

# 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 | <a href="#">see superordinate chapter</a> |



## 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, 2021) <sup>1</sup>.

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, 2021) <sup>2</sup>, 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. (2021b) <sup>3</sup>) (cf. NFR 1.A.4 - mobile).

Table 2: Annual contribution of agricultural vehicles and mobile machinery to the primary diesel<sup>1</sup> fuels delivery data provided in NEB line 67

| 1990  | 1995  | 2000  | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 47.6% | 45.6% | 43.9% | 46.2% | 45.1% | 45.9% | 46.4% | 47.2% | 47.5% | 47.2% | 47.3% | 48.0% | 47.8% | 48.3% | 48.5% | 48.5% | 48.4% | 48.4% | 48.3% |

<sup>1</sup> no gasoline used in agricultural vehicles and mobile machinery

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

|            | 1990   | 1995   | 2000   | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   | 2020   |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Diesel Oil | 53,263 | 44,622 | 41,696 | 37,942 | 37,462 | 38,245 | 39,332 | 42,296 | 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  | 4,141  | 4,707  | 3,737  | 3,379  | 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          | 2006          | 2007          | 2008          | 2009          | 2010          | 2011          | 2012          | 2013          | 2014          | 2015          | 2016          | 2017          | 2018          | 2019          | 2020          |
|-------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| <b>Σ 1.A.4.c ii (i)</b> | <b>53,263</b> | <b>44,622</b> | <b>41,696</b> | <b>40,366</b> | <b>41,602</b> | <b>42,952</b> | <b>43,069</b> | <b>45,675</b> | <b>45,246</b> | <b>45,855</b> | <b>45,111</b> | <b>47,172</b> | <b>49,102</b> | <b>51,580</b> | <b>53,732</b> | <b>55,367</b> | <b>51,855</b> | <b>52,509</b> | <b>54,641</b> |

## 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<sup>1</sup>, in kg/TJ

|                       | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| <b>NH<sub>3</sub></b> | 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 | 0,16 | 0,16 | 0,16 |
| <b>NM VOC</b>         | 258  | 232  | 205  | 165  | 157  | 150  | 144  | 131  | 124  | 118  | 112  | 106  | 99,7 | 93,8 | 88,6 | 83,8 | 79,1 | 74,8 | 70,6 |
| <b>NO<sub>x</sub></b> | 874  | 886  | 916  | 832  | 808  | 784  | 760  | 713  | 682  | 655  | 629  | 605  | 581  | 560  | 541  | 523  | 506  | 489  | 471  |
| <b>SO<sub>x</sub></b> | 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 | 0,37 | 0,37 | 0,37 |
| <b>PM<sup>2</sup></b> | 125  | 109  | 93,1 | 74,7 | 71,0 | 67,8 | 65,2 | 60,1 | 57,4 | 54,8 | 52,4 | 50,1 | 47,4 | 44,8 | 42,2 | 39,8 | 37,5 | 35,4 | 33,2 |
| <b>BC<sup>3</sup></b> | 229  | 201  | 171  | 134  | 126  | 119  | 114  | 103  | 97,1 | 91,5 | 86,2 | 81,5 | 76,3 | 71,4 | 66,9 | 62,7 | 58,6 | 54,9 | 51,3 |
| <b>CO</b>             | 882  | 834  | 779  | 674  | 653  | 633  | 616  | 575  | 555  | 536  | 518  | 502  | 484  | 468  | 453  | 441  | 428  | 416  | 403  |

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

<sup>2</sup> EF(PM<sub>2,5</sub>) also applied for PM<sub>10</sub> and TSP (assumption: > 99% of TSP consists of PM<sub>2,5</sub>)

<sup>3</sup> estimated via a f-BCs as provided in <sup>4)</sup>, 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 2019.

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

|                            | <b>2019</b> |
|----------------------------|-------------|
| <b>current submission</b>  | 52,509      |
| <b>previous submission</b> | 52,415      |
| <b>absolute change</b>     | 94.2        |
| <b>relative change</b>     | 0.18%       |



For more information on recalculated emission estimates reported for Base Year and 2019, please see the pollutant-specific recalculation tables following chapter [8.1 - Recalculations](#).

## Planned improvements

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

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<sup>1)</sup> AGEb, 2021: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen (Hrsg.), AGEb): Energiebilanz für die Bundesrepublik Deutschland; URL: <http://www.ag-energiebilanzen.de/7-0-Bilanzen-1990-2019.html>, (Aufruf: 23.11.2021), Köln & Berlin, 2021.

<sup>2)</sup> BAFA, 2021: Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA): Amtliche Mineralöl-daten für die Bundesrepublik Deutschland; URL: [https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel\\_amtliche\\_daten\\_2018\\_dezember.html](https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel_amtliche_daten_2018_dezember.html), Eschborn, 2021.

<sup>3)</sup> Knörr et al. (2021b): 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) 2021, Heidelberg, 2021.

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