Zemo Partnership

Zero Emission Bus Certification ID: **ZEB-ADL-NextGen-Enviro400EV-2024**

Approved Test facility UTAC

Zero Emission Bus Certificate

Customer:	**Alexander Dennis**			**DYNAMOMETER SETTINGS**		
Customer Address:	**Trident House, 2, Voyager Park, Farnborough, GU14 6FF**	*Telematics Capability*	Yes	Test Weight	16147	kg
Test Purpose:	**Zero Emission Bus Testing**	*Maximum Speed (km/h)*	92 km/h	F°	-252.36	N
Vehicle Manufacturer:	**Alexander Dennis Ltd**	*Seated Capacity*	76	F^1	-1.6070	N/kmh
Vehicle Model Name:	**Enviro400 EV**	*Passenger Capacity*	84	F^2	0.1517	N/kmh ²
Powertrain Technology	**Battery Electric**	*Declared Unladen Weight (kg)*	13663	*Equivalent test passengers*	38	passengers
Powetrain Configuration	**Direct Drive**	*Gross Weight (kg)*	19450	*Measured Unladen Weight*	13565	kg
Zero Emission Heating	**Heat Pump**	*GVW Check*	**OK**	Number of conseuitve tests completed	4	Tests

Battery Specification		**Charging and Refuelling Capability**		**Hydrogen Specification**	
Battery Manufacturer	**Impact**	**Plug Type**	**Dual CCS2/OppCharge**	**Fuel Cell Manufacturer**	**N/A**
Battery Chemistry	**NMC**	**Max Charge Capability (kW)**	**Up to 150kW/250 kW**	**Fuel Cell Power Rating (kW)**	**N/A**
Battery Installed Capacity (kWh)	**472**	**Charger Compatibility**	**DC**	**Hydrogen Storage Capacity (kg)**	**N/A**
Battery Usable Capacity (kWh)*	**415**	**Charge time from 20-80% SOC****	**1.5-2 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***	**N/A**	**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	4.71	0.72	88.59
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.80	0.71	87.23
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.49	0.61	74.21
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.51	0.72	88.21
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.00	0.67	**81.90**

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

Test Charger Used	**38 kW**	**Total measured energy consumed on vehicle (kWh)[1]**	**111**	**Max ZE Range at 100% SOC (km)**	**620**
Hydrogen Energy Over Test (kWh)	**N/A**	**Measured grid energy during charging (kWh)**	**136**	**Max ZE Range at 80% SOC (km)**	**496**
Hydrogen Delivered to Vehicle (kg)	**N/A**	**Grid-to-Wheel efficiency (%)[2]**	**82%**	**Test Distance Travelled (km)**	**72**

[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	3.19	231.70
Inner Urban	N/A	N/A	3.14	228.14
Rural	N/A	N/A	2.67	194.09
LBC Average	N/A	N/A	3.18	230.70
UK BUS Average	N/A	N/A	2.95	214.20

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	**214.2**	**g CO2e / km**	**Average Diesel GHG Emissions Equivalent**	**1306**	**g CO2e / km**
WTW CO2 per passenger km (@ Max Pass Capacity)	**2.5**	**g CO2e/pass km**	**WTW CO2 per passenger km (@ Max Pass Capacity)**	**15.6**	**g CO2e/pass km**

Overall Zero Emission Bus Performance

WTW GHG saving	**1092.1**	**g CO2e / km**	**Maximum Theoretical Zero Emission Range (km)**	**620.1**
% WTW GHG saving	**84%**	**g CO2e / km**	**Vehicle Energy Consumption (kWh/ km)**	**0.67**
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. State of charge was 85% at the start of warmup. Total measured energy consumed, measured grid energy during charging and charging efficiency are all calculated over two iterations of UKBC procedure. All other results are recorded from 2nd iteration of UKBC procedure performed.

Heating Requirement	**Cell**	**Lower Saloon**	**Upper Saloon**
Target Temperatures ±2 (°C) :	**10**	**17**	**17**
Average Temperatures across testing (°C)	10.00	16.23	16.08

Test Numbers: 20231220_1701_2xUKBC, 20233120_1855_2xUKBC

Certificate approved by:
On behalf of Bus manufacturer
Gary Chandler
29.01.2024

Certificate Approved by:
On behalf of DfT / Zemo Partnership
Tim Griffen
29.01.2024