

# 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 <sup>o</sup>	-252.36	N
Vehicle Manufacturer:	Alexander Dennis Ltd	Seated Capacity	76	F <sup>1</sup>	-1.6070	N/kmh
Vehicle Model Name:	Enviro400 EV	Passenger Capacity	84	F <sup>2</sup>	0.1517	N/kmh <sup>2</sup>
Powertrain Technology	Battery Electric	Declared Unladen Weight (kg)	13663	Equivalent test passengers	38	passengers
Powertrain Configuration	Direct Drive	Gross Weight (kg)	19450	Measured Unladen Weight	13565	kg
Zero Emission Heating	Heat Pump	GVW Check	OK	Number of consecutive 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 CO <sub>2</sub> e / MJ	Fuel Provider	UK market standard	WTT evidence	DBEIS Conversion 2022
Well-to-Tank Factor: Hydrogen	N/A	g CO <sub>2</sub> e / MJ	Capacity of Tanker (kg)	N/A	Fuel Type / Pathway	UK Grid Electricity
Energy Density	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 <sub>2</sub> (g/km)	CH <sub>4</sub> (g/km)*	N <sub>2</sub> 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	4.71	0.72	74.78
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.80	0.71	73.64
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.49	0.61	62.64
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.51	0.72	74.46
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.00	0.67	69.13

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

Test Charger Used	38 kW	Total measured energy consumed on vehicle (kWh) <sup>1</sup>	N/A*	Max ZE Range at 100% SOC (km)	620
Hydrogen Energy Over Test (kWh)	N/A	Measured grid energy during charging (kWh)	N/A*	Max ZE Range at 80% SOC (km)	496
Hydrogen Delivered to Vehicle (kg)	N/A	Grid-to-Wheel efficiency (%) <sup>2</sup>	97%	Test Distance Travelled (km)	72

<sup>1</sup> Total measured energy may include energy used during the 23 minute warmup, this is needed for charge efficiency calculation.

<sup>2</sup> 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<sub>2</sub> equivalent emissions over test

Test Phase	Fuel Energy (MJ / km)	Fuel WTT*GHG Emissions (g CO <sub>2</sub> e / km)	Electrical Energy (MJ / km)	Electricity WTT* GHG Emissions (g CO <sub>2</sub> e / km)
Outer Urban	N/A	N/A	2.69	195.59
Inner Urban	N/A	N/A	2.65	192.59
Rural	N/A	N/A	2.26	163.84
LBC Average	N/A	N/A	2.68	194.75
UK BUS Average	N/A	N/A	2.49	180.81

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	Average Diesel GHG Emissions Equivalent
180.8 g CO <sub>2</sub> e / km	1306 g CO <sub>2</sub> e / km
WTW CO <sub>2</sub> per passenger km (@ Max Pass Capacity)	WTW CO <sub>2</sub> per passenger km (@ Max Pass Capacity)
2.2 g CO <sub>2</sub> e/pass km	15.6 g CO <sub>2</sub> e/pass km
Overall Zero Emission Bus Performance	
WTW GHG saving	Maximum Theoretical Zero Emission Range (km)
1125.5 g CO <sub>2</sub> e / km	620.1
% WTW GHG saving	Vehicle Energy Consumption (kWh/ km)
86% g CO <sub>2</sub> e / km	0.67
<b>Approved as Zero Emission Bus? (50% GHG saving or more)</b>	<b>YES</b>

\* 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. **January 2024** - 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. **September 2024 Update** - Due to issues with charging procedure in original test, a charge event was subsequently carried out independently by UTAC, and approved by Zemo, to determine a representative charge efficiency.

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: Gary Chandler  
On behalf of Bus manufacturer 30th September 2024

Certificate Approved by: Tim Griffen  
On behalf of DIT / Zemo Partnership 30th September 2024