

## Simulated Zero Emission Bus Certificate

|   |   |   |                             |  |                        |
|---|---|---|-----------------------------|--|------------------------|
| <b>Customer:</b> Alexander Dennis       |   |   | <b>DYNAMOMETER SETTINGS</b> |  |                        |
| <b>Customer Address:</b>                | Cameron House, Priorswood Pl, Skelmersdale, Lancs | <b>Telematics Capability</b>              | Yes                         | Test Weight                                  | 15821 kg               |
| <b>Test Purpose:</b>                    | Zero Emission Bus Testing                         | <b>Maximum Speed (km/h)</b>               | 92 km/h                     | F°   | N/A N                  |
| <b>Vehicle Manufacturer:</b>            | Alexander Dennis                                  | <b>Seated Capacity</b>                    | 80                          | F <sup>1</sup>                               | N/A N/kmh              |
| <b>Vehicle Model Name:</b>              | Enviro400EV                                       | <b>Passenger Capacity</b>                 | 94                          | F <sup>2</sup>                               | N/A N/kmh <sup>2</sup> |
| <b>Powertrain Technology:</b>           | Battery Electric                                  | <b>Declared Unladen Weight (kg)</b>       | 13026                       | <b>Equivalent test passengers</b>            | 40 passengers          |
| <b>Powertrain Configuration:</b>        | Direct Drive                                      | <b>Gross Weight (kg)</b>                  | 19500                       | <b>Measured Unladen Weight</b>               | N/A kg                 |
| <b>Zero Emission Heating:</b>           | Heat Pump   | <b>GVW Check</b>                          | OK                          | <b>Number of consecutive tests completed</b> | N/A Tests              |
| <b>Battery Specification</b>            |   | <b>Charging and Refuelling Capability</b> |                             | <b>Hydrogen Specification</b>                |                        |
| <b>Battery Manufacturer</b>             | Impact Clean Power Technology                     | <b>Plug Type</b>                          | CCS2 & OppCharge            | <b>Fuel Cell Manufacturer</b>                | N/A                    |
| <b>Battery Chemistry</b>                | NMC   | <b>Max Charge Capability (kW)</b>         | Up to 150kW/300 kW          | <b>Fuel Cell Power Rating (kW)</b>           | N/A                    |
| <b>Battery Installed Capacity (kWh)</b> | 354   | <b>Charger Compatibility</b>              | DC                          | <b>Hydrogen Storage Capacity (kg)</b>        | N/A                    |
| <b>Battery Usable Capacity (kWh)*</b>   | 312   | <b>Charge time from 20-80% SOC**</b>      | 2-4 hours                   | <b>Hydrogen Storage Pressure (bar)</b>       | N/A                    |

\* Recommended manufacturer guideline, subject to warranty

\*\* Based on manufacturer estimate

### Declared fuel, properties and source plus carbon conversion factors

|   |       |                         |  |                    |                            |                       |
|---|-------|-------------------------|--|--------------------|----------------------------|-----------------------|
| <b>Well-to-Tank Factor: Electricity</b> | 80.92 | g CO <sub>2e</sub> / MJ | <b>Fuel Provider</b>                       | UK market standard | <b>WTT evidence</b>        | DBEIS Conversion 2021 |
| <b>Well-to-Tank Factor: Hydrogen</b>    | N/A   | g CO <sub>2e</sub> / MJ | <b>Capacity of Tanker (kg)</b>             | N/A                | <b>Fuel Type / Pathway</b> | UK Grid Electricity   |
| <b>Energy Density Hydrogen</b>          | 120   | MJ / kg                 | <b>Transport Distance of Hydrogen (km)</b> | N/A                | <b>Energy Source</b>       | 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                      | 5.90                           | 0.91                                | 113.75  |
| Inner Urban           | N/A       | N/A       | N/A        | N/A       | N/A                    | N/A                     | N/A                      | 3.10                           | 1.22                                | 152.50  |
| Rural                 | N/A       | N/A       | N/A        | N/A       | N/A                    | N/A                     | N/A                      | 5.70                           | 0.77                                | 96.25   |
| LBC Average           | N/A       | N/A       | N/A        | N/A       | N/A                    | N/A                     | N/A                      | 9.00                           | 1.00                                | 125.00  |
| <b>UK BUS Average</b> | N/A       | N/A       | N/A        | N/A       | N/A                    | N/A                     | N/A                      | 14.70                          | 0.90                                | 112.50  |

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

|   |       |  |     |                                      |     |
|---|-------|--|-----|--------------------------------------|-----|
| <b>Test Charger Used</b>                  | 22 kW | <b>Total measured energy consumed on vehicle (kWh)<sup>1</sup></b> | N/A | <b>Max ZE Range at 100% SOC (km)</b> | 346 |
| <b>Hydrogen Energy Over Test (kWh)</b>    | N/A   | <b>Measured grid energy during charging (kWh)</b>                  | N/A | <b>Max ZE Range at 80% SOC (km)</b>  | 277 |
| <b>Hydrogen Delivered to Vehicle (kg)</b> | N/A   | <b>Grid-to-Wheel efficiency (%)<sup>2</sup></b>                    | 80% | <b>Test Distance Travelled (km)</b>  | N/A |

<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>2e</sub> / km) | Electrical Energy (MJ / km) | Electricity WTT* GHG Emissions (g CO <sub>2e</sub> / km) |
|-----------------------|-----------------------|--|-----------------------------|--|
| Outer Urban           | N/A                   | N/A  | 4.10                        | 331.37   |
| Inner Urban           | N/A                   | N/A  | 5.49                        | 444.25   |
| Rural                 | N/A                   | N/A  | 3.47                        | 280.39   |
| LBC Average           | N/A                   | N/A  | 4.50                        | 364.14   |
| <b>UK BUS Average</b> | N/A                   | N/A  | 4.05                        | 327.73   |

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 |                             |  |      |                             |
|--|-----------------------------------|-----------------------------|--|------|-----------------------------|
| <b>Greenhouse Gas Emissions: Well-to-Wheel</b>                   | 327.7                             | g CO <sub>2e</sub> / km     | <b>Average Diesel GHG Emissions Equivalent</b>                   | 1365 | g CO <sub>2e</sub> / km     |
| <b>WTW CO<sub>2</sub> per passenger km (@ Max Pass Capacity)</b> | 3.5                               | g CO <sub>2e</sub> /pass km | <b>WTW CO<sub>2</sub> per passenger km (@ Max Pass Capacity)</b> | 14.5 | g CO <sub>2e</sub> /pass km |

### Overall Zero Emission Bus Performance

|                         |        |                         |   |       |
|-------------------------|--------|-------------------------|---|-------|
| <b>WTW GHG saving</b>   | 1037.8 | g CO <sub>2e</sub> / km | <b>Maximum Theoretical Zero Emission Range (km)</b> | 346.1 |
| <b>% WTW GHG saving</b> | 76%    | g CO <sub>2e</sub> / km | <b>Vehicle Energy Consumption (kWh/ km)</b>         | 0.90  |

**Approved as Zero Emission Bus? (50% GHG saving or more)**
**YES**

\* WTT : Well-to-Tank

\*\* TTW : Tank-to-Wheel

\*\*\* WTW : Well-to Wheel

**COMMENTS:** LBC = London Bus Cycle - Inner & Outer Urban phases of UKBC only. Certificate generated using simulated data from AVL Cruise M multi-physics simulation tool. Simulated certificate valid until 31/12/23 - following receipt of purchase order number for physical chassis dynamometer test. Results to be replaced from valid UKBC tests. Certificate will become invalid. Charger efficiency based on existing certified ADL E400EV and E200EV.

| Heating Requirement                             | Cell | Lower Saloon | Upper Saloon |
|---|------|--------------|--------------|
| <b>Target Temperatures ±2 (°C) :</b>            | 10   | 17           | 17           |
| <b>Average Temperatures across testing (°C)</b> | N/A  | N/A          | N/A          |

**Test Numbers:**

Certificate approved by:

On behalf of Bus manufacturer

Certificate Approved by:

On behalf of DfT / Zemo Partnership

Daniel Hayes 23.01.23

# ZEB\_Simulated\_Certificate\_ADL\_E400\_EV\_354 kWh\_November\_22\_V2

Final Audit Report

2023-01-23

|                 |  |
|-----------------|--|
| Created:        | 2023-01-23                                   |
| By:             | Zemo Partnership (admin@zemo.org.uk)         |
| Status:         | Signed                                       |
| Transaction ID: | CBJCHBCAABAAJDyImi7X2tiDGA6Rnr3DLqjEJXE7Xxla |

## "ZEB\_Simulated\_Certificate\_ADL\_E400\_EV\_354kWh\_November\_22\_V2" History

-  Document created by Zemo Partnership (admin@zemo.org.uk)  
2023-01-23 - 2:46:21 PM GMT- IP address: 81.170.24.16
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2023-01-23 - 2:46:35 PM GMT
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2023-01-23 - 3:09:50 PM GMT- IP address: 3.10.24.136
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Signature Date: 2023-01-23 - 3:10:31 PM GMT - Time Source: server- IP address: 3.10.24.136
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