ENERGY RESEARCH ACCELERATOR

Hydrogen: Research Capabilities and Regional Commercial Activities

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Overview

There are several drivers for hydrogen in the UK, but the main ones are linked to decarbonisation of heat and low carbon, low emissions transport. The scale of hydrogen production required for the former, which could be potentially through direct injection into the gas grid, is very significant and at present could only realistically be achieved through steam methane reforming, requiring Carbon Capture Utilisation and Storage (CCUS) to prevent the release of the CO2 and meet net zero commitments. Hydrogen for transportation is beginning to be deployed in the UK, however further work is needed on improved technologies and establishing the supporting infrastructure.

ERA has a long track record of working on hydrogen projects and fuel cells. The universities of Loughborough, Nottingham and Birmingham have run the EPSRC Sustainable Hydrogen Centre for Doctoral Training (CDT) for a approx. 10 years, which has linked the academic research base to the industry through collaborative research projects and training and skills development. This collaboration has also delivered a range of research facilities, including the Research and Demonstration (RAD) building in Nottingham housing a hydrogen systems test bed; the HyPER project (Bulk Hydrogen Production by Sorbent Enhanced Steam Reforming) to construct a state-of-the-art 1.5 MWth pilot plant; the HyDeploy project to demonstrate that hydrogen can be deployed into the grid up to 100% hydrogen; generation of hydrogen from bioprocessing and:, the Thermo Catalytic Reforming facility developed in collaboration with the Fraunhofer – based at the ERA supported Tyseley Energy Park. A large-scale Steam Methane Reforming plant, with CCUS, is being planned for the Tyseley Energy Park with hydrogen production for buses, trains and injection into the gas grid for domestic heating.

This paper briefly summarises the facilities we have across the region as well as some of the more notable commercial activities taking place.

Generation and storage

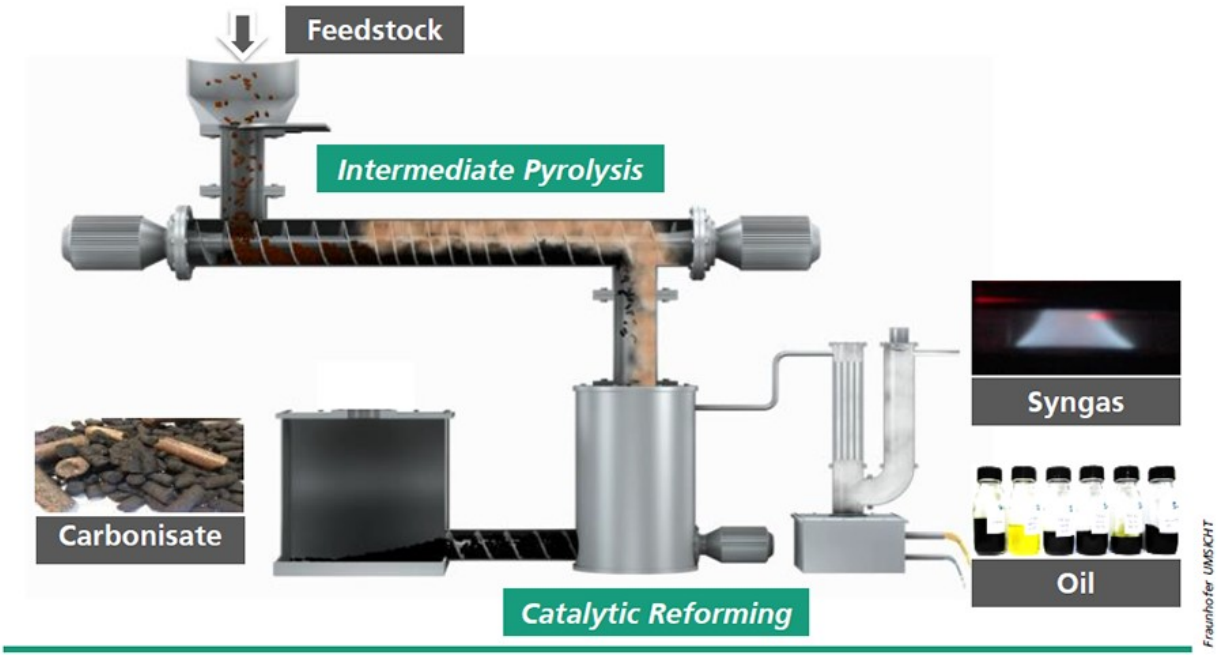
An international collaboration led by **Cranfield University** is set to examine the potential for low-carbon hydrogen to be the clean fuel of the future. The HyPER project (Bulk Hydrogen Production by Sorbent Enhanced Steam Reforming) will construct a state-of-the-art 1.5 MWth pilot plant at Cranfield University to test an innovative hydrogen production technology that substantially reduces greenhouse gas emissions. With £7.5 million funding from the Department for Business, Energy and Industrial Strategy's (BEIS) Energy Innovation Programme, the project also involves US-based research and development organisation GTI and Doosan Babcock, a specialist in delivery of low-carbon technologies. The project centres on a novel hydrogen production technology invented by GTI.

Cranfield University's pilot hydrogen production plant

The **University of Birmingham** has, as part of the Energy Research Accelerator (ERA) project, invested in an innovative **Thermo-Catalytic Reformer (TCR),** which uses an improved pyrolysis technology to transform various kinds of biomass into synthesis gas, charcoal and diesel quality oil, effectively using around 70% of the energy in the biomass. The TCR process has the ability to convert the biomass into high quality syngas, bio-oil, biochar, water and hydrogen. The TCR® demonstrator can process up to 80kg of biowaste per hour and produces hydrogen rich synthesis gas used to fuel engines, separate H2 or purification for H2 fuel cells, bio-oil and bio-char. To date the University of Birmingham has attracted significant industrial co-investment from a number of organisations in support of this facility.

The learning from the ERA funded TCR® at Tyseley is being used as the basis for new, larger scale demonstrators. The aim is for a full-scale commercial plant to be developed on the site in the next few years, which will be capable of processing much larger quantities of biomass per hour and make a significant contribution to the delivery of green fuel for the city.

The University of Birmingham has also developed a hydrogen powered boat with hydrogen storage using metal hydrides and created a fleet of hydrogen powered vehicles.



The Thermo-Catalytic Reformer (TCR) process being researched by University of Birmingham and the Fraunhofer Institute

The research capability in hydrogen storage involves projects investigating hydrogen compression (EPSRC ESCHER), catalytic nanoparticles (EPSRC CL4W) and complex hydrides (EC ITN ECOSTORE) and in involves bilateral networks on hydrogen storage with Japan and Korea. Key topics include

- Hydrogen storage materials
- Gas separation membranes
- Hard magnetic materials
- Microstructural processing of materials using hydrogen
- Nanomaterials

The Hydrogen Systems Test Bed, funded by the Energy Research Accelerator and hosted at the **University of Nottingham**, is the largest academic hydrogen research lab in the UK and will be used to investigate hydrogen production, storage and utilisation technologies. The £1.45m of funding has been invested in technologies that is making a major impact on two important energy challenges: decarbonisation of heat and zero emission vehicles. The Hydrogen Systems Test Bed is a flexible test facility for developing different hydrogen components relating to generation, storage and use. The facility also includes a 1MWh hydrogen store that enables testing to systems up to 100 kW in scale. The facilities are developing novel materials such as a low cost AB2 metal hydride alloy which have a very high energy density (1 kWh/L) – cf. Li-ion batteries. Metal hydride storage enables compact storage of hydrogen at low pressures (<10 bar).

The Research Accelerator Development (RAD) Building at University of Nottingham

The university is also investigating new main group **catalysts** for hydrogen production and investigations into porous nickels, novel nickel and iron based complexes, which replicate reaction pathways seen in nature, aim to produce more efficient, cheaper and longer-life catalysts for the production of hydrogen through means other than steam gas reformation of hydrocarbons. This work will allow a shift towards a cleaner and more sustainable society.
Research is taking place into hydrogen systems includes **storage technology**, the preparation and processing of novel materials, **materials characterisation** and the testing and validation of materials. Of particular note is current research on the development of solid-state hydrogen storage materials - light metal hydrides, intermetallic hydrides and complex hydrides. Research encompasses computational material discovery and the development of new materials through to the engineering design of prototype hydrogen stores. Application for the prototype stores include renewable energy back-up storage, energy storage for the Creative Energy Homes, microgrid and hydrogen fuelling stations. High temperature hydrides are being investigated as high energy density materials for thermal energy storage, for concentrated solar power plants and high-pressure hydrides are being investigated for low maintenance, low noise hydrogen compressors.

Aston University's thermochemical conversion research focuses on both fundamental and applied studies of the thermal **transformation of biomass and organic materials** into valuable solid, liquid and gaseous products that are relevant to industry and modern society. Innovative methods include pyrolysis, gasification, and hydrothermal processing, involving catalysts (homogeneous/heterogeneous) and additives (organic solvents, ionic liquids) for efficient processing at atmospheric to moderate pressures. We operate diverse process equipment configurations from batch/semi-batch, fixed-bed to fluidised beds, with variable processing capacities, ranging from lab-scale systems (milligram to gram scale) up to a 300 kg/h pilot plant. These give us the capability and flexibility to study a wide range of feedstocks and process conditions. The team works with various feedstocks including sustainable biomass (woody biomass, straw, miscanthus, willow, micro/macro-algae, brewery spent grains), plastic waste, municipal solid waste (MSW), composite waste, industrial/pharmaceutical effluents, sewage sludge, and virgin/used/inedible fats and oils producing a range of industrial chemicals, solid, liquid and gaseous hydrocarbon fuels, including hydrogen.

The Energy and Bi-products Research Institute at Aston University

The university's **catalysis** group focusses in different areas of catalysis from synthesis to close-to-industrial operation. EBRI catalysis group explores the synthesis and characterisation of tailor-made green catalysts, with different pore architectures, functionalities and chemical properties, with the aim to develop novel and more sustainable catalytic routes for the production of biofuels and high-value chemicals. Also, they synthesise and assess commercial catalysts for the optimisation of the steps involved in biomass conversion to bioenergy and chemicals that require the presence of catalysts such as pre-treatment, thermal/chemical conversions, and downstream bioproduct upgrading.

Loughborough University is working on low-cost generation of H_2 from a **methane cracking technology** in collaboration with industry. Methane cracking is a direct rival technology to SMR (the major hydrogen production technology operates at scale at the moment) and it has numerous advantages over electrolysis. The technology produces hydrogen from methane and carbon is captured as solid carbon. Due to the nature of the technology, it has the potential to produce H_2 at very low-cost on demand. The team in Loughborough University is working towards scaling up the technology in collaboration with industry (e.g. DNVGL, SGN, BSI, EffecTech, and Zinergy).

Key areas of research expertise include:

- Electrolysis
- On-board and on-demand Hydrogen generation.
- Energy storage
- Methane cracking
- Materials for hydrogen technologies
- Photoelectrolysis
- Ammonia as an alternative energy vector

The **British Geological Survey** (BGS) is in a unique position in assessing the national **subsurface geological storage** potential, and also in researching the behaviour of hydrogen in different natural underground storage scenarios. A series of world-leading laboratories are hosted at the Survey, and these are engaged in experimental research assessing the behaviour of hydrogen in different geological settings across the UK. BGS is assessing the storage potential for hydrogen in the UK as an aid to planners and policymakers who help shape the options for uptake of hydrogen for heating and also as a route to decarbonisation of industrial areas. This work fits within a portfolio of research targeting energy storage options for the UK and elsewhere, part of a broad effort focussed on “Decarbonisation and Resource Management”.

BGS is also working with the University of Nottingham on the **GeoEnergy Test Bed** based at UoN Sutton Bonnington campus, The facility is a multi-borehole array to test and develop surface and subsurface monitoring for the potential injection of fluids and gases, including hydrogen, into the subsurface.

There are hydrogen storage options in some parts of the UK where accumulations of halite in the subsurface are suitable for the creation of underground gas storage caverns (e.g., Cheshire, Teesside). Research focuses on the behaviour of halite in contact with hydrogen and borehole infrastructure such as well cement, and also on the properties of halite where it has not been commercially developed (e.g., Somerset, Dorset). In areas of the UK where storage in solution mined caverns is not an option, research is assessing the properties of other geological units (e.g., depleted reservoirs, porous rocks) and the behaviour of those rocks in the presence of hydrogen.

The **University of Warwick** hosts Warwick FIRE, a multidisciplinary research laboratory for research into **fire and explosion hazards** as well as accidental releases of hazardous materials. Understanding the safety of hydrogen devices is absolutely essential. The research is focused on the development and application of computational fluid dynamics (CFD). They are a member of the first European Hydrogen Safety Panel appointed by the Fuel Cells and Hydrogen 2 Joint Undertaking and leads one of the four tasks.

Key research topics

- Spontaneous ignition
- Hydrogen jet fires
- Heat fluxes to hydrogen cylinder surface subject to fire impingement
- Hydrogen deflagration, DDT and detonation
- Modelling liquid hydrogen release covering pool spread and flashing jets

Fuel cell development and applications

Fuel cell technology research originated at **Loughborough** in 1988 and the ground-breaking work has given rise to a new generation of clean power systems based on advanced fuel cell technology. In 1995, the research team constructed the first 1kW proton exchange membrane fuel cell, and spin-out company Advanced Power Sources – now **Intelligent Energy** (2001) – was launched to explore the pre-commercial development of prototype fuel cells. Intelligent Energy now numbers more than 350 highly skilled employees and works closely with Loughborough experts as well as global industrial partners on a range of projects. Its global headquarters are part of the thriving energy cluster on Loughborough University Science and Enterprise Parks (LUSEP). The University is also working on Solid Oxide Fuel Cells technology in collaboration with industry. The current work is involved Single step SOFCs co-sintering process, Degradation of SOFC: Diagnostic tool development, In-situ thermal sensing of SOFC cells/stacks and Gas composition sensors (e.g. Lambda Sensor).

Pioneering fuel cell technology spun out of Loughborough University

The University of Birmingham's **Centre for Fuel Cell and Hydrogen Research (CFCHR)** has integrated research work across all aspects of fuel cells and their fuels and a £3.5 million investment has resulted in high-quality facilities including state-of-the-art fuel cell test stations, a CHP development unit from BAXI and developmental stack from Fuel Cells Scotland. It also has facilities for nano-particle characterisations; powder processing; sono-electrochemistry and dilatometery. **UoB** has projects currently engaged in include **New Generation Solid Oxide Fuel Cells (NewGenSOFC)** with goals of: Low-cost fuel cell manufacture, Low carbon energy generation and Movement towards a hydrogen economy; **Solid Oxide Fuel Cell (SOFC) Systems Development,** developing stacks and systems that can operate with either syngas or natural gas; **Low Temperature Fuel Cells**; **Techno-economic and social aspects of hydrogen and fuel cells; Use of Hydrogen Separation Membranes to improve hydrogen purity.**

The UoB has worked with commercial partners to develop the UK's first practical hydrogen-powered locomotive, is part of a research project "**Small 4-Wheel Fuel Cell Passenger Vehicle Applications in Regional and Municipal Transport (SWARM)"** *which aims to* optimise and build 100 low cost fuel cell hybrid vehicles and deploy supporting infrastructure, has a zero emissions canal boat, used to raise awareness of the practical applications of hydrogen. And is running a research project with Unilever called 'fuel cell integration for refrigeration applications', which focuses on how to use fuel cell technology in a refrigerated truck with a gross weight of seven tonnes and above). It is also part of a Europe-wide project to extend the mission duration of mini-UAVs using micro tubular SOFC power system.

The HydroFLEX team celebrating the successful proof-of-concept of the UK's first hydrogen train

The **HydroFLEX** project is a ground-breaking partnership between the **Birmingham Centre for Railway Research and Education** and railway rolling stock company, Porterbrook. A UK first, it is demonstrating how hydrogen could be deployed across the rail network to offer a cleaner alternative to current diesel trains. The FLEX concept involves conversion of current rolling stock, by fitting two new powerpacks – one under each driving vehicle. The modular design means the vehicle can be adapted for future energy modes, with diesel engines able to be replaced by battery packs and hydrogen fuel cells to create a zero emission self-powered unit. This exciting concept will result in passenger trains offering performance that can match or exceed the diesel fleets they replace, significantly raise air-quality, and offer a cost-effective alternative to commissioning brand new trains.

The **National Centre for Doctoral Training in Fuel Cells and their Fuels (CDT)** is a project between the universities of Birmingham, Nottingham, Loughborough, Imperial College and University College of London lasting until 2022. The PEFC Group is housed within the CDT laboratories, which are well equipped for a wide variety of applied research work on fuel cells, and overall facilities in terms of workshop support, libraries, IT, and technical support is of a high standard. The Group has wide-ranging interests in fuel-cell related work: from fundamental electrochemistry to catalyst and membrane development, all with application to low temperature proton exchange and alkaline fuel cells up to single cell level.

Student research as part of the Fuel Cells and their Fuels CDT

Key research topics include:

- Solid Oxide Fuel Cells and Electrolysers, reversible fuel cells (SOFC, SOE, rSOFC, and SOC): reversible operation, carbon deposition, catalysis, dry reforming, tape casting, inkjet printing, tubular SOFC stack development,
- PEFC, IT-PEFC, DMFC: catalysis, nanowires and low Pt-Alloys for electrodes, GDLs,
- Hydrogen from biomass, sunlight, and renewable electricity; hydrocarbon reforming catalysts,
- Fuel cell systems and their integration into energy systems, power-to-gas, hydrogen for storage of electricity; synthetic methane and diesel production from renewable energy, hydrogen, and CO2,
- Integration of fuel cells on vehicles, absorption chillers driven by fuel cells, SOFC hybrid heavy duty vehicles; fuel cells in rail, aircraft, maritime applications.

The University of Nottingham are **Developing Materials for Solid Oxide Fuel Cells, by** investigating electrochemical impedance and characterisation of materials, primarily focusing on perovskite structures. We also have expertise in solid state synthesis of doped materials to identify new characteristics and are undertaking investigations into potential solid oxide fuel cell and oxygen separator applications. University of Nottingham's research on **Proton Exchange Membrane Fuel Cells focuses on** developing improved materials through understanding the behaviour of various cathode materials. Key research interests include:

- Characterisation of electrical properties of functional materials
- Oxide ion conductors
- Mixed ionic-electronic conductors
- Solid oxide fuel cells
- Oxygen separation membranes
- Integration of hydrogen systems for microgrid applications.
- Systems analysis and energy management
- New materials for hydrogen applications (e.g. electrolysers, water splitting, purification, SOFC)
- Electrocatalysis in polymer electrolyte fuel cells and electrolysers
- Ionic liquid-based electrolyte membranes for intermediate temperature fuel cells and electrolysers
- High-throughput screening of fuel cell electrocatalysts
- Electrocatalysis in regenerative fuel cells

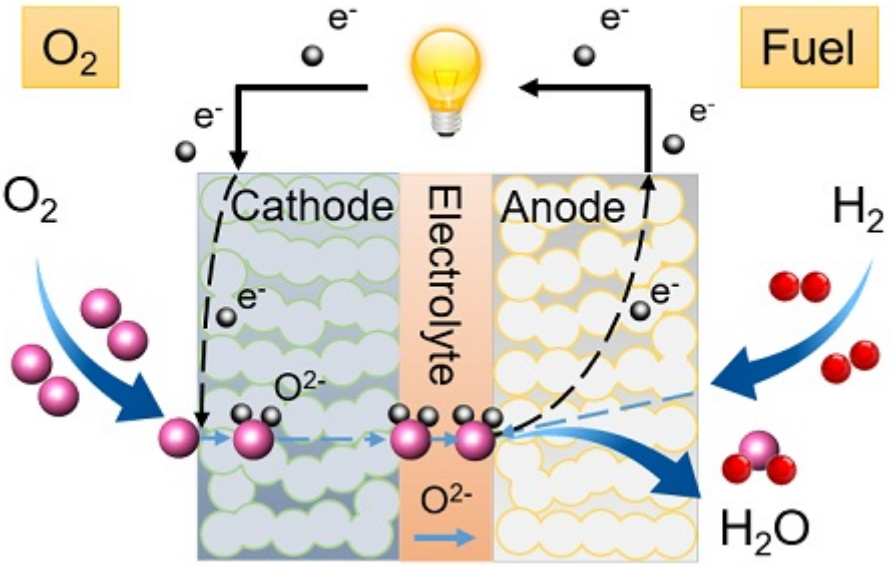


Diagram of solid oxide fuel cells being researched at the University of Nottingham

Loughborough University have expertise in electrochemistry, catalysis, electrochemical energy and environmental systems and engineering (fuel cells, batteries, ozone and advanced oxidation technologies for water treatment and disinfection), electro-synthesis, nanomaterials, nano-technologies, electro-catalysis, in-situ spectroscopy, surface science and surface engineering
Key research areas are:

- Electro-catalysis and catalytic reactions
- Fuel Cells: PEM Fuel Cells, Direct Alcohol Fuel Cells, Alkaline Fuel Cells
- Electrochemical In-situ FTIR spectroscopy and DFT modelling
- Nanomaterials: synthesis, characterization and applications in Energy technologies
- Electrocatalytic generation of ozone from water and for advanced oxidation reaction

University of Warwick have a focus on **materials for energy and sustainable synthesis**. They develop ionic and electronic conducting materials to be used as electrolyte or electrode materials for electrochemical devices such as fuel cells, electrolysers, batteries and supercapacitors. They work on direct ammonia/ urea/ urine fuel cells and direct carbon fuel cells. There is also expertise in electrochemical synthesis technologies using hydrogen or water as the precursors.
Key research topics include

- Materials for solid oxide fuel cells and electrolysers
- Membranes and catalysts for polymer membrane fuel cells
- Direct ammonia/urea/urine fuel cells
- Direct carbon fuel cells
- Electrochemical synthesis of ammonia and hydrocarbons
- New materials for batteries and supercapacitors

Hydrogen in gas networks for domestic and commercial use

The UK's first live pilot to inject zero carbon hydrogen into a gas network to heat homes and buildings at **Keele University** is now fully operational. ***HyDeploy*** is a ground-breaking green energy trial at Keele University and this demonstration project is injecting up to 20% (by volume) of hydrogen into Keele University's existing natural gas network, feeding 100 homes and 30 faculty buildings. The 20% hydrogen blend is the highest in Europe, together with a similar project being run by Engie in Northern France. Backed by Ofgem's Network Innovation Competition, the £7 million project is led by Cadent in partnership with Northern Gas Networks, Keele University, the Health and Safety Executive (HSE) Science Division, integrated hydrogen energy systems manufacturer ITM-Power, and independent clean energy company Progressive Energy.

Skills development

The **Doctoral Training Centre (DTC) on Sustainable Hydrogen (SusHy)** continues a long running and highly successful collaboration in hydrogen research between the Universities of Nottingham, Loughborough, and Birmingham (UoN, LU, UoB) and brings together the world leading expertise in **hydrogen generation, purification, sensors/monitoring, and storage, along with whole systems issues** (resilience engineering, business economic models and life cycle analysis) which exist across the three Universities. A gap in the consortium expertise is in the research field of hydrogen safety and we identified the internationally renowned Hydrogen Safety Engineering and Research Centre (HySAFER) at Ulster University (UU) as the right partner to deliver on this key aspect. This is the first broad collaboration in the world seeking to investigate, train researchers and produce leaders in Sustainable Hydrogen.

The DTC has a programme that is tailored to the sector needs for high-quality, industry-ready doctoral Energy Innovation Leaders. The consortium works closely together with key industry players across the hydrogen sector, including through co-supervision, mentoring of doctoral students and industry involvement in CDT events. Our industrial stakeholders include those working on hydrogen production (ITM Power, Hydrogen Green Power, Pure Energy) and distribution (Northern Gas, Cadent), storage (Luxfer, Haydale, Far UK), safety (HSL, Shell, ITM Power), low carbon transport (Ulemco, Arcola Energy), heat and power (Bosch, Northern Gas).

Innovation activity in the region

Across the ERA partners there are combined programmes totalling around £50m focused on supporting industry and SMEs to decarbonise and develop low carbon products or services. These are hosted across a number of our partners and enable our research community to work with companies interested in R&D linked to the hydrogen economy.

The University of Birmingham has recently gained funding to build the Tyseley Sustainable Energy Systems Research and Innovation Centre (TSESRIC) which will help realise the vision for the Tyseley Energy Innovation Zone by bringing together various well-established energy research groups in Birmingham into one central facility covering innovative research into strategic elements and critical materials, waste, energy storage and fuel cells and hydrogen vehicles. This project will deliver innovation-led regional growth in the integrated waste, energy and low carbon vehicle systems sector in the West Midlands.

Key commercial activity and research partners in the region

In addition to the activity being undertaken by research organisations there are a number of companies active in the hydrogen space in the region, including the following:

ADELAN Fuel cell innovation realised	Birmingham-based Adelan pioneered microtubular solid oxide fuel cell (mSOFC) technology more than 30 years' ago and Adelan is the longest running fuel cell company in Britain. Adelan's patented, scalable technology offers unprecedented fuel flexibility, allowing the system to run cleanly on a range of commonly available fuels such as LPG, natural gas or propane/butane mix. Adelan Chairs the Midlands Hydrogen and Fuel Cell Network (MHFCN).
arcola energy	Tier 1 supply of hydrogen and fuel cell systems. Engineering services and expertise in: ○ Clean energy and transport strategy ○ Complex multi-partner project creation and delivery ○ Hydrogen and fuel cell system engineering, manufacture, deployment and aftermarket support ○ Public and youth education in hydrogen and fuel cells. Partner on the Sustainable Hydrogen Centre for Doctoral Training.

Baxi are developing and testing boilers in our R&D laboratory that are running on 100% hydrogen. We are at the forefront of this exciting new technology. Our parent company, BDR Thermea Group, has a hydrogen boiler on a field trial in Rozenburg, The Netherlands. Member of Hydrogen Taskforce. Partner in Hy4Heat and HyDeploy.

BP are a partner on the Sustainable Hydrogen Centre for Doctoral Training.

Cadent manages gas pipes throughout the West Midlands (and other regions). Leading the £7m HyDeploy trial at Keele University to blend hydrogen into the gas network on the campus. Also lead partner in a Steam Methane Reforming project at Tyseley Energy Park via the Cadent Foundation.

Located at Loughborough University campus and work on low carbon vehicles, including hydrogen. Cenex aims to assist technology developers to transition low carbon technologies from research to market applications and help first adopters to trial these new technologies.

Doosan Babcock designs and delivers smart energy products and solutions globally to help create a greener future for generations to come. Member of Cranfield University's HYPER project focused on bulk hydrogen production by Sorbent Enhanced Steam Reforming).

EDF is a member of ERA's Industrial Advisory Board, with interests in hydrogen storage and production of hydrogen from its nuclear assets.

Intelligent Energy is a fuel cell engineering business built on 30 years of PEM fuel cell development and spun out of Loughborough University. It is focused on the development and commercialisation of its PEM fuel cell technologies for a range of markets including automotive, stationary power and UAVs. It is headquartered in the UK, with additional operations in the US, Japan, Korea and China.

ITM Power Plc is a British manufacturer of PEM electrolysers and hydrogen systems based on electrolysis.
It has been involved in projects based at the University of Nottingham and Tyseley Energy Park.

JCB heir Jo Bamford recently acquired Wrightbus, a bus manufacturer and plans to introduce 400 hydrogen buses in Birmingham as part of the move to lead the nation's economic recovery. As well as Birmingham, plans are being drawn up to introduce a fleet of 3,000 buses – in which passengers benefit from USB charging points and more spacious seating – across the UK in places such as Aberdeen, London, Liverpool, Manchester, Brighton, Glasgow, Edinburgh and Belfast.

Johnson Matthey global Fuel Cell business is dedicated to the supply of high quality fuel cell components for automotive and stationary applications. They provide the full range of catalysts used in the process including desulphurization, pre-reforming, steam reforming and water gas shift catalysts.

Johnson Matthey are a partner on the Fuel Cells and their Fuels Centre for Doctoral Training.

NPL is the UK's National Measurement Institute, and is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available. It is supporting the rollout of hydrogen technologies through the development of in situ diagnostic techniques, modelling tools and standard test methods for fuel cells and electrolysers, and by taking a leading role in the establishment of standards for hydrogen purity.

NPL are a partner on the Fuel Cells and their Fuels Centre for Doctoral Training.

Porterbrook owns around 1/3 of the UK's passenger rail fleet and supports around 1.5m passenger journeys each day. Porterbrook are partnering with the University of Birmingham's Centre for Railway Research and Education (BCRRE), Porterbrook have developed the UK's first hydrogen powered train – the HydroFLEX.

The project demonstrates a practical application of hydrogen in a full size passenger train fitted with hydrogen fuel tanks, a fuel cell and battery pack to provide independent traction power capable of operation with zero carbon emissions.

Pure Energy Centre are a manufacturer of small, medium and large scale hydrogen systems. PEC's focal point is on the development and deployment of projects centred on electrolysers, storage, compressors, and complex hydrogen refuelling stations operating at 350 and 700 bar.

Partner on the Sustainable Hydrogen Centre for Doctoral Training.

Ryse Hydrogen operates affordable hydrogen distribution and dispensing assets as well as renewable-powered electrolysers. Their current focus is on providing hydrogen fuel for buses as these are the most mature of the heavy vehicle transport options.

Siemens are one of ERA's Industrial Advisory Board members with interest in use of hydrogen as an alternative fuel. Part of Tyseley project which examined hydrogen.

Tyseley Refuelling Hub
ITM Power refuelling with hydrogen

The low and zero carbon refuelling station at the Tyseley Energy Park will be unmanned with 24/7 refuelling available. Pay at pump option will be integrated into the dispenser display head at each refuelling point which will accept credit, debit and fuel card payments. Refuelling facilities at TEP will include Hydrogen, CNG, Biodiesel and electrical charging options. The hydrogen will be produced on site using a 3MW ITM Power Proton Exchange Membrane (PEM) electrolyser. The hydrogen generated is very high purity, meeting all requirements for Fuel Cell Electric Vehicles (FCEVs).