

Zero Emission Bus Certificate

Customer:	Volvo Group UK Ltd			DYNAMOMETER SETTINGS		
Customer Address:	Wedgcock Lane, Warwick, CV34 5YA	Telematics Capability	Yes	Test Weight	16391	kg
Test Purpose:	Zero Emission Bus Testing	Maximum Speed (km/h)	80 km/h	F⁰	-73.65	N
Vehicle Manufacturer:	Volvo Group UK Ltd	Seated Capacity	64	F¹	-0.0397	N/kmh
Vehicle Model Name:	BZL Double Deck	Passenger Capacity	81	F²	0.08246	N/kmh ²
Powertrain Technology	Battery Electric	Declared Unladen Weight (kg)	13406	F³	0.000000	N/kmh ³
Powertrain Configuration	Direct Drive	Gross Weight (kg)	18985	Equivalent test passengers		
Zero Emission Heating	Heat Pump	GVW Check	OK	Measured Unladen Weight		
					14215	kg
Battery Specification		Charging and Refuelling Capability		Hydrogen Specification		
Battery Manufacturer	N/A	Plug Type	CCS2 & OppCharge	Fuel Cell Manufacturer		
Battery Chemistry	NCA	Max Charge Capability (kW)	Up to 150kW/300 kW	Fuel Cell Power Rating (kW)		
Battery Installed Capacity (kWh)	470	Charger Compatibility	DC	Hydrogen Storage Capacity (kg)		
Battery Usable Capacity (kWh)*	376	Charge time from 20-80% SOC	2-4 hours	Hydrogen Storage Pressure (bar)		
				N/A		

* Recommended manufacturer guideline, subject to warranty

Declared fuel, properties and source plus carbon conversion factors

Well-to-Tank Factor: Electricity	72.65	g CO₂e / MJ	Fuel Provider	UK market standard	WTT evidence	DBEIS Conversion 2022
Well-to-Tank Factor: Hydrogen	N/A	g CO₂e / MJ	Capacity of Tanker (kg)	N/A	Fuel Type / Pathway	UK Grid Electricity
Energy Density Hydrogen	120	MJ / kg	Transport Distance of Hydrogen (km)	N/A	Energy Source	UK Grid

Emissions and Energy consumption results from approved test facility - Average 4 tests

Test Phase	HC (g/km)	CO (g/km)	NOx (g/km)	PM (g/km)	CO ₂ (g/km)	CH ₄ (g/km)*	N ₂ O (g/km)*	Total Energy Consumption (kWh)	Vehicle Energy Consumption (kWh/km)	Grid Electrical Energy Consumption (kWh/ 100km)
Outer Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.64	1.19	160.81
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.75	1.50	202.70
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.33	0.86	116.22
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.39	1.27	171.62
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.72	1.09	147.30

Zero Emissions (Z.E.) Range: Energy consumption and charging efficiency

Test Charger Used	22 kW	Total measured energy consumed on vehicle (kWh)¹	71.00	Max ZE Range at 100% SOC (km)	345
Hydrogen Energy Over Test (kWh)	N/A	Measured grid energy during charging (kWh)	96.00	Max ZE Range at 80% SOC (km)	276
Hydrogen Delivered to Vehicle (kg)	N/A	Grid-to-Wheel efficiency (%)²	74%	Test Distance Travelled (km)	65

¹ Total measured energy includes energy used during the 23 minute warmup, this is needed for charge efficiency calculation.

² Grid to Wheel efficiency represents the total energy losses between the grid and the wheels of the bus.

Calculated total Well-to-Wheel GHG CO₂ equivalent emissions over test

Test Phase	Fuel Energy (MJ / km)	Fuel WTT*GHG Emissions (g CO ₂ e / km)	Electrical Energy (MJ / km)	Electricity WTT* GHG Emissions (g CO ₂ e / km)
Outer Urban	N/A	N/A	5.79	420.58
Inner Urban	N/A	N/A	7.30	530.15
Rural	N/A	N/A	4.18	303.95
LBC Average	N/A	N/A	6.18	448.86
UK BUS Average	N/A	N/A	5.30	385.24

Data Generated by (On behalf of Test facility): _____ Date: _____
Data Approved by: _____ Date: _____

Zero Emission Bus Certificate Summary

Test Vehicle		Average Euro VI Diesel Equivalent	
Greenhouse Gas Emissions: Well-to-Wheel	385.2 g CO ₂ e / km	Average Diesel GHG Emissions Equivalent	1243 g CO ₂ e / km
WTW CO₂ per passenger km (@ Max Pass Capacity)	4.8 g CO ₂ e/pass km	WTW CO₂ per passenger km (@ Max Pass Capacity)	15.3 g CO ₂ e/pass km
Overall Zero Emission Bus Performance			
WTW GHG saving	857.8 g CO ₂ e / km	Maximum Theoretical Zero Emission Range (km)	345.0
% WTW GHG saving	69% g CO ₂ e / km	Vehicle Energy Consumption (kWh/ km)	1.1
Approved as Zero Emission Bus? (50% GHG saving or more)		YES	

* WTT : Well-to-Tank

** TTW : Tank-to-Wheel

*** WTW : Well-to Wheel

COMMENTS: Emission results marked in red are below detection levels. LBC = London Bus Cycle - Inner & Outer Urban phases of UKBC only. Fourth Battery was not measured due to incorrect location of current clamp, the current for this battery has been taken as an average of batteries 1, 2 & 3. Fifth battery was also not measured but was shown to be not operational during test and

Heating Requirement	Cell	Lower Saloon	Upper Saloon
Target Temperatures ±2 (°C) :	10	17	17
Average Temperatures across testing (°C)	10.12	17.63	19.79

Test Numbers: 20220404_1606, 20220404_1731, 20220404_1848, 20220404_1955

Certificate approved by: Phil Fletcher
On behalf of Bus manufacturer 14.04.23

Certificate Approved by: Tim Griffen
On behalf of DfT / Zemo Partnership 21.03.2023