

gallery size="medium" : 1A3dii_AD.png gallery

Table 2: Specific fuel consumption data for domestic maritime and inland navigation, in terajoule

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NATIONAL MARITIME NAVIGATION														
Diesel Oil	15940	11258	11860	9962	8685	8489	9046	9047	9965	13359	16295	15221	16336	13961
Heavy fuel oil	11723	8041	8577	7172	6114	5961	6410	6376	6046	50,0	7,05	7,01	190	358
NATIONAL INLAND NAVIGATION														
Diesel Oil	20,664	18,597	6,788	8,634	7,497	8,466	7,556	7,777	8,567	9,422	7,873	7,179	6,636	
Σ 1.A.3.d ii	48,326	37,896	27,224	26,036	22,988	23,673	23,719	23,846	25,282	23,528	24,635	22,927	23,298	

The emission factors applied for **national maritime navigation** are derived from different sources and therefore are of very different quality.

For the main pollutants, country-specific implied values are used, that are based on tier3 EF included in the BSH model ³⁾ which mainly relate on values from the EMEP/EEA guidebook 2019 ⁴⁾. These modelled IEFs take into account the ship specific information derived from AIS data as well as the mix of fuel-qualities applied depending on the type of ship and the current state of activity.

Here, for **sulphur dioxide** and **particulate matter**, annual values are available representing the impact of fuel sulphur legislation. In addition, regarding SO_x, the increasing operation of so-called scrubbers in order to fulfil emission limits especially within SECA areas is reflected for heavy fuel oil.

Table 3: Country-specific emission factors applied for fuels used in domestic maritime navigation, in [kg/TJ]

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DIESEL OIL														
NH₃														
NMVOC														
NO_x														
SO_x														
BC¹														
PM_{2.5}														
PM₁₀														
TSP²														
HEAVY FUEL OIL														
CO														
NH₃														
NMVOC														
NO_x														
SO_x														
BC¹														
PM_{2.5}														
PM₁₀														
TSP²														
CO														

¹ estimated from f-BCs as provided in ⁵⁾: f-BC (HFO) = 0.12, f-BC (MDO/MGO) = 0.31 as provided in ⁶⁾, chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii Navigation, Tables 3-1 & 3-2

² ratios PM_{2.5}, : PM₁₀, : TSP derived from the tier1 default EF as provided in ⁷⁾, chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii Navigation, Tables 3-1 & 3-2





For the country-specific emission factors applied for particulate matter, no clear indication is available, whether or not condensables are included.

For main pollutants and particulate matter from **national inland navigation**, modelled emission factors are available from TREMOD (Knörr et al. (2019a)) ⁸⁾. Here, for $SO_{2,,}$ and PM , annual values reflect the impact of fuel-sulphur legislation.

Table 4: Country-specific emission factors for diesel fuels used in domestic inland navigation, in [kg/TJ]

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NH₃														
NMVOC														
NO_x														
SO_x														
BC¹														
PM²														
CO														

¹ calculated from f-BC as provided in ⁹⁾, Chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii, Table 3-2: f-BC (MDO/MGO) = 0.31

² EF(PM_{2.5,,}) also applied for PM_{10,,} and TSP (assumption: > 99% of TSP from diesel oil combustion consists of PM_{2.5,,})



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 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.3.d ii is key category for emissions of **NO_{x,,}**, **PM_{2.5,,}**, and **PM_{10,,}**.

For **ammonia**, **NMVOC**, and **nitrogen oxides** as well as **carbon monoxide**, emission trends more or less represent the trend in over-all fuel consumption.

Nonetheless, for these pollutants, annual emission factors from BSH ¹⁰⁾ and TREMOD ¹¹⁾ have been applied for national *maritime* and *inland* navigation, respectively, reflecting the technical development of the German inland navigation fleet.

[gallery size="medium"](#) : EM_1A3dii_NH3.png : EM_1A3dii_NMVOC.png : EM_1A3dii_NOx.png : EM_1A3dii_CO.png [gallery](#)

Here, the trends in **sulphur dioxide** and **particulate matter** emissions reflect the impact of ongoing fuel-sulphur legislation especially in maritime navigation.

[gallery size="medium"](#) : EM_1A3dii_SO2.png : EM_1A3dii_PM.png [gallery](#)

Recalculations

Major changes in **activity data** result from the revision of the National Energy Balance 2017 and revised shares of biodiesel mixed to diesel oil in 2016 and 2017.

Table 5: Revised fuel consumption data for national maritime navigation, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
diesel oil													
Submission 2021	2.695	1.332	2.051	2.519	2.781	2.902	2.646	2.711	2.886	3.092	3.016	3.185	3.590
Submission 2020	2.666	1.311	1.946	2.221	2.519	2.645	2.408	2.510	2.662	2.846	2.778	2.931	2.758
absolute change	28,9	21,2	105	298	262	257	239	201	223	245	239	254	831
relative change	1,08%	1,62%	5,38%	13,4%	10,4%	9,70%	9,91%	8,00%	8,38%	8,62%	8,59%	8,67%	30,1 %
Biodiesel													
Submission 2021	2.695	1.332	2.051	2.519	2.781	2.902	2.646	2.711	2.886	3.092	3.016	3.185	3.590
Submission 2020	2.666	1.311	1.946	2.221	2.519	2.645	2.408	2.510	2.662	2.846	2.778	2.931	2.758
absolute change	28,9	21,2	105	298	262	257	239	201	223	245	239	254	831
relative change	1,08%	1,62%	5,38%	13,4%	10,4%	9,70%	9,91%	8,00%	8,38%	8,62%	8,59%	8,67%	30,1%
Heavy Fuel Oil													
Submission 2021	3.093	3.004	3.325	3.043	1.603	1.462	409	400	430	1.732	1.644	1.655	1.819
Submission 2020	3.093	3.004	3.325	3.057	1.624	1.484	416	407	439	1.772	1.685	1.700	1.663
absolute change	0,00	0,00	0,00	-14,0	-21,0	-21,7	-7,1	-7,7	-9,0	-39,6	-41,8	-45,1	155
relative change	0,00%	0,00%	0,00%	-0,46%	-1,29%	-1,46%	-1,70%	-1,88%	-2,06%	-2,23%	-2,48%	-2,66%	9,34%
over-all fuel consumption													
Submission 2021	5.788	4.336	5.375	5.562	4.383	4.364	3.055	3.110	3.316	4.824	4.660	4.840	5.409
Submission 2020	5.759	4.315	5.271	5.278	4.143	4.129	2.824	2.917	3.102	4.618	4.463	4.631	4.422
absolute change	28,9	21,2	105	284	241	235	231	193	214	206	197	209	987
relative change	0,50%	0,49%	1,99%	5,38%	5,81%	5,69%	8,20%	6,62%	6,90%	4,46%	4,41%	4,51%	22,3%

Furthermore, the country-specific **emission factors** applied for diesel fuels used in **domestic inland navigation** have been revised within TREMOD ¹²⁾:

Table 6: Revised country-specific emission factors for diesel fuels used in domestic inland navigation, in [kg/T]

[illegible]

relative change																	
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In contrast, the country-specific **emission factors** applied for fuels used in **national maritime navigation** remain unaltered.



For more 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) ¹³⁾.

Planned improvements

Besides the **routine revisions of the models** used for maritime and inland navigation, no specific improvements are scheduled.

bibliography : 1 : AGEb, 2019: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen (Hrsg.), AGEb): Energiebilanz für die Bundesrepublik Deutschland; URL: <http://www.ag-energiebilanzen.de/7-0-Bilanzen-1990-2017.html>, Köln & Berlin, 2019. : 2 : BAFA (2019): Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA): Amtliche Mineralöl-daten für die Bundesrepublik Deutschland; URL: https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel_amtliche_daten_2018_dezember.xlsx?__blob=publicationFile&v=4, (Aufruf: 29.11.2019), Eschborn, 2019. : 3 : MWV, 2019: German Petroleum Industry Association (Mineralölwirtschaftsverband, MWV): MWV Jahresberichte; URL: <https://www.mwv.de/publikationen/jahresberichte/>, Berlin, 2019. : 4 : Deichnik (2019): Deichnik, K.: Aktualisierung und Revision des Modells zur Berechnung der spezifischen Verbräuche und Emissionen des von Deutschland ausgehenden Seeverkehrs. from Bundesamts für Seeschifffahrt und Hydrographie (BSH); Hamburg, 2019. : 5 : 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 1960-2035, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg & Berlin, 2019. : 6 : EMEP/EEA (2019): EMEP/EEA air pollutant emission inventory guidebook 2019, Copenhagen, 2019. : 7 : 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**

¹⁾ (bibcite 1)

²⁾ (bibcite 4)

³⁾ (bibcite 4)

⁴⁾ (bibcite 2)

⁵⁾ (bibcite 2)

⁶⁾ (bibcite 2)

⁷⁾ (bibcite 2)

⁸⁾ (bibcite 5)

⁹⁾ (bibcite 3)

¹⁰⁾ (bibcite 4)

¹¹⁾ (bibcite 5)

¹²⁾ (bibcite 5)

¹³⁾ (bibcite 7)

1)

During test-bench measurements, temperatures are likely to be significantly higher than under real-world conditions, thus reducing condensation. On the contrary, smaller dilution (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.