



# Towards Commercial, Large-Scale Deployment of Hydrogen Infrastructure and Captive Bus Fleets. A Case Study of the OLEV-funded Project in Liverpool City Region

**Dr Ben Todd**

Founder and CEO – Arcola Energy

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**GEOTAB**<sup>®</sup>  
management by measurement

# **Commercial deployment of FCEV buses, Liverpool City Region**

## **Arcola Energy**

**Dr Ben Todd - CEO**

# About Arcola Energy

- Systems engineering specialising in hydrogen, fuel cells, and batteries
- International network of suppliers, partners and clients
- Breadth and depth of knowledge in fuel cell and hydrogen technologies
- Experience in a wide range of applications - transport, stationary and portable power
- International network of clients, partners and suppliers
- Fast growing company, well connected and respected in the UK and abroad
- Focus on Quality, Safety & Compliance



230+ mile ZERO EMISSIONS range

3x energy storage per kg of battery-only

Best in class efficiency:  
~6kgH<sub>2</sub>/100km

At expected hydrogen prices,  
running cost = diesel

Range not compromised by cold weather

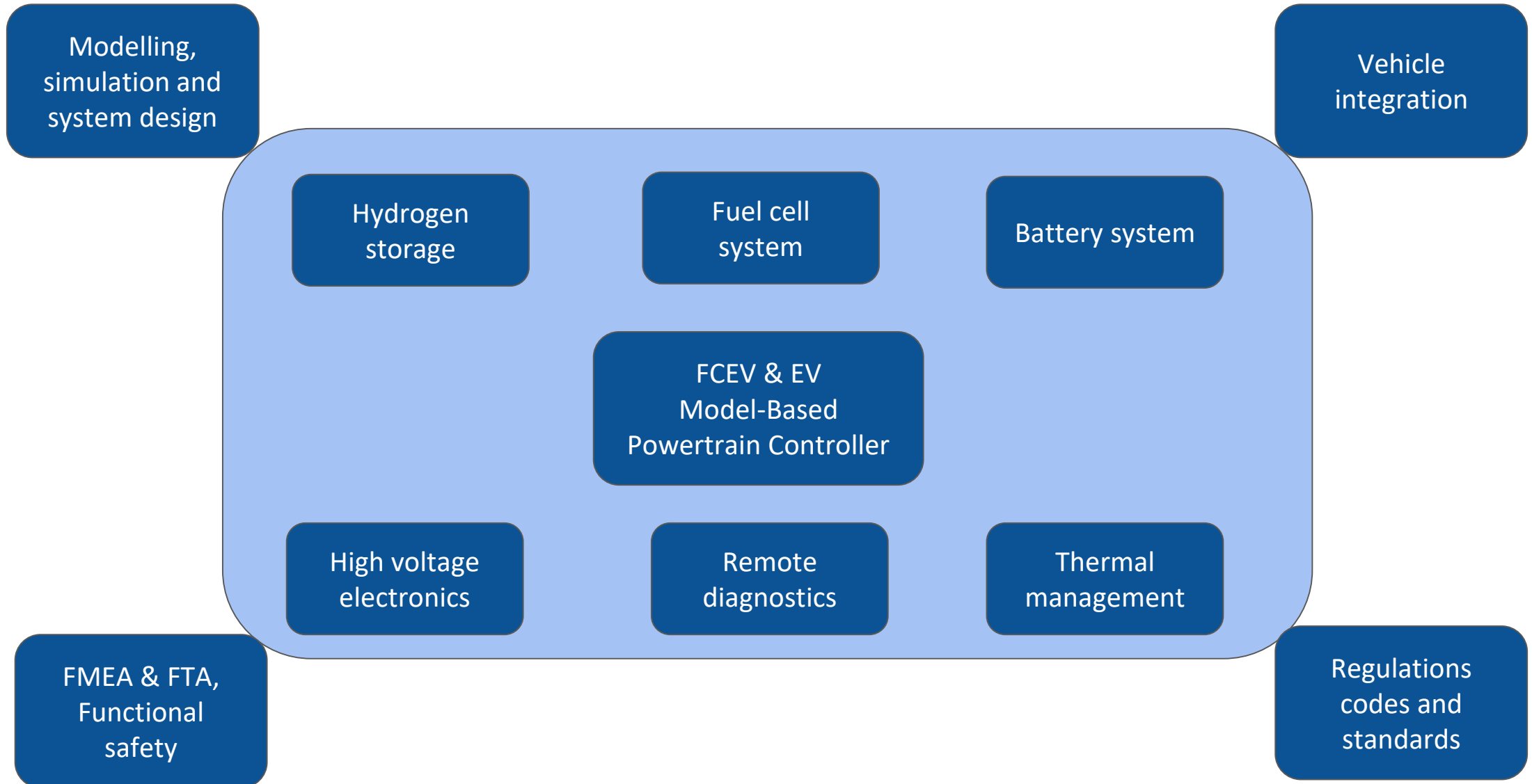
Powertrain waste heat integrated into bus heating system

**ADL ADDS HYDROGEN FUEL CELL TECHNOLOGY TO THE MARKET'S WIDEST RANGE OF LOW AND ZERO EMISSION BUSES**

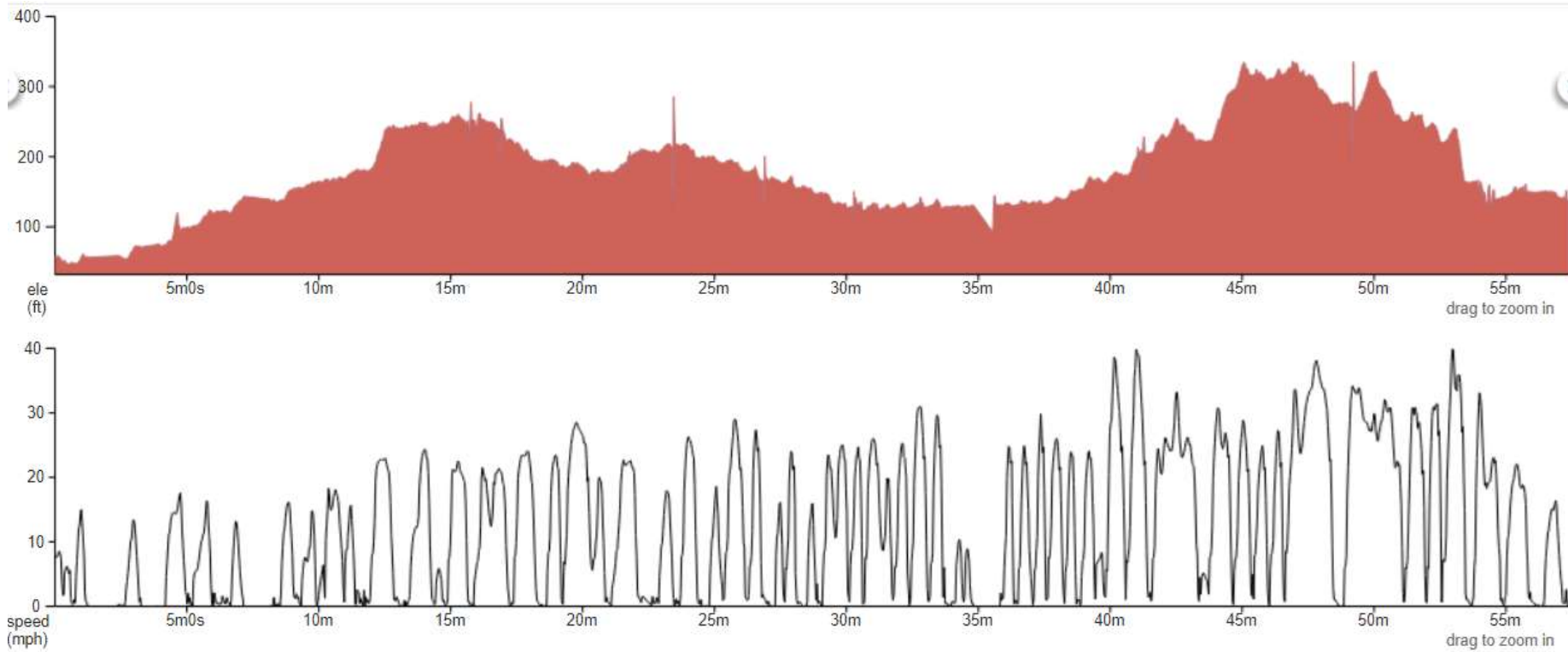


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# Arcola Hydrogen Fuel Cell Powertrain Platform



# Requirements Capture



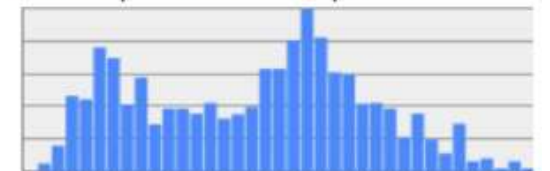
Departed:	Jan 27, '19, 07:33PM
Starts in:	Liverpool, England, GB
Distance:	12.2 mi
Elevation:	+ 564 / - 477 ft
Max Grade:	5.3 %
Avg. Grade:	0.3 %
Total Duration:	00:57:25
Moving Time:	00:40:17
Stopped Time:	00:17:08
Max Speed:	39.9 mph
Avg. Speed:	18.1 mph
Pace:	00:04:43
Moving Pace:	00:03:19

Data collected Sunday evening: Low traffic therefore slightly higher speeds than typical

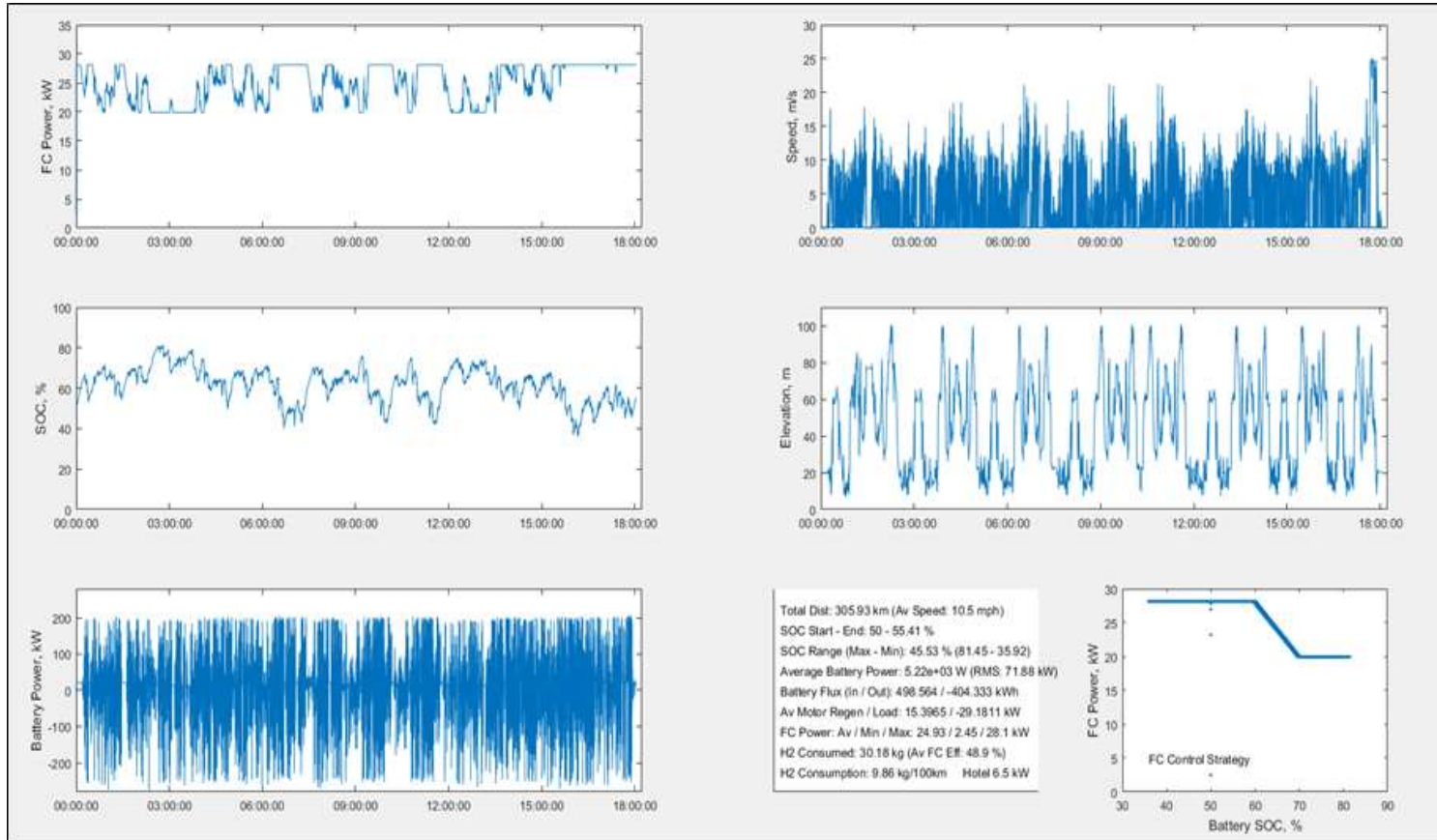
Bus stopped at most stops



Time spent at each speed

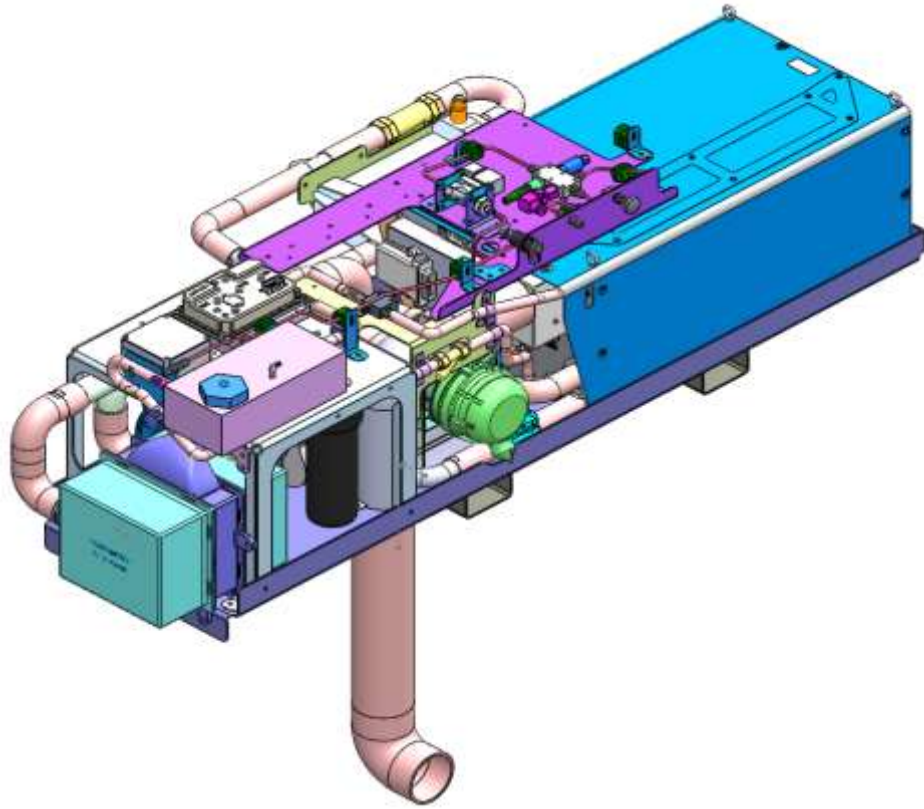


# Powertrain Design Tools



- Arcola computational model (Matlab) takes a duty cycle from operator (speed & elevation vs time) as input.
- Simulates power required for traction and produced through regen braking
- System architecture validation
- Control strategy development
- Fuel consumption estimates inform TCO and business-case calculations

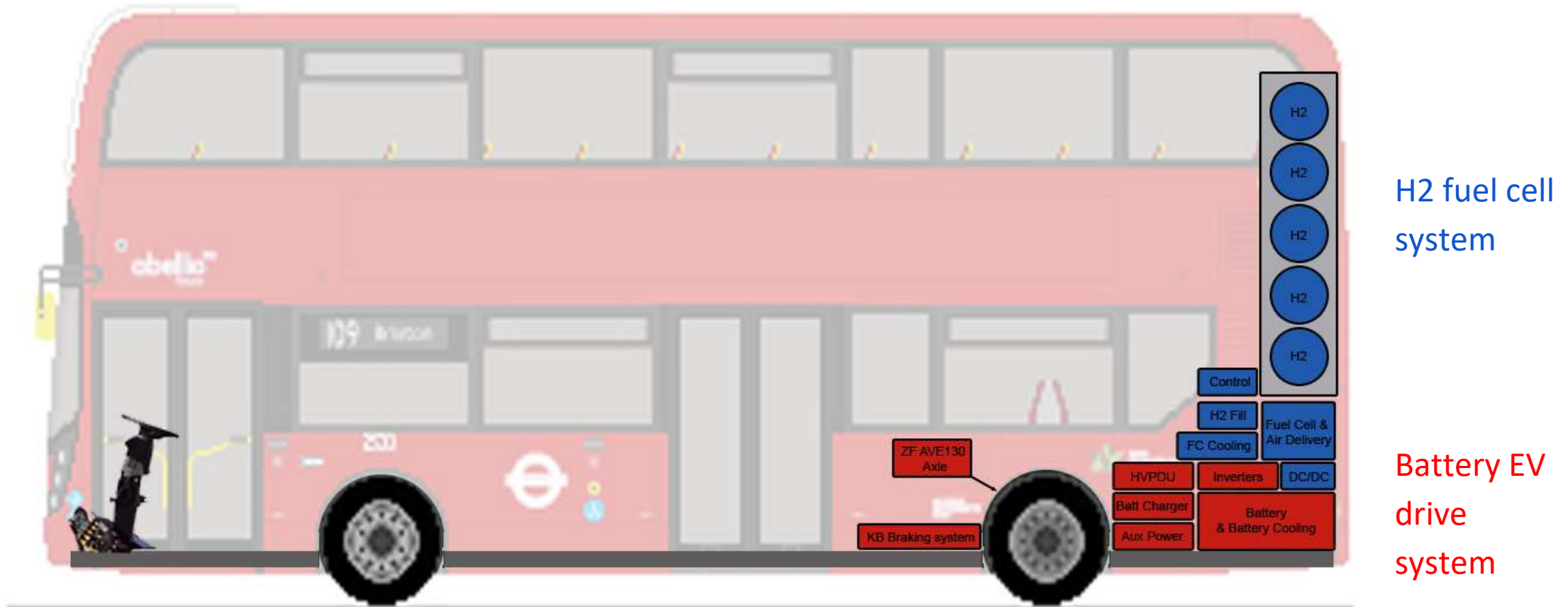
# Fuel Cell System Integration



Indicative design only



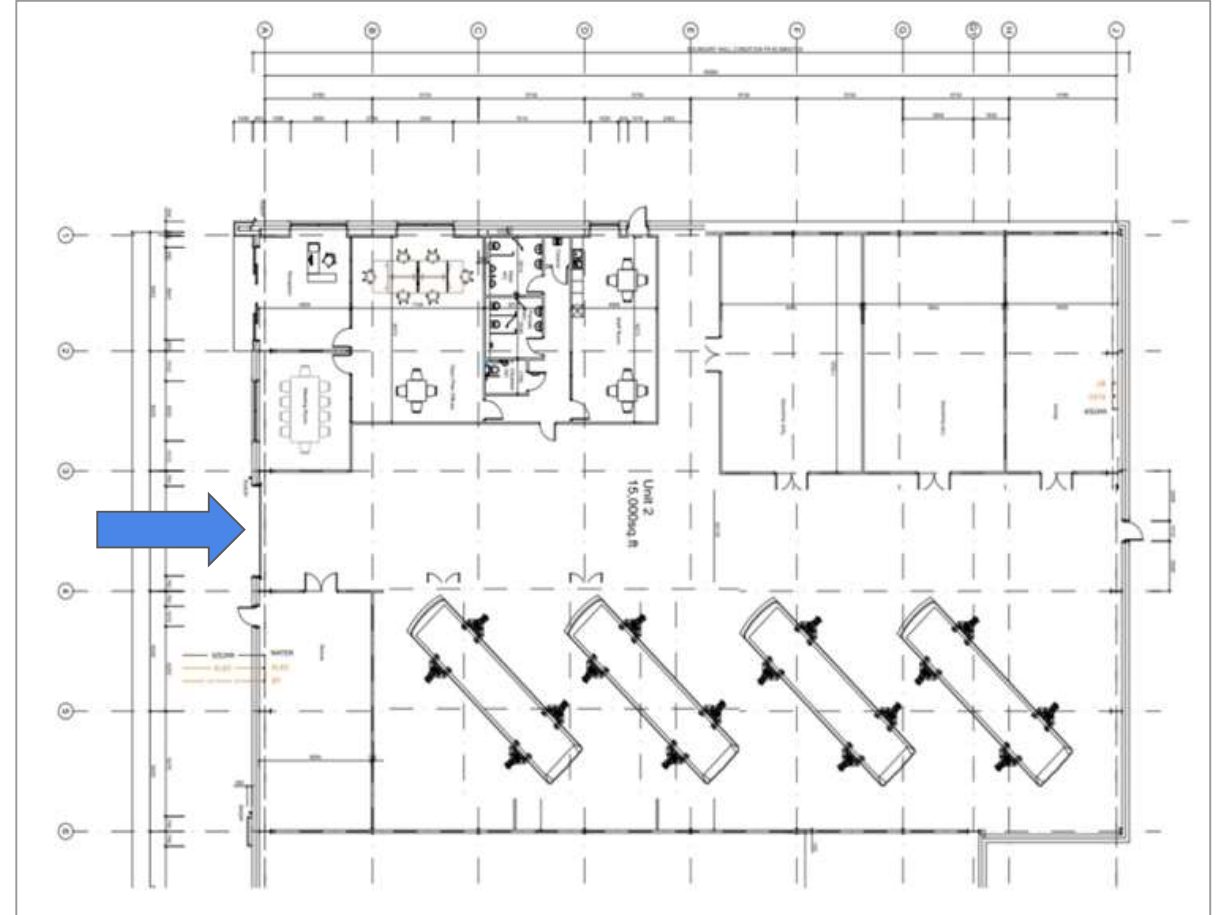
# Arcola Energy Hydrogen Powertrain Integration



# Partnerships for zero-emission buses and commercial vehicles



# Production, Installation & Maintenance Facility in Liverpool





# Future plans

- Any vehicle > 200 miles zero emission range
- 12T truck with innovation in complete UK powertrain
- Refuse collection vehicles
- Trains



**Thanks**

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