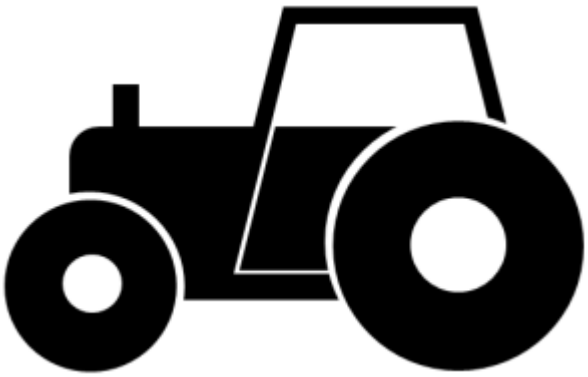
1.A.4.c ii (a) - Off-road Vehicles and other Machinery: Agriculture

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, 2019) [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, 2019) [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. (2019b)) (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
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%

[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
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	49.009	49.591
Biodiesel	0	0	0	2.424	3.222	2.991	2.974	2.641	2.843	2.675	2.705	2.806	2.849	2.824

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**	**51.858**	**52.415**

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 [3)] 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
NH_3														
NMVOC														
NO_x														
SO_x														
BC[3]														
PM[2]														
CO														

[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.footnote 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. footnote
>
> 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

++ Unregulated pollutants (NH,,3,,, HMs, POPs)

For all unregulated pollutants, emission trends directly follow the trend in fuel consumption.

gallery size="medium" : EM_1A2gvii_NH3.PNG : EM_1A2gvii_Cd.PNG gallery

++ Regulated pollutants (NO,,x,,, SO,,2,,)

For all regulated pollutants, emission trends follow not only the trend in fuel consumption but also reflect the impact of fuel-quality and exhaust-emission legislation.

gallery size="medium" : EM_1A2gvii_NOx.PNG : EM_1A2gvii_SOx.PNG gallery

++ Particulate matter (PM,,2.5,,, PM,,10,,, and TSP)

Over-all PM emissions are by far dominated by emissions from diesel oil combustion with the falling trend basically following the decline in fuel consumption between 2000 and 2005. Nonetheless, the decrease of the over-all emission trend was and still is amplified by the expanding use of particle filters especially to eliminate soot emissions.

Additional contributors such as the impact of TSP emissions from the use of leaded gasoline (until 1997) have no significant effect onto over-all emission estimates.

gallery size="medium" : EM_1A2gvii_PM.PNG : EM_1A2gvii_TSP(Pb).PNG gallery

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+ Recalculations

Revisions in **activity data** result from slightly adapted NCVs and biofuel shares (2015-2017) as well as the implementation of primary activity data from the now finalised NEB 2017.

Table 5: Revised annual mobile fuel consumption in agriculture, 2015-2017, in terajoules

=	= **2015**	= **2016**	= **2017**
~ Submission 2020	> 54,190	> 56,531	> 58,245
~ Submission 2019	> 54,188	> 56,529	> 57,905
~ absolute change	> 2	> 2	> 340
~ relative change	> 0.003%	> 0.004%	> 0.583%

As, in contrast, all **emission factors** remain unrevised compared to last year's susbmission, emission estimates for the years as of 2015 change in accordance with the underlying activity data.

> For **information on the impacts on emission estimates for Base Year and 2017**, please see the pollutant specific recalculation tables following chapter 8.1 - Recalculations].

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bibliography : 1 : AGEB, 2019: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen (Hrsg.), AGEB): Energiebilanz für die Bundesrepublik Deutschland; URL: https://ag-energiebilanzen.de/7-0-Bilanzen-1990-2017.html, (Aufruf: 29.11.2019), 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_2017_dezember.html, Eschborn, 2019. : 3 : Knörr et al. (2018b): Knörr, W., Heidt, C., Gores, S., & Bergk, F. (2019b): ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Aktualisierung des Modells TREMOD-Mobile Machinery (TREMOD MM) 2018, Heidelberg, 2019. : 4 : EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook – 2019, Copenhagen, 2019. : 5 : Rentz et al., 2008: Nationaler Durchführungsplan unter dem Stockholmer Abkommen zu persistenten organischen Schadstoffen (POPs), im Auftrag des Umweltbundesamtes, FKZ 205 67 444, UBA Texte | 01/2008, January 2008 - URL: http://www.umweltbundesamt.de/en/publikationen/nationaler-durchfuehrungsplan-unter-stockholmer bibliography

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[1)] (bibcite 1)
[2)] (bibcite 2)
[3)] (bibcite 3)
[4)] (bibcite 3)