Well-to-Wheel Analysis for the European FlixBus fleet

In January 2021 atmosfair finalised a Well-to-Wheel analysis for the European FlixBus fleet. This calculation will serve both for the determination of FlixBus' Corporate Carbon Footprint (CCF) as well as the calculation of climate contributions payable by FlixBus passengers upon booking a trip.

The emission factor per passenger km resulting from this calculation is an average over all European FlixBus regions considered. It replaces the previously used intensity for long-distance buses in Germany published by the German Environment Agency (UBA).

1. Calculation method

A Well-to-Wheel analysis takes into account all emissions along the lifecycle of a fuel from its generation (well) to its consumption (wheel). The total emissions can be split into two components:

Well-to-tank (WtT) emissions are indirect greenhouse gas emissions arising from the production, processing and delivery of a fuel from its source to the vehicle tank.
For the purpose of this calculation, a standard value for Diesel from the European norm EN 16258 was used.

Tank-to-Wheel (TtW) emissions are direct greenhouse gas emissions arising during operation of a vehicle, i.e. through fuel combustion. These emissions were calculated based on fuel consumption data from FlixBus.

2. Data

The calculation was based on FlixBus travel data from 2019 covering the European regions BeNeLux, Bulgaria, Croatia, Czech Republic, DACH, Denmark, France, Hungary, Iberia, Italy, Poland, Romania, Sweden and Ukraine.

While default values were used for the calculation of WtT emissions, TtW emissions were calculated based on fuel consumption data provided by FlixBus. This data was collected by FlixBus between 2018 and 2020 via the fleet management system interface of their buses. The resulting Fuel Consumption Report indicates that data on the European fleet was collected over a total of 75,532,244.5 bus km. The average fuel consumption found for double-deckers was 28.4 l/100km, while for single-deckers it was 25.1 l/100km. These values are notably lower than those previously assumed by FlixBus of 30 l/100km double-deckers and 27 l/100 km for single-deckers. Based on FlixBus's assumption that the European fleet is made up of 18% double-decker and 82% single-deckers, the resulting weighted average consumption amounts to 25.7 l/100km.

Table 1: Data used for the calculation of Well-to-Wheel emissions

Parameter	Value	Source
Physical data		
Well-to-tank emissions Diesel	0.69 tCO_{2eq}/t	EU norm EN16258

Tank-to-wheel emissions Diesel	3.21 tCO_{2eq}/t	EU norm EN16258
Diesel density	0.832 kg/l	Gemis database
Diesel consumption of fleet	0.257 l/km	FlixBus
Travel data		
Total Bus km 2019 European fleet	516,187,819 km	FlixBus
Total Passenger km 2019 European fleet	16,542,284,205 km	FlixBus

3. Results

The results in Table 2 show that TtW emissions make up 82% of total emissions, the most decisive parameter being the fuel consumption of the fleet.

The resulting total emission factor per passenger is 26 gCO_{2eq}/pkm.

Table 2: Resulting Well-to-Wheel emissions

Parameter	Value
Well-to-tank emissions	
WtT emissions per distance	0.15 $kgCO_{2eq}$/km
WtT emissions European fleet	76,158 tCO_{2eq}
WtT emissions per passenger km	4.6 gCO_{2eq}/pkm
Tank-to-wheel emissions	
TtW emissions per distance	0.69 $kgCO_{2eq}$/km
TtW emissions European fleet	354,298 tCO_{2eq}
TtW emissions per passenger km	21.4 gCO_{2eq}/pkm
Total emissions	
Total emissions per distance	0.83 $kgCO_{2eq}$/km
Total emissions European fleet	430,456 tCO_{2eq}
Total emissions per passenger km	**26.0 gCO_{2eq}/pkm**

4. Comparison to UBA emission factor

For the base year 2019, UBA indicates the emission factor per pkm for long-distance buses as 29 gCO_{2eq}/pkm[1], i.e. slightly higher than the value obtained in this Well-to-Wheel analysis.

The UBA emission factor is calculated using the TREMOD model and represents a national average over all long-distance buses which also includes lighter buses than those operated by FlixBus. These lighter buses (<= 18t) have a higher emission factor per pkm than heavier ones, as shown in Table 3.

[1] https://www.umweltbundesamt.de/themen/verkehr-laerm/emissionsdaten#verkehrsmittelvergleich_personenverkehr

Table 3: UBA data on emission factors of long-distance buses

Emissionsfaktoren Fernlinienbusse 2018 - Treibhausgasemissionen in Gramm CO2-Äquivalente pro Personenkilometer (Pkm)
(Quelle: TREMOD 6.03, 01/2020)

Busgröße	Energie	gTHG in CO2eq/Pkm (direkt)	gTHG in CO2eq/Pkm (total)
<=18t	Diesel (total)	29,40	34,30
>18t	Diesel (total)	23,27	27,16
>18t	Elektrisch	0	25,08
alle	Diesel (total)	25,03	29,21
<=18t	alle	29,40	34,30
>18t	alle	23,23	27,15
alle	alle	25,00	29,21

On the other hand, FlixBus data shows that in relation to the European average, the DACH region has a lower emission factor as a result of its relatively modern bus fleet.

A comparative calculation using data provided by UBA for long-distance buses >18t shows that the difference in emission factors is determined by different assumptions on fuel consumption. It is important to note that the UBA emission factor calculation for this bus class is based exclusively on fuel consumption data provided by FlixBus. For this purpose, however, FlixBus provided consumption indications as given by manufacturers rather than metered during operations. It can thus be assumed that the emission factor resulting from the Well-to-Wheel analysis at hand is more accurate for the European FlixBus fleet than the emission factor published by UBA.

Continuous monitoring of fuel consumption by FlixBus is strongly recommended in order to regularly update and reconfirm the calculation of TtW emissions.

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