

1.A.4.c ii (a) - Off-road Vehicles and other Machinery: Agriculture

Short description

Under sub-category *1.A.4.c ii (a)* fuel combustion activities and resulting emissions from agricultural off-road vehicles and mobile machinery are reported.

NFR-Code	Source category	Method	AD	EF	Key Category Analysis
1.A.4.c ii (a)	Off-road Vehicles and Other Machinery: Agriculture	T1, T2	NS, M	CS, D, M	see superordinate chapter



Methodology

Activity data

Subsector-specific consumption data is included in the primary fuel-delivery data are available from NEB line 67: 'Commercial, trade, services and other consumers' (AGEB, 2022) ¹⁾.

Table 1: Sources for primary fuel-delivery data

through 1994	AGEB - National Energy Balance, line 79: 'Haushalte und Kleinverbraucher insgesamt'
as of 1995	AGEB - National Energy Balance, line 67: 'Gewerbe, Handel, Dienstleistungen u. übrige Verbraucher'

Following the deduction of energy inputs for military vehicles as provided in (BAFA, 2022) ²⁾, the remaining amounts of gasoline and 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. ii) as well as agriculture and forestry (NFR 1.A.4.c ii) based upon annual shares derived from TREMOD-MM (Knörr et al. (2022b) ³⁾ (cf. NFR 1.A.4 - mobile).

Table 2: Annual contribution of agricultural vehicles and mobile machinery to the primary diesel¹ fuels delivery data provided in NEB line 67

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
47.6%	45.6%	43.9%	46.2%	47.5%	47.2%	47.3%	48.0%	47.8%	48.3%	48.5%	48.5%	48.4%	48.4%	48.3%	

¹ no gasoline used in agricultural vehicles and mobile machinery

Table 3: Annual mobile fuel consumption in agriculture, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Diesel Oil	53,263	44,622	41,696	37,942	42,024	42,864	42,137	44,531	46,259	48,905	51,027	52,561	49,006	49,679	50,450	
Biodiesel	0	0	0	2,424	3,222	2,991	2,974	2,641	2,843	2,675	2,705	2,806	2,849	2,830	4,191	

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Σ 1.A.4.c ii (i)	53,263	44,622	41,696	40,366	45,246	45,855	45,111	47,172	49,102	51,580	53,732	55,367	51,855	52,509	54,641	

Emission factors

The emission factors applied here are of rather different quality: For all **main pollutants, carbon monoxide** and **particulate matter**, annual IEF modelled within TREMOD MM are used, representing the sector's vehicle-fleet composition, the development of mitigation technologies and the effect of fuel-quality legislation.

Table 3: Annual country-specific emission factors¹, in kg/TJ

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NH₃	0,15	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	
NMVO	258	232	205	165	124	118	112	106	99,7	93,8	88,6	83,8	79,1	74,8	70,6	
NO_x	874	886	916	832	682	655	629	605	581	560	541	523	506	489	471	
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	
PM²	125	109	93,1	74,7	57,4	54,8	52,4	50,1	47,4	44,8	42,2	39,8	37,5	35,4	33,2	
BC³	229	201	171	134	97,1	91,5	86,2	81,5	76,3	71,4	66,9	62,7	58,6	54,9	51,3	
CO	882	834	779	674	555	536	518	502	484	468	453	441	428	416	403	

¹ due to lack of better information: similar EF are applied for fossil and biofuels

² EF(PM_{2,5}) also applied for PM₁₀ and TSP (assumption: > 99% of TSP consists of PM_{2,5})

³ estimated via a f-BCs as provided in ⁴⁾, Chapter 1.A.2.g vii, 1.A.4.a ii, b ii, c ii, 1.A.5.b i - Non-road, note to Table 3-1: Tier 1 emission factors for off-road machinery

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. 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.

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.

Recalculations

With **emissions factors** unrevised, recalculated emission estimates result solely from the implementation of the now finalized NEB 2020.

Table 4: Revised diesel-oil consumption 2019, in [TJ]

	2019
current submission	52,509
previous submission	52,415
absolute change	94.2
relative change	0.18%



For **pollutant-specific information on recalculated emission estimates reported for Base Year and 2020**, please see the recalculation tables following chapter [8.1 - Recalculations](#).

Planned improvements

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

¹⁾ AGEB, 2022: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen (Hrsg.), AGEB): Energiebilanz für die Bundesrepublik Deutschland;

<https://ag-energiebilanzen.de/daten-und-fakten/bilanzen-1990-bis-2020/?wpv-jahresbereich-bilanz=2011-2020>, (Aufruf: 23.11.2021), Köln & Berlin, 2022

²⁾ BAFA, 2022: Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA): Amtliche Mineralöl Daten für die Bundesrepublik Deutschland;

https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel_amtliche_daten_2021_12.xlsx;jsessionid=80E1FD32B36918F682608C03FDE79257.1_cid381?__blob=publicationFile&v=5, Eschborn, 2022.

³⁾ Knörr et al. (2022b): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Aktualisierung des Modells TREMOD-Mobile Machinery (TREMOD MM) 2022, Heidelberg, 2022.

⁴⁾ EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook – 2019, Copenhagen, 2019.