

# 1.A.3.b iii - Transport: Road Transport: Heavy Duty Vehicles and Buses

## Short description

In sub-category 1.A.3.b iii - Road Transport: Heavy Duty Vehicles and Buses emissions from fuel combustion in trucks, lorries, buses etc. are reported.

| Category Code | Method          |        |                 |                 |                   | AD               |     |     |     |     | EF       |     |      |     |     |
|---------------|-----------------|--------|-----------------|-----------------|-------------------|------------------|-----|-----|-----|-----|----------|-----|------|-----|-----|
| 1.A.3.b iii   | T1, T3          |        |                 |                 |                   | NS, M            |     |     |     |     | CS, M, D |     |      |     |     |
|               | NO <sub>x</sub> | NM VOC | SO <sub>2</sub> | NH <sub>3</sub> | PM <sub>2.5</sub> | PM <sub>10</sub> | TSP | BC  | CO  | PB  | Cd       | Hg  | Diox | PAH | HCB |
| Key Category: | L/T             | -/-    | -/-             | -/-             | L/T               | L/T              | -/- | L/T | -/- | -/- | -/-      | -/- | -/-  | -/- | -   |

**T** = key source by Trend **L** = key source by Level

### Methods

|           |                                 |
|-----------|---------------------------------|
| <b>D</b>  | Default                         |
| <b>T1</b> | Tier 1 / Simple Methodology *   |
| <b>T2</b> | Tier 2*                         |
| <b>T3</b> | Tier 3 / Detailed Methodology * |
| <b>C</b>  | CORINAIR                        |
| <b>CS</b> | Country Specific                |
| <b>M</b>  | Model                           |

\* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in the group specific chapters.

|                                           |                                      |
|-------------------------------------------|--------------------------------------|
| <b>AD - Data Source for Activity Data</b> |                                      |
| <b>NS</b>                                 | National Statistics                  |
| <b>RS</b>                                 | Regional Statistics                  |
| <b>IS</b>                                 | International Statistics             |
| <b>PS</b>                                 | Plant Specific data                  |
| <b>As</b>                                 | Associations, business organisations |
| <b>Q</b>                                  | specific Questionnaires (or surveys) |
| <b>M</b>                                  | Model / Modelled                     |
| <b>C</b>                                  | Confidential                         |
| <b>EF - Emission Factors</b>              |                                      |
| <b>D</b>                                  | Default (EMEP Guidebook)             |
| <b>C</b>                                  | Confidential                         |
| <b>CS</b>                                 | Country Specific                     |
| <b>PS</b>                                 | Plant Specific data                  |
| <b>M</b>                                  | Model / Modelled                     |

## Methodology

### Activity data

Specific consumption data for heavy-duty vehicles (trucks and lorries) and buses are generated within TREMOD <sup>1)</sup>. - The following tables provide an overview of annual amounts of fuels consumed by these vehicles in Germany.



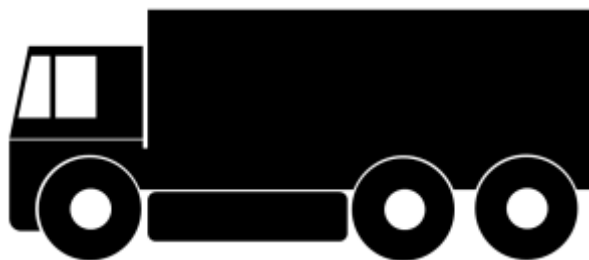


Table 1: Annual fuel consumption of trucks and lorries, in terajoules

|                        | 1990    | 1995    | 2000    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    | 2015    | 2016    | 2017    | 2018    | 2019    | 2020    |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| HDVs: Buses            |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Diesel oil             | 57,322  | 49,060  | 49,204  | 39,890  | 39,400  | 37,316  | 38,776  | 42,093  | 44,448  | 44,080  | 47,336  | 48,611  | 46,147  | 49,428  | 51,353  | 50,519  | 48,606  | 50,088  | 38,954  |
| Biodiesel              | 0       | 77      | 545     | 2,666   | 4,750   | 4,993   | 3,863   | 3,401   | 3,408   | 3,076   | 3,341   | 2,883   | 2,836   | 2,704   | 2,722   | 2,697   | 2,825   | 2,853   | 3,236   |
| CNG                    | 0       | 0       | 0       | 1,183   | 1,682   | 1,965   | 2,072   | 2,255   | 2,200   | 2,011   | 2,157   | 1,720   | 1,663   | 1,591   | 1,213   | 1,150   | 955     | 1,004   | 1,152   |
| Biogas                 | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 308     | 340     | 419     | 268     | 285     | 318     | 257     | 408     | 529     |
| Petroleum              | 0       | 610     | 414     | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |
| Σ Buses                | 57,322  | 49,137  | 49,750  | 43,739  | 45,832  | 44,274  | 44,711  | 47,748  | 50,056  | 49,167  | 53,142  | 53,555  | 51,065  | 53,991  | 55,574  | 54,684  | 52,644  | 54,353  | 43,871  |
| HDVs: Trucks & Lorries |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Diesel oil             | 401,801 | 541,198 | 631,094 | 486,181 | 508,342 | 492,112 | 496,382 | 483,129 | 526,568 | 527,325 | 550,954 | 566,780 | 539,718 | 559,069 | 564,622 | 568,615 | 553,447 | 562,904 | 537,774 |
| Biodiesel              | 0       | 844     | 6,991   | 32,490  | 61,291  | 65,841  | 49,454  | 39,031  | 40,370  | 36,793  | 38,884  | 33,613  | 33,166  | 30,581  | 29,933  | 30,355  | 32,171  | 32,062  | 44,671  |
| CNG                    | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 395     | 338     | 316     | 275     | 194     | 187     | 170     | 222     | 348     |
| Biogas                 | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 56      | 67      | 80      | 46      | 46      | 52      | 46      | 90      | 160     |
| Σ Trucks & Lorries     | 401,801 | 542,043 | 638,086 | 518,670 | 569,633 | 557,953 | 545,836 | 522,160 | 566,938 | 564,118 | 590,290 | 600,798 | 573,279 | 589,972 | 594,796 | 599,209 | 585,834 | 595,278 | 582,953 |
| HDVs over all          |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Diesel oil             | 459,124 | 590,259 | 680,299 | 526,071 | 547,742 | 529,429 | 535,158 | 525,222 | 571,016 | 571,405 | 598,290 | 615,392 | 585,865 | 608,497 | 615,976 | 619,134 | 602,053 | 612,992 | 576,728 |
| Biodiesel              | 0       | 921     | 7,537   | 35,155  | 66,042  | 70,833  | 53,317  | 42,432  | 43,778  | 39,869  | 42,225  | 36,496  | 36,002  | 33,285  | 32,656  | 33,052  | 34,996  | 34,915  | 47,907  |
| CNG                    | 0       | 0       | 0       | 1,183   | 1,682   | 1,965   | 2,072   | 2,255   | 2,200   | 2,011   | 2,552   | 2,058   | 1,979   | 1,866   | 1,407   | 1,337   | 1,125   | 1,226   | 1,500   |
| Biogas                 | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 365     | 407     | 499     | 315     | 331     | 370     | 303     | 498     | 688     |
| Petroleum              | 0       | 610     | 414     | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |
| Σ I.A.3.b iii          | 459,124 | 591,179 | 687,835 | 562,409 | 615,465 | 602,227 | 590,547 | 569,908 | 616,994 | 613,284 | 643,432 | 654,353 | 624,344 | 643,963 | 650,370 | 653,893 | 638,477 | 649,631 | 626,824 |

source: TREMOD <sup>2)</sup>



For information on mileage, please refer to sub-chapters on emissions from [tyre & brake wear and road abrasion](#).

## Emission factors

The majority of emission factors for exhaust emissions from road transport are taken from the 'Handbook Emission Factors for Road Transport' (HBEFA, version 4.1) <sup>3)</sup> where they are provided on a tier3 level mostly and processed within the TREMOD software used by the party <sup>4)</sup>.

However, it is not possible to present these tier3 values in a comprehensible way here.



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. <sup>1)</sup>

For heavy-metal (other than lead from leaded gasoline) and PAH exhaust-emissions, default emission factors from the 2019 EMEP Guidebook (EMEP/EEA, 2019) <sup>5)</sup> have been applied. Regarding PCDD/F, tier1 EF from (Rentz et al., 2008) <sup>6)</sup> are used instead.

Table 2: tier1 EF derived from default values

[illegible]

|                                        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |          |
|----------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------|
| <b>Petroleum</b>                       | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |          |
| <b>all fuels: buses</b>                |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0.000019 |
| <b>all fuels: trucks &amp; lorries</b> |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0.000016 |

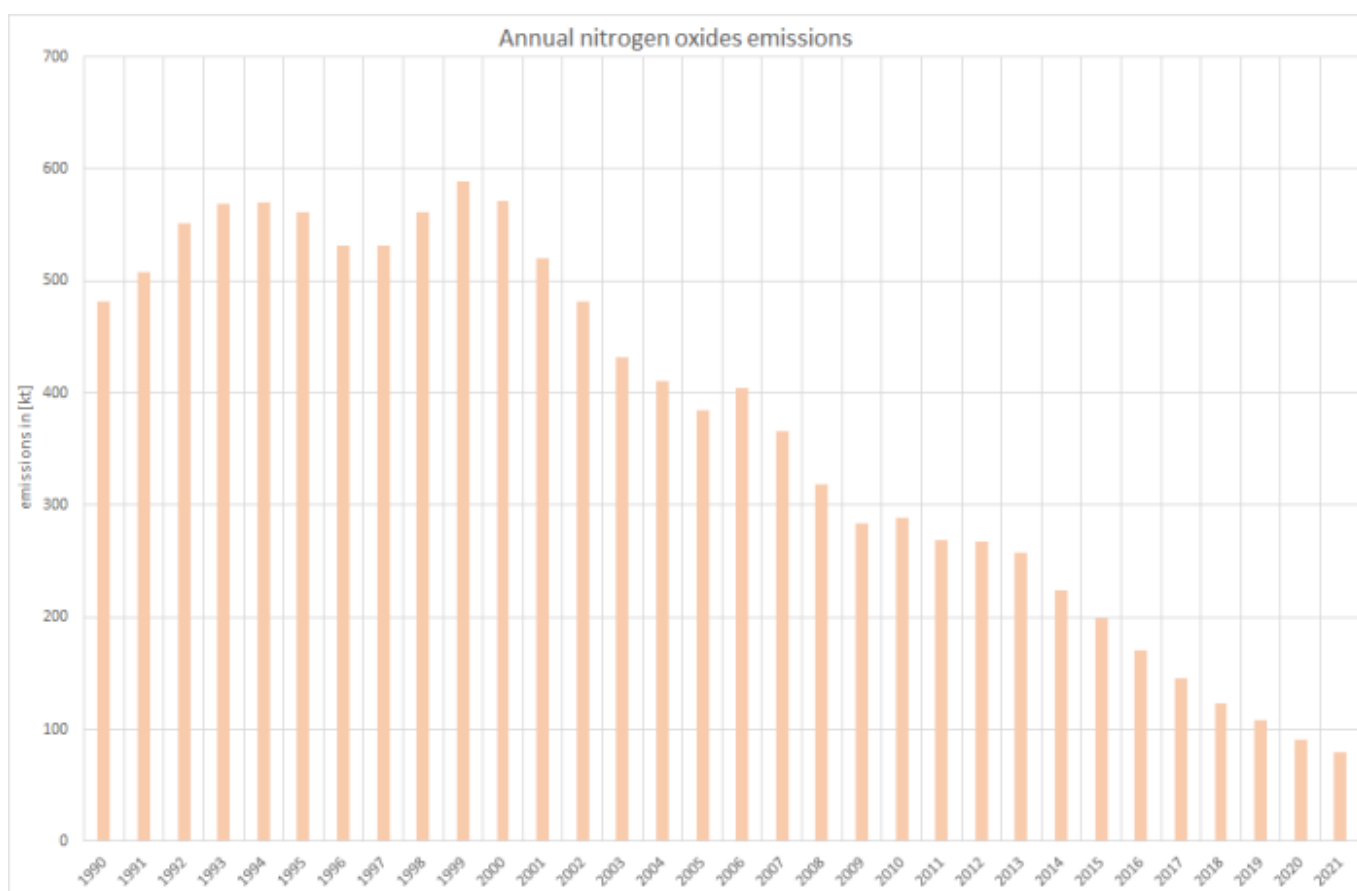
## Discussion of emission trends

### Outcome of Key Category Analysis

|      |                       |           |                        |                         |
|------|-----------------------|-----------|------------------------|-------------------------|
| for: | <b>NO<sub>x</sub></b> | <b>BC</b> | <b>PM<sub>10</sub></b> | <b>PM<sub>2.5</sub></b> |
| by:  | L/T                   | L/T       | L/T                    | L/T                     |

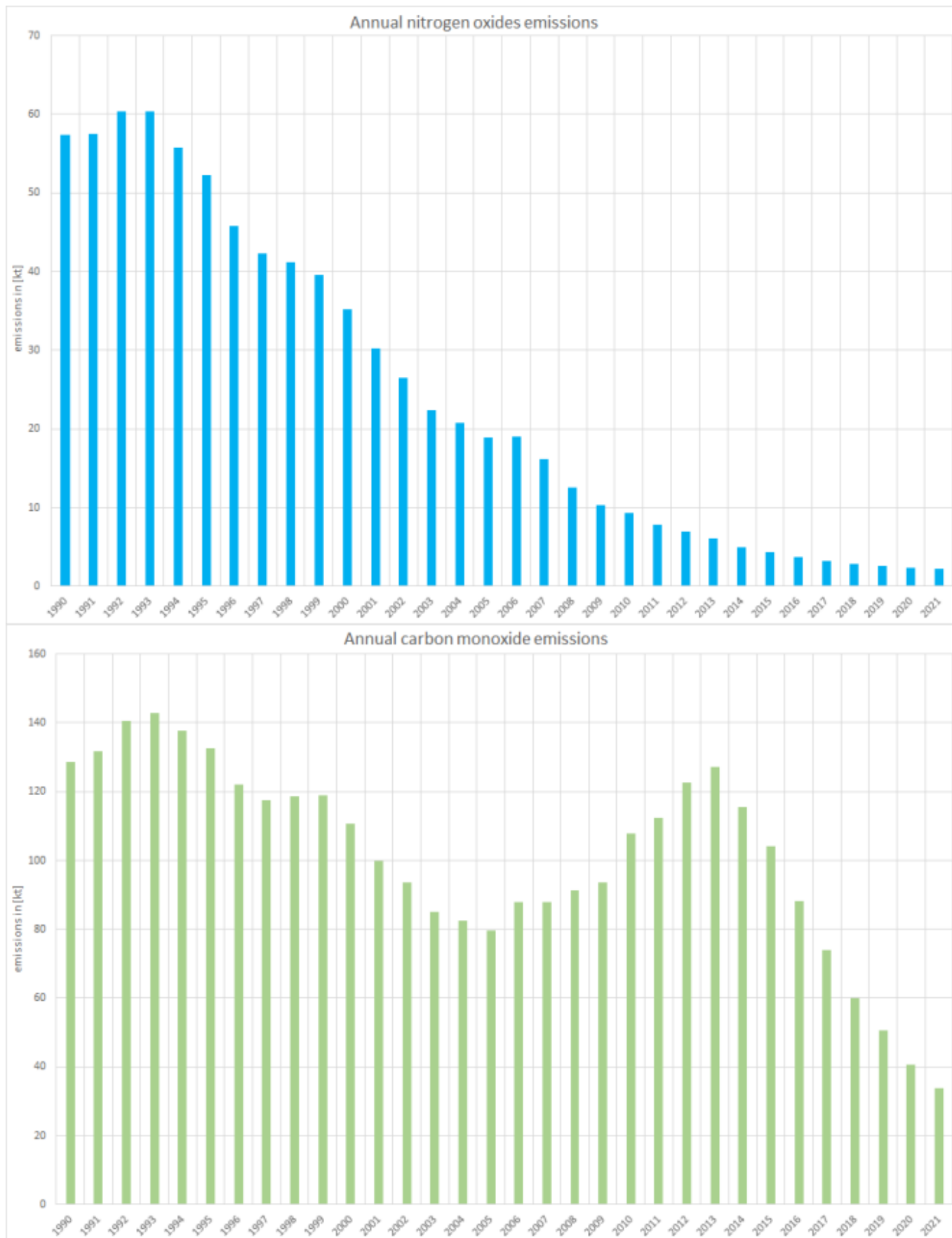
### Nitrogen oxides

Until 2005, NO<sub>x</sub> emissions followed mileage and fuel consumption. Since 2006, in contrast to nearly unchanged fuel consumption, emissions have decreased due to controlled catalytic-converter use and engine improvements resulting from continual tightening of emissions laws.



### Non-methane volatile organic compounds (NMVOC) and carbon monoxide

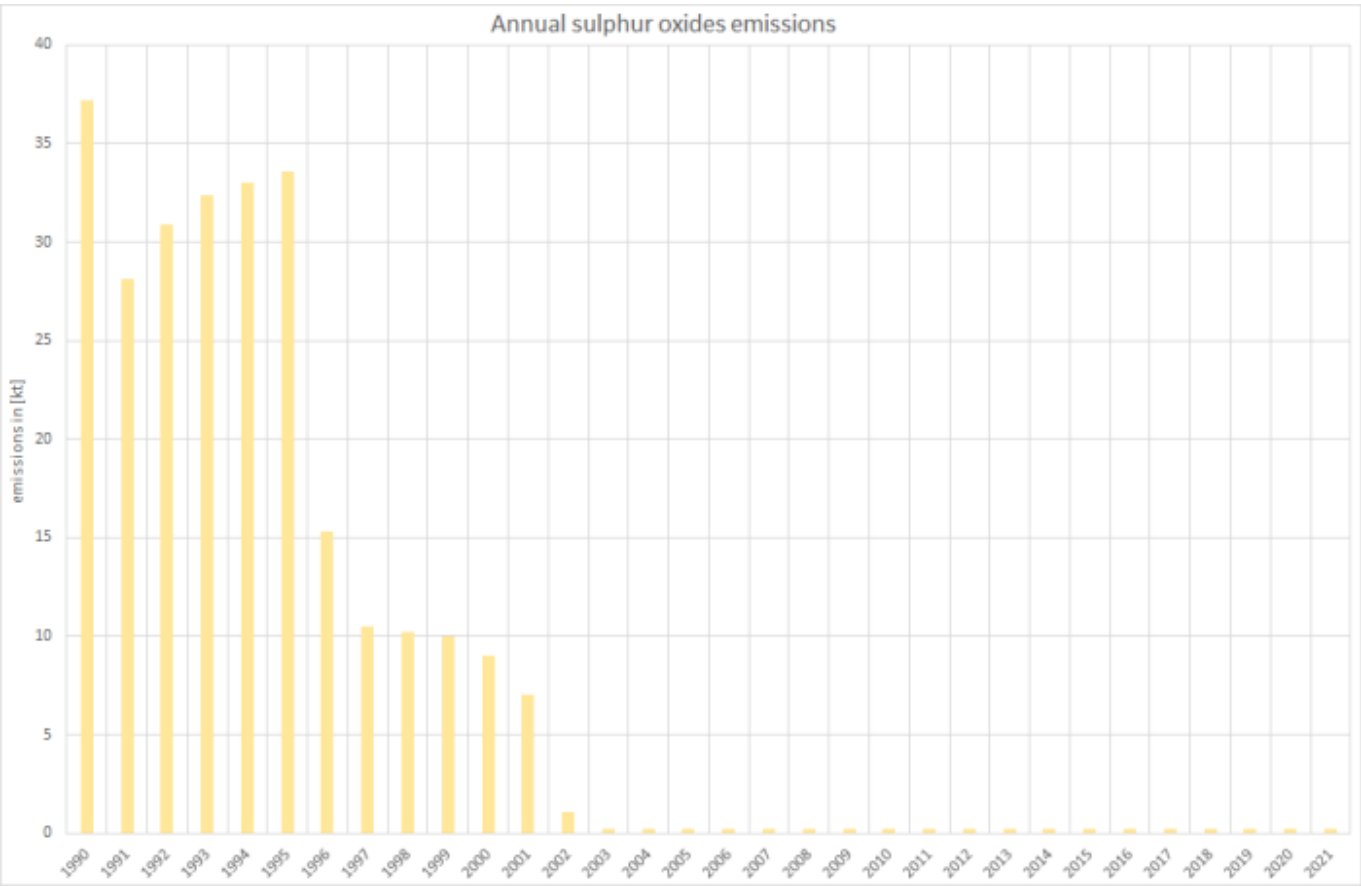
Since 1990, exhaust emissions of **NMVOC** and **carbon monoxide** have decreased sharply due to catalytic-converter use and engine improvements resulting from ongoing tightening of emissions laws and improved fuel quality.



### Ammonia and sulphur dioxide

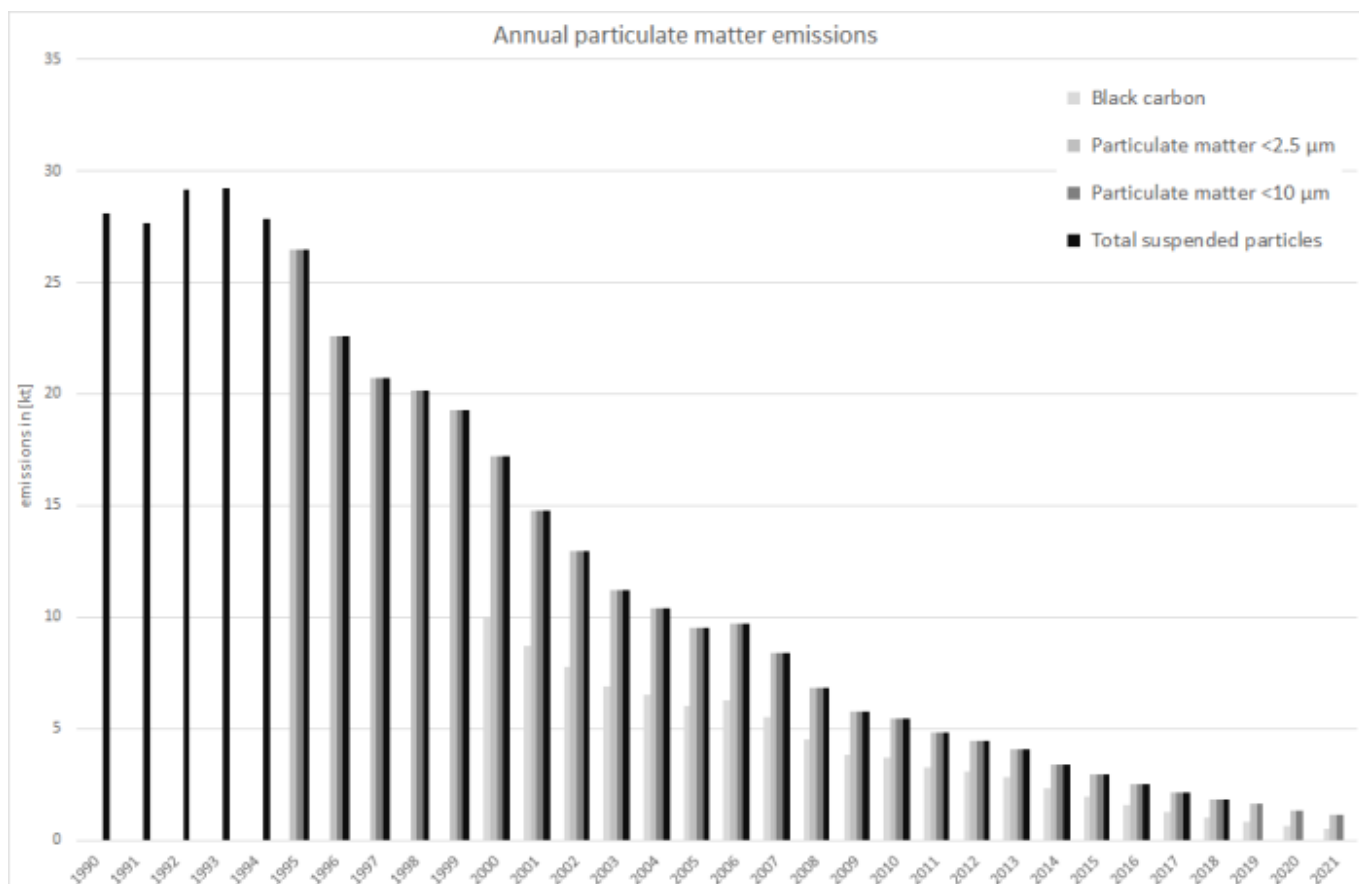
As for the entire road transport sector, the trends for **sulphur dioxide** (SO<sub>2</sub>) and **ammonia** (NH<sub>3</sub>) exhaust emissions from heavy duty vehicles show characteristics different from those shown above: Here, the strong dependence on increasing fuel qualities (sulphur content) leads to a cascaded downward trend of SO<sub>2</sub> emissions, influenced only slightly by increases in

fuel consumption and mileage. For **ammonia** emissions the increasing use of catalytic converters in gasoline driven cars in the 1990s lead to a steep increase whereas both the technical development of the converters and the ongoing shift from gasoline to diesel cars resulted in decreasing emissions in the following years.



Particulate matter & Black carbon

As for all reported exhaust PM emissions from mobile diesel vehicles the Party assumes that nearly all particles emitted are within the PM<sub>2.5</sub> range, resulting in similar emission values for PM<sub>2.5</sub>, PM<sub>10</sub>, and TSP.



## Recalculations

Compared to submission 2020, recalculations were carried out due to a routine revision of the TREMOD software and the revision of several National Energy Balances (NEB).

Here, **activity data** were revised within TREMOD due to the provision of the final NEB 2019.

Furthermore, significant re-allocations of consumption shares between the different vehicle types and classes were conducted, effecting the entire time series but with the 1.A.3.b consumptipon totals remaining unaltered.

Table 4: Revised fuel consumption data, in terajoules

|                 | 1990    | 1995    | 2000    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    | 2015    | 2016    | 2017    | 2018    | 2019    |
|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| DIESEL OIL      |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Submission 2022 | 459.124 | 590.259 | 680.299 | 526.071 | 547.742 | 529.429 | 535.158 | 525.222 | 571.016 | 571.405 | 598.290 | 615.392 | 585.865 | 608.497 | 615.976 | 619.134 | 602.053 | 612.992 |
| Submission 2021 | 459.124 | 590.259 | 680.299 | 526.071 | 547.742 | 529.429 | 535.158 | 525.220 | 571.008 | 571.389 | 598.264 | 615.361 | 585.893 | 608.417 | 615.537 | 618.619 | 601.836 | 613.898 |
| absolute change | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 2,07    | 8,16    | 16,2    | 26,4    | 30,7    | -28,5   | 79,2    | 439     | 515     | 217     | -906    |
| relative change | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,01%   | 0,07%   | 0,08%   | 0,04%   | -0,15%  |
| BIO DIESEL      |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Submission 2022 |         | 921     | 7.537   | 35.155  | 66.042  | 70.833  | 53.317  | 42.432  | 43.778  | 39.869  | 42.225  | 36.496  | 36.002  | 33.285  | 32.656  | 33.052  | 34.996  | 34.915  |
| Submission 2021 |         | 921     | 7.537   | 35.155  | 66.042  | 70.833  | 53.317  | 42.432  | 43.777  | 39.867  | 42.223  | 36.494  | 36.004  | 33.281  | 32.633  | 33.025  | 34.984  | 34.954  |
| absolute change |         | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,17    | 0,63    | 1,13    | 1,86    | 1,82    | -1,75   | 4,33    | 23,3    | 27,5    | 12,6    | -39,5   |
| relative change |         | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,01%   | 0,07%   | 0,08%   | 0,04%   | -0,11%  |
| CNG             |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Submission 2022 |         |         |         | 1.183   | 1.682   | 1.965   | 2.072   | 2.255   | 2.200   | 2.011   | 2.552   | 2.058   | 1.979   | 1.866   | 1.407   | 1.337   | 1.125   | 1.226   |
| Submission 2021 |         |         |         | 1.183   | 1.682   | 1.965   | 2.072   | 2.255   | 2.200   | 2.011   | 2.552   | 2.057   | 1.967   | 1.846   | 1.390   | 1.173   | 1.104   | 1.060   |
| absolute change |         |         |         | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,02    | 1,10    | 12,0    | 20,3    | 17,1    | 165     | 21,4    | 166     |
| relative change |         |         |         | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,05%   | 0,61%   | 1,10%   | 1,23%   | 14,04%  | 1,94%   | 15,7%   |
| BIO GAS         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |

|                               | 1990    | 1995    | 2000    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    | 2015    | 2016    | 2017    | 2018    | 2019    |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <b>Submission 2022</b>        |         |         |         |         |         |         |         |         |         |         | 365     | 407     | 499     | 315     | 331     | 370     | 303     | 498     |
| <b>Submission 2021</b>        |         |         |         |         |         |         |         |         |         |         | 365     | 407     | 496     | 311     | 327     | 365     | 297     | 485     |
| <b>absolute change</b>        |         |         |         |         |         |         |         |         |         |         | 0,00    | 0,22    | 3,03    | 3,43    | 4,03    | 4,98    | 5,77    | 13,7    |
| <b>relative change</b>        |         |         |         |         |         |         |         |         |         |         | 0,00%   | 0,05%   | 0,61%   | 1,10%   | 1,23%   | 1,37%   | 1,94%   | 2,83%   |
| <b>PETROLEUM</b>              |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>Submission 2022</b>        |         | 610     | 414     |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>Submission 2021</b>        |         | 610     | 414     |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>absolute change</b>        |         | 0,00    | 0,00    |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>relative change</b>        |         | 0,00%   | 0,00%   |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>TOTAL FUEL CONSUMPTION</b> |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| <b>Submission 2022</b>        | 459.124 | 591.789 | 688.249 | 562.409 | 615.465 | 602.227 | 590.547 | 569.908 | 616.994 | 613.284 | 643.541 | 654.470 | 624.469 | 644.101 | 650.529 | 654.098 | 638.776 | 650.539 |
| <b>Submission 2021</b>        | 459.124 | 591.789 | 688.249 | 562.409 | 615.465 | 602.227 | 590.547 | 569.906 | 616.985 | 613.267 | 643.403 | 654.319 | 624.360 | 643.855 | 649.887 | 653.181 | 638.221 | 650.396 |
| <b>absolute change</b>        | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 0,00    | 2,24    | 8,79    | 17,4    | 138     | 151     | 110     | 245     | 642     | 916     | 556     | 143     |
| <b>relative change</b>        | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,00%   | 0,02%   | 0,02%   | 0,02%   | 0,04%   | 0,10%   | 0,14%   | 0,09%   | 0,02%   |

Due to the variety of highly specific tier3 **emission factors** applied, it is not possible to display any changes in these data sets in a comprehensible way.



For **pollutant-specific information on recalculated emission estimates reported for Base Year and 2019**, 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.

## FAQs

<sup>1), 2), 4)</sup> Knörr et al. (2021a): Knörr, W., Heidt, C., Gores, S., & Bergk, F.: ifeu Institute for Energy and Environmental Research (Institut für Energie- und Umweltforschung Heidelberg gGmbH, ifeu): Fortschreibung des Daten- und Rechenmodells: Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1960-2035, sowie TREMOD, im Auftrag des Umweltbundesamtes, Heidelberg & Berlin, 2021.

<sup>3)</sup> Keller et al. (2017): Keller, M., Hausberger, S., Matzer, C., Wüthrich, P., & Notter, B.: Handbook Emission Factors for Road Transport, version 4.1 (Handbuch Emissionsfaktoren des Straßenverkehrs 4.1) URL: <http://www.hbefa.net/e/index.html> - Dokumentation, Bern, 2017.

<sup>5)</sup> EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019; <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view>; Copenhagen, 2019.

<sup>6)</sup> 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>

<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 likeliness of condensation. So over-all condensables are very likely to occur but different to real-world conditions.