

Update on Long Distance Zero Emission Coaches

UKCOA Members Meeting

13th September 2022



**Zemo
Partnership**
Accelerating Transport to Zero Emissions



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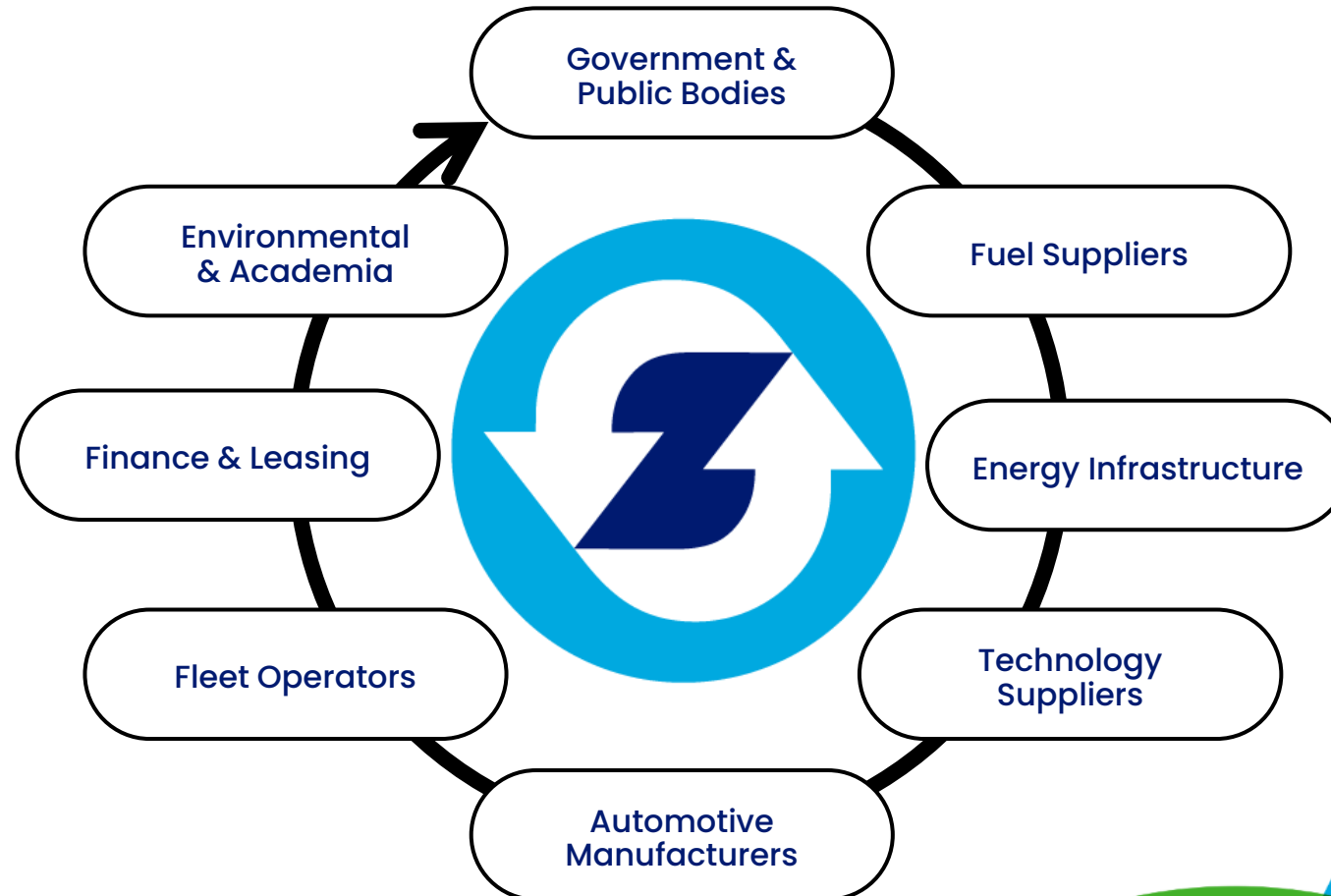
Welcome to the most experienced sustainable mobility partnership in the UK.

We bring government, industry and the widest range of expert stakeholders together to accelerate transport to zero emissions.

We work tirelessly with our members to shape government policy, create influential initiatives and provide expert advice and guidance to those working to reduce transport emissions.



We provide an independent platform for debate and cross-sector collaboration



Just some of our 230+ Zemo members:



West Midlands
Combined Authority



Nottinghamshire
County Council



JOHN LEWIS
PARTNERSHIP



First Bus

Stagecoach LONDON



*
ARRIVAL

UK pia

DENNIS EAGLE

Office for
Zero Emission
Vehicles

Department
for Transport

Go-Ahead



SMMT
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iam
RoadSmart



mint green
sustainability

RAC
Foundation

elementenergy

Transport for
Greater Manchester

From freight, fleet and fuels to bus operators and energy suppliers

Zemo working groups:



Buses & Coaches

Action programmes to speed the introduction of zero emission buses in the UK by working with passenger transport companies and local authorities



Cars

Working with manufacturers, fleet operators, environment and consumer groups to accelerate the adoption of zero emission cars.



Fuels

We explore measures to increase the adoption of sustainable low carbon fuels such as biofuels and renewable hydrogen.



Commercial Vehicles

For manufacturers, freight transport operators, technology suppliers, technical experts and others interested in accelerating the transition to cleaner, greener road freight.



Energy Infrastructure

Formed to make suggestions to Government and industry to ensure that the GB energy system is ready for and able to facilitate and exploit the mass take up of electric vehicles.



Collaborative Initiatives

Joint working group projects where content crosses over, overseen by the members' council.

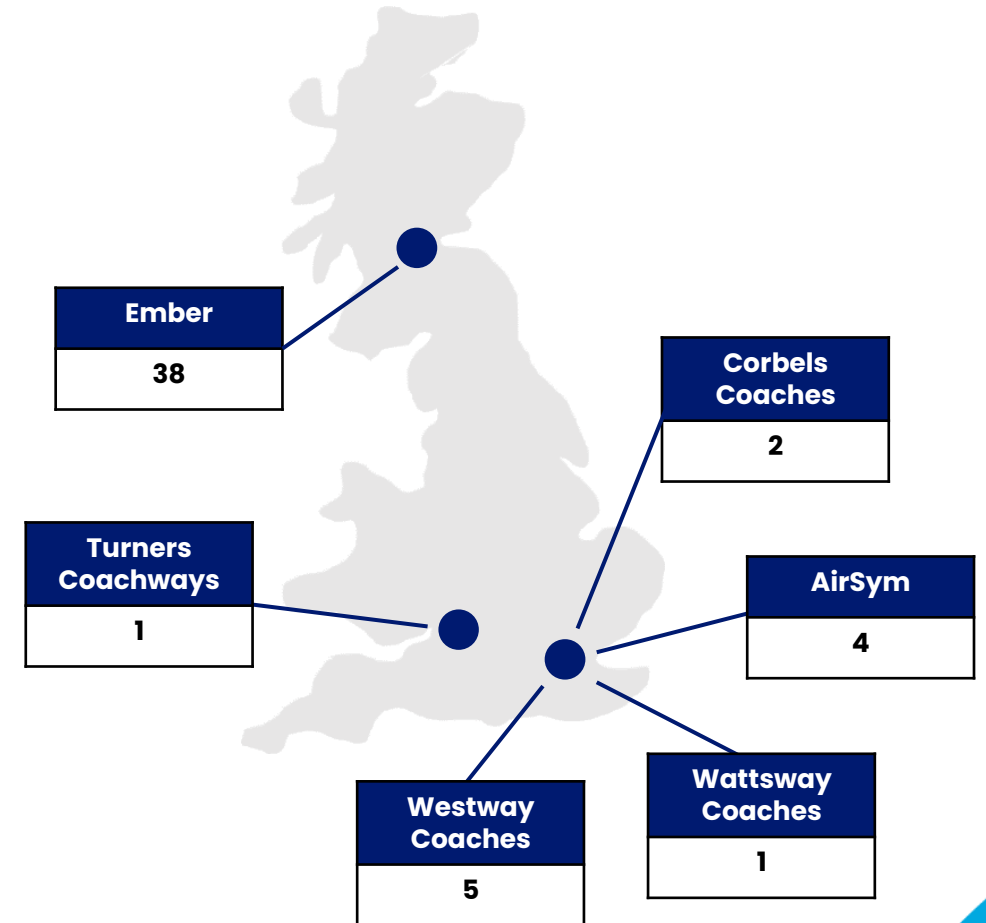
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1. Zero Emission Coach (ZEC) uptake in the UK
2. Funding
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5. Zemo Partnership Voluntary Zero Emission Coach Certification (ZEC) Scheme
6. Questions?

Zero Emission Coach (ZEC) uptake in the UK

Fledgling market in the UK

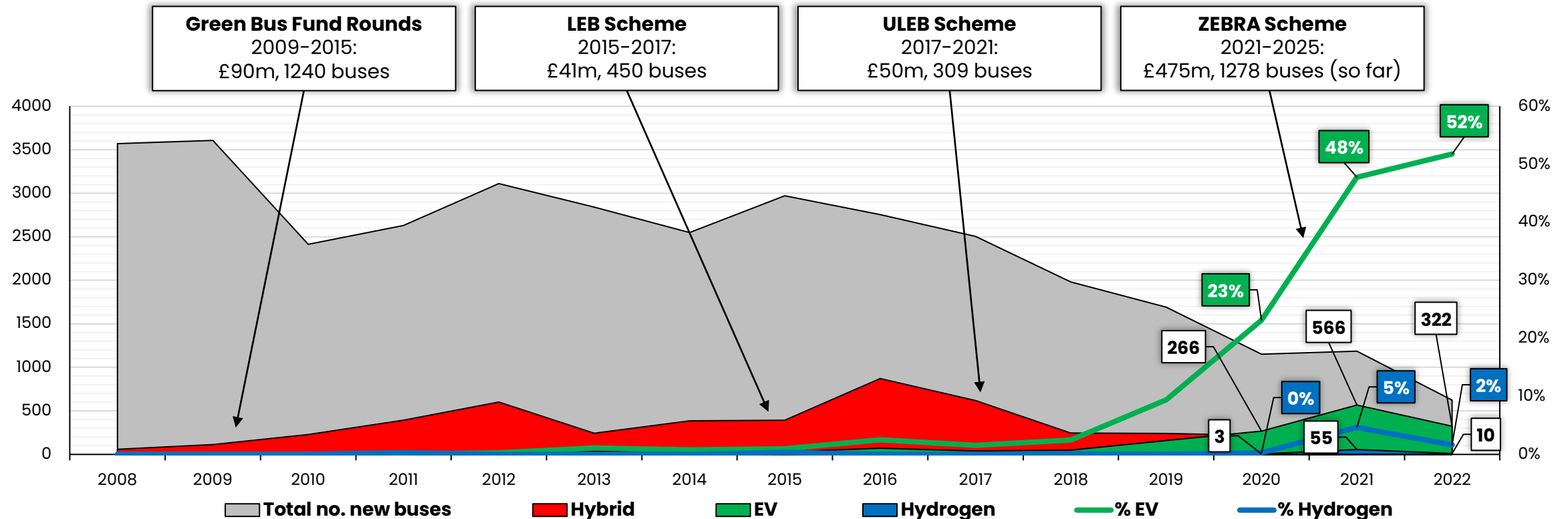
- ⌚ Since 2019, just **over 50 zero emission coaches** have been ordered in the UK – 18 of these are currently in-service.
- ⌚ These coaches are being deployed in a variety of scenarios including on **scheduled bus services, domestic tourism,** and **air-side shuttle work at airports.**
- ⌚ All of the vehicles ordered to date are the Yutong TCe12 battery-electric coach – the only zero emission coach currently available in the UK.
- ⌚ Despite registrations beginning to grow, zero emission coaches remain a **tiny minority** of overall annual coach registrations.
- ⌚ This compares to **over 50%** of all new bus registrations being zero emission in 2021 (*Zemo Partnership estimate*).
- ⌚ In Europe, there has been limited uptake of electric coaches with some experience in France and Germany.



Funding – what’s missing?

Grants drive competition and technological development

Development of UK bus market highlights impact of grants on ZEB uptake



Total of £656m investment in bus industry over 15 years – **Coach sector is only sector not eligible for DfT grants.**

Where are we now?

Scotland leading the way!

- Transport Scotland is continuing to support zero emission coaches with capital grants – having done so through SULEBS and Scottish Zero Emission Bus (ScotZEB) Challenge Fund Phase 1.
- Latest round offered up to **£180k for an EV coach** and **£230k for a hydrogen FCEV coach**. Funding also supported cost of supporting infrastructure.
- 5-year warranty and Zemo Partnership certification required for qualification, and the vehicles must operate in Scotland for 5 years.
- Indicative guidance was recently published on **ScotZEB Phase 2**, with even broader support for zero emission coaches.
- Funding will support zero emission coaches (and infrastructure) operating in Scotland for:
 - Public service routes
 - Home to School transport
 - Community transport
 - Transport to Health and Social Care
 - Private Hire Coaches
 - Tourist Coaches
- ‘Green financing’** and **repowering** may provide coach operators other avenues to electrify their fleets (both of which are also supported through ScotZEB 2).



Ultra Low Emission Bus Certificate										
Customer: Pelican Bus And Coach		Approved Test Facility:				DYNAMOMETER SETTINGS				
Customer Address: Westfield Road, 48/49 Lane, Callerton, WF15 8JH		Maximum Test Weight (kg)				Maximum Test Speed (km/h)				
Test Purpose: SULEBS Testing		Equivalent Test Category: 25				Test Weight: 15000				
Vehicle Make/Model: Yutong		Vehicle Category: EV		Year: 2022		Test Date: 13/08/2022		Test Location: 1000		
Vehicle Type & Number: TCR17		Passenger Capacity: 30		EV Range (km): 180		EV Power (kW): 110		EV Energy Consumption (kWh/100km): 1.2		
Engine: EV		Onboard Fuel Storage (kg): 0		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Transmission: N/A		Drive Shaft Energy (kg): 0		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Euro VI CO2Emission (g/kWh): N/A		Manufacturer Code: 45W-0202		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Declaration of fuel, properties and other carbon conversion factors										
Net Heating Value: 120.00 MJ/Ltr		Fuel Provider: UK Market standard		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Gross-to-Net Factor: 0.95		Fuel Provider: UK Market standard		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Net-to-Gross Factor: 0.95		Fuel Provider: UK Market standard		Fuel Type: H2		FCEV Range (km): 100		FCEV Power (kW): 110		
Emissions and Energy consumption results from approved test facility - Average of tests										
Test Phase	HC (g/kWh)	CO (g/kWh)	NOx (g/kWh)	PM (g/kWh)	CO2 (g/kWh)	CH4 (g/kWh)	N2O (g/kWh)	Energy Consumption (kWh/100km)	Energy use (kWh/100km)	Charging time (min)
Outer Urban	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	134.717
Inner Urban	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	185.222
Urban	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	159.969
100% Average	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	144.314
100% Average	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	125.438
Zero Emissions (Z.E.) Range: Energy consumption and charging efficiency										
Total measured energy consumed on vehicle (kWh)		Charging efficiency (%)		Usable Battery Capacity (kWh)		Max Theoretical Z.E. Range (km)		Z.E. Range (km)		Z.E. Range (km)
0.000		100%		0.000		0.000		0.000		0.000
Total Fuel-to-Wheel GHG CO2 equivalent										
Test Phase	CO2 (g/kWh)	CH4 (g/kWh x 25)	N2O (g/kWh x 298)	Fuel THW** GHG CO2 Equivalent (g/kWh)						
Outer Urban	0.000	0.000	0.000	0.000						
Inner Urban	0.000	0.000	0.000	0.000						
Urban	0.000	0.000	0.000	0.000						
100% Average	0.000	0.000	0.000	0.000						
100% Average	0.000	0.000	0.000	0.000						
Calculated total Well-to-Wheel GHG CO2 equivalent emissions over test										
Test Phase	Fuel Energy (MJ/kWh)	Fuel THW** GHG Emissions (g CO2e/kWh)	Electrical Energy (MJ/kWh)	Electrical THW** GHG Emissions (g CO2e/kWh)	Measured Fuel THW** GHG Emissions (g CO2e/kWh)	Total THW** GHG Emissions (g CO2e/kWh)				
Outer Urban	N/A	N/A	4.35	124.81	0.000	129.16				
Inner Urban	N/A	N/A	6.57	184.61	0.000	191.18				
Urban	N/A	N/A	5.46	154.71	0.000	160.17				
100% Average	N/A	N/A	5.33	149.71	0.000	155.04				
100% Average	N/A	N/A	5.33	149.71	0.000	155.04				
Date Generated by (On behalf of Test Facility): P.P. Date: 14/08/2022 Date Approved by: Date: 13/08/2022										
Ultra Low Emission Bus Certificate Summary										
GHG Well-to-Wheel	282.7	g CO2e/kWh								
Sum of Average Diesel Equivalent	282.0	g CO2e/kWh								
WTW GHG saving (Equivalent with Euro VI diesel equivalent)	0.000	%								
% WTW GHG saving (Equivalent with Euro VI diesel equivalent)	0.000	%								
Max Theoretical Zero Emission Range (km)	121.5	km								
WTW CO2 per passenger km (See Test Report)	2.2	g CO2e/pass km								
Approved as Ultra Low Emission Bus (100% saving or more)	YES									
Comments: BSE Decelerator was turned off during all testing. Windows could not be opened during testing.										
Target Temperatures at (°C)		Call	Lower Subson	Upper Subson						
Average Temperature across testing (°C)		9.5B	16.7	N/A						
Test Numbers: M620019104 (13-Aug-20), M620019113 (13-Aug-20), M620019114 (13-Aug-20), M620019115 (13-Aug-20), M620019116 (13-Aug-20)										
Certificate approved by:		Certificate Approved by:		Date: 13/08/2022						
On behalf of Bus manufacturer:		On behalf of Zemo Partnership: 20/08/2022								

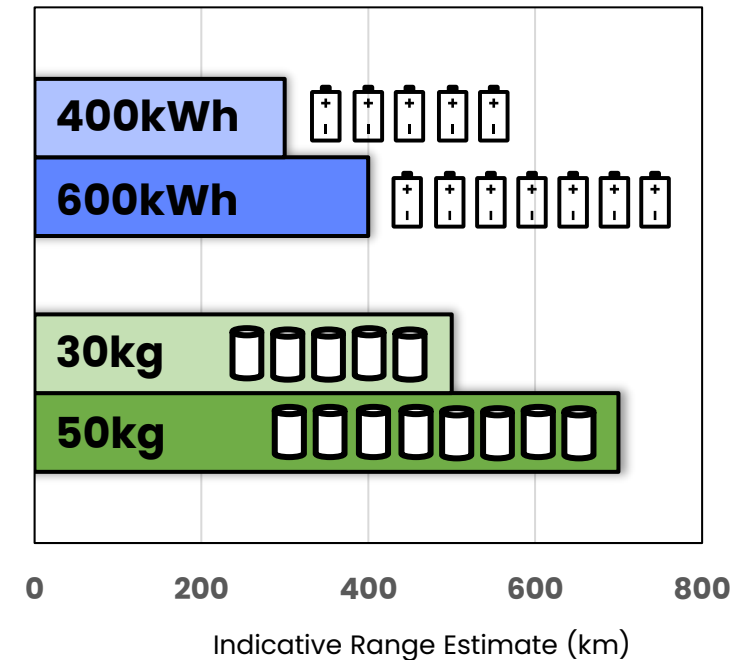
Yutong TCE12 Certificate

Technology challenges....and solutions!

Matching the range and carrying capacity of diesel coaches

- ⌚ Diesel coaches have the **flexibility of both range and carrying capacity** (luggage space and passenger capacity).
- ⌚ Zero emission coaches face the challenge of matching that range **without impeding on the carrying capacity** of the coach.
- ⌚ Today OEMs face a challenge in packaging the necessary number of battery packs and/or hydrogen storage tanks needed to meet range requirements, into existing space under the cabin (reduced luggage).
- ⌚ Some changes to energy storage systems could help to solve packaging challenges:
 - **700 bar hydrogen storage** tank system and refuelling, instead of 350 bar (as is common now). This will allow fewer tanks to be used for the same mass of hydrogen stored (higher density) – effectively doubles range at same storage capacity, but at higher cost.
 - **Liquid hydrogen storage** and refuelling, instead of gaseous storage of hydrogen. This will allow fewer tanks to be used for the same mass of hydrogen stored (higher density) – increases range but comes with significant need for cooling (-273°C).
 - **Opportunity / rapid charging** capability to allow fewer/ smaller batteries.

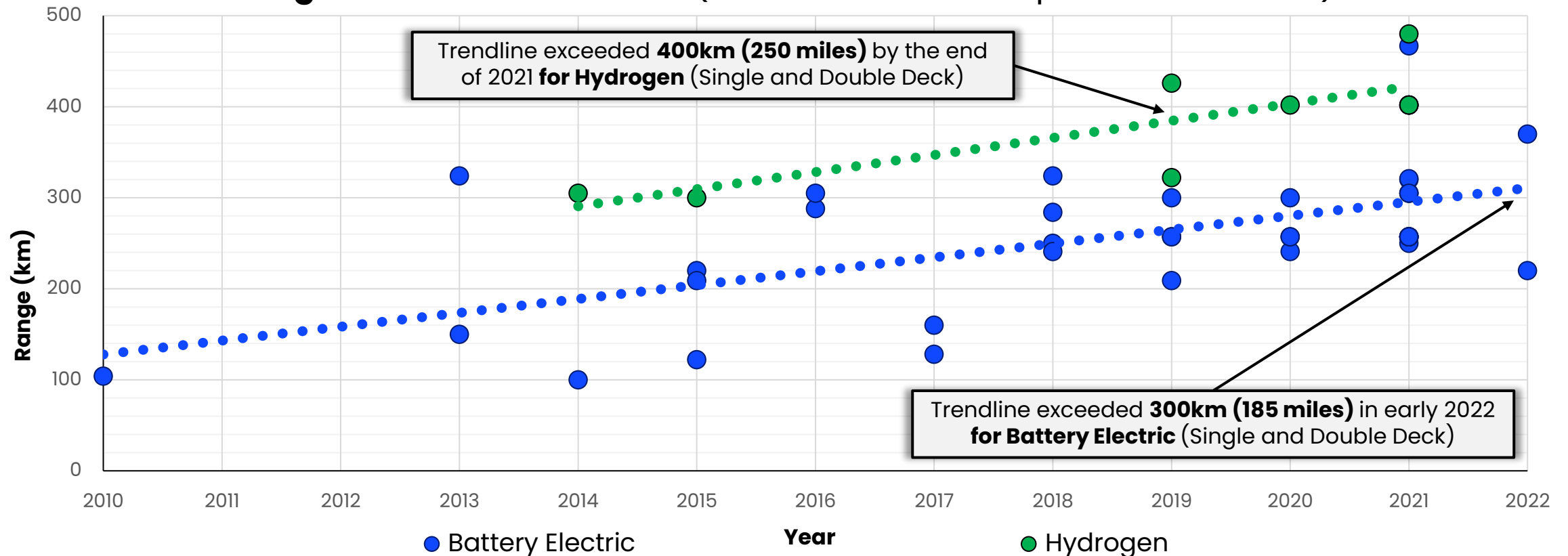
Indicative Range Estimates of Zero Emission Coach



Range improvements

Ranges of ZEBs have increased year-on-year since inception

Range of UK ZEBs since 2010 (includes new and repowered vehicles)



ZEBs are now mainstream having only too recently been seen as technology which wouldn't meet the needs of operators.

What can we do now to support the transition?

Tackle the 'low hanging fruit'

- ⌚ For operators, what is possible today for one vehicle / one service?
- ⌚ **Early adopters are already demonstrating** that some services are suitable for zero emission coaches today.
- ⌚ Zero emission coach operation is possible today. In practice this means scenarios such as:
 - Short distance scheduled services (up to 100 miles) with top-up charging
 - 'Back to base' educational transport
 - 'Back to base' day trip / domestic tourism work
- ⌚ The focus should be on **what services can be achieved today**, not what can't be achieved.
- ⌚ Following in the footsteps of buses – early adopters focused on **'low hanging fruit' routes** in urban areas where mileage was achievable with the technology available at the time.
- ⌚ Operators and manufacturers went through a **valuable period of knowledge building** helping to develop zero emission buses, feeding mass adoption occurring today (over 1,500 in service).



Zero Emission Coach Certification Scheme

Zemo Partnership 'setting the standard'



- ④ The Zero Emission Bus testing and certification scheme, developed and accredited by Zemo Partnership, supports UK national funding schemes.
- ④ ZEB testing and accreditation is required to ensure public money supports proven technologies that will perform in-service. Certificates enable operators to understand the expected performance, determined through testing over a representative cycle (three phases, heating/cooling impact & passenger loading).
- ④ To achieve accreditation and certification, vehicles must:
 - have no combustion engines on-board (including diesel heaters)
 - produce no regulated emissions from the tailpipe(s)
 - achieve a 50% well-to-wheel greenhouse gas saving compared to a conventional Euro VI diesel over the UK Bus Cycle.
- ④ A major challenge in the transition to zero emission coach technologies is understanding the performance and capabilities of new zero emission models.
- ④ This project seeks to support market understanding by creating an **independent, voluntary certification scheme** that demonstrates key details about ZE coaches, such as **energy storage capacity, estimated range and energy consumption.**

Zero Emission Bus Certificate

Customer: Pelican Bus and Coach
 Customer Address: Westfield Garage, Aylesbury, Bucks, MK45 1JH
 Fuel System: Zero Emission Bus Testing
 Vehicle Manufacturer: Tazaki
 Vehicle Model Name: TAZAKI
 Powertrain Technology: Battery Electric
 Powertrain Configuration: Drive Shaft
 Zero Emission Vehicle: BEV
 Battery Manufacturer: CATL
 Battery Chemistry: LFP
 Battery Installed Capacity (kWh): 281
 Battery Usable Capacity (kWh): 247

Declared fuel, properties and source plus carbon conversion factors

Emissions and Energy consumption results from approved test facility - Average 4 tests

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

Calculated total Well-to-Wheel GHG CO₂ equivalent emissions over test

Zero Emission Bus Certificate Summary

Test Vehicle: 366.6 g CO₂/km
 Average Euro VI Diesel Equivalent: 961 g CO₂/km
 WTW CO₂ per passenger km (at Max Pass Capacity): 1.3 g CO₂/passenger km
 WTW CO₂ per passenger km (at Max Pass Capacity): 18.9 g CO₂/passenger km
 Overall Zero Emission Bus Performance: 84.6 g CO₂/km
 Maximum Theoretical Zero Emission Range (km): 274.8
 % WTW GHG saving: 61%
 Vehicle Energy Consumption (kWh/km): 0.9

Zero Emission Bus Certificates

Thank you

Any questions? Please get in touch

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Interested in joining the Partnership?

Please contact: Members@Zemo.org.uk



**Zemo
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Accelerating Transport to Zero Emissions

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