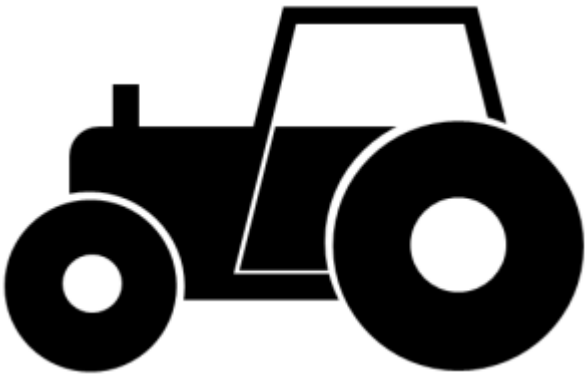
1.A.4.c ii (a) - Off-road Vehicles and other Machinery: Agriculture

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 diesel[1] fuels delivery data provided in NEB line 67

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
47.5%	45.6%	43.8%	46.2%	47.4%	47.2%	47.2%	48.0%	47.8%	48.2%	48.4%	48.5%	48.4%	48.4%	48.2%	48.6%

[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	53,188	44,553	41,633	37,893	41,973	42,813	42,087	44,479	46,205	48,848	50,968	52,500	48,950	49,622	50,901	51,619
Biodiesel	0	0	0	2,421	3,218	2,987	2,970	2,638	2,839	2,672	2,702	2,803	2,846	2,826	4,228	3,586

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Σ 1.A.4.c ii (i)	**53,188**	**44,553**	**41,633**	**40,315**	**45,191**	**45,800**	**45,057**	**47,117**	**49,045**	**51,520**	**53,670**	**55,302**	**51,795**	**52,448**	**55,129**	**55,205**

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 factors[1], in kg/TJ

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NH_3	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	0.16
NMVOC	258	231	205	165	124	118	112	106	99.7	93.8	88.6	83.8	79.1	74.8	70.6	66.4
NO_x	873	886	916	832	682	655	629	605	581	560	541	522	505	489	471	451
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	0.37
PM^2	125	109	93.1	74.7	57.4	54.8	52.4	50.1	47.5	44.8	42.3	39.8	37.5	35.4	33.2	30.9
BC^3	229	201	171	134	97.1	91.5	86.3	81.5	76.4	71.5	66.9	62.7	58.6	54.9	51.3	47.6
CO	882	834	779	674	555	536	518	500	479	459	441	424	407	391	375	359

[1] due to lack of better information: similar EF are applied for fossil and biofuels
[2] EF($PM_{2.5}$) also applied for PM_{10} 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 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.
>
> 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

Revisions in **activity data** result from slightly revised annual shares adapted EBZ 67 shares as well as the implementation of primary activity data from the now finalised NEB 2020.

Table 6: Revised annual shares of NEB line 67, in %

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
current submission	0,475	0,456	0,438	0,462	0,474	0,472	0,472	0,480	0,478	0,482	0,484	0,485	0,484	0,484	0,482
previous submission	0,476	0,456	0,439	0,462	0,475	0,472	0,473	0,480	0,478	0,483	0,485	0,485	0,484	0,484	0,483
absolute change	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001	-0,001
relative change	-0,14%	-0,15%	-0,15%	-0,13%	-0,12%	-0,12%	-0,12%	-0,12%	-0,12%	-0,12%	-0,12%	-0,12%	-0,1%	-0,12%	-0,1%

Table 5: Revised activity data, in terajoules

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
current submission	53,188	44,553	41,633	40,315	45,191	45,800	45,057	47,117	49,045	51,520	53,670	55,302	51,795	52,448	55,129

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
previous submission	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
absolute change	-75.7	-68.7	-63.4	-51.4	-54.6	-54.8	-53.6	-54.7	-56.7	-59.9	-62.4	-64.3	-59.9	-60.6	488
relative change	-0.14%	-0.15%	-0.15%	-0.1%	-0.1%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	-0.12%	0.89%

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 Mineralöldaten 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.