



**Zemo
Partnership**
Accelerating Transport to Zero Emissions

Zero Emission Bus Workshop

London, 21st April 2022

In partnership with:



Metroline



**Zemo
Partnership**
Accelerating Transport to Zero Emissions

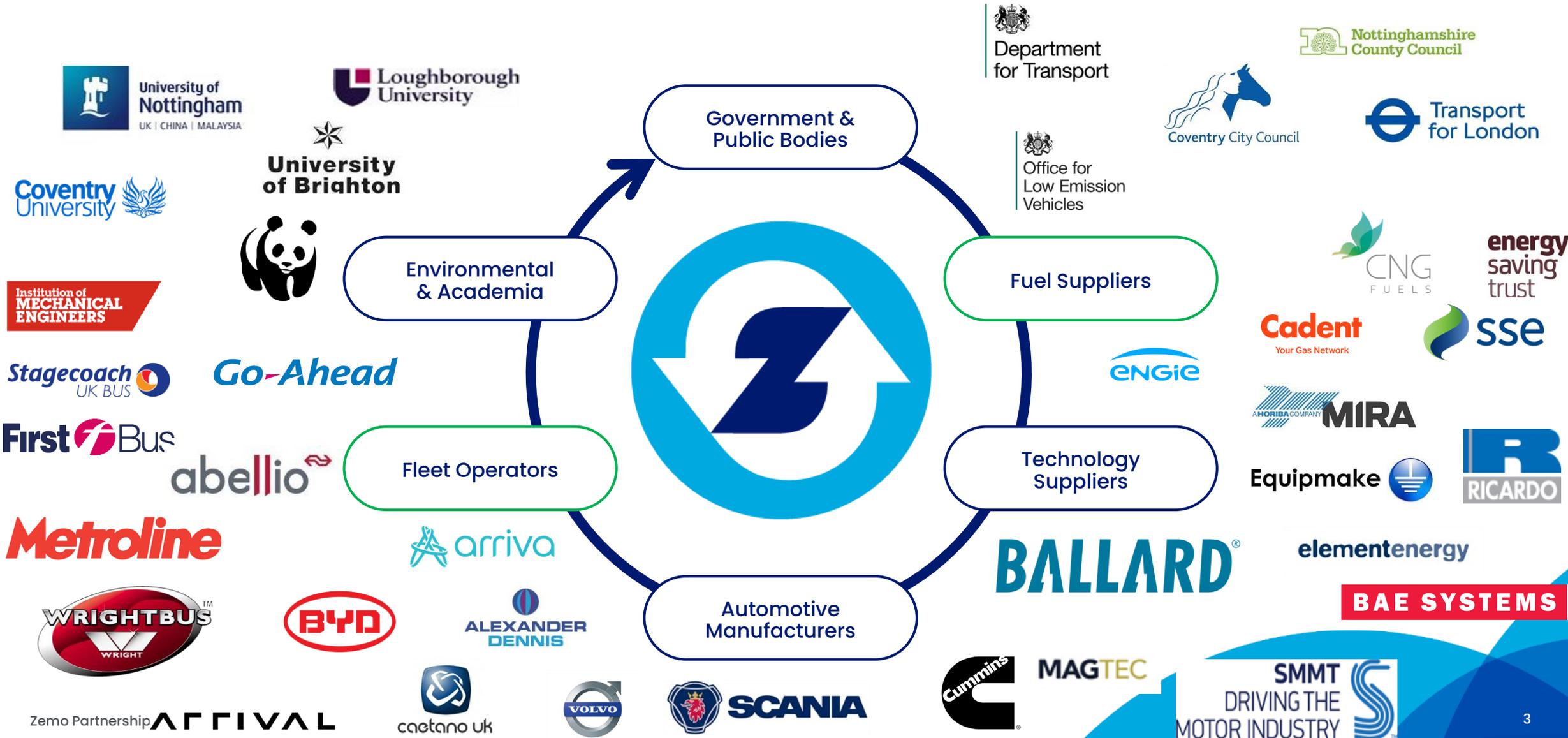
Zero Emission Bus Workshop London

Hydrogen Fuel Cell Buses

Document prepared by Zemo Partnership

Crown Plaza Hotel, Hanger Lane, London 21st April 2022

We are a **public-private partnership** between UK Government and industry helping to **accelerate the shift to a net zero transport system in the UK** through innovative policy development



Our working groups



Working Groups are at the heart of our member action on buses, passenger cars, fuels, commercial vehicles and energy infrastructure.



Buses

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

Daniel.Hayes@zemo.org.uk



Cars

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

Alexander.Thomson@zemo.org.uk



Fuels

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

Gloria.Esposito@zemo.org.uk



Commercial Vehicles

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

Brian.Robinson@zemo.org.uk



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.

Jonathan.Murray@zemo.org.uk



Collaborative Initiatives

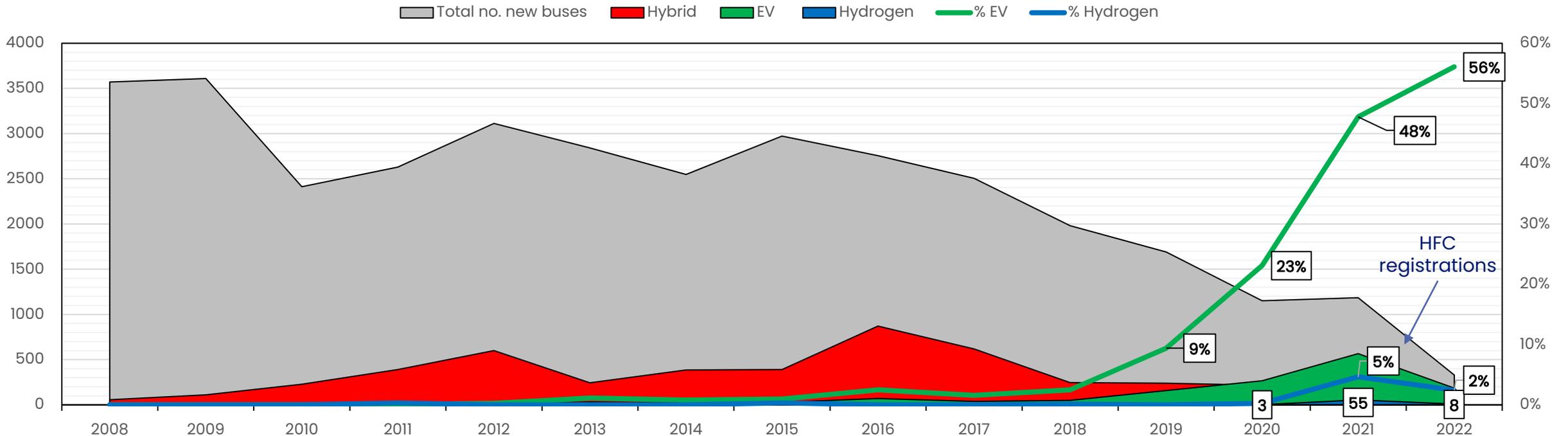
Joint working group projects where content crosses over, overseen by the members' council.

James.McGeachie@zemo.org.uk

State of the UK Bus Industry



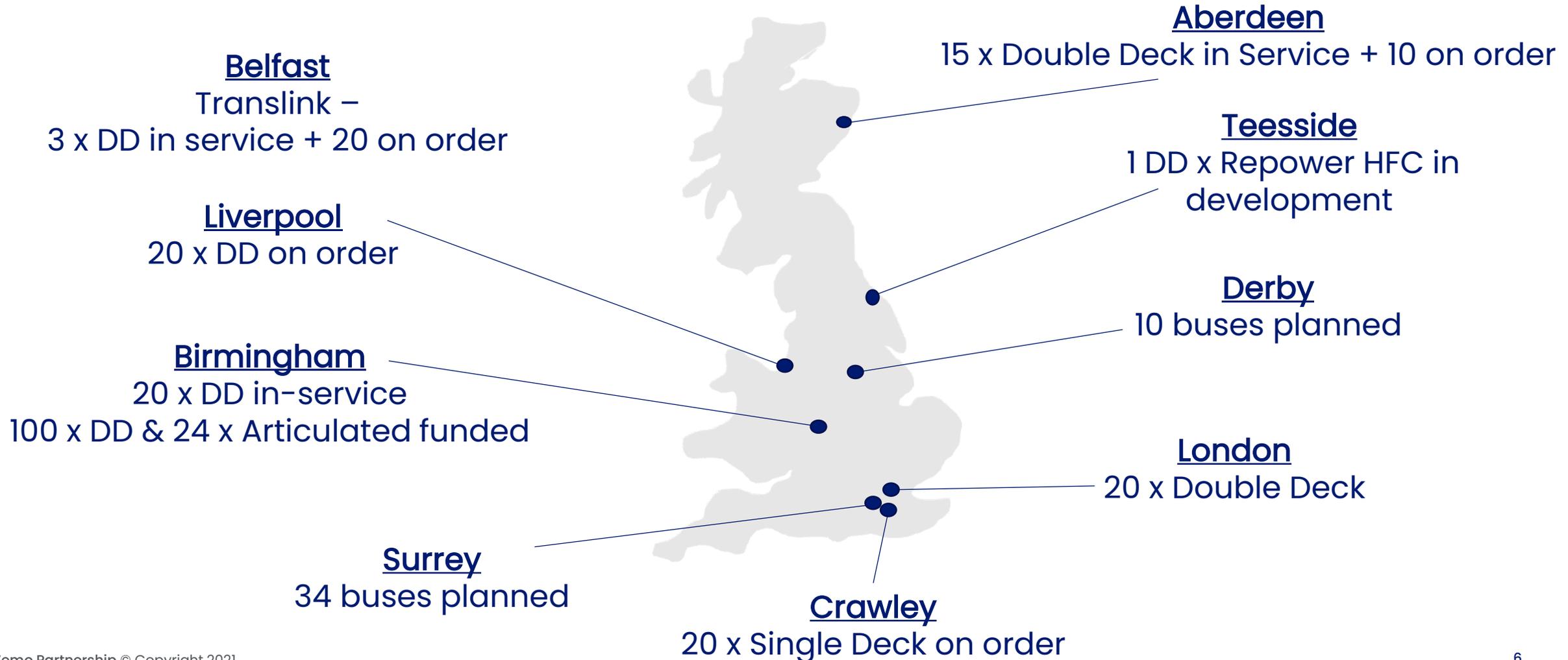
Over 1,500 Zero Emission Buses in service



- Historic average of 2,000–3,000 buses registered annually but market shrinking since 2015
- UK bus industry leading the adoption of zero emission – 53% of buses registered in 2021 were zero emission
- Major uncertainty around passenger numbers post covid makes investment planning challenging

UK Hydrogen Bus Fleets

66 Hydrogen Fuel Cell buses in service, 230 funded/planned



Major Hydrogen Infrastructure Plans



Government Hydrogen Strategies

England: 5 GW Hydrogen Production Capacity by 2030

Scotland : 5 GW Hydrogen Production Capacity by 2030

Glasgow (Whitelee)
20MW Electrolyser

Liverpool
HyNet North West – 1GW Blue Hydrogen



Aberdeen

Dolphyn – up to 200MW Electrolyser with Floating Wind Farm

Teeside

Hydrogen Transport Hub
H2 Teeside – 1GW Blue Hydrogen
HyGreen – 60MW Electrolyser

Humberside

Hydrogen to Humber
– x MW Blue Hydrogen

Kent

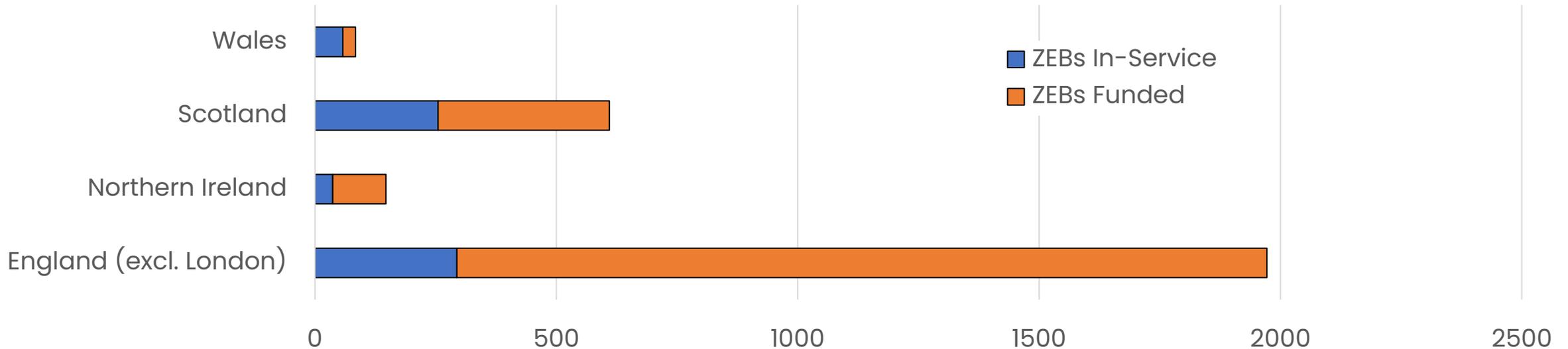
4-10MW Electrolyser

Emerging trend that hydrogen production is centralised and then transported to depots for refuelling.

Government Funding Driving ZEB uptake



Almost 3,000 Zero Emission Buses in service or funded (excl London).



Future ZEB Funding

- England – £205m allocated for ZEBs (2022-2025)
- Scotland – £58m allocated for ZEBs (2022-2025)
- Other Funding Pots – City Region Sustainable Transport Settlements, Levelling Up Funding, Bus Service Improvement Plans, etc

ZEB Certificates & BSOG ZEB in England



Zemo publishing Zero Emission Bus Certificates for BSOG & Grant Funding

- Zemo have defined a Zero Emission Bus
- Demonstrate energy efficiency & well-to-wheel GHG emissions over UK Bus Cycle.
- Certificates published on Zemo website
- Details **energy efficiency**, estimated range, battery capacity, fuel storage etc.
- Certificates used for claiming 22p/km in England under Bus Service Operators Grant (BSOG)
- Certs also required for successful ZEBRA and ScotZEB Challenge Fund funding.



Buses & Coaches

Projects ▾ [Low, Ultra Low & Zero Emission Buses](#) ▾ [Low Emission Coaches](#) | [Publications & Resources](#)

You are here: [Home](#) > [Work With Us](#) > [Buses & Coaches](#) > [Low, Ultra Low & Zero Emission Buses](#) > Zero Emission Bus Ce

Zero Emission Bus Certificates

This page displays the details of the Zero Emission Bus Certificate for the bus model specified. The certificate is valid for use in the UK, Scotland and Northern Ireland. It is a requirement for BSOG uplift in England.

ZEB accreditation is required for in-service. Certificate reference sheet.

Zero Emission Bus Certificate									
Customer: Alexander Dennis		Manufacturer: Alexander Dennis		Model: A55EV		Year: 2021		Certificate ID: ZEB-ADL-0308-2021	
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 CO ₂ e equivalent emissions									
Zero Emission Bus Certificate Summary									

<https://www.zemo.org.uk/work-with-us/buses-coaches/low-emission-buses/zero-emission-bus-certificates.htm>

Renewable Fuels Assurance Scheme



Independent certification of liquid and gaseous fuels

- Zemo verify claims made by companies supplying renewable fuels to operators regarding their **product's GHG emission savings and provenance** of raw material feedstocks.
- Aligns with UK Renewable Transport Fuels Obligation (RTFO)
- Helps operators choose the lowest carbon fuel supplier
- Provides greater detail of greenhouse gas emissions from individual fuel suppliers, ensuring accurate and representative information for company carbon reporting
- Example renewable fuel types include biodiesel, hydrotreated vegetable oil, biomethane, renewable hydrogen



<https://www.zemo.org.uk/work-with-us/fuels/the-renewable-fuels-assurance-scheme.htm>

Upcoming Zemo Activity

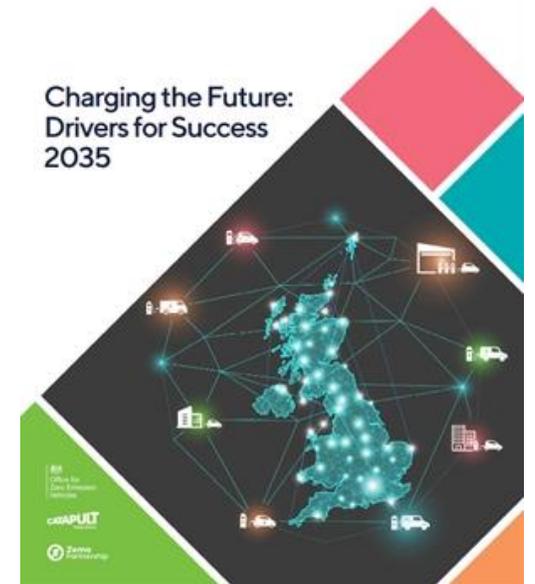


[Visit Zemo website to register for upcoming events](#)

- EV Energy Taskforce Webinars – Green Infrastructure Week
25th –29th April
- Bus WG meeting at Millbrook, Bedford– 28th April
 - Physical in-person event with tour of test facilities .
- Commercial Vehicle WG – 10th May (TBC)
- ITT Hub – 11, 12th May
- Future ZEB workshops in 2022
 - Newport, Manchester, Birmingham & more
- ZE Truck/Van Workshops in 2022



Charging the Future:
Drivers for Success
2035



UK funding streams for Zero Emission Buses



Historic and current pots for ZEB funding by country

Funding Scheme	No. of EVs Funded	Total EV Funding	No. of HFCs Funded	Total HFC Funding
England				
Green Bus Fund	97	£8,605,794.92		
LEBS 1.0	80	£13,388,283.40	40	£2,474,000.00
LEBS 1.5	43	£6,357,182.00		
ULEB 1.0	235	£35,815,780.00	20	£4,360,435.00
All Electric Bus Town	300	£50,000,000.00		
Transforming Cities	18	£7,100,000.00	20	£12,400,000.00
ZEBRA Fast Track	335	£70,900,000.00		
ZEBRA Standard Track	819	£168,000,000.00	124	£30,000,000.00
£205m allocated for 2022-25. <i>No scheme designed yet.</i>	970*	£205,000,000.00		
Scotland				
Scottish Green Bus Fund 1-4	1	£96,288.00		
Scottish Green Bus Fund 5-8	10	£1,152,431.00		
SULEBS 1.0	57	£10,139,412.00		
SULEBS 2.0	215	£40,543,348		
ScotZEB Challenge Fund	276	£62,000,000		
£58m allocated to 2022-2025	250	£58,000,00		
Wales				
ULEB 1.0	54	£6,694,659.00		
AdHoc Governement Grants	16	£8,850,000.00		
Northern Ireland				
Northern Ireland Hydrogen Transport (NIH2 T)**			3	£1,953,937.00
Department for Infrastructure (Translink)	80	£74,000,000.00	20	(Included in £74 million)
Department for Infrastructure (Translink)	38	£30,000,000.00		

*Zemo estimate

Thank you



**Zemo
Partnership**
Accelerating Transport to Zero Emissions

Any questions? Please get in touch

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Programme Manager

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Interested in joining the Partnership?

Carolyn Webb

Company & Membership Coordinator

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Prabhjeet Rai

Senior Policy Advisor,
Department for Transport





Department
for Transport

Zemo Hydrogen workshop

21/04/22

Hydrogen

- Hydrogen can help the UK to achieve net zero by 2050, and our Sixth Carbon Budget target by 2035
- The PM's 10-point plan set an aim for 5GW of low carbon hydrogen production capacity by 2030 for use across the economy
- The Hydrogen Strategy, published last year, sets out how we will achieve this
- Energy Security Strategy doubled this ambition to 10GW by 2030

UK Hydrogen Strategy



Hydrogen

- Renewable hydrogen supplied in the UK is eligible for support under the Renewable Transport Fuel Obligation (RTFO), a certificate trading scheme.
- Under the RTFO renewable hydrogen is categorised as a development fuel, which potentially benefits from a higher tradeable certificate value.
- The Energy Security Strategy committed to set up a hydrogen certification scheme by 2025
- Government is also aiming to run annual allocation rounds for electrolytic hydrogen, moving to price competitive allocation by 2025 as soon as legislation and market conditions allow

Hydrogen buses



- HM Government takes a technology neutral approach to zero emission buses
- The Low and Ultra-Low Emission Bus Schemes have supported 60 Hydrogen buses
- The EU supported Joint Initiative for hydrogen Vehicles across Europe (JIVE), also provided funding and support

Zero Emission Bus Regional Areas (ZEBRA)

ZEBRA scheme has provided nearly £270m funding supporting 1,279 zero emission buses:

- On 26 March 2022, we announced £198.3m from the ZEBRA scheme to 12 areas to support 943 zero emission buses.
- In October 2021, we announced nearly £71m from the ZEBRA scheme to five areas to support 335 zero emission buses.
- A further c.£200m funding is available over FY 2022-23 to FY 2024-25, which will support even more ZEBs.
- The West Midlands Combined Authority's bid to ZEBRA, for 124 hydrogen buses and refuelling infrastructure, is the largest ever hydrogen bus project in the UK.



BSOG Zero Emission Bus incentive

- All buses which meet the normal BSOG rules and can demonstrate zero tailpipe emissions and have no internal combustion engine (e.g. electric and hydrogen fuel cell buses), will be eligible
- Operators claiming the ZEB incentive will be able to claim for any kilometres that would ordinarily be payable under BSOG rules for conventionally fuelled vehicles.
- Unlike the LCEB, this includes vehicles under 22 seats/passengers



BSOG Zero Emission Bus incentive

- For the purposes of this uplift only, all hydrogen buses will be eligible, regardless of the source of the hydrogen. The future treatment of ZEBs, particularly the treatment of energy source for both hydrogen and electric buses will be consulted on as part of the wider reform of BSOG
- This is a pragmatic approach for the uplift, recognising the currently limited supply of green hydrogen and aligns with ambitions across government.



Zero Emission Bus definition

- The Zemo Partnership and DfT have developed a new ZEB definition and certificate. A ZEB is defined as a bus which:
 - Has no combustion engine on board.
 - Has no tailpipe that emits any regulated air pollutants.
 - Achieves 50% GHG savings target vs Euro VI diesel bus over UK Bus Cycle



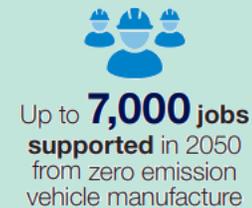
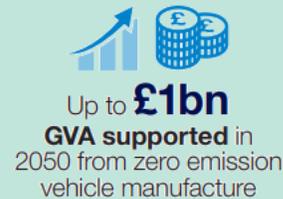
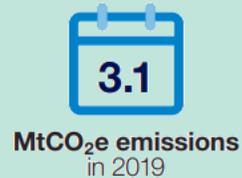
Zero Emission Bus definition

- The Zemo Partnership is developing a Zero Emission Vehicle Re-power Accreditation Scheme (ZEV-RAS), which will create and develop a code of practice for ZEB retrofit installations.
- Vehicles accredited through this process will be able to receive ZEB certificates, and thus the BSOG uplift.



Ending the sale of new, non-zero emission buses

- The Government is now seeking views on setting a specific date between 2025-2032 for ending the sale of new non-zero emission (at the tailpipe) buses.
- The proposed position is that the end of sales would apply across the UK, regardless of where or how a bus operates
- It is proposed that the end of new sales date would apply to Class I and II, M2 and M3 buses, i.e. those with a capacity exceeding 22 passengers, in addition to the driver.
- The final agreed end of sales date for new non-zero emission buses could be enabled by regulation laid out in proposals for a future UK CO2 Regulatory regime for road transport vehicles.





Department
for Transport

Thank you



Tom Greenshields

Head of Business Development,
Wrightbus



Hydrogen Vehicle Technology Pipeline

Metroline/Zemo April 2022

Tom Greenshields
Head of Business Development Wrightbus

21 April 2022





The Wrightbus Story So Far...

Since its inception in 1946, Wrightbus has cultivated a rich history and brand name recognized synonymously with manufacturing quality and innovation.

75 Years of Engineering Heritage

- ▶ A leading industry innovator since 1946 of low emission diesel, hybrid, zero-emission hydrogen and electric buses.
- ▶ First Battery-EV built in 1990s.
- ▶ Transitioned from body-only to integral products in 2007.
- ▶ First single-deck hydrogen fuel-cell EV in 2008.
- ▶ Manufacturer of Iconic Routemaster for London in 2012.
- ▶ Unveiled world's first double-deck FCEV in 2016.
- ▶ Only manufacturer globally to offer single and double-deck hydrogen and electric buses.

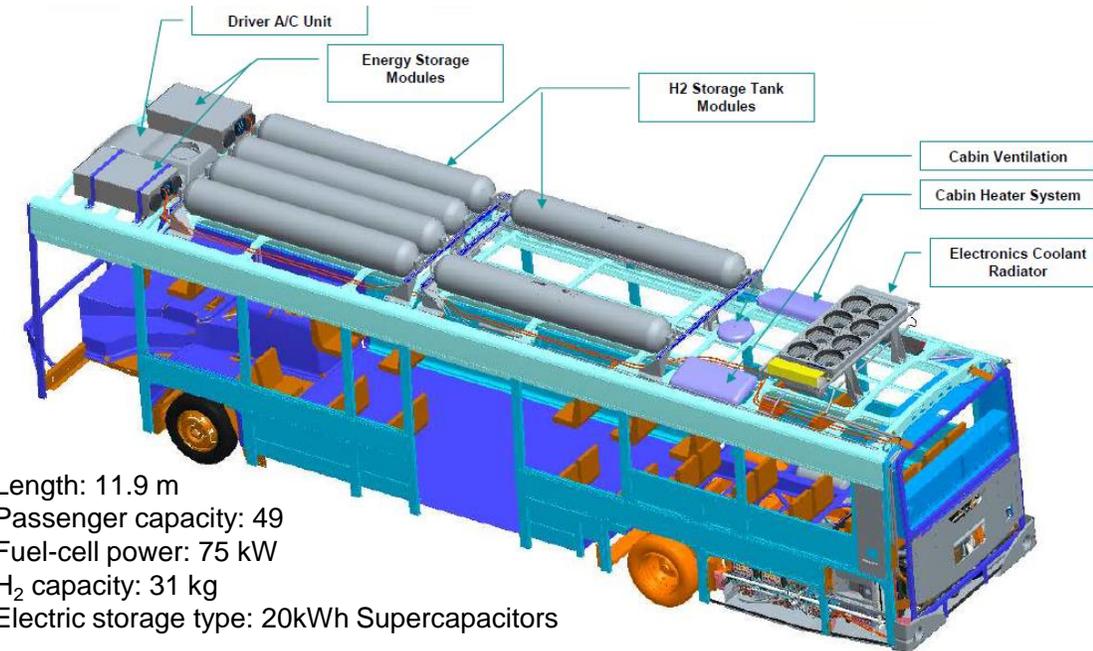
2021 Production
70% Low-Emission
30% Zero-Emission

2022 Production
70% Zero-Emission
30% Low-Emission



Hydrogen FCEV Experience

- ▶ 2008 - eight single-deck FCEBs for London.
- ▶ 12 years in service operating in dense, slow, urban traffic in the centre of the city, and with very long daily duty cycles.
- ▶ In-service achievements:
 - ✓ > 215,000 hours in service.
 - ✓ > 1.25 million miles in service
 - ✓ Daily range of 155-185 miles
 - ✓ Daily operation 16 – 18 hr/day.
 - ✓ Refueling time <10 mins.
 - ✓ Fuel-cell power stack achieving > 35,000 hrs.



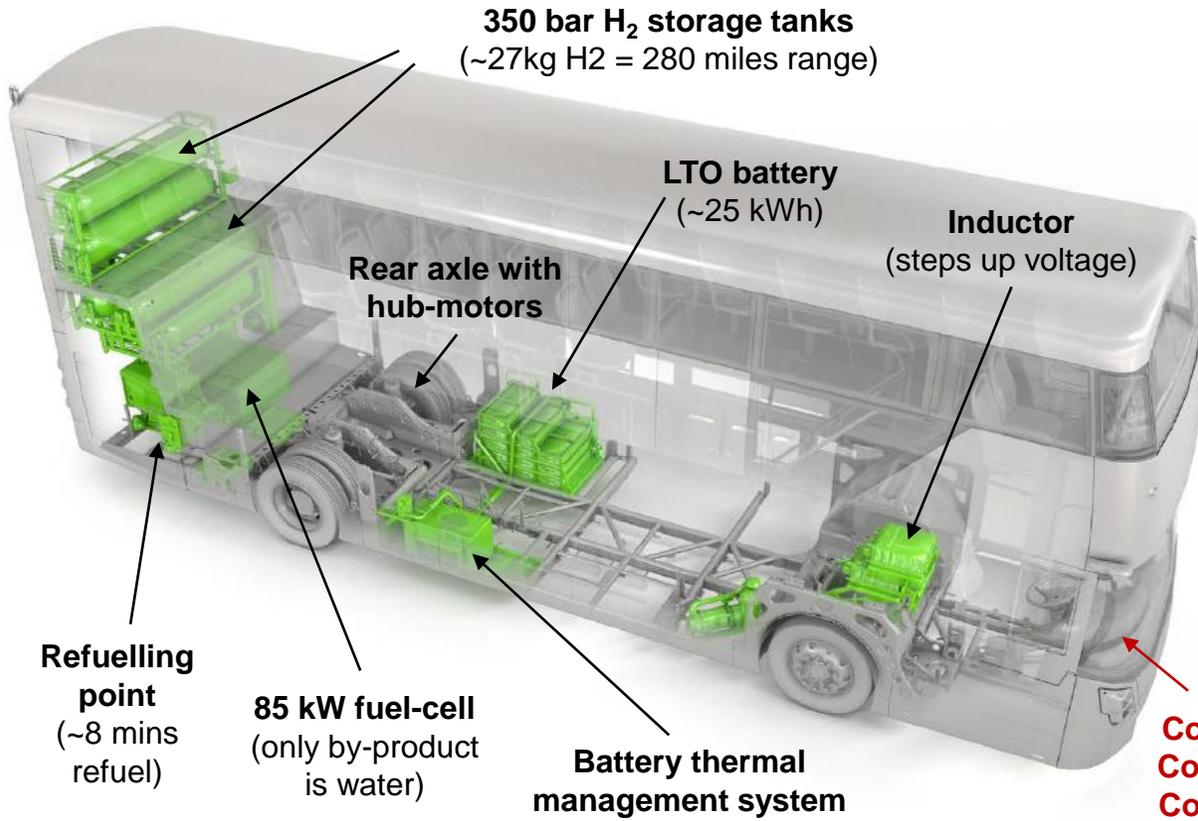
STREETDECK FCEV | HYDROLINER

Hydrogen Fuel-Cell

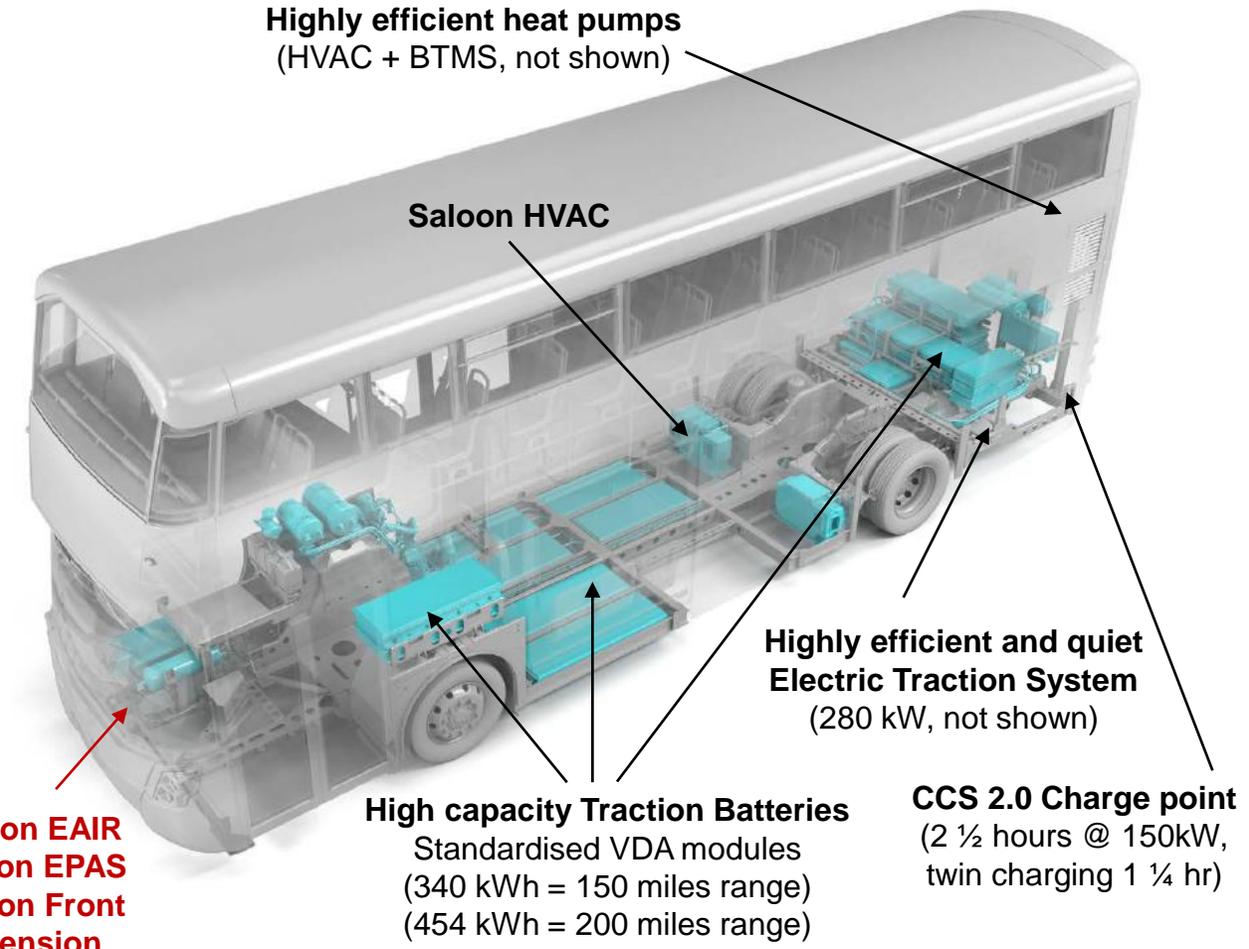


World's first production Hydrogen Double-Deck Bus, designed and built in Ballymena, NI.

Hydrogen Fuel-Cell

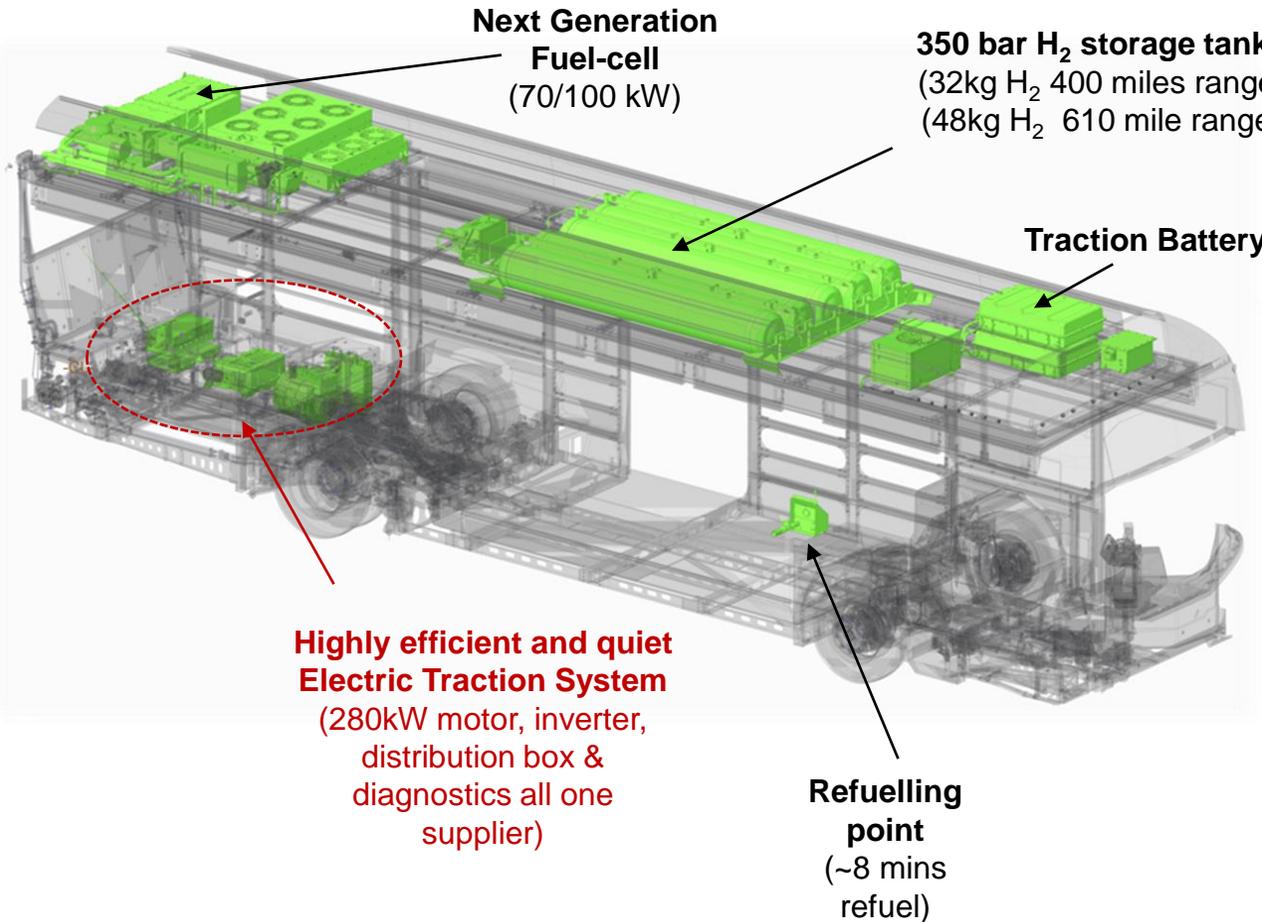


Common EAIR
Common EPAS
Common Front Suspension



Battery-Electric

Hydrogen Fuel-Cell

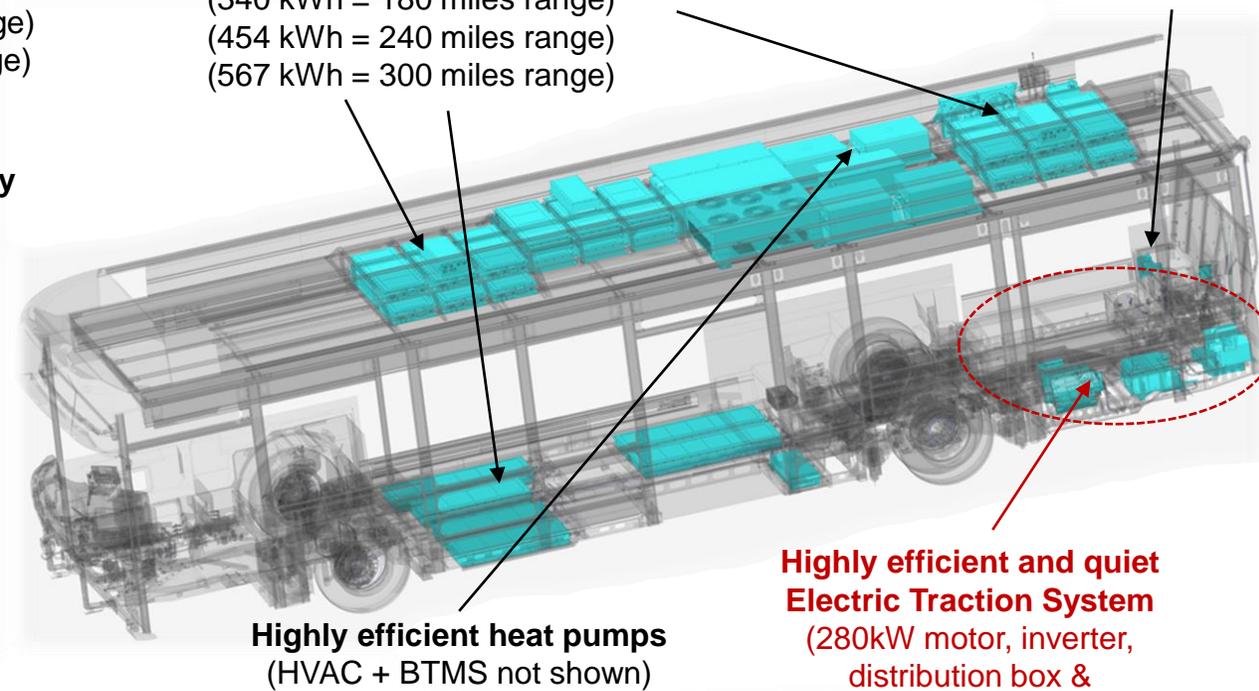


High capacity Traction Batteries

Standardised VDA modules
(340 kWh = 180 miles range)
(454 kWh = 240 miles range)
(567 kWh = 300 miles range)

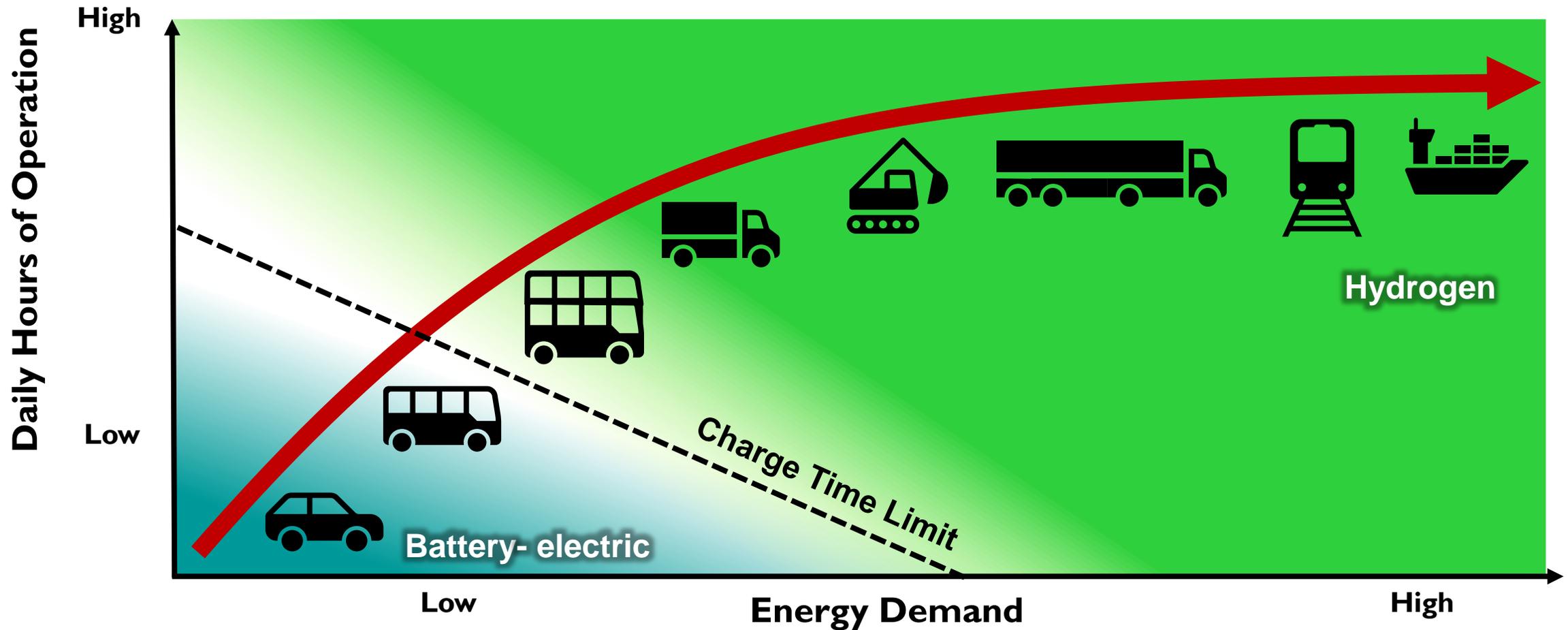
CCS 2.0 Charge point

(2 ½ hours @ 150kW,
twin charging 1 ¼ hr)



Battery-Electric

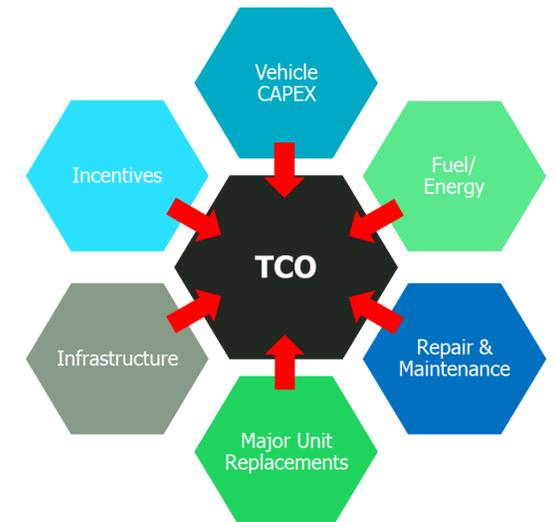
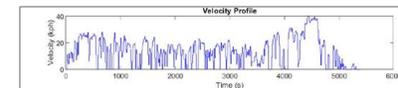
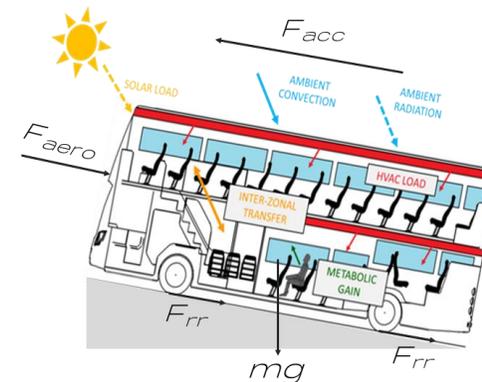
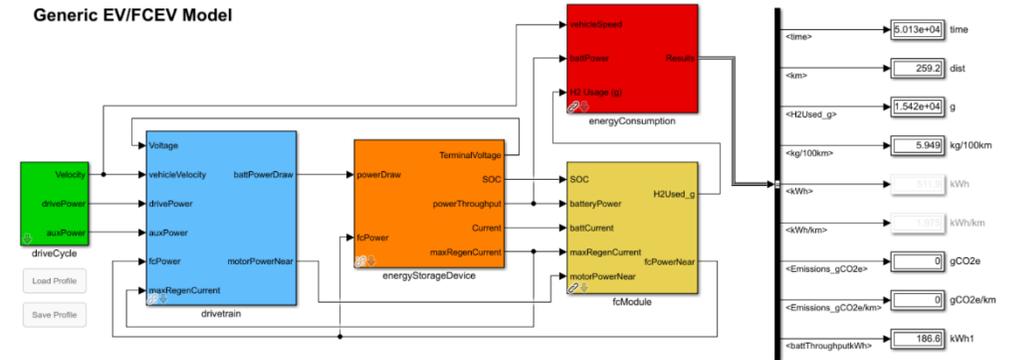
When does Hydrogen Make Sense?



Customer Advisory Tools

Strong Academic Foundations

- ▶ Over 25 years of direct collaboration between Wrightbus and Queens University, Belfast.
 - ▶ Academically robust modelling tools to support our customers in decision-making process for selecting most appropriate zero-emission technology for their bespoke operation and budget.
- ✓ Full route, fleet & depot analysis, including generation of representative bus duty cycles and charge profiles.
 - ✓ Vehicle performance simulations to accurately predict power demands, range and energy consumption per route.
 - ✓ Total cost of ownership and life-cycle carbon forecasts.



Energy Efficiency / Operational Flexibility

	DD FCEV Today	SD FCEV NextGen		
H ₂ storage	27	35	50	kg
Efficiency	7	6	6.2	kg/100km
	2.3	2.0	2.1	kWh/km
Range	386	583	806	km
	241	365	504	miles

	BEV standard	BEV large	
Battery capacity	340	454	kWh
Efficiency	1.1	1.13	- kWh/km
Range	247	321	km
	155	201	miles

- ▶ **BEVs more energy efficient** on less energy demanding routes, but limited on range without costly infrastructure.
- ▶ **FCEVs provide greater operational flexibility** (not route/depot locked), but lower energy efficiency.
- ▶ **Both technologies complementary** – stakeholders should identify best fit to satisfy operational & cost constraints.
- ▶ **Consider daily operational demands**, e.g. minimum mileage, available charging time, # buses + drivers.
- ▶ **Low/zero-carbon sources** of both electricity/hydrogen should always be sourced from where possible.

Safety

Key Considerations when working with Hydrogen machines:-

- ▶ Prevent the formation of ignitable concentrations of hydrogen.
- ▶ Removing all sources of ignition from the facility.
- ▶ A safety regime can be set up in a workshop.
- ▶ The basic principle in the workshop is to respect the fire triangle.

Future of Hydrogen

Falling Total Cost of Ownership

- Step change in costs of fuel-cell modules, H₂ storage tanks and EV drivelines.
- Scaling up production of low carbon H₂ via water electrolysis.
- Increasing fuel-cell stack durability, decreasing maintenance costs.

Improving efficiency

- Control and optimization of powertrain to minimize fuel-consumption.
- Greater use of fuel-cell waste heat for heating interior of bus.

Cross-pollination

- Hydrogen technology is proven on buses.
- H₂ combustion engines or Fuel Cell for coach, ships, trains, off-highway, etc...

Ben Werth

Managing Director,
Fuze



FUZE

Bus as a service

Lease & Asset Management

Ben Werth

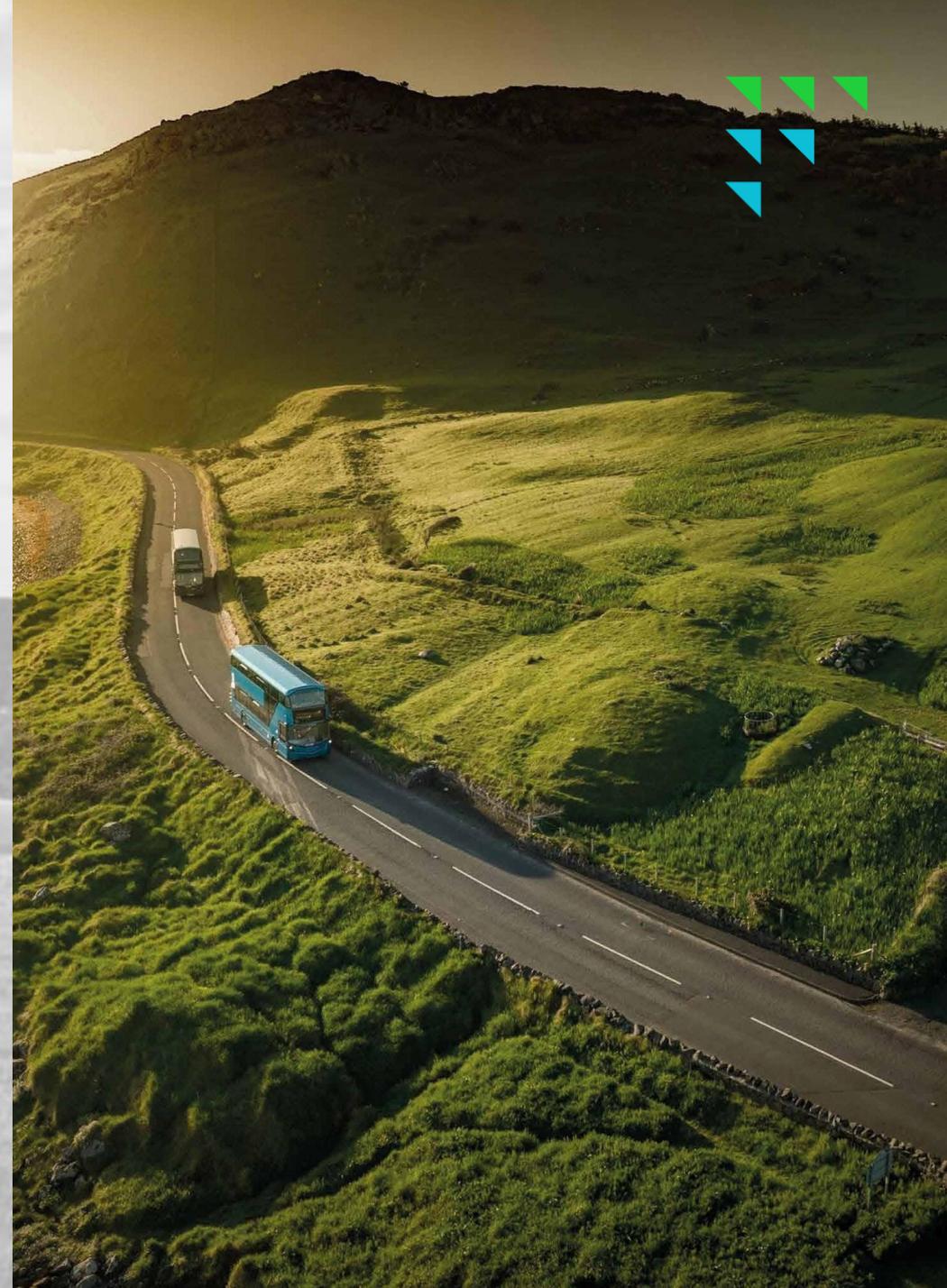




FUZE



- Privately owned by green pioneer Jo Bamford
- Zero Emission specific Asset Finance & Asset Management Company
- Developed SPV funding model to accommodate all ecosystem stakeholders
- Long term access to zero-emission buses and infrastructure at a fixed lease rate
- Provide an all encompassing bus service including: depot upgrades, charging and fuelling services, zero emission vehicles with option of R & M or Parts Assurance contracts
- An accelerated route to a zero-emission bus system



Fuze Lease & Asset Management: 'Enabling The Ecosystem'



Infrastructure



Route Planning



Base Vehicle



Fuel/Power



Maintenance



FUZE



TCO Calculation

Single monthly payment

Asset management for duration of the agreement

Asset Management



Duration of the lease agreement



Lease & Asset Records



Maintenance Records



Annual Asset Inspections



R & M Contracts



Asset Telematics



Daily monitoring of assets



24 hour engagement with operators



Vehicle uptime Predictive to Preventative



Asset usage warranty & service requirements



Energy Monitoring

Funding Zero Emissions



Turnkey solution

FUZE 

Lease & Asset
Manager



Conduit between end
user (PTA & PTO)
& stakeholders



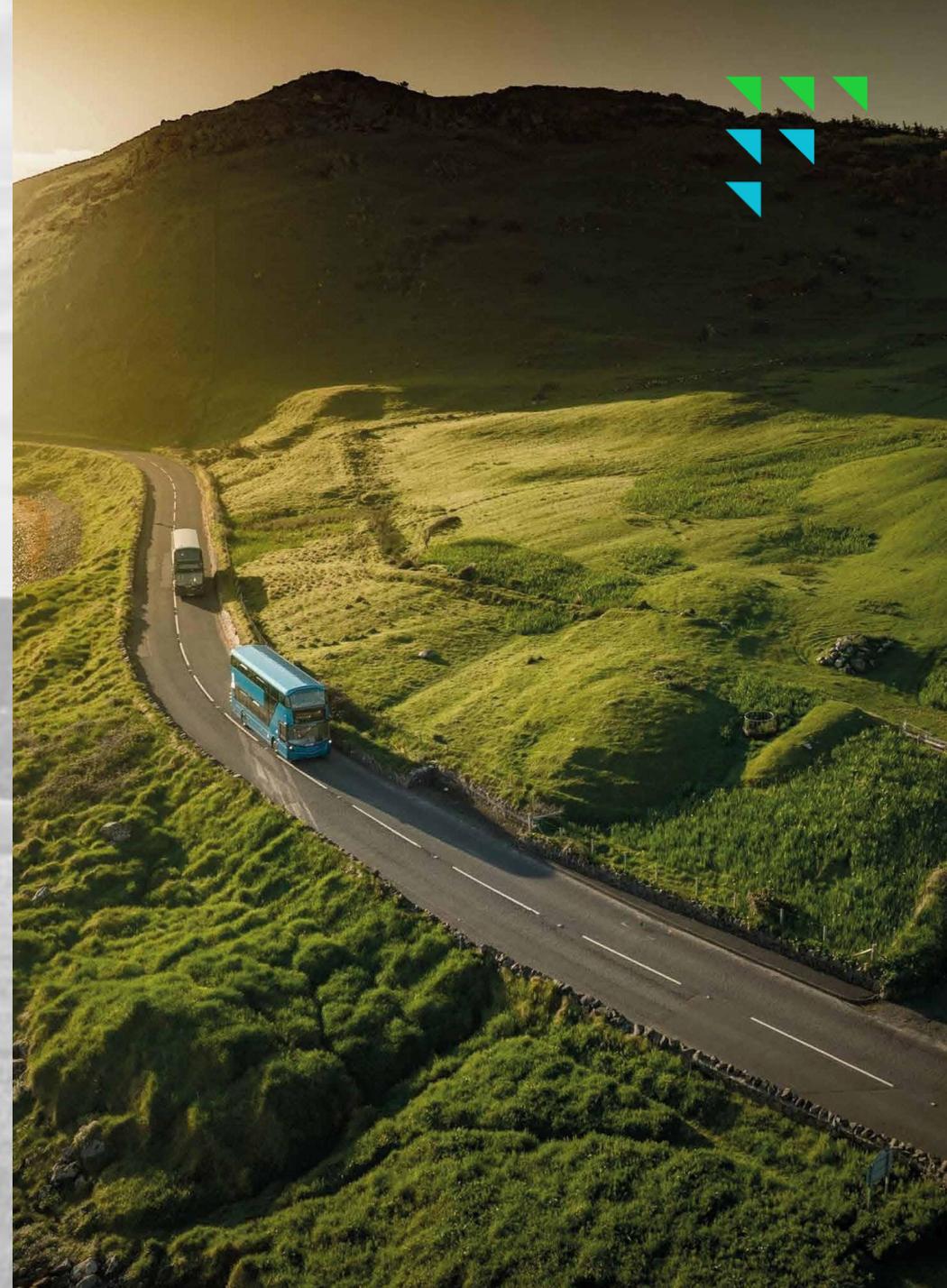
TCO Calculation



Uptime365



Single Monthly
Payment



Thank you!

...any questions?





David Yorke

Market Development Manager,
Ballard

Ian Foster

UK & Ireland Engineering Director,
Metroline, Comfort DelGro (UK)





**Zemo
Partnership**
Accelerating Transport to Zero Emissions

Q&A Session

End of Presentations

