1.A.3.d ii - National Navigation

Short description

Under category *1.A.3.d ii - National Navigation* emissions from national navigation (both inland and maritime) are reported.

Method	AD	EF	Key Category
T1, T2, T3	NS, M	CS, D, M	**L&T**: PM,,10,, & PM,,2.5,, / **L**: NO,,x,,

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

As described for the over-all sector 1.A.3.d and all other navigational activities here], specific fuel consumption data for NFR 1.A.3.d ii is included in the primary fuel deliveries data provided in NEB lines 6 ('International Maritime Bunkers') and 64 ('Coastal and Inland Navigation') [1).

Here, the annual fuel consumption for domestic *maritime* navigation are modelled within [2] based on AIS data and deduced from NEB lines 6 and 64 respectively, depending on whether or not a certain ship is registered by the International Maritime Organization (IMO). Here, fuels consumed by large, IMO-registered and sea-going ships and vessels are included in NEB line 6 whereas fuels consumed by smaller ships without IMO-registration are included in NEB line 64. After these deductions, the amounts of fuels remaining in NEB 64 are allocated to domestic *inland* navigation.

Table 1: Annual over-all fuel consumption for domestic navigation, in terajoule

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	36,604	29,855	18,648	18,596	16,895	17,232	16,517	16,615	16,183	16,954	16,601	16,824	18,532	22,781	24,167	22,400	22,492	
Heavy fuel oil	11,723	8,041	8,577	7,172	7,004	7,425	7,797	6,733	6,114	5,961	6,410	6,376	6,046	50,0	7,05	7,01	283	
Σ 1.A.3.d ii	**48,326**	**37,896**	**27,224**	**26,036**	**24,209**	**25,131**	**24,790**	**24,077**	**22,988**	**23,673**	**23,719**	**23,846**	**25,282**	**23,528**	**24,635**	**22,927**	**23,298**	

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NATIONAL MARITIME NAVIGATION																		
Diesel Oil	15,940	11,258	11,860	9,962	9,845	10,395	10,834	9,486	8,685	8,489	9,046	9,047	9,965	13,359	16,295	15,221	15,856	
Biodiesel	0	0	0	79	104	169	195	238	205	202	215	192	210	167	146	134	135	
Heavy fuel oil	11,723	8,041	8,577	7,172	7,004	7,425	7,797	6,733	6,114	5,961	6,410	6,376	6,046	50	7,05	7,01	283	
NATIONAL INLAND NAVIGATION																		
Diesel Oil	20,664	18,597	6,788	8,634	7,050	6,836	5,683	7,129	7,497	8,466	7,556	7,777	8,567	9,422	7,873	7,179	6,636	
Biodiesel	0	0	0	189	205	305	281	491	486	555	493	454	495	530	315	385	388	
Σ 1.A.3.d ii	**48,326**	**37,896**	**27,224**	**26,036**	**24,209**	**25,131**	**24,790**	**24,077**	**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 fullfil 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														
NH_3														
NMVOC														
NO_x														
SO_x														
BC[1]														

$PM_{2.5}$														
PM_{10}														
TSP[2]														
HEAVY FUEL OIL														
CO														
NH_3														
NMVOC														
NO_x														
SO_x														
BC[1]														
$PM_{2.5}$														
PM_{10}														
TSP[2]														
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,, : PM,,10,, : 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.

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

	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
NH_3														
NMVOC														
NO_x														
SO_x														
BC[1]														
PM[2]														
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 2016 & 2017, in terajoules

=		= **Diesel oil**		= **Biodiesel**		= **Heavy fuel oil**		= **Over-all fuel consumption**
=	= **2016**	= **2017**	= **2016**	= **2017**	= **2016**	= **2017**	= **2016**	= **2017**
~ Submission 2020	> 24,167	> 22,400	> 461	> 520	> 7,05	> 7,01	> 24,635	> 22,927
~ Submission 2019	> 24,167	> 23,245	> 524	> 539	> 7,05	> 7,01	> 24,698	> 23,790
~ absolute change	> 0.00	> -844	> -62.5	> -19.3	> 0.00	> 0.00	> -62.5	> -864

~ relative change	> 0.00%	> -3.63%	> -11.9%	> -3.57%	> 0.00%	> 0.00%	> -0.25%	> -3.63%

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/TJ]

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
NON-METHANE VOLATILE ORGANIC COMPUNDS - NMVOC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
NITROGEN OXIDES																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
SULPHUR OXIDES																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
BLACK CARBON - BC																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
PARTICULATE MATTER - PM																	
Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	
CARBON MONOXIDE - CO																	

Submission 2021																	
Submission 2020																	
absolute change																	
relative change																	

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.

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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 Mineralöldaten 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:
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[1] (bibcite 1)
[2] (bibcite 4)
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[4] (bibcite 2)
[5] (bibcite 2)
[6] (bibcite 2)
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[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 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.