

Primary NO₂ Emission Factors for Road Vehicles

March 2020 UPDATE

Nitrogen oxides (NO_x) are emitted in the form of nitric oxide (NO) and nitrogen dioxide (NO₂). The fraction emitted directly as NO₂ (f-NO₂) is of particular interest for air quality modelling. Road transport is the major source of primary NO₂ emissions especially in urban areas and different vehicle types emit different proportions of NO_x as NO₂. Evidence has shown that diesel vehicles are particularly prone to high f-NO₂ 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 carbon monoxide, hydrocarbons, and particulate matter. Thus, diesel vehicles meeting more recent Euro standards tend to have higher f-NO₂ values

Values of f-NO₂ have been developed from factors in the EMEP/EEA Emissions Inventory Guidebook (2019)^[1] for different vehicle types and Euro standards and recent studies by Carslaw et al (2016)^[2]. 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 NO₂/NO_x ratios using roadside remote sensing. The Carslaw et al study suggests lower f-NO₂ factors for Euro V and VI HGVs and buses than the EMEP/EEA Emissions Inventory Guidebook.

Values of f-NO₂ for each main vehicle type and Euro standard are provided in the spreadsheet "By Euro" tab. These figures refer to the mixing ratio of NO₂ in emitted NO_x, i.e. the volume fraction of NO₂ in the emitted NO_x

Other worksheets provide weighted values of f-NO₂ 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_x emissions from each detailed vehicle category.

The factors for years up to 2018 are based on the NO_x emissions inventory reported up to that year in February 2020 using fleet composition and vehicle kilometre data derived from the Department for Transport (DfT) to estimate the NO_x emissions by each Euro standard. Details on the method for estimating NO_x 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)^[3]. Fleet composition uses evidence from DfT's Automatic Number Plate Recognition data (2007-2018) on how the age and fuel mix of vehicles vary on different types of roads. The emission factors for NO_x are those derived from COPERT 5^[4].

Primary NO₂ factors from 2019-2035 are based on the latest NAEI projections on road transport NO_x emissions, as reported in March 2020 to CLRTAP^[5]. The key assumptions behind the forecasts in weighted f-NO₂ factors are those that define the composition of the future vehicle fleet, future traffic activity and the corresponding NO_x and f-NO₂ factors for current and future vehicles.

The composition of the future vehicle fleet is based on figures provided by DfT in January 2020 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 (provided in January 2020) for Great Britain (GB) projected to 2035 and re-set to the 2018 base year. Fleet composition and vehicle activity forecasts for London were provided by Transport for London in January 2020.

Projections are from a 2018 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_x 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_x emissions coming from petrol and diesel cars on each road type. The values for different parts of London reflect the different proportions of NO_x 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_x 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_x 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_x emissions coming from the mix of Euro standards on all roads.

'Fleet-avg all_traffic'. This sheet provides the most aggregated values of f-NO₂ 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_x emissions occurring from the mix of vehicle types on urban, non-urban and for all UK roads combined.

These Base 2020 Projection figures are an update of the March 2019 f-NO₂ factors (PrimaryNO₂ factors_NAEIBase_2019_v1.xlsx). The significant changes from the previous version are given below:

- Re-setting the base year of the traffic projections to 2018. This changes the vehicle km projections for each vehicle type which in turn affects the overall contribution of each vehicle type to the NO_x emissions and therefore the weightings used to derive the f-NO₂ factors in the 'Fleet-avg all_traffic' sheet
- The use of new traffic forecasts data from DfT with information showing an increasing share of car vehicle kilometres from petrol cars relative to diesel cars. As the f-NO₂ values for petrol cars are much lower for petrol cars relative to diesel cars, this leads to a reduction in the weighted f-NO₂ value for cars for future years.
- Use of updated Transport for London fleet composition data for London.

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

References:

[1] 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>

[2] Carslaw et al (2016). "Have vehicle emissions of primary NO₂ peaked?". Faraday Discuss., 2016, 189, 439

[3] UK Informative Inventory Report (1990 to 2018), Richmond et al, March 2020, http://uk-air.defra.gov.uk/reports/cat07/2003131327_GB_IIR_2020_v1.0.pdf

[4] <https://www.emisia.com/utilities/copert/>

[5] UK Projected emissions – March 2020
<https://cdr.eionet.europa.eu/gb/un/clrtap/projected/envxmo40w/index.html>