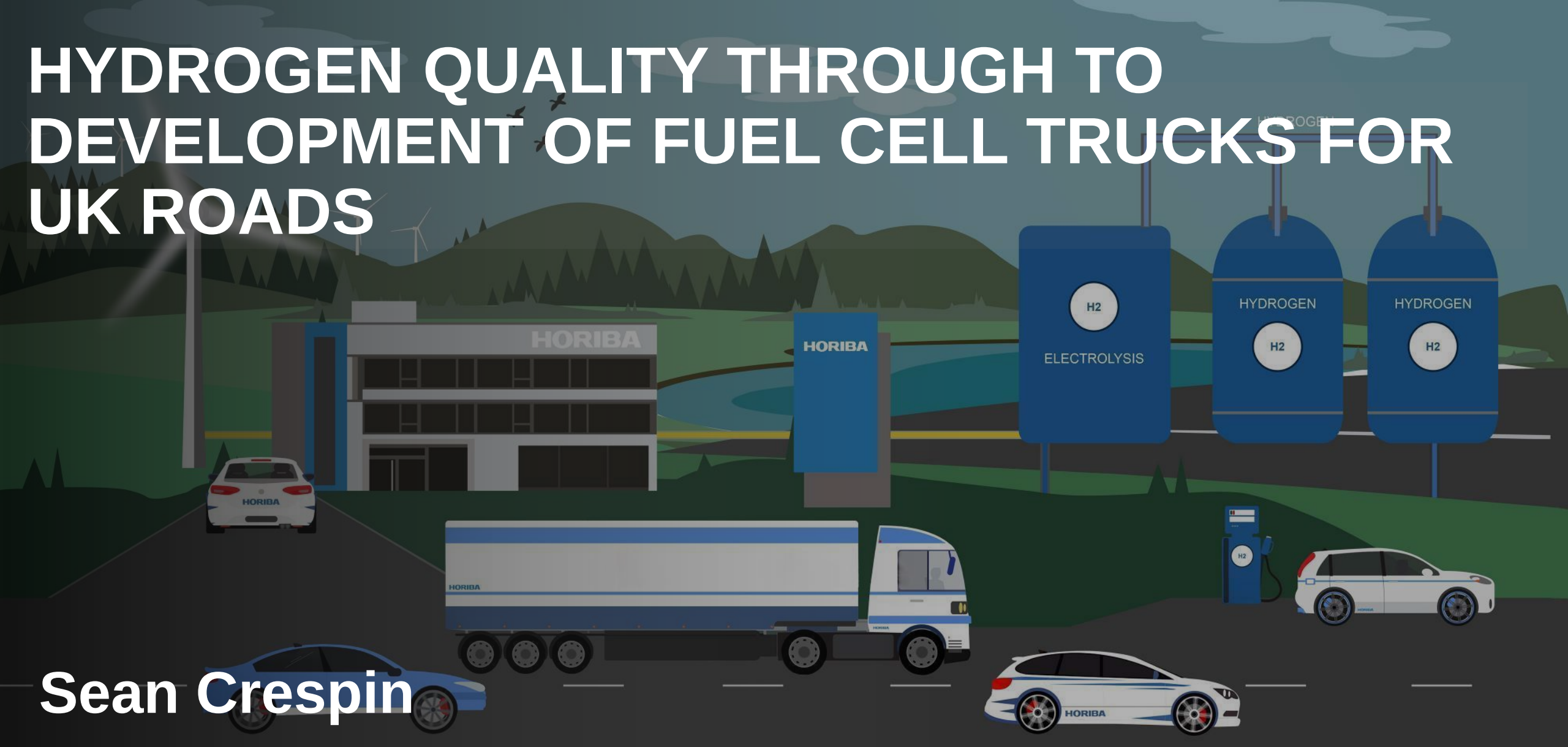


HYDROGEN QUALITY THROUGH TO DEVELOPMENT OF FUEL CELL TRUCKS FOR UK ROADS



Sean Crespín

HORIBA

Providing Solutions Across the hydrogen value chain from R&D to applications, including industrialization and manufacturing

Research and Development on Materials

- Technologies for characterization at macro-, micro- and nano-scales
- Laboratory systems for performance test of fuel cells and stacks
- Partner for R&D national and international projects
- Application laboratories open to researchers



Manufacturing Process Control

- End-of-line full testing
- Quality control of materials and on-line characterization tools
- Full link with Manufacturing Execution Systems (MES)



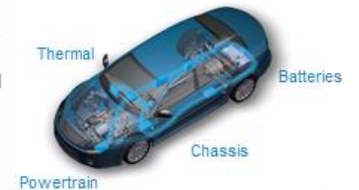
Gas Management

- H₂ quality control and standards compliance from production to fueling stations. Precise and safe measurement of impurities
- H₂ concentration measurement
- H₂ detection in testing system
- Durability of storage materials



Solutions for Testing

- Reducing development cycle with the help of a complete test facility providing a safe, efficient, optimized, and integrated testing experience
- Wide range of test bed types for fuel cell powertrain integration
- Durability and performance testing
- H₂ ICE engine test bed
- H₂ fuel flow measurement



Engineering and Consultancy

End-to-end powertrain system development, optimization, vehicle integration and validation service for H₂ powered vehicles, thanks to advanced model-based design techniques.

- Benchmarking and performance target setting
- System architecture definition
- Modeling and performance simulation
- Design and components selection
- Thermal and energy management control
- Powertrain and vehicle prototype building
- Component, system and vehicle level testing
- Validation and certification





Why is Hydrogen purity important and what are the challenges today?

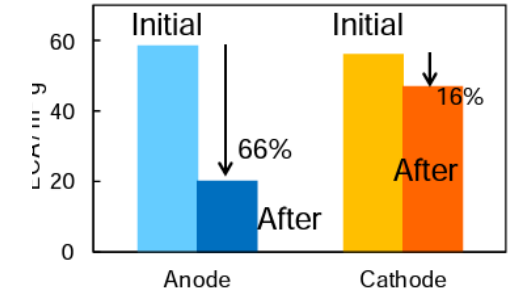
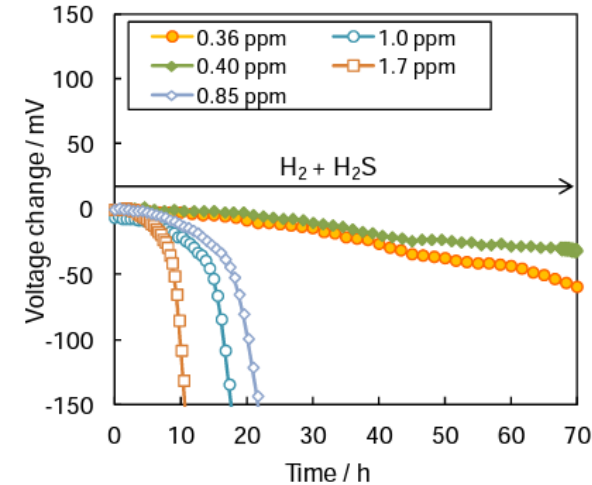
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The Need to Ensure Fuel Quality



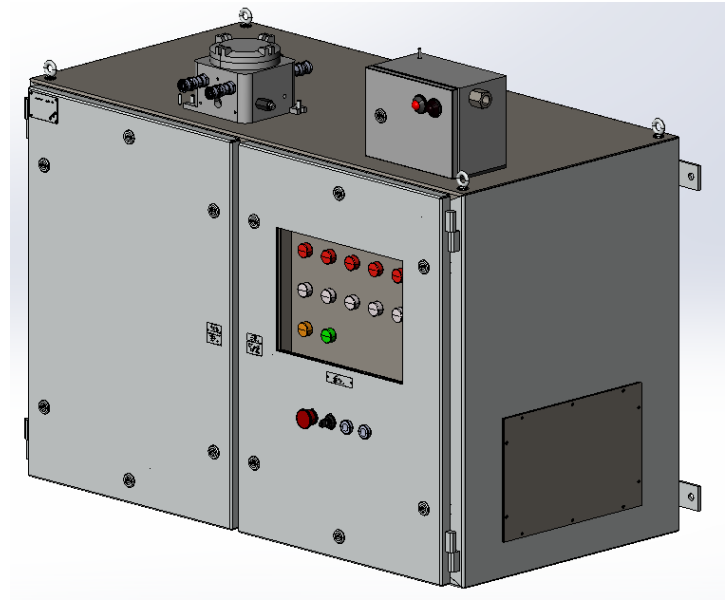
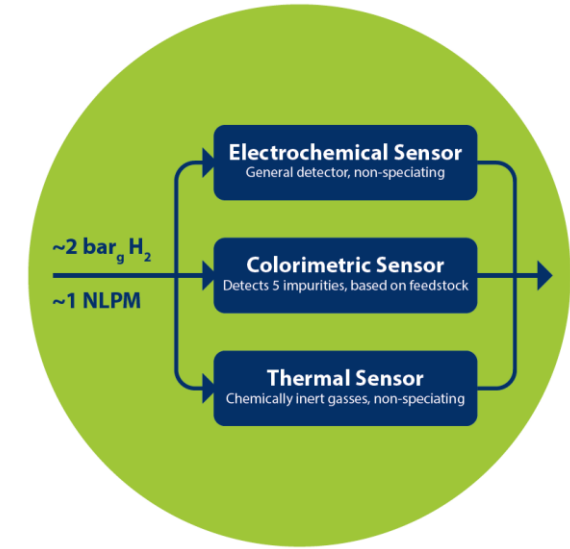
Reference number
ISO 14687:2019(E)

- ❑ Hydrogen fuel cell-powered electric vehicles offer great potential for clean, carbon-neutral transportation
- ❑ However, contaminants originating in the hydrogen supply chain can damage fuel cells
- ❑ The **ISO 14687:2019** standard provides acceptable limits for impurities within hydrogen fuel
- ❑ Current sampling methods cost thousands, take weeks for the results and only three laboratories in Europe can perform the task.
- ❑ ***It is only a matter of time until we poison a fleet of vehicles, but who will be liable for the repair bill?***



Is Online Monitoring the Solution?

- ❑ NPL and HORIBA are developing an online hydrogen fuel quality monitoring system that will trigger a warning when any impurities that could damage a fuel cell reach critical levels.
- ❑ This innovative and low-cost solution is a significant improvement over current best practice.
- ❑ The system combines three innovative sensors to provide coverage of all impurities in the ISO 14687 standard.
- ❑ Packaged in an ATEX rated cabinet
- ❑ Provides traceability of your gas quality



Prototypes & Field Testing – On-Line Monitoring

Two trials covering both Green and Blue hydrogen refuelling station installations;



- Hydrogen Refuelling Station (Sheffield) - Producing Green Hydrogen
- Monitoring requirements: Fluorine, Nitrogen, Oxygen and Water required



- Hydrogen Refuelling Station (Sheffield) – Importing Hydrogen (Green, Blue, Grey ..)
- Monitoring requirements: H₂O, O₂ CO₂ CH₄ NH₃ CO, Hydrocarbon/Toluene, Total Sulphur / H₂S, N₂, Ar





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What are the challenges of Introducing 44t Hydrogen Trucks to UK Roads?

H2GVMids Project

Helping the Midlands make the transition to hydrogen powered HGVs



Feasibility Study

The study will examine:

- ☐ A design for a 44t HGV including a detailed analysis of the fuel requirements and fuel efficiency
- ☐ Modelling of logistics routes across the Midlands in collaboration with logistics organisations
- ☐ A plan for the optimal distribution of hydrogen refuelling stations, capacity requirements and a plan for the generation of hydrogen with both on- and off-site options
- ☐ An evaluation of the skills required to underpin a hydrogen freight programme
- ☐ A map of Midlands-based supply/value chains to identify gaps and opportunities

Project Partners

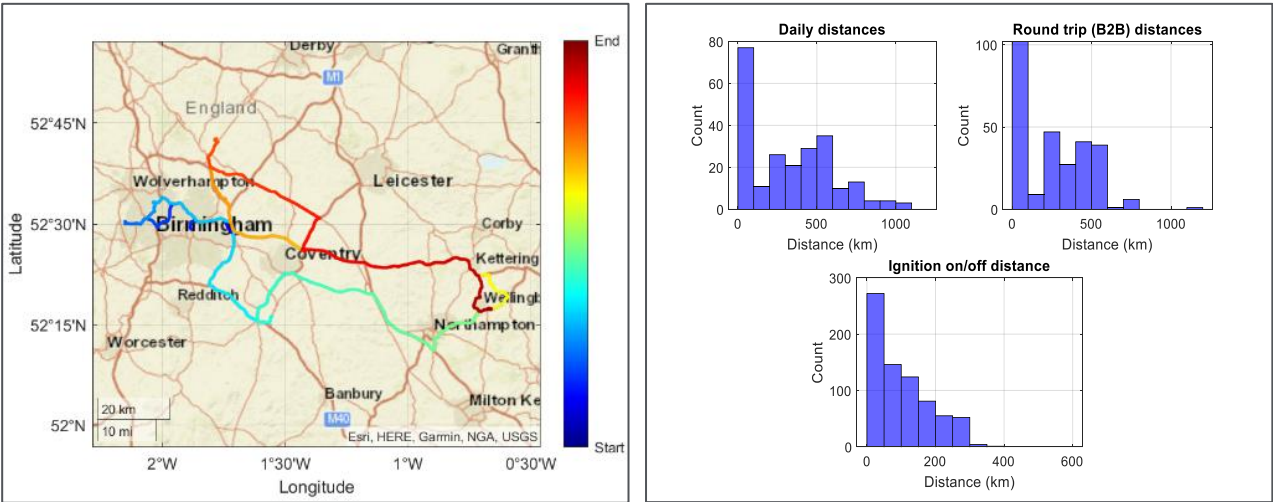


Technical delivery – Work package 1

Summary of outputs



- ❑ Survey & interviews with logistic operators to understand ‘user requirements’
- ❑ Statistical analysis of real world data to derive typical duty cycles
- ❑ Simulation and component selection across a number of vehicle concepts to determine best in class
- ❑ Hydrogen demand vs vehicle mass and daily distances to determine refuelling consumption



		Vehicle mass	
		31T	24.6T
Daily distance	212 km	19.6	18.2
	240 km	22.2	20.7
	348 km	32.2	30.0

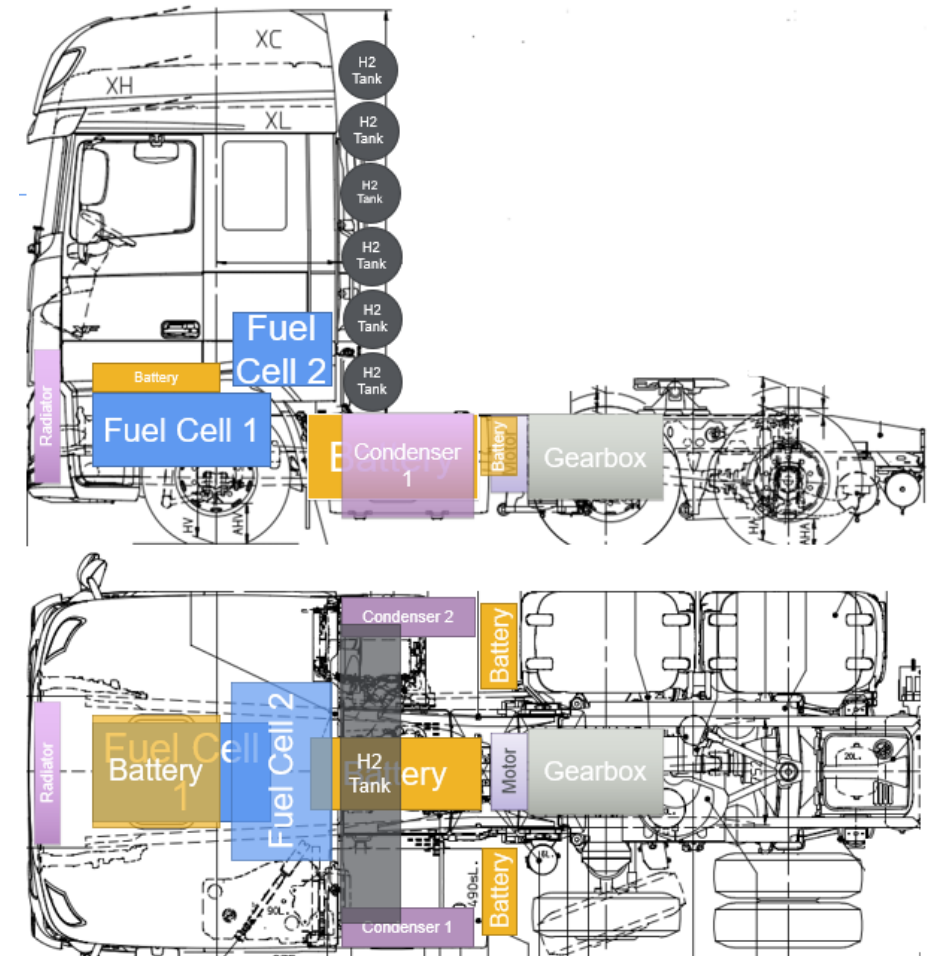
2 x FC (external charging) H2 requirement per vehicle (kg)

	Motor Power	Battery Size	Fuel Cell Power	Hydrogen Storage	Range*	Layout
	kW	kWh	kW	kg	km	
HORIBA MIRA 2FC	400	121	140	30	297 ^[1]	6x2
Supplier #1	372	85.2	200	35	350 ^[2]	6x2
Supplier #2	450/550	140	120	30	300-500	6x2
Supplier #3	660	70	300	80	1000	4x2
Supplier #4	350	73	190	32	400	4x2
Supplier #5	700	22.4	300	50	1000	6x2
Supplier #6	–	–	200	32	505-830	4x2
Supplier #7	480	–	–	–	805	6x2

In Summary

What are some of the remaining challenges?

- 44t fuel cell trucks are coming to market
- Total Cost of Ownership needs improvements
- Fuel cell power needs increasing (kW/L & kW/kg)
- Fuel cell stack lifetime needs increasing past 30,000hrs
- Packaging of the fuel cell stacks, BoP and auxiliaries is challenging
- Increase hydrogen onboard storage capacity to reach 500km+ range





HYDROGEN & FUEL CELL SOLUTIONS

Introducing The UK's Hydrogen Technology Hub

HORIBA

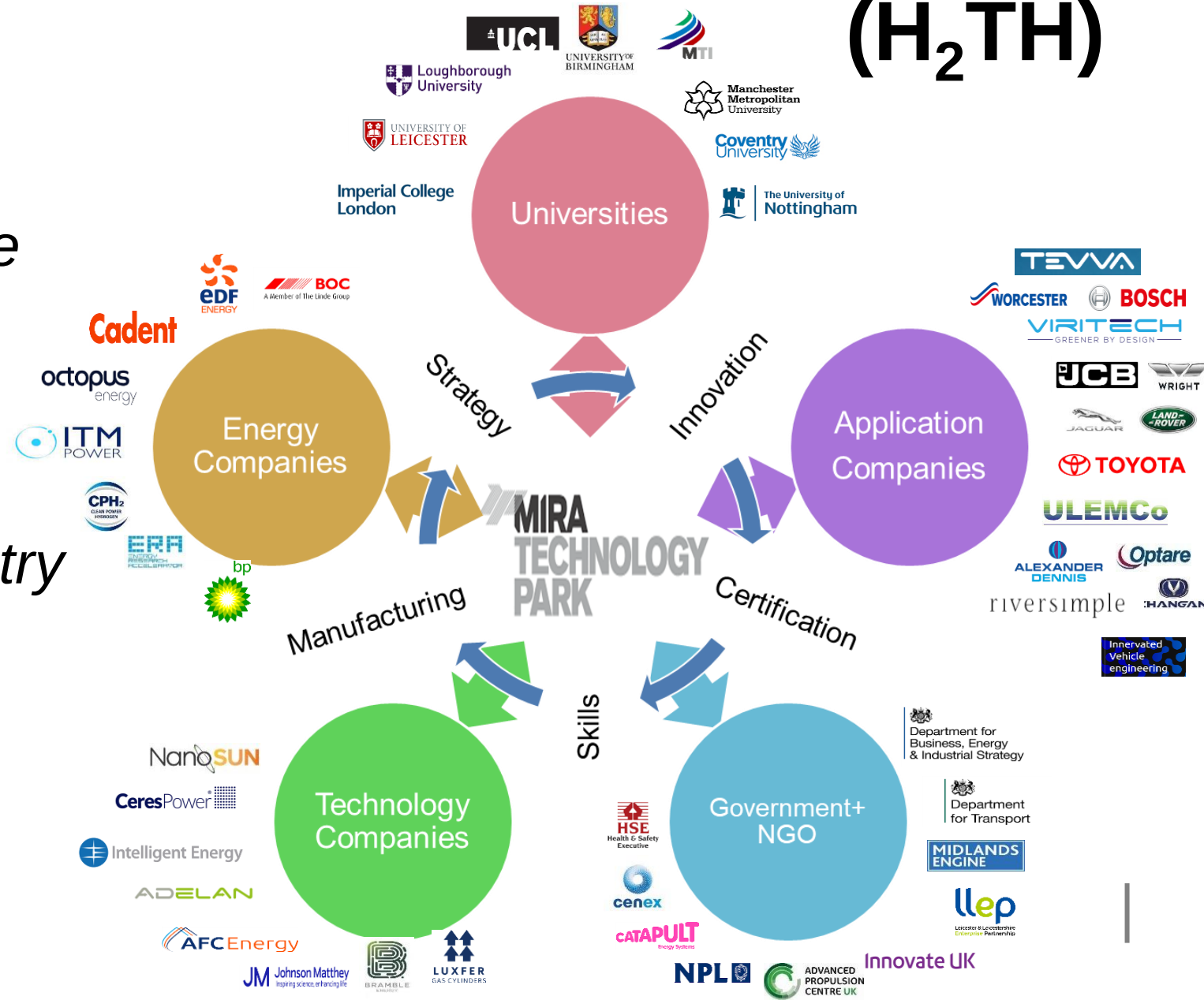
H₂ Technology Hub - Our Vision

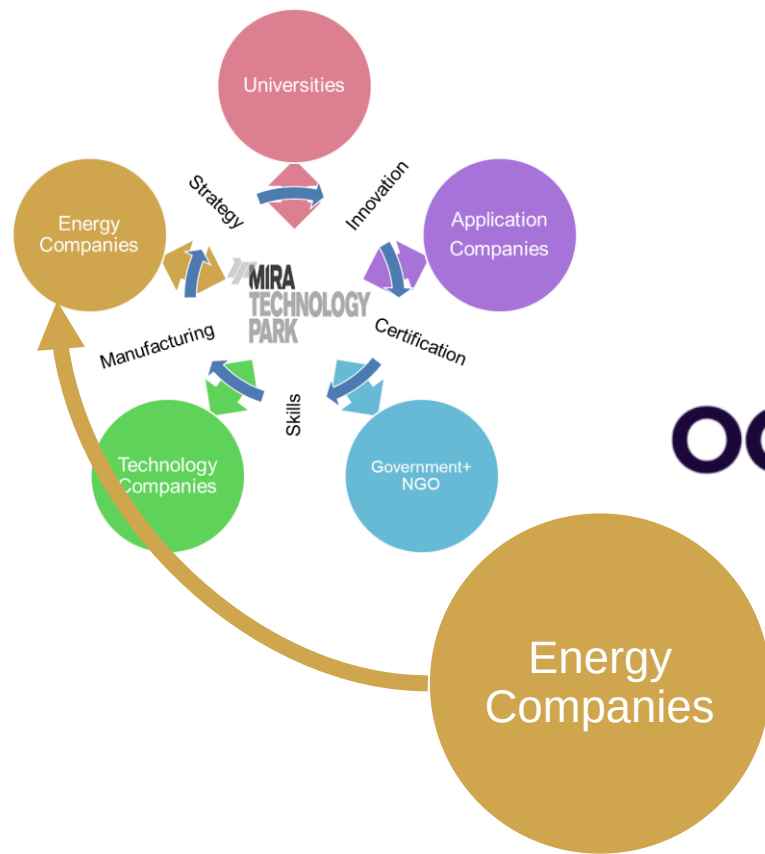
To create a thriving UK Hydrogen location developing technologies to accelerate the large-scale adoption of zero-emission green Hydrogen in the energy and automotive sectors.

UK's Hydrogen Technology Hub (H₂TH)

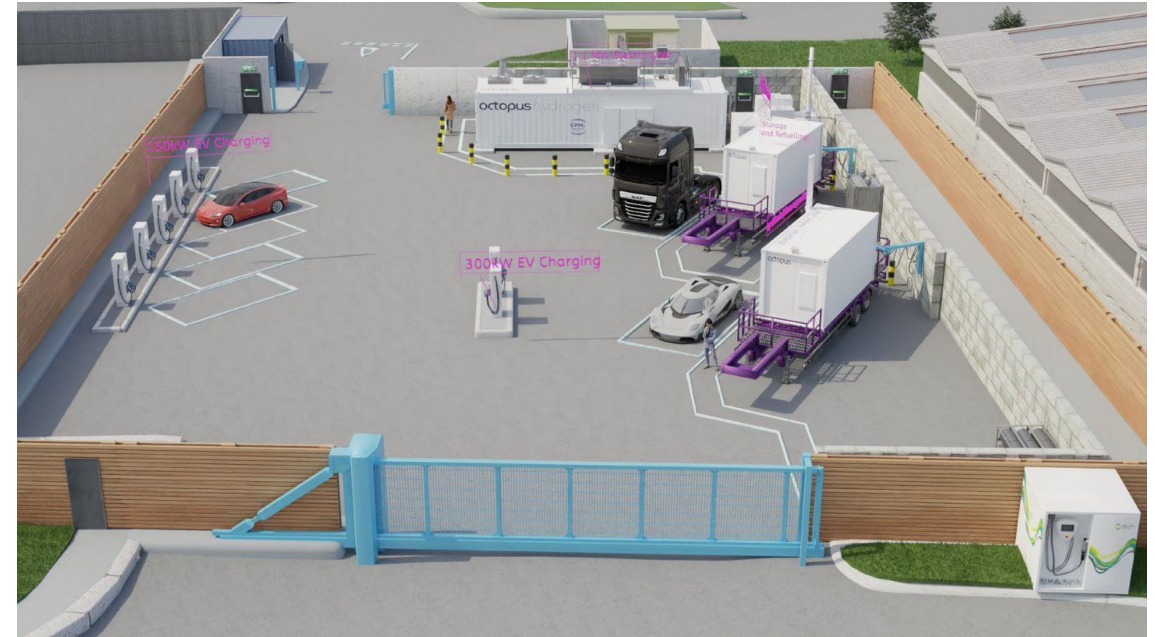
Focus;

1. *H₂ Production & Storage*
2. *Integrated Energy Systems*
3. *H₂ Combustion*
4. *Fuel Cell Electrochemistry*
5. *Stationary & Mobility Applications*



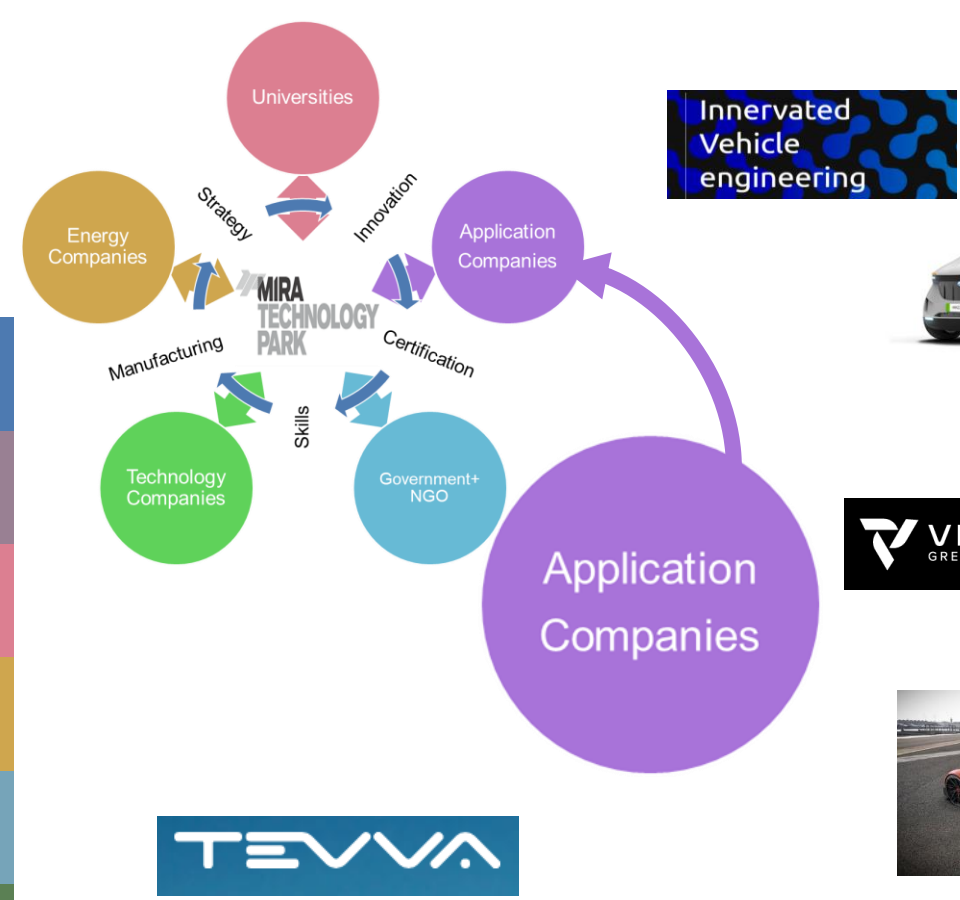


octopus
hydrogen



Hydrogen & EV charging forecourt installation includes;

- 150 and 300kw electric vehicle chargers
- 1.1MW electrolyser producing over 300kg per day of Green hydrogen
- 350 & 700bar refuelling for cars, buses and trucks
- All powered by a 7MW solar array to ensure clean Green Hydrogen is produced.
- Also providing transportable hydrogen storage units for onsite and offsite distribution.
- Hydrogen production and refuelling should start in Q3 this year.



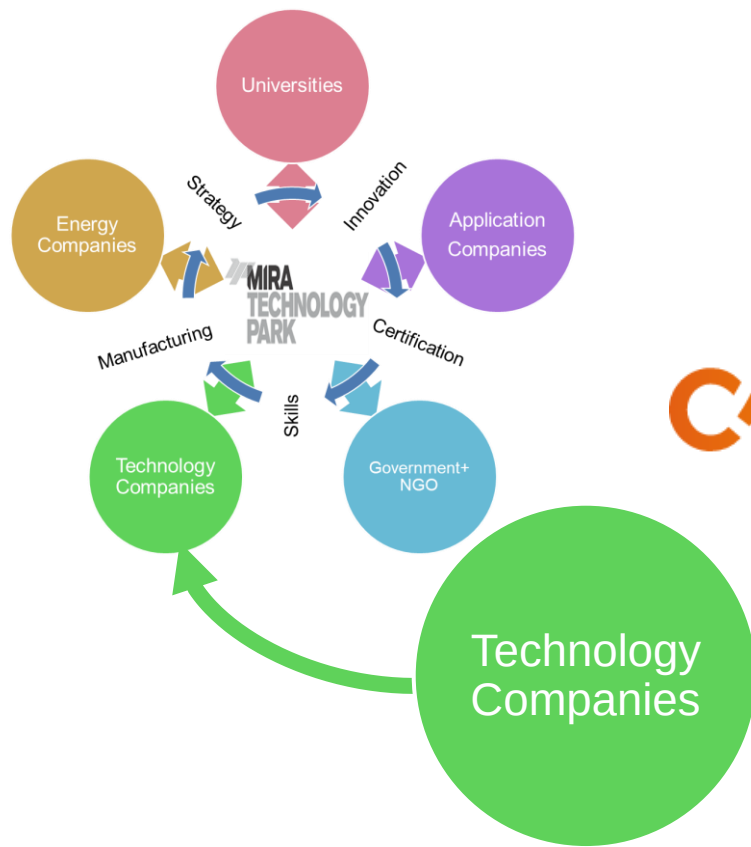
- ❑ IVE's *IndiGo* tackles to decarbonise some of the 2.5 million diesel vans on the UK roads
- ❑ *IndiGo* van is scheduled for pre-series trial orders in September 2023, with production orders arriving in early 2024.



- ❑ Viritech's revolutionary Apricale™ will harness hydrogen energy density to deliver hypercar performance
- ❑ Developing 44t fuel cell trucks that showcase Viritech's structural tank & powertrain technology



- ❑ Tevva focusses on electrifying 7.5-19t GVW trucks that are not just greener but a better truck
- ❑ Aim is to provide fleet owners with low total cost of ownership options that are emissions-free yet can manage a 1.5 tonne payload across a daily itinerary of over 600km.



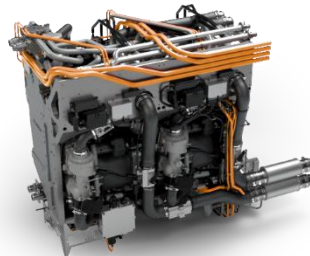
ceres

- ❑ Ceres Power large scale fuel cell testing laboratory at HORIBA MIRA's Technology Park will be state-of-the-art
- ❑ HORIBA Product company will be test partner and supplier of next-generation fuel cell test stands



BOSCH

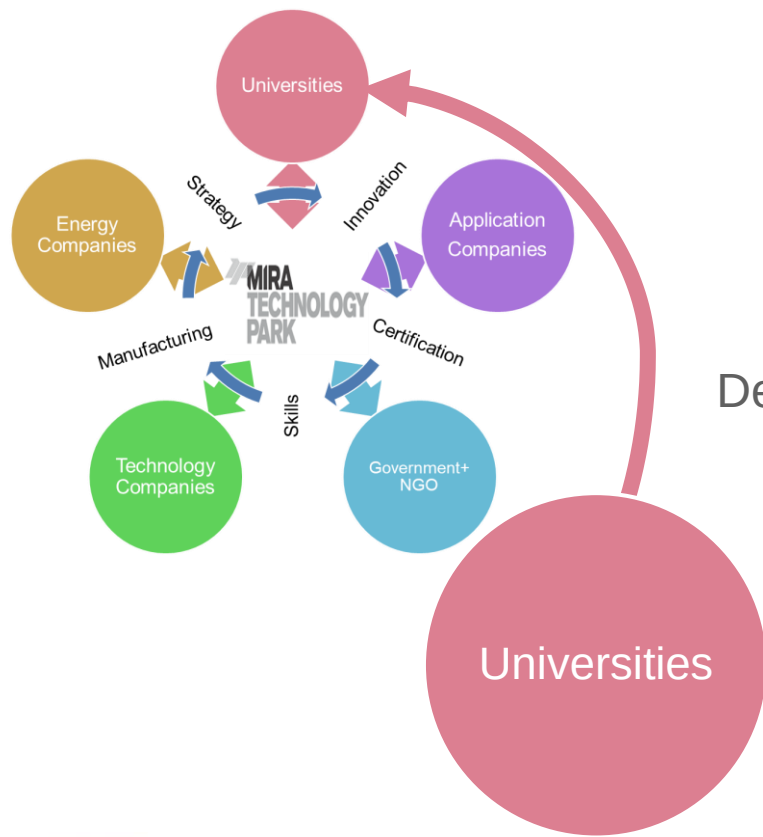
Invented for life



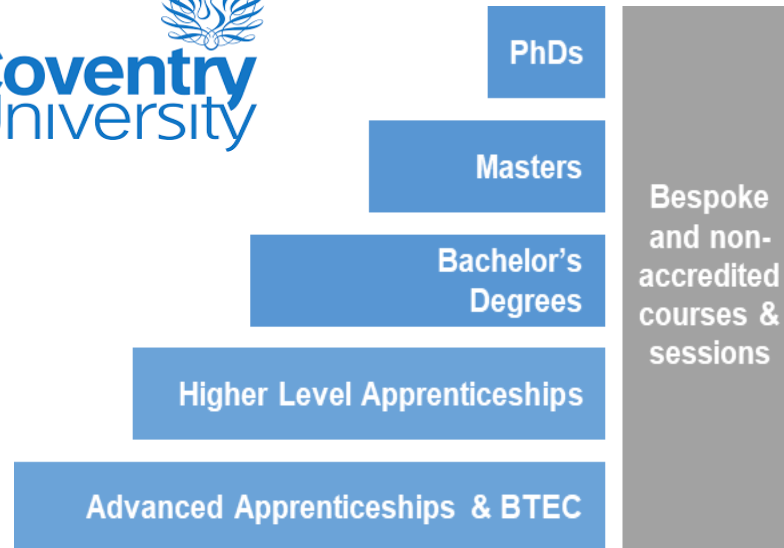
- ❑ Bosch can offer solutions for an innovative fuel-cell concept to meet any requirement – from individual components and modules to an all-in-one system for commercial vehicles.



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Opened in
2018

£9.5m
initial
funding

15
training
rooms

3
workshops

Industry led
course content

Omoshiro-okashiku
Joy and Fun

おもしろおかしく



Thank you

Terima kasih

감사합니다

Cảm ơn

ありがとうございました

Dziękuję

धन्यवाद

Grazie

Merci

谢谢

நன்றி

ขอบขอบคุณ

Obrigado

Σας ευχαριστώ πάρα πολύ.

شُكْرًا

Tack ska du ha

Большое спасибо

Danke

Gracias