly: including buses) * **MCs** - Motorcycles (if not reported separatly: including mopeds)

Emissions from motorised road traffic in Germany are reported under this category. It includes traffic on public roads within Germany, except for agricultural and forestry transports and military transports. Calculations are made for the vehicle categories of passenger cars, motorcycles, light duty vehicles, heavy duty vehicles and buses. For calculation purposes, the vehicle categories are broken down into so-called vehicle layers with the same emissions behaviour. To this end, vehicle categories are also broken down by type of fuel used, vehicle size (trucks and buses by weight class; automobiles and motorcycles by engine displacement) and pollution control equipment used, as defined by EU directives for emissions control ("EURO norms"), and by regional traffic distribution (outside of cities, in cities and autobahn).

Since 1990, emissions of NO,,x,,, CO, NMVOC and SO,,2,, from road transports have decreased sharply, due to catalytic-converter use and engine improvements resulting from continual tightening of emissions laws, and due to improved fuel quality.

For buses and heavy duty vehicles (over 3.5 t total permissible vehicle weight), maximum permissible levels of hydrocarbon (HC, incl. NMVOC) emissions were lowered especially sharply (-40%) via the introduction of the EURO3 standard in 2000. Since EURO3 vehicles were very quick to reach the market as of 2000, the emission factor for hydrocarbon emissions from diesel fuel - and the relevant emissions themselves – decreased considerably after 2000.

Methodology

Emissions are calculated with the aid of the TREMOD model ("Transport Emission Estimation Model" v6.02) from (Knörr, W. et al. (2019a)) [1)]. 4

This model adopts a "bottom-up" (tier3) approach whereby mileage of the individual vehicle layers is multiplied by region-specific emission factors. For passenger cars and light duty vehicles, a "cold start surplus" is also added. The total consumption calculated on the basis of fuel type is compared with the consumption according to the Energy Balance. The emissions are then corrected with the aid of factors obtained from this comparison process. For petrol-powered vehicles, the evaporation emissions of VOC are calculated in keeping with the pollution-control technology used. From the emissions and fuel consumption for the various vehicle layers, aggregated, fuelbased emission factors (kg of emissions per TJ of fuel consumption) are derived, and then the emission factors are forwarded to the CSE via a relevant interface. In keeping with the CORINAIR report structure, these factors are differentiated only by type of fuel, type of road (autobahn, rural road, city road) and, within the vehicle categories, by "without/with emissions-control equipment". The following emissions-control categories are differentiated:

For calculation with TREMOD, extensive basic data from generally accessible statistics and special surveys were used, coordinated, and supplemented. An overview of the principal sources and key assumptions is given below. Detailed descriptions of the databases, including information on the sources used, and the calculation methods used in TREMOD, are provided in the aforementioned IFEU report.

Activity Data

The basis for CSE data collection for the road-transport sector consists of fuel consumption data provided by the Working Group on Energy Balances (AGEB). For each year, the sum of the activity rates for the various individual structural elements must correspond to the Energy Balance data, in terajoule. The relevant basic Energy Balance data is shown in the table below.

Table 1: Fuel consumption in German road transport, in terajoule

	= **Diesel oil**	= **Gasoline**	= **Biodiesel**	= **Biogasoline**	= **Biogas**	= **Liquefied Petroleum Gas**	= **Compressed Natural Gas**	= **Liquefied Natural Gas**	= **Petroleum**	= **lubricant in 2-Stroke mix**
~ 1990	> 735,920	> 1,330,479	> 0	> 0	> 0	> 138	> 0	> 0	> 0	> 2,660
~ 1991	> 785,174	> 1,332,285	> 0	> 0	> 0	> 137	> 0	> 0	> 0	> 1,779
~ 1992	> 853,502	> 1,344,129	> 0	> 0	> 0	> 229	> 0	> 0	> 0	> 1,355
~ 1993	> 907,787	> 1,350,617	> 0	> 0	> 0	> 184	> 0	> 0	> 473	> 908
~ 1994	> 932,060	> 1,276,637	> 0	> 0	> 0	> 184	> 0	> 0	> 559	> 611
~ 1995	> 964,013	> 1,299,982	> 1,504	> 0	> 0	> 138	> 0	> 0	> 610	> 463
~ 1996	> 964,580	> 1,299,879	> 2,046	> 0	> 0	> 115	> 0	> 0	> 638	> 376
~ 1997	> 979,586	> 1,297,487	> 3,652	> 0	> 0	> 106	> 0	> 0	> 357	> 266
~ 1998	> 1,022,794	> 1,300,463	> 4,081	> 0	> 0	> 106	> 0	> 0	> 637	> 204
~ 1999	> 1,097,036	> 1,300,602	> 5,370	> 0	> 0	> 100	> 0	> 0	> 637	> 110
~ 2000	> 1,108,105	> 1,237,055	> 12,276	> 0	> 0	> 94	> 0	> 0	> 414	> 77
~ 2001	> 1,097,416	> 1,199,318	> 16,740	> 0	> 0	> 98	> 0	> 0	> 471	> 70
~ 2002	> 1,105,842	> 1,166,381	> 20,460	> 0	> 0	> 607	> 0	> 0	> 472	> 73
~ 2003	> 1,078,352	> 1,108,989	> 29,948	> 0	> 0	> 694	> 0	> 0	> 0	> 69
~ 2004	> 1,110,931	> 1,072,720	> 38,806	> 1,144	> 0	> 1,887	> 0	> 0	> 0	> 71
~ 2005	> 1,078,620	> 992,377	> 71,824	> 6,817	> 0	> 2,357	> 3,127	> 0	> 0	> 75
~ 2006	> 1,082,042	> 930,834	> 130,165	> 13,418	> 0	> 4,605	> 4,446	> 0	> 0	> 74
~ 2007	> 1,073,987	> 892,982	> 143,235	> 12,061	> 0	> 8,942	> 5,845	> 0	> 0	> 77
~ 2008	> 1,102,623	> 854,002	> 109,393	> 16,328	> 0	> 15,652	> 7,144	> 0	> 0	> 78
~ 2009	> 1,114,939	> 829,227	> 89,375	> 23,691	> 0	> 23,842	> 8,443	> 0	> 0	> 85
~ 2010	> 1,168,063	> 791,416	> 88,886	> 30,577	> 0	> 21,823	> 8,768	> 0	> 0	> 80

~ 2011	> 1,197,252	> 787,803	> 82,810	> 32,292	> 0	> 23,613	> 8,771	> 0	> 0	> 79
~ 2012	> 1,223,718	> 742,000	> 85,683	> 32,882	> 1,267	> 23,532	> 8,869	> 37	> 0	> 75
~ 2013	> 1,283,637	> 741,150	> 75,504	> 31,770	> 1,462	> 23,077	> 7,389	> 42	> 0	> 77
~ 2014	> 1,296,828	> 744,661	> 79,014	> 32,383	> 1,883	> 21,464	> 7,472	> 47	> 0	> 78
~ 2015	> 1,348,789	> 708,672	> 73,116	> 30,736	> 1,249	> 18,963	> 7,407	> 50	> 0	> 78
~ 2016	> 1,393,481	> 709,179	> 73,337	> 30,804	> 1,375	> 16,799	> 5,848	> 58	> 0	> 78
~ 2017	> 1,425,424	> 719,580	> 75,599	> 30,337	> 1,616	> 15,377	> 5,198	> 93	> 0	> 78
~ 2018	> 1,377,158	> 692,694	> 79,488	> 31,146	> 1,443	> 13,570	> 6,172	> 165	>	> 75

Source: Evaluation tables of the Energy Balances, “Mineralölzahlen” (“Petroleum Data”) of the Association of the German Petroleum Industry (MWV) and “Amtliche Mineralöldaten” (“Official Petroleum Data”, BAFA); lubricant in 2-Stroke mix: TREMOD

> For more information on the derivation of activity data and the emission factors applied, please refer to the sub-ordinate chapters as well as appendix 2.2].

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+ Emission trends in road transport

Whereas emission trends for **nitrogen oxides** (NO,,x,,), **NMVOC**, and **carbon monoxide** (CO) depend on the coming into force of the diferent EURO regulations, ongoing technical developments (engines, catalysts etc.) the trend chart for **sulphur dioxide** (SO,,2,,) shows a totally different charcteristics: Here, the strong dependence on increasing fuel qualities (sulphur content) leads to an cascaded downward trend, influenced only slightly by increases in fuel consumption and mileage. - The **ammonia** emissions chart varies significantly. Here, the increasing use of catalytic converters in gasoline driven cars in the 1990s lead to a steep increase of ammonia emissions whereas both the technical development of the converters and the ongoing shift from gasoline to diesel cars result in decreasing emissions in the following years.

gallery size="medium" : 1A3b_EM_NH3.png : 1A3b_EM_NMVOC.png : 1A3b_EM_NOx.png : 1A3b_EM_SO2.png : 1A3b_EM_CO.png gallery

Emissions of **particulate matter** in road transport result from (i) fuel combustion and (ii) tyre and brake wear and road abrasion. With implemetation of particle filter systems and the ongoing increase of annual mileage, today

gallery size="medium" : 1A3b_EM_PM.png : 1A3b_EM_BC.png : 1A3b_EM_PM2.5.png : 1A3b_EM_PM10.png : 1A3b_EM_TSP.png gallery

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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)) [2].

Uncertainty estimates for **emission factors** for all 1.A.3.b sub-categories were compiled during the PAREST research project. Here, the final report has not yet been published.

Recalculations

Due to the revision of the underlying TREMOD model adapting the new version of the Handbook Emission Factors for Road

Transport (HBEFA) now available in version 4.1, all country-specific emission factors have been revised fundamentally for the entire time series as of 1990. For more details please refer to chapter 1.A.3.b i-iv - Emissions from Fuel Combustion in Road Vehicles] of this report.

In addition, for emissions from tyre and brake wear and road abrasion, the emission factors applied for heavy metals and POPs have been adapted to the 2019 version of the EMEP/EEA Guidebook. For more details please refer to chapter 1.A.3.b vi-vii - Road Transport: Automobile Tyre and Brake Wear and Road Abrasion] of this report.

Planned improvements

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

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bibliography : 1: Knörr et al. (2019a): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: Fortschreibung des Daten- und Rechenmodells: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2035, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg [u.a.]: Ifeu Institut für Energie- und Umweltforschung Heidelberg GmbH, Heidelberg & Berlin, 2019. : 2 : 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. bibliography

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[1] (bibcite 1)
[2] (bibcite 2)