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 Analysis
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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	36,604	29,855	18,648	18,596	16,183	16,954	16,601	16,824	18,532	22,781	24,167	22,400	23,847	21,556
Heavy fuel oil	11,723	8,041	8,577	7,172	6,114	5,961	6,410	6,376	6,046	50,0	7,05	7,01	190	358
Σ 1.A.3.d ii	**48,326**	**37,896**	**27,224**	**25,768**	**22,297**	**22,916**	**23,011**	**23,200**	**24,578**	**22,831**	**24,174**	**22,407**	**24,037**	**21,914**

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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	7.511	7.595
Σ 1.A.3.d ii	**48.326**	**37.896**	**27.224**	**25.768**	**22.297**	**22.916**	**23.011**	**23.200**	**24.578**	**22.831**	**24.174**	**22.407**	**24.037**	**21.914**

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	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,33	0,32	0,32	0,32	0,32
NMVOC	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,4	48,0	44,8	44,7	45,0	45,2	45,2
NO_x	1.070	1.070	1.070	1.070	1.069	1.069	1.069	1.073	1.077	1.151	1.132	1.157	1.128	1.128

SO_x	465,5	419,0	232,8	186,2	69,8	65,18	54,53	52,56	50,48	40,74	40,61	40,74	40,76	40,76
BC[1]	109,2	98,6	54,7	43,8	16,4	15,4	15,3	15,2	15,2	16,3	16,9	16,9	16,5	16,5
$PM_{2.5}$	352,4	318,0	176,5	141,2	53,0	49,6	49,5	49,1	49,1	52,7	54,5	54,5	53,1	53,1
PM_{10}	377,1	340,3	188,9	151,0	56,7	53,0	53,0	52,5	52,6	56,4	58,3	58,3	56,9	56,9
TSP[2]	377,1	340,3	188,9	151,0	56,7	53,0	53,0	52,5	52,6	56,4	58,3	58,3	56,9	56,9
CO	127	128	128	128	128	128	128	127	128	134	139	138	136	136
HEAVY FUEL OIL														
NH_3	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,35	0,33	0,33	0,34	0,35	0,35
NMVOC	36,6	36,6	36,6	36,6	36,6	36,6	36,6	37,6	37,8	30,0	36,8	30,4	28,3	28,3
NO_x	1.379	1.378	1.378	1.378	1.378	1.377	1.379	1.382	1.393	1.348	1.245	1.360	1.503	1.503
SO_x	1.319	1.332	1.323	1.336	496	496	496	496	506	47,5	49,3	46,4	49,8	49,8
BC[1]	57,4	58,0	57,6	58,2	21,6	21,6	21,6	22,1	22,4	18,1	24,7	18,3	14,7	14,7
$PM_{2.5}$	479	483	480	485	180	180	180	184	187	151	205	153	123	123
PM_{10}	526	532	528	533	198	198	198	203	206	166	226	168	135	135
TSP[2]	526	532	528	533	198	198	198	203	206	166	226	168	135	135
CO	162	162	162	162	162	162	162	162	167	165	198	167	134	134

[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.

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**
NH_3	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23
NMVOC	96,4	87,9	77,7	73,4	69,3	68,2	66,9	65,9	64,6	63,4	62,2	61,0	59,8	59,8
NO_x	1.327	1.331	1.336	1.294	1.245	1.236	1.224	1.213	1.198	1.184	1.170	1.155	1.141	1.141
SO_x	86,4	60,5	60,5	60,5	60,5	0,37	0,37	0,37	0,38	0,37	0,38	0,38	0,38	0,38
BC[1]	17,5	16,0	14,1	12,2	10,07	9,86	9,61	9,44	9,23	9,04	8,87	8,69	8,53	8,53
PM[2]	56,5	51,7	45,6	39,3	32,5	31,8	31,0	30,5	29,8	29,2	28,6	28,0	27,5	27,5
CO	417	387	337	307	277	272	266	261	256	251	246	241	236	236

[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.

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Recalculations

Major changes in **activity data** result from the revision of the National Energy Balance 2018. Furthermore, as no biodiesel is blended to marine diesel oil for technical reasons, no more biodiesel is reported for nautical activities. This correction results in additional recalculations for all years as of 2004.

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	15940	11258	11860	9962	8685	8489	9046	9047	9965	13359	16295	15221	16336
Submission 2020	15940	11258	11860	9962	8685	8489	9046	9047	9965	13359	16295	15221	15856

absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	480
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	3,03%
Biodiesel													
Submission 2021	0	0	0	0	0	0	0	0	0	0	0	0	0
Submission 2020	0	0	0	79,2	205	202	215	192	210	167	146	134	135
absolute change	0,00	0,00	0,00	-79,2	-205	-202	-215	-192	-210	-167	-146	-134	-135
relative change				-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Heavy Fuel Oil													
Submission 2021	11723	8041	8577	7172	6114	5961	6410	6376	6046	50,0	7,05	7,01	190
Submission 2020	11723	8041	8577	7172	6114	5961	6410	6376	6046	50,0	7,05	7,01	283
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-92,4
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	-32,7%
over-all fuel consumption													
Submission 2021	27662	19299	20436	17134	14799	14450	15455	15423	16011	13409	16302	15228	16527
Submission 2020	27662	19299	20436	17214	15004	14652	15670	15615	16220	13576	16448	15363	16274
absolute change	0,00	0,00	0,00	-79,2	-205	-202	-215	-192	-210	-167	-146	-134	253
relative change	0,00%	0,00%	0,00%	-0,46%	-1,37%	-1,38%	-1,37%	-1,23%	-1,29%	-1,23%	-0,89%	-0,87%	1,55%

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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[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.