Zemo Partnership | **Zero Emission Bus Certification ID:** **ZEB-CAETANO-ECITYGOLD-2022** | Approved Test facility UTAC

# Zero Emission Bus Certificate

| | | | | | | |
|---|---|---|---|---|---|---|
| *Customer:* | **CaetanoBus, S.A.** | | | **DYNAMOMETER SETTINGS** | | |
| *Customer Address:* | **4431-901 Vila Nova de Gaia** | *Telematics Capability* | Yes | Test Weight | 14375 | kg |
| *Test Purpose:* | **Zero Emission Bus Testing** | *Maximum Speed (km/h)* | 80 km/h | F° | 346.64 | N |
| *Vehicle Manufacturer:* | **CaetanoBus** | *Seated Capacity* | 31 | F¹ | -10.2804 | N/kmh |
| *Vehicle Model Name:* | **e.CityGold** | *Passenger Capacity* | 65 | F² | 0.52 | N/kmh ² |
| *Powertrain Technology* | **Battery Electric** | *Declared Unladen Weight (kg)* | 13530 | *Equivalent test passengers* | 16 | passengers |
| *Powetrain Configuration* | **Elbe Direct Drive** | *Gross Weight (kg)* | 17950 | *Measured Unladen Weight* | 13195 | 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** | **Forsee Power** | **Plug Type** | **DC CCS2** | **Fuel Cell Manufacturer** | **N/A** |
| **Battery Chemistry** | **NMC** | **Max Charge Capability (kW)** | **Up to 150kW** | **Fuel Cell Power Rating (kW)** | **N/A** |
| **Battery Installed Capacity (kWh)** | **385** | **Charger Compatibility** | **DC** | **Hydrogen Storage Capacity (kg)** | **N/A** |
| **Battery Usable Capacity (kWh)*** | **308** | **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*** | **80.92** | **g CO2e / MJ** | *Fuel Provider* | **UK market standard** | *WTT evidence* | **DBEIS Conversion 2021** |
| *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 | 6.53 | 1.02 | 133.86 |
| Inner Urban | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 2.98 | 1.20 | 157.88 |
| Rural | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 5.64 | 0.76 | 100.25 |
| *LBC Average* | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 9.51 | 1.07 | 141.57 |
| **UK BUS Average** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 15.15 | 0.93 | **122.27** |

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

| | | | | | |
|---|---|---|---|---|---|
| **Test Charger Used** | **22 kW** | **Total measured energy consumed on vehicle (kWh)[1]** | **90.90** | **Max ZE Range at 100% SOC (km)** | **331** |
| **Hydrogen Energy Over Test (kWh)** | **N/A** | **Measured grid energy during charging (kWh)** | **119.40** | **Max ZE Range at 80% SOC (km)** | **265** |
| **Hydrogen Delivered to Vehicle (kg)** | **N/A** | **Grid-to-Wheel efficiency (%)[2]** | **76%** | **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 $CO_2$e / km) | Electrical Energy (MJ / km) | Electricity WTT* GHG Emissions (g $CO_2$e / km) |
|---|---|---|---|---|
| Outer Urban | N/A | N/A | 4.82 | 389.95 |
| Inner Urban | N/A | N/A | 5.68 | 459.92 |
| Rural | N/A | N/A | 3.61 | 292.04 |
| *LBC Average* | N/A | N/A | 5.10 | 409.48 |
| **UK BUS Average** | N/A | N/A | 4.40 | 356.19 |

*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** | **356.2** | **g CO2e / km** | **Average Diesel GHG Emissions Equivalent** | **1092** | **g CO2e / km** |
| **WTW CO2 per passenger km (@ Max Pass Capacity)** | **5.5** | **g CO2e/pass km** | **WTW CO2 per passenger km (@ Max Pass Capacity)** | **16.8** | **g CO2e/pass km** |

### Overall Zero Emission Bus Performance

| | | | |
|---|---|---|---|
| **WTW GHG saving** | **736.1** | **Maximum Theoretical Zero Emission Range (km)** | **331.2** |
| **% WTW GHG saving** | **67%** | **Vehicle Energy Consumption (kWh/ km)** | **0.93** |
| ***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.

| **Heating Requirement** | **Cell** | **Lower Saloon** | **Upper Saloon** |
|---|---|---|---|
| **Target Temperatures ±2 (°C) :** | **10** | **17** | **17** |
| **Average Temperatures across testing (°C)** | 9.40 | 18.58 | N/A |

***Test Numbers:*** ML02019187 (24-June-20), ML02019188 (24-Jun-20), ML02019189 (24-Jun-20), ML02019189 (24-Jun-20)

*Certificate approved by:*
*On behalf of Bus manufacturer*

*Certificate Approved by:*
*On behalf of DfT / Zemo Partnership*