



Zero Emission Bus Certification ID:

ZEB-WRIGHTBUS-STREETDECK-HYDROLINER-FCEV-2023 Approved Test facility

N/A - Simulated

Simulated Zero Emission Bus Certificate

Customer:	Wrightbus			DYNAMOMETER SETTINGS				
Customer Address:	201 Galgorm Rd, Ballymena, County Antrim, BT42 1SA			Telematics Capability	Yes	Test Weight	14039	kg
Test Purpose:	Zero Emission Bus Testing			Maximum Speed (km/h)	80 km/h	F ⁰	N/A	N
Vehicle Manufacturer:	Wrightbus			Seated Capacity	63	F ¹	N/A	N/kmh
Vehicle Model Name:	StreetDeck Hydroliner FCEV			Passenger Capacity	86	F ²	N/A	N/kmh ²
Powertrain Technology	Hydrogen Fuel Cell			Declared Unladen Weight (kg)	12502	Equivalent test passengers	N/A	passengers
Powetrain Configuration	Hub Motors			Gross Weight (kg)	18425	Measured Unladen Weight	N/A	kg
Zero Emission Heating	HVAC utilising fuel-cell waste heat			GVW Check	OK	Number of consecutive tests completed	N/A	Tests
Battery Specification			Charging and Refuelling Capability			Hydrogen Specification		
Battery Manufacturer	Forsee Power		Plug Type	N/A		Fuel Cell Manufacturer	Ballard	
Battery Chemistry	LTO		Max Charge Capability (kW)	N/A		Fuel Cell Power Rating (kW)	85	
Battery Installed Capacity (kWh)	27		Charger Compatibility	N/A		Installed Hydrogen Storage Capacity (kg)	26.9	
Battery Usable Capacity (kWh)*	13.5		Charge time from 20-80% SOC**	N/A		Usable Hydrogen Storage Capacity (kg)*	25.0	

* Recommended manufacturer guideline, subject to warranty

** Based on manufacturer estimate

Declared fuel, properties and source plus carbon conversion factors

Well-to-Tank Factor:	Electricity	N/A	g CO _{2e} / MJ	Fuel Provider	UK market standard	WTT evidence	Zemo Calculated
Well-to-Tank Factor:	Hydrogen	7.22	g CO _{2e} / MJ	Capacity of Tanker (kg)	N/A	Fuel Type / Pathway	Off-site Electrolyser
Energy Density	Hydrogen	120	MJ / kg	Transport Distance of Hydrogen (km)	200 km	Energy Source	Renewable

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 ₂ O (g/km)*	Total Fuel Consumption (kg)	Vehicle Fuel Consumption (kg/km)	Fuel Consumption (kg/100km)
Outer Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.43	0.067	6.69
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.21	0.084	8.42
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.46	0.062	6.20
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.65	0.072	7.24
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.11	0.067	6.72

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

Test Charger Used	N/A	Total measured energy consumed on vehicle (kWh) ¹	N/A	Max ZE Range at 100% Usable Tank Capacity (km)	372
Hydrogen Energy Over Test (kWh)	N/A	Measured grid energy during charging (kWh)	N/A	Max ZE Range at 80% Usable Tank Capacity (km)	298
Hydrogen Delivered to Vehicle (kg)	N/A	Grid-to-Wheel efficiency (%) ²	N/A	Test Distance Travelled (km)	N/A

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 CO₂ equivalent 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)	Data Generated by (On behalf of Test facility):	Date:
Outer Urban	8.03	57.96	N/A	N/A	Data Approved by:	Date:
Inner Urban	10.10	72.95	N/A	N/A		
Rural	7.44	53.72	N/A	N/A		
LBC Average	8.69	62.73	N/A	N/A		
UK BUS Average	8.06	58.22	N/A	N/A		

Zero Emission Bus Certificate Summary

Test Vehicle		Average Euro VI Diesel Equivalent	
Greenhouse Gas Emissions: Well-to-Wheel	58.2 g CO _{2e} / km	Average Diesel GHG Emissions Equivalent	1290.1 g CO _{2e} / km
WTW CO ₂ per passenger km (@ Max Pass Capacity)	0.7 g CO _{2e} /pass km	WTW CO ₂ per passenger km (@ Max Pass Capacity)	15.0 g CO _{2e} /pass km
Overall Zero Emission Bus Performance			
WTW GHG saving	1231.9 g CO _{2e} / km	Maximum Theoretical Zero Emission Range (km)	372.0
% WTW GHG saving	95% g CO _{2e} / km	Fuel Consumption (kg / 100 km)	6.72
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 fully-validated multi-physics simulation tool due to lack of available physical hydrogen testing and measurement facility. Certificate will be replaced with valid UKBC test as and when this method of certification becomes available. Simulated certificate is valid until 31/12/23, at which point it will be reviewed. Actual usable hydrogen storage will be slightly less than gross hydrogen storage capacity due to technical reasons relating to minimum allowable working pressures.

Test Numbers:

Certificate approved by:
On behalf of Bus manufacturerBrian Maybin
06.07.2023Certificate Approved by:
On behalf of DfT / Zemo PartnershipTim Griffen
04.07.2023

Note: Hydrogen Fuel Pathway - Off-Site, On-Shore Electrolysis, using Renewable Electricity. Compressed gas delivery (200km), 350bar dispense. For more information on hydrogen production pathways, please contact hello@zemo.org.uk



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Vehicle Manufacturer:	Wrightbus			Seated Capacity	63	F ¹	N/A	N/kmh
Vehicle Model Name:	StreetDeck Hydroliner FCEV			Passenger Capacity	86	F ²	N/A	N/kmh ²
Powertrain Technology	Hydrogen Fuel Cell			Declared Unladen Weight (kg)	12502	Equivalent test passengers	N/A	passengers
Powetrain Configuration	Hub Motors			Gross Weight (kg)	18425	Measured Unladen Weight	N/A	kg
Zero Emission Heating	HVAC utilising fuel-cell waste heat			GVW Check	OK	Number of consecutive tests completed	N/A	Tests
Battery Specification			Charging and Refuelling Capability			Hydrogen Specification		
Battery Manufacturer	Forsee Power		Plug Type	N/A		Fuel Cell Manufacturer	Ballard	
Battery Chemistry	LTO		Max Charge Capability (kW)	N/A		Fuel Cell Power Rating (kW)	85	
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Battery Usable Capacity (kWh)*	13.5		Charge time from 20-80% SOC**	N/A		Usable Hydrogen Storage Capacity (kg)*	25.0	

* Recommended manufacturer guideline, subject to warranty

** Based on manufacturer estimate

Declared fuel, properties and source plus carbon conversion factors

Well-to-Tank Factor:	Electricity	N/A	g CO _{2e} / MJ	Fuel Provider	UK market standard	WTT evidence	Zemo Calculated
Well-to-Tank Factor:	Hydrogen	139.95	g CO _{2e} / MJ	Capacity of Tanker (kg)	N/A	Fuel Type / Pathway	Off-site Electrolyser
Energy Density	Hydrogen	120	MJ / kg	Transport Distance of Hydrogen (km)	200 km	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 ₂ O (g/km)*	Total Fuel Consumption (kg)	Vehicle Fuel Consumption (kg/km)	Fuel Consumption (kg/100km)
Outer Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.43	0.067	6.69
Inner Urban	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.21	0.084	8.42
Rural	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.46	0.062	6.20
LBC Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.65	0.072	7.24
UK BUS Average	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.11	0.067	6.72

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

Test Charger Used	N/A	Total measured energy consumed on vehicle (kWh) ¹	N/A	Max ZE Range at 100% Usable Tank Capacity (km)	372
Hydrogen Energy Over Test (kWh)	N/A	Measured grid energy during charging (kWh)	N/A	Max ZE Range at 80% Usable Tank Capacity (km)	298
Hydrogen Delivered to Vehicle (kg)	N/A	Grid-to-Wheel efficiency (%) ²	N/A	Test Distance Travelled (km)	N/A

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 CO₂ equivalent 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	8.03	1123.52	N/A	N/A
Inner Urban	10.10	1414.05	N/A	N/A
Rural	7.44	1041.23	N/A	N/A
LBC Average	8.69	1215.89	N/A	N/A
UK BUS Average	8.06	1128.56	N/A	N/A

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	1128.6	g CO _{2e} / km	Average Diesel GHG Emissions Equivalent	1290.1	g CO _{2e} / km
WTW CO ₂ per passenger km (@ Max Pass Capacity)	13.1	g CO _{2e} /pass km	WTW CO ₂ per passenger km (@ Max Pass Capacity)	15.0	g CO _{2e} /pass km
Overall Zero Emission Bus Performance					
WTW GHG saving	161.6	g CO _{2e} / km	Maximum Theoretical Zero Emission Range (km)	372.0	
% WTW GHG saving	13%	g CO _{2e} / km	Fuel Consumption (kg / 100 km)	6.72	
Approved as Zero Emission Bus? (50% GHG saving or more)			NO (Based on UK Grid Electricity)		

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

Test Numbers:

Certificate approved by: On behalf of Bus manufacturer	Brian Maybin 06.07.2023	Certificate Approved by: On behalf of DfT / Zemo Partnership	 Tim Griffen 04.07.2023
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