Zemo Partnership | **Zero Emission Bus Certification ID:** | **ZEB-VOLVO-BZLSD-2023** | Approved Test facility | UTAC

Zero Emission Bus Certificate

Customer:	**Volvo Group UK Ltd**			**DYNAMOMETER SETTINGS**		
Customer Address:	**Dept 86100, ARAK3 S, SE-405 08, Gothenburg**	*Telematics Capability*	Yes	Test Weight	14579	kg
Test Purpose:	**Zero Emission Bus Testing**	*Maximum Speed (km/h)*	80 km/h	F°	789.20	N
Vehicle Manufacturer:	**Volvo Group UK Ltd**	*Seated Capacity*	43	F^1	6.4041	N/kmh
Vehicle Model Name:	**BZL Single Deck**	*Passenger Capacity*	86	F^2	0.1303	N/kmh ²
Powertrain Technology	**Battery Electric**	*Declared Unladen Weight (kg)*	13098	*Equivalent test passengers*	21.75	passengers
Powetrain Configuration	**Direct Drive**	*Gross Weight (kg)*	19500	*Measured Unladen Weight*	13167	kg
Zero Emission Heating	**CO2 Heat Pump & PTC Heaters**	*GVW Check*	**OK**	Number of conseuitve tests completed	4	Tests

Battery Specification		**Charging and Refuelling Capability**		**Hydrogen Specification**	
Battery Manufacturer	**N/A**	**Plug Type**	**CCS 2 & OppCharge**	**Fuel Cell Manufacturer**	**N/A**
Battery Chemistry	**NCA**	**Max Charge Capability (kW)**	**Up to 150kW /300kW**	**Fuel Cell Power Rating (kW)**	**N/A**
Battery Installed Capacity (kWh)	**376**	**Charger Compatibility**	**DC / OppCharge**	**Hydrogen Storage Capacity (kg)**	**N/A**
Battery Usable Capacity (kWh)*	**300**	**Charge time from 20-80% SOC****	**2-4 hours**	**Hydrogen Storage Pressure (bar)**	**N/A**

* Recommended manufacturer guideline, subject to warranty ** Based on manufacturer estimate

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_2O (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	7.93	1.23	143.54
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.79	1.12	131.00
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.88	0.93	109.19
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.71	1.20	140.01
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.59	1.08	**126.10**

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

Test Charger Used	**22 kW**	**Total measured energy consumed on vehicle (kWh)[1]**	**105.55**	**Max ZE Range at 100% SOC (km)**	**278**
Hydrogen Energy Over Test (kWh)	**N/A**	**Measured grid energy during charging (kWh)**	**123.48**	**Max ZE Range at 80% SOC (km)**	**223**
Hydrogen Delivered to Vehicle (kg)	**N/A**	**Grid-to-Wheel efficiency (%)[2]**	**85%**	**Test Distance Travelled (km)**	**65**

[1] Total measured energy may include 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 CO_2 equvialent emissions over test

Test Phase	Fuel Energy (MJ /km)	Fuel WTT*GHG Emissions (g CO_2e / km)	Electrical Energy (MJ / km)	Electricity WTT* GHG Emissions (g CO_2e / km)
Outer Urban	N/A	N/A	5.17	375.42
Inner Urban	N/A	N/A	4.72	342.61
Rural	N/A	N/A	3.93	285.58
LBC Average	N/A	N/A	5.04	366.19
UK BUS Average	N/A	N/A	4.54	329.79

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	**329.8**	**g CO2e / km**	**Average Diesel GHG Emissions Equivalent**	**1290**	**g CO2e / km**
WTW CO2 per passenger km (@ Max Pass Capacity)	**3.8**	**g CO2e/pass km**	**WTW CO2 per passenger km (@ Max Pass Capacity)**	**15.0**	**g CO2e/pass km**

Overall Zero Emission Bus Performance

WTW GHG saving	**960.3**	**g CO2e / km**	**Maximum Theoretical Zero Emission Range (km)**	**277.8**
% WTW GHG saving	**74%**	**g CO2e / km**	**Vehicle Energy Consumption (kWh/ km)**	**1.08**
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.
Certification based on previous Volvo 7900e test results, with updated weight and battery capacity.

Heating Requirement	**Cell**	**Lower Saloon**	**Upper Saloon**
Target Temperatures ±2 (°C) :	**10**	**17**	**17**
Average Temperatures across testing (°C)	9.41	16.05	N/A

Test Numbers: ML02018887 (10-Oct-19), ML02018888 (10-Oct-19), ML02018889 (10-Oct-19), ML02018890 (10-Oct-19), ML02018891 (10-Oct-19), ML02018892 (10-Oct-19).

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

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