

## Primary NO<sub>2</sub> Emission Factors for Road Vehicles

March 2019 UPDATE

Nitrogen oxides (NO<sub>x</sub>) are emitted in the form of nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>). The fraction emitted directly as NO<sub>2</sub> (f-NO<sub>2</sub>) is of particular interest for air quality modelling. Road transport is the major source of primary NO<sub>2</sub> emissions especially in urban areas and different vehicle types emit different proportions of NO<sub>x</sub> as NO<sub>2</sub>. Evidence has shown that diesel vehicles are particularly prone to high f-NO<sub>2</sub> values and especially those vehicles fitted with certain types of catalyst systems for controlling other pollutant emissions such as oxidation catalysts and diesel particulate filters for controlling CO, HC and PM. Thus, diesel vehicles meeting more recent Euro standards tend to have higher f-NO<sub>2</sub> values

Values of f-NO<sub>2</sub> have been developed from factors in the EMEP/EEA Emissions Inventory Guidebook (2016) for different vehicle types and Euro standards<sup>[1]</sup> and recent studies by Carslaw et al (2016)<sup>[2]</sup>. All the factors are taken from the Guidebook, except those for Euro V and VI HGVs and buses which are based on Carslaw et al from measurements of NO<sub>2</sub>/NO<sub>x</sub> ratios using roadside remote sensing. The Carslaw et al study suggests lower f-NO<sub>2</sub> factors for Euro V and VI HGVs and buses than previously estimated.

Values of f-NO<sub>2</sub> for each main vehicle type and Euro standard are provided in the spreadsheet “By Euro” tab. These figures refer to the mixing ratio of NO<sub>2</sub> in emitted NO<sub>x</sub>, i.e. the volume fraction of NO<sub>2</sub> in the emitted NO<sub>x</sub>

Other work sheets provide weighted values of f-NO<sub>2</sub> for years between 2013 and 2035. The weighting has been done in different ways for use when the user does not have detailed information on the mix of Euro standards in the fleet. The weighting of the factors are by the NO<sub>x</sub> emissions from each detailed vehicle category.

The factors for years up to 2017 are based on the NO<sub>x</sub> emissions inventory reported up to that year in February 2019 using fleet composition and vehicle kilometre data derived from DfT to estimate the NO<sub>x</sub> emissions by each Euro standard. Details on the method for estimating NO<sub>x</sub> emissions from road transport are given in the UK’s official Informative Inventory Report submitted under the revised EU Directive 2016/2284/EU on National Emissions Ceilings (NECD) and the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP)<sup>[3]</sup>. Fleet composition uses evidence from DfT’s Automatic Number Plate Recognition data (2007-2017) on how the age and fuel mix of vehicles vary on different types of roads. The emission factors for NO<sub>x</sub> are those derived from COPERT 5<sup>[4]</sup>.

Primary NO<sub>2</sub> factors from 2018-2035 are based on the latest NAEI projections on road transport NO<sub>x</sub> emissions, as reported in March 2019 to CLRTAP<sup>[5]</sup>. The key assumptions behind the forecasts in weighted f-NO<sub>2</sub> factors are those that define the composition of the future vehicle fleet, future traffic activity and the corresponding NO<sub>x</sub> and f-NO<sub>2</sub> factors for current and future vehicles.

The composition of the future vehicle fleet is based on figures provided by DfT in January 2018 on sales and activities of new cars and vans and on updated assumptions made by the NAEI on future sales, annual mileage and survival rates of HGVs and buses derived from

analysis of past trends. Outside of London, a fleet turnover model is used to calculate the future fleet composition using vehicle survival rates derived from trends in historic licensing data. Traffic growth assumptions for each main vehicle type come from DfT's Road Transport Forecasts 2018 (RTF18) for Great Britain (GB) projected to 2035<sup>[6]</sup> and re-set to the 2017 base year. The Reference Scenario 1 forecast is used. Fleet composition and vehicle activity forecasts for London were provided by TfL in January 2018.

Projections are from a 2017 base year taking into account the introduction of new vehicles up to Euro 6/VI standards. Euro 6 standards for diesel cars and LGVs are introduced in 3 stages from 2015/16 according to COPERT 5.

**'Fleet-avg by area\_road\_type'**. This sheet provides values for each main vehicle class weighted by NO<sub>x</sub> emissions by each fuel type and Euro standard in the fleet. The different values for cars and taxis on urban, rural and motorway roads reflect the different mix of NO<sub>x</sub> emissions coming from petrol and diesel cars on each road type. The values for different parts of London reflect the different proportions of NO<sub>x</sub> emissions coming from diesel taxis and cars in each part of London. The different values for cars in Northern Ireland reflect the different proportions of NO<sub>x</sub> emissions coming from diesel and petrol cars in Northern Ireland due to the different petrol/diesel car fleet in this country. The different values for LGVs, HGVs and buses for London and the rest of the UK reflect the different fleet age mix of these vehicles in London as a result of the current Low Emission Zone and future Ultra Low Emission Zone introduced from 2019.

**'Fleet-avg by\_vehicle\_fuel\_type'**. This sheet shows values weighted by NO<sub>x</sub> emissions occurring from each Euro class in the mix of vehicles on all roads outside London, but provides separate values for cars and LGVs by fuel type. This should be used when the user knows the fuel mix of vehicles on the road(s) being modelled, but not the mix of Euro standards. The factors for each vehicle type are weighted by the NO<sub>x</sub> emissions coming from the mix of Euro standards on all roads.

**'Fleet-avg all\_traffic'**. This sheet provides the most aggregated values of f-NO<sub>2</sub> which can be used when the user does not know the mix of vehicles on the roads being modelled. The factors for individual vehicle types are weighted by the relative amounts of NO<sub>x</sub> emissions occurring from the mix of vehicle types on urban, non-urban and for all UK roads combined.

**These Base 2019 Projection figures are an update of the March 2018 f-NO<sub>2</sub> factors (PrimaryNO2 factors\_NAEIBase\_2018\_v1.xls). The changes from the previous version are small and occur for the following reasons:**

- **Re-setting the base year of the traffic projections to 2017 changes the vehicle km projections for each vehicle type which in turn affects the overall contribution of each vehicle type to the NO<sub>x</sub> emissions and therefore the weightings used to derive the f-NO<sub>2</sub> factors in the 'Fleet-avg all\_traffic' dataset**
- **The use of new traffic forecasts data from DfT with information showing a change in the share of petrol and battery electric car activities. Although overall projected NO<sub>x</sub> emissions are lower, the share of these emissions coming from diesel cars is slightly increased which has the effect of increasing the overall f-NO<sub>2</sub> value for cars in future years**

- **An enhancement in the method used in the calculations of NO<sub>x</sub> emissions by each Euro standard used in the f-NO<sub>2</sub> weightings by using more granular information on activities and emissions at different vehicle speeds**

These factors will be updated annually after submission of each version of the NAEI's UK inventory figures.

### **References:**

- [<sup>1</sup>] EMEP/EEA air pollutant emission inventory guidebook 2016. Update July 2018  
<https://www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view>
- [<sup>2</sup>] Carslaw et al (2016). "*Have vehicle emissions of primary NO<sub>2</sub> peaked?*". Faraday Discuss., 2016, 189, 439
- [<sup>3</sup>] UK Informative Inventory Report (1990 to 2017), Richmond et al, March 2019, [https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903151113\\_GB\\_IIR\\_2019\\_v1.0.pdf](https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1903151113_GB_IIR_2019_v1.0.pdf)
- [<sup>4</sup>] <https://www.emisia.com/utilities/copert/>
- [<sup>5</sup>] UK Projected emissions – March 2019  
<https://cdr.eionet.europa.eu/gb/un/clrtap/projected/envxio6gq/index.html>
- [<sup>6</sup>] DfT Road Traffic Forecasts 2018, <https://www.gov.uk/government/publications/road-traffic-forecasts-2018>