

# 1.A.4.c ii (b) - Off-road Vehicles and other Machinery: Forestry

## Short description

Under sub-category *1.A.4.c ii (b)* fuel combustion activities and resulting emissions from off-road vehicles and mobile machinery used in forestry 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

Primary activity data (PAD) are taken from National Energy Balances (NEBs) line 67: 'Commercial, trade, services and other consumers' (AGEB, 2018) <sup>1)</sup>.

Following the deduction of energy inputs for military vehicles as provided in (BAFA, 2018) <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. (2019b)) <sup>3)</sup> (cf. [NFR 1.A.4 - mobile](#) ).

Table 1: Annual contribution of forestry vehicles and mobile machinery to the primary fuel delivery data provided in NEB line 67

| 1990                  | 1995  | 2000  | 2005  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Diesel fuels</b>   |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 2,41%                 | 1,36% | 2,16% | 2,88% | 2,92% | 2,99% | 2,77% | 2,76% | 2,81% | 2,89% | 2,72% | 2,79% | 3,35% | 3,54% |
| <b>Gasoline fuels</b> |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 68,5%                 | 40,3% | 44,9% | 41,4% | 35,5% | 35,6% | 33,1% | 32,9% | 33,1% | 33,3% | 31,6% | 31,9% | 35,8% | 36,8% |

source: own estimates based on <sup>4)</sup>

Table 2: Annual mobile fuel consumption in forestry, in terajoules

|                          | 1990         | 1995         | 2000         | 2005         | 2010         | 2011         | 2012         | 2013         | 2014         | 2015         | 2016         | 2017         | 2018         | 2019         |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>Diesel Oil</b>        | 2.695        | 1.332        | 2.051        | 2.368        | 2.583        | 2.712        | 2.472        | 2.559        | 2.718        | 2.931        | 2.865        | 3.024        | 3.393        | 3.625        |
| <b>Biodiesel</b>         | 3.093        | 3.004        | 3.325        | 3.022        | 1.543        | 1.404        | 392          | 383          | 412          | 1.660        | 1.575        | 1.588        | 1.741        | 1.739        |
| <b>Gasoline</b>          | 0            | 0            | 0            | 151          | 198          | 189          | 174          | 152          | 167          | 160          | 152          | 161          | 197          | 206          |
| <b>Biogasoline</b>       | 0            | 0            | 0            | 21           | 60           | 58           | 17           | 16           | 18           | 72           | 68           | 67           | 78           | 75           |
| <b>Σ 1.A.4.c ii (ii)</b> | <b>5.788</b> | <b>4.336</b> | <b>5.375</b> | <b>5.562</b> | <b>4.383</b> | <b>4.364</b> | <b>3.055</b> | <b>3.110</b> | <b>3.316</b> | <b>4.824</b> | <b>4.660</b> | <b>4.840</b> | <b>5.409</b> | <b>5.646</b> |

## Emission factors

The emission factors used here are of rather different quality: For all **main pollutants, carbon monoxide** and **particulate matter**, annually changing values computed within TREMOD MM (Knörr et al. (2018b))<sup>5)</sup> are used, representing the development of mitigation technologies and the effect of fuel-quality legislation.

Table 3: Annual country-specific emission factors from TREMOD MM<sup>1)</sup>

|                           | 1990  | 1995  | 2000  | 2005  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Gasoline fuels</b>     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| <b>NH<sub>3</sub></b>     | 0,075 | 0,083 | 0,083 | 0,086 | 0,087 | 0,088 | 0,091 | 0,092 | 0,092 | 0,092 | 0,092 | 0,092 | 0,092 | 0,092 |
| <b>NMVOC<sup>2)</sup></b> | 3,04  | 6,37  | 4,67  | 4,56  | 4,83  | 4,74  | 5,23  | 5,22  | 5,11  | 5,00  | 5,32  | 5,19  | 4,30  | 4,07  |
| <b>NMVOC<sup>3)</sup></b> | 5795  | 5099  | 5099  | 5320  | 5424  | 4858  | 3596  | 2897  | 2897  | 2897  | 2897  | 2897  | 2897  | 2901  |
| <b>NO<sub>x</sub></b>     | 42,6  | 49,4  | 49,4  | 76,4  | 86,0  | 78,5  | 63,1  | 55,1  | 55,1  | 55,1  | 55,1  | 55,1  | 55,1  | 55,1  |
| <b>SO<sub>x</sub></b>     | 10,1  | 8,27  | 3,22  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  | 0,37  |
| <b>BC<sup>5)</sup></b>    | 5,09  | 3,73  | 3,73  | 3,86  | 3,91  | 3,96  | 4,08  | 4,13  | 4,13  | 4,13  | 4,13  | 4,13  | 4,13  | 4,13  |
| <b>PM<sup>4)</sup></b>    | 102   | 74,6  | 74,6  | 77,2  | 78,1  | 79,2  | 81,5  | 82,7  | 82,7  | 82,7  | 82,7  | 82,7  | 82,7  | 82,7  |
| <b>TSP<sup>6)</sup></b>   | 2,35  | 0,82  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  | 0,00  |
| <b>CO</b>                 | 16813 | 14796 | 14796 | 15371 | 15609 | 15827 | 16279 | 16514 | 16514 | 16514 | 16514 | 16514 | 16514 | 16514 |
| <b>Pb</b>                 | 1,471 | 0,516 | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |
| <b>Diesel fuels</b>       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| <b>NH<sub>3</sub></b>     | 0,164 | 0,169 | 0,174 | 0,176 | 0,177 | 0,177 | 0,177 | 0,177 | 0,177 | 0,177 | 0,177 | 0,177 | 0,177 | 0,178 |
| <b>NMVOC</b>              | 191   | 157   | 130   | 80,2  | 46,5  | 42,4  | 38,7  | 35,0  | 31,4  | 28,1  | 25,3  | 22,9  | 20,9  | 19,1  |
| <b>NO<sub>x</sub></b>     | 982   | 1.053 | 1.071 | 834   | 543   | 495   | 454   | 422   | 397   | 375   | 351   | 326   | 305   | 287   |
| <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  |
| <b>BC<sup>5)</sup></b>    | 84,6  | 60,8  | 41,8  | 27,7  | 21,6  | 21,0  | 20,4  | 19,3  | 17,8  | 16,1  | 14,5  | 13,0  | 11,5  | 10,1  |
| <b>PM<sup>4)</sup></b>    | 155   | 112   | 75,8  | 45,3  | 30,4  | 28,8  | 27,3  | 25,3  | 23,1  | 20,8  | 18,6  | 16,5  | 14,6  | 12,9  |
| <b>CO</b>                 | 689   | 619   | 554   | 395   | 282   | 269   | 258   | 252   | 249   | 248   | 249   | 251   | 254   | 257   |

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

<sup>2)</sup> from fuel combustion

<sup>3)</sup> from gasoline evaporation

<sup>4)</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>5)</sup> estimated via a f-BCs as provided in <sup>6)</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

<sup>6)</sup> from leaded gasoline (until 1997)



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. <sup>1)</sup>

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 adapted NCVs (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 forestry, in terajoules

|                                    | = 2015    | = 2016    | = 2017    |  |
|------------------------------------|-----------|-----------|-----------|--|
| <b>= diesel fuels</b>              |           |           |           |  |
| ~ Submission 2020                  | > 2,846   | > 2,778   | > 2,931   |  |
| ~ Submission 2019                  | > 2,846   | > 2,778   | > 2,914   |  |
| ~ absolute change                  | > 0.10    | > 0.11    | > 17.09   |  |
| ~ relative change                  | > 0.003%  | > 0.004%  | > 0.59%   |  |
| <b>= gasoline fuels</b>            |           |           |           |  |
| ~ Submission 2020                  | > 1,772   | > 1,685   | > 1,700   |  |
| ~ Submission 2019                  | > 1,772   | > 1,686   | > 1,970   |  |
| ~ absolute change                  | > -0.03   | > -0.02   | > -270    |  |
| ~ relative change                  | > -0.002% | > -0.001% | > -13.72% |  |
| <b>= over-all fuel consumption</b> |           |           |           |  |
| ~ Submission 2020                  | > 4,618   | > 4,463   | > 4,631   |  |
| ~ Submission 2019                  | > 4,618   | > 4,463   | > 4,884   |  |
| ~ absolute change                  | > 0.07    | > 0.08    | > -253    |  |
| ~ relative change                  | > 0.002%  | > 0.002%  | > -5.19%  |  |

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

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

[!-

+ [Planned improvements](#)

+ [FAQs](#)

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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: 30.11.2019), Köln & Berlin, 2019. : 2 : BAFA, 2019: 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\\_2017\\_dezeember.html](https://www.bafa.de/SharedDocs/Downloads/DE/Energie/Mineraloel/moel_amtliche_daten_2017_dezeember.html), Eschborn, 2019. : 3 : Knörr et al. (2019b): 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

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<http://www.umweltbundesamt.de/en/publikationen/nationaler-durchfuehrungsplan-unter-stockholmer-bibliography>

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<sup>1)</sup> (bibcite 1)

<sup>2)</sup> (bibcite 2)

<sup>3)</sup> (bibcite 3)

<sup>4)</sup> (bibcite 3)

<sup>5)</sup> (bibcite 3)

<sup>6)</sup> (bibcite 3)

<sup>1)</sup>

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 likelihood of condensation. So overall condensables are very likely to occur but different to real-world conditions.