

KlimaLink Standard

Calculation of emissions in bus transport

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Berlin, October 2025

Description

Emissions from motor vehicles such as minibuses and coaches are relatively easy to calculate, provided that the mileage and utilisation are known.

The simplest and most accurate way to determine emissions for bus journeys is to multiply the amount of fuel consumed by the corresponding emission factor (kilograms of CO₂e per litre)¹. Once this information is available, accurate calculations can be made.

Alternatively, emissions can be determined on the basis of the kilometres to be travelled. In this case, an emission factor (kilograms of CO₂e per kilometre) is applied and the total emissions are divided by the actual or assumed utilisation rate. Since the actual fuel consumption is not available in this case, average values for the bus type must be assumed.

KlimaLink vehicle categories

There are different categories for buses. From a climate perspective, these can be divided into the following categories:

- Minibus (up to 10 seats) for transfers and smaller day trips.
- Local public transport bus (low-floor, solo or articulated bus, 35–45 seats) for city tours, inner-city public transport and transfers.
- Long-distance public transport buses (standard or double-decker, 45–80 seats) for longer journeys between cities and hotels, excursions, day trips, multi-day bus trips and coach hire.

Fuel types

There are a variety of possible fuel types (including LPG, methanol, hydrogen and multi-fuel) for which no relevant data is currently available. Therefore, only diesel and electric fuel types are taken into account for KlimaLink's emissions calculation.

Emission factors

The KlimaLink standard specifies the emission factors for diesel and electric as follows:

- Diesel: 2.65 kg CO₂ e per litre of diesel
- Electric: 342 g CO₂ e per kw/h

These values were taken from the website of the German Federal Environment Agency (UBA) and cover the entire fuel production chain (well-to-wheel). The UBA only lists electric for local buses, so an additional data source is used for electric drive in long-distance transport.

Country-specific emission factors for electrical energy will be used for electricity consumption in future. One source with good global coverage is Our World in Data, based on data from Ember and the Energy Institute (<https://ourworldindata.org/grapher/carbon-intensity-electricity>). Until this function is fully implemented, an EU average value of 342 g CO₂e/kWh will be used.

¹ When a vehicle burns one litre of petrol, it emits 2.37 kilograms of CO₂. When it runs on diesel, the figure is 2.65 kilograms of CO₂. When a combustion engine runs on natural gas, emissions amount to 2.23 kg of CO₂ per kilogram of natural gas. (Values based on https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/28_2022_cc.pdf)

Calculation formula

Depending on the input, KlimaLink displays emission data in different levels of accuracy, Tiers 1-3.

- **Tier 1:** Ex-post determination based on actual fuel consumption multiplied by the emission factor, including emissions from the upstream chain.
- **Tier 2:** Emission factor of the above vehicle categories and fuel type multiplied by the estimated distance and assumed utilisation.
- **Tier 3:** Emission factor of the above vehicle categories and fuel type multiplied by the estimated distance and average utilisation.

In all tiers, the energy source must be included in the emission factor (diesel including upstream chain, hybrid or renewable energy). Tier 2 uses average emission factors, while Tier 3 also uses average utilisation rates. According to the Federal Environment Agency (UBA)², CO₂e-emissions for regular service buses are 92 g / km / person across all drive types (load factor 16 % in local transport) and 30 g / km / person (load factor 52 %) across all drive types for long-distance regular service buses.

$$CO_2e = F * f_F$$

The calculation of the amount of fuel or electrical energy F depends on the Tier used:

- Tier 1: Direct user input
- Tier 2: $F = d * c_{cat}$

Variable	Description	Units	Source
CO ₂ e	Formula symbol for the specific CO ₂ e for a journey per passenger.	kg	-
F	Tank capacity or consumption	L or kWh	User
f _B	CO ₂ e emission factor per km based on a vehicle category	g CO ₂ e / km	UBA, DIN EN 16258, KlimaLink research ³
f _F	CO ₂ e emission factor in CO ₂ e based on the fuel consumed	kg CO ₂ e/L or kg CO ₂ e/kWh	DIN EN 16258
d	Distance (actual/planned)	km	
c _{cat}	Consumption of vehicle category	L/km or kWh/km	

² Source from 2023: <https://www.umweltbundesamt.de/themen/verkehr/emissionsdaten#verkehrsmittelvergleich>