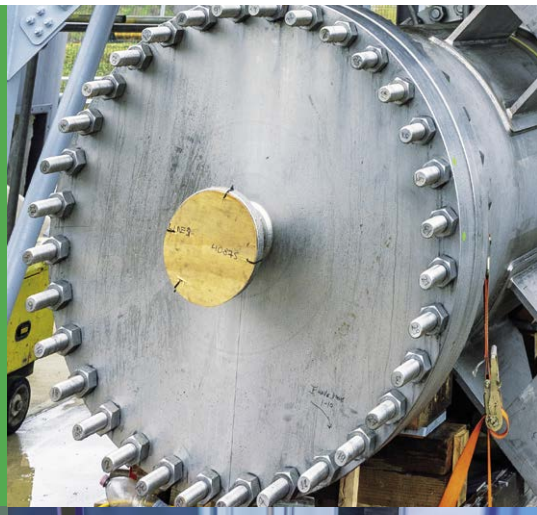
@HyDEXMidlands

HyDEX

Creating a new hydrogen economy in the Midlands

Hydrogen demonstration facilities for businesses

HyDEX.ac.uk



Funded by UKRI Research England

Delivered by ERA Energy Research Accelerator

Contents

HyDEX university partners

Aston University BIRMINGHAM UK

University of Birmingham

Cranfield University

Keele University

Loughborough University

University of Nottingham UK | CHINA | MALAYSIA

Warwick The University of Warwick

Funded by

UKRI Research England

Delivered by

ERA Energy Research Accelerator

Supported by

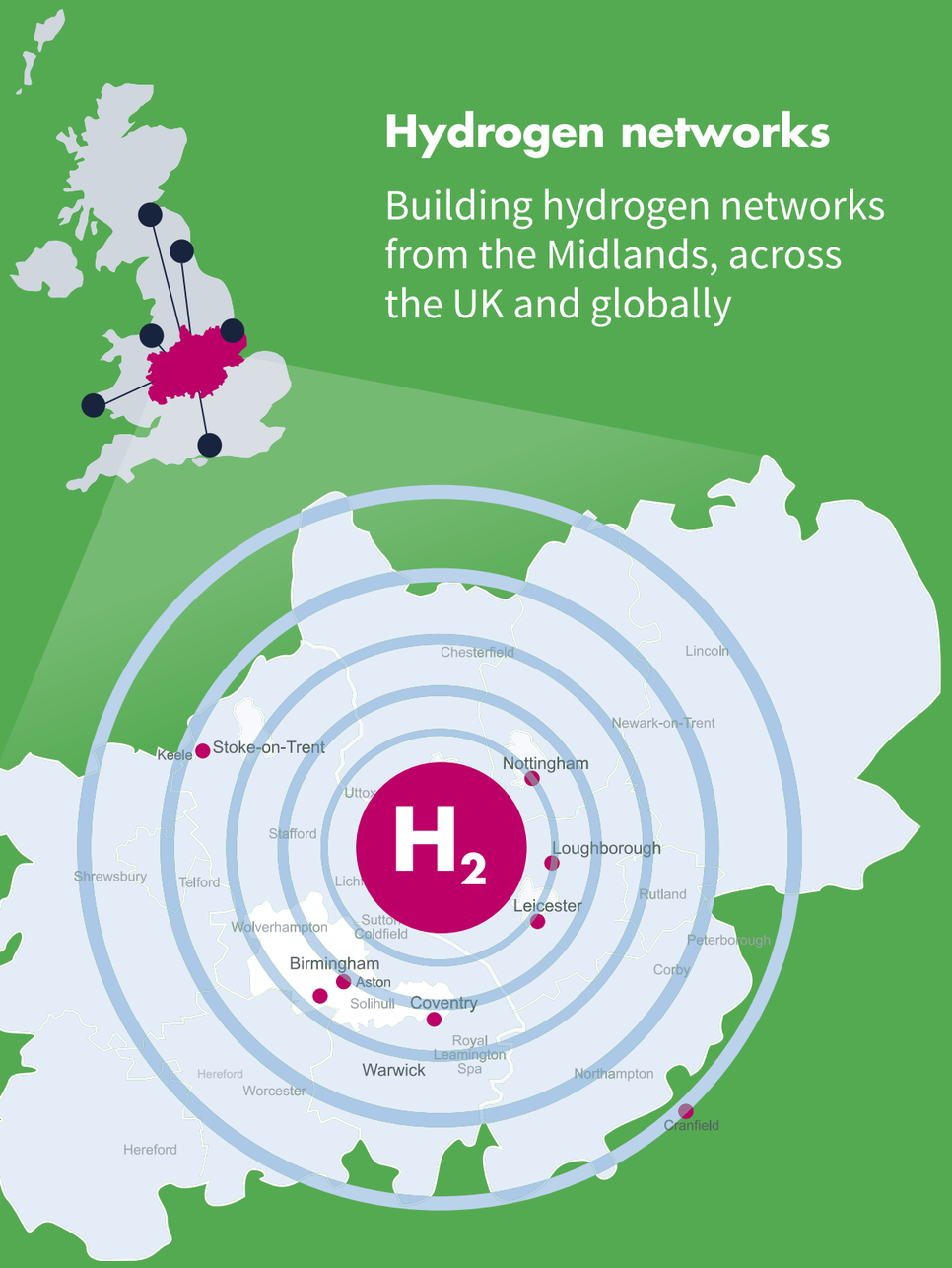
Midlands Engine

About HyDEX

Low-carbon technologies are being developed to address an urgent need to meet our energy needs while reducing the impact on our climate. Hydrogen offers a solution for cleaner energy production and the hydrogen economy is developing at an increasing pace. There is a need for increased hydrogen production to support the decarbonisation of the national gas grid, manufacturing, transport and heat production.

The HyDEX partnership offers a range of services for businesses of all sizes, including technological development, demonstration and testing, skills, access to international markets and much more.

HyDEX brings together a combined resource of around £55m worth of hydrogen demonstrator and research facilities across the Midlands region to help businesses develop skills, products and services, accelerating the rapidly growing hydrogen economy.



Why hydrogen?

Globally, hydrogen has become more prominent in the challenge to transition to low-carbon energy, with the potential to simultaneously decarbonise both heating and transport.

Hydrogen is set to be a crucial vector in rapidly reducing the UK's emissions across a wide range of industrial processes.

The international Hydrogen Council suggests that by 2050 the establishment of a worldwide hydrogen economy would create a US$2.5 trillion market for hydrogen and fuel cell equipment, providing sustainable employment for more than 30 million people.

Germany has announced a €9 billion hydrogen investment programme, Japan has set the target to have a complete hydrogen society by 2050, and countries such as China, South Korea and Australia have major ambitions associated with hydrogen-based technology.

The UK has established a Hydrogen Advisory Council that is to inform the development of hydrogen as a strategic decarbonised energy carrier. The UK's Ten Point Plan for Net Zero aims to generate 5GW of low carbon hydrogen production capacity for industry by 2030.

The UK government has committed £1 billion to accelerate commercialisation of low-carbon technologies and systems for net-zero. Evidence suggests that developing a UK hydrogen economy will also support over 9,000 British jobs by 2030 and up to 100,000 jobs by 2050.

Developing a UK hydrogen economy

Support over
9,000
British jobs by 2030

Up to
100,000
Jobs by 2050

Aston University
BIRMINGHAM UK

Aston University

Aston University has a history of leading the way. It has evolved over the last 120 years to become a research-led university known for world-class teaching quality. Aston focuses on high quality, exploitable research that has an impact on society through medical breakthroughs, advancements in engineering, policy and practice in government, and the strategies and performance of business.

BACKGROUND

Aston University specialises in the production methods needed to provide a reliable, affordable and green supply of hydrogen. With a long history in gasification and pyrolysis research, the Energy and Bioproducts Research Institute (EBRI) at Aston carries out world-leading research into new and innovative ways of converting biomass into sources of sustainable energy such as hydrogen, using thermochemical, biological and catalytic processes.

he Energy & Bioproducts Research Institute (EBRI) at Aston University is researching the potential of gasification and pyrolysis in hydrogen production.

THE GASIFICATION PILOT PLANT

The EBRI Gasification Pilot Plant is a distributed renewable energy demonstrator. The facility is a microgrid equipped with a biomass gasification plant (1 MWth), a combined heat and power generator (400 kWel), and 10 kW smart bidirectional chargers for electric vehicles.

The biomass gasification plant is the largest gasification plant for R&D in the UK. It is a four-storey building with a fully instrumented fluidised bed gasifier for the conversion of biomass into a gaseous fuel.

The EBRI microgrid can be fully powered in terms of heat and power by a dual-fuel engine, which is controlled by a demand-side management system.

The Gasification Pilot Plant at EBRI has expertise and facilities for testing and developing fuel cells with commercial applications in heating and transport.

The plant is used for:

- The production of hydrogen from gasification processes, including biomass
- Assessing the potential of pyrolysis in hydrogen-rich gases production
- Gasification and fuel cell integrated systems

By optimising production, through catalysis and integrating conversion methods such as methanol conversion, the process of providing hydrogen can be enhanced.

THE URBAN BIOCHAR AND SUSTAINABLE MATERIALS DEMONSTRATOR

Aston University's second demonstrator, which is based at a plant nursery in Birmingham, processes tree cuttings from parks and roadsides in the Birmingham City area. It uses low/intermediate pyrolysis to produce hydrogen and other gases alongside bio-oils, herbicides and biochar. This demonstrator is working to provide heat for greenhouses as well as biochar to help trees and plants to grow.

Operation of the demonstrator is supported by industry partners and also engagement and research staff at the Energy and Bioproducts Research Institute (EBRI) at Aston University.

HOW CAN IT HELP BUSINESSES?

The demonstrator has been used to develop a regional supply chain of companies able to design, fabricate and supply the specialised equipment needed to process the residues to produce the hydrogen and other products. The creation and operation of the demonstrator has helped these companies gain access to opportunities in UK and export markets. A wider cluster of companies has been established that are able to benefit from both the consumption of residues such as tree shreddings and also the use of the new products that are created. This includes use of hydrogen and other gasses gases in fuel cells, but also industrial heating, use of solids for plant growth enhancement, peat replacement, as a plaster and cement additives, surface coatings, odour control and filtration.

WHAT'S ON OFFER?

EBRI offers visits to the demonstrator along with technical advice and support with business modelling. In addition, case studies and events are being developed to illustrate the commercial potential uses of the demonstrator.

EBRI welcomes enquiries from companies that are interested in exploring applications of the technologies and products.

CONTACT

Energy & Bioproducts Research Institute (EBRI)
Aston University
Aston Triangle
Birmingham B4 7ET
Telephone: **+44 (0)121 204 3383**
Email: **bioenergy@aston.ac.uk**

FIND OUT MORE

Discover EBRI
www.aston.ac.uk/ebri

UNIVERSITY OF BIRMINGHAM

University of Birmingham

The University of Birmingham has been challenging and developing great minds for more than a century. Its research has broken new ground, pushed forward the boundaries of knowledge and made a lasting impact. Capitalising on its inter-disciplinary strengths, Birmingham's research is creating innovative and enduring solutions to complex global challenges. From advanced manufacturing, transport and energy, to life sciences and global ethics, we are at the forefront of research and innovation.

Researchers at the University of Birmingham working in the hydrogen laboratories.

BACKGROUND

Working with Tyseley Energy Park (TEP) and other partners in the Midlands, the University of Birmingham is pioneering infrastructure solutions in renewable heat and power, energy storage and clean transport fuels in combination with advanced waste processing. TEP features a hydrogen refuelling station and integrated ammonia cracker.

THE BIRMINGHAM ENERGY INNOVATION CENTRE

The Birmingham Energy Innovation Centre (BEIC) at Tyseley Energy Park, is designed to promote innovation in waste, energy, and low carbon vehicle systems. Funded by the Greater Birmingham and Solihull LEP, the BEIC supports the delivery of a greener and cleaner ecosystem for Birmingham and the West Midlands

The BEIC focuses particularly on the work of the University of Birmingham's Birmingham Energy Institute. The institute is a nationally recognised centre of excellence in hydrogen and fuel cells, energy storage, magnet and battery recycling and converting waste to fuels and energy. Innovations developed at the Centre are spun out into the city and region, national and international markets.

HOW CAN IT HELP BUSINESSES?

With a strong focus on transport and energy system decarbonisation, the BEIC at Tyseley Energy Park offers companies:

- Access to a variety of energy and related technologies
- Testing and validating materials and components for hydrogen and alternative fuel production or fuel cell systems, where components can be tested and evaluated within a real system environment
- Opportunities to consult with academic experts in:
  - fuel cell and hydrogen production
  - smart grids
  - decarbonisation of heating and cooling
  - recycling critical materials such as rare earth metals
  - influencing and shaping regional policy to support clean growth

WHAT'S ON OFFER?

Birmingham University can offer the use of equipment and laboratories, as well as expertise, advice and training.

THE TYSELEY ENERGY PARK DEMONSTRATOR

Tyseley Energy Park is committed to delivering low and zero carbon power, transport, heat, waste and recycling solutions for a greener, cleaner, healthier Birmingham. Harnessing the vision, passion and innovation of industry, academics, local government and located on the site of a 300 year-old business, TEP is focused on:

- Generating low and zero carbon energy and fuels from waste
- Producing low and zero carbon transport fuels including Hydrogen, Electric charging, Biogas and Bio Diesel / GTL
- Innovating clean technology business through direct access to world class, research, testing and laboratory facilities at the University of Birmingham's Energy Innovation Centre
- Leading the low carbon heating agenda via the National Centre for the Decarbonisation of Heat
- Incubating companies/technologies through the Energy Incubation Hub.

CONTACT

Dr Yousif Al-Sgheer, Research Fellow
Email: **y.i.w.al-sagheer@bham.ac.uk**

Dr Artur Majewski, Research Fellow
Email: **a.j.majewski@bham.ac.uk**

School of Chemical Engineering
University of Birmingham

FIND OUT MORE

The Centre for Fuel Cell & Hydrogen Research
bit.ly/CFCHR-link

Birmingham Energy Innovation Centre
bit.ly/BEICweb

Tyseley Energy Park
bit.ly/TyseleyWeb

Cranfield University

As the UK's only exclusively postgraduate university, Cranfield's world-class expertise, large-scale facilities and unrivalled industry partnerships is creating leaders in technology and management globally. Cranfield is the largest UK provider of master's-level graduates in engineering and offer a flagship MBA, extensive world-class customised executive education and professional development programmes. Our work informs government policy and leads the way in producing cutting edge new technologies and products in partnership with industry.

BACKGROUND

Home to the Hydrogen Research Network and the HyPER project (www.hyperh2.co.uk). Cranfield University is exploring bulk hydrogen production by Sorbent Enhanced Steam Reforming (SESR), as well as catalytic methane cracking. SESR can produce higher purity, lower carbon and lower cost hydrogen from natural gas than conventional technologies. The university also has a batch processing methane cracking reactor and is looking into blended hydrogen formulations for targeted applications. In addition, researchers at Cranfield are exploring with manufacturers potential end-user opportunities for the carbon by-product.

Cranfield University's HyPER pilot plant shown during construction (left and bottom right), and Cranfield University's turquoise hydrogen demonstrator (right).

THE HYPER DEMONSTRATOR

This demonstrator can produce hundreds of kg of H2 per day. It is a megawatt scale pilot facility that utilises sorbent enhanced reforming to generate clean H2.

HOW CAN IT HELP BUSINESSES?

This pilot scale facility can be used by businesses as a test bed for their equipment either integrated into or around the facility. We actively encourage businesses to implement their technology with our equipment so that mutually beneficial research can be achieved.

This could be of use to any business developing anything from H2/CO2 leak detection, gas analysis, pipe fittings/gaskets, non-destructive testing and evaluation of metals/pipes, new instrumentation, new metal alloys, gas compressors, gas purification systems, and more. Furthermore, we welcome engagement from businesses interested in scaling up and installing clean H2 production facilities at their sites.

WHAT'S ON OFFER?

All the above uses of the facility plus tours, technical advice, use of the demonstrator, integration of new equipment and demonstration of component parts.

CONTACT

Dr Peter Clough
Senior Lecturer in Energy Engineering
Centre for Renewable and Low Carbon Energy
Cranfield University
Telephone: **+44 (0)1234 754873**
Email: **p.t.clough@cranfield.ac.uk**

THE TURQUOISE HYDROGEN DEMONSTRATOR

By spring of 2023, the turquoise hydrogen production pilot demonstrator will be in operation. This demonstrator consists of a central upright fixed fluidised bed reactor which generates hydrogen from methane, with built in mechanisms for heating and heat recovery. In the reactor, methane molecules are split into their constituents, H2 and carbon. This pilot reactor will have in-built system to separate gaseous H2 and remove the solid carbon, with a projected minimum hydrogen output of ~ 6 kg/day. In order to reduce the cost of hydrogen (per kg), we currently exploit the by-product solid carbon in batteries, water and air purification, soil-based crop enhancement products, magnetic applications.

HOW CAN IT HELP BUSINESSES?

The pilot reactor will be made available as a test bed for production of low carbon hydrogen. This will be particularly beneficial to businesses that use carbon as feedstocks, for example manufacturing and product development for batteries, supercapacitors, water purification, air purification, electronics, ink formulations.

WHAT'S ON OFFER?

We can offer all above, tours, technical advice and use of the demonstrator as a test bed.

CONTACT

Professor Upul Wijayantha
Professor and Head of Centre
Centre for Renewable and Low Carbon Energy
Cranfield University
Telephone: **+44 (0)1234 752955**
Email: **upul.wijayantha@cranfield.ac.uk**

FIND OUT MORE

hyperh2.co.uk

FIND OUT MORE

bit.ly/CranfieldH2Research

Keele University

At Keele University, 97% of research is deemed to be world-leading, or of international importance (REF 2014). The interdisciplinary institutes are undertaking cutting edge research that aims to tackle some of society's most pressing challenges. They bring students, academics and researchers together from across the university, and serve as hubs that stimulate collaboration and debate. Keele is helping to change the world for the better by engaging in cutting-edge research, and tackling some of society's most urgent problems, including renewable energy.

Keele University has built a strong reputation in hydrogen innovation and smart energy systems.

BACKGROUND

Keele University has a long been involved in hydrogen research and innovation. Using the campus as a living laboratory, the HyDEPLOY trial demonstrated that a blend of 20% hydrogen could be used in the heating network.

Keele is today involved in numerous hydrogen and energy initiatives, applying its expertise to real world situations to develop practical solutions.

DEMONSTRATOR FACILITY

The Smart Energy Network Demonstrator (SEND) The demonstrator brings together real-time, end-to-end hydrogen production, storage, and use in a facility using the campus as a "living laboratory". Leading technology via the Smart Energy Network Demonstrator (SEND) in monitoring and managing production.

Linked to prediction modelling, renewable energy production and demand allows smart control of hydrogen to maximise the efficiency of on-site wind and solar energy production. This allows us to produce hydrogen when renewable energy is abundant leaving more room for battery storage on site to really maximise our onsite storage.

Other demonstration projects at Keele include:

- **HyDeploy** – pioneering the safe use of blended hydrogen in gas networks to reduce carbon emissions
- **Keele Low Carbon Energy Park** – generating half of Keele's electricity with 12,500 solar panels and two wind turbines
- **Carbon Zero Rugeley** – a consortium led by ENGIE to develop a Smart Local Energy System (SLES)
- **POLKA** – which focuses on technical problems unique to hydrogen combustion, thermoacoustic instabilities and flashback.

HOW CAN IT HELP BUSINESSES?

Businesses can see how the technology works, both technically and economically. Businesses can not only see the footprint of the facility but can learn from the end-to-end production process on site, and the end-to-end process of planning, set up and running. SEND can be used for CPD, as well as for developing and testing products and services.

This demonstrator is of particular interest to those interested in smart energy generation and storage and hydrogen from renewables (green hydrogen) applications. This includes businesses and organisations involved in control systems associated IT infrastructure, planning and regulation, and site development.

WHAT'S ON OFFER?

Our demonstrator is available for visits tours and technical advice. CPD is available on request.

CONTACT

Dr Sharon George
Director of Environmental Sustainability and Green Technology, Keele University
Telephone: **+44 (0)1782 733986**
Email: **s.m.george@keele.ac.uk**

FIND OUT MORE ABOUT OUR HYDROGEN PROJECTS

SEND
bit.ly/KeeleSmart

HyDeploy
hydeploy.co.uk

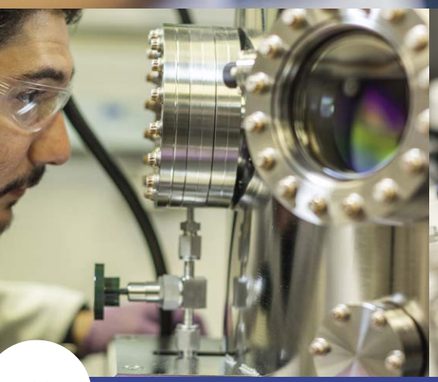
POLKA
bit.ly/PolkaKeele

Loughborough University

Loughborough University

Loughborough University has an international reputation for research that matters, excellence in teaching, strong links with industry and unrivalled achievement in sport and its academic disciplines.

Ranked in the top ten in England for research intensity, Loughborough has been awarded seven Queen's Anniversary Prizes in recognition of its contribution to the sector. Awarded five stars in the independent QS Stars university rating scheme, it is among the best universities in the world.



Through its Centre for Renewable Energy Systems Technologies (CREST) Loughborough University provides a huge range of expertise in hydrogen and other energy technologies.

BACKGROUND

Our hydrogen research areas encompass all areas of hydrogen from production through to end use including storage, distribution, combustion, policy, economics and safety, sustainability analysis and lifecycle management.

Our research goals include:

- low-cost design (for example not using exotic materials)
- sustainable use of materials (for example abundant materials)
- developing products with a good life span (robust chemistry), ease of use and repair
- recyclability
- 15 year maximum payback period.

RESEARCH CAPABILITIES

Loughborough University boasts a host of original research and development capabilities including:

- Sustainable production of green hydrogen from water and seawater electrolysis using renewable energy
- PEM and alkaline AEM electrolysers and fuel cells
- Solid Oxide and Proton-conducting Ceramic fuel cells and electrolysers
- Metal-air batteries, lithium-ion and hybrid batteries, redox flow batteries
- Photo-electrochemical hydrogen production
- Biomass conversion to hydrogen
- CO_2 conversion to high-value platform molecules and liquid fuels
- Catalytic ozone and hydrogen co-production from water splitting for water treatment
- Advanced oxidation technologies with green hydrogen as by-product.

Loughborough University also has comprehensive electrochemical testing facility; catalyst, electrode and reactor design and testing capability; in-situ FTIR spectroscopy, DFT calculations and multiscale modelling capability (expertise and facility).

CONTACT

Professor Wen-Feng Lin, FRSC
Professor of Chemical Engineering
Director of Research
Department of Chemical Engineering
School of AACME
Loughborough University
Loughborough
Leicestershire, LE11 3TU

Telephone: **+44 (0)1509 222 506**
Email: **w.lin@lboro.ac.uk**
Web: **bit.ly/LinLboro**

FURTHER INFORMATION ON RELATED HYDROGEN PROJECTS

Find out more about our hydrogen research:
bit.ly/LboroHydrogen

University of Nottingham
UK | CHINA | MALAYSIA

University of Nottingham

The University of Nottingham has a long history of delivering world-class research. Ranked 8th in the UK on research power, more than 97 per cent of our research is recognised as international standard, with wide-ranging impact on society, the economy, health and welfare, culture, public policy and the environment. By grouping our research around five global themes, we can use creative interdisciplinary approaches to deliver research excellence on a global scale.

University of Nottingham decarbonised flex fuel industrial engine with advanced diagnostics and control.

BACKGROUND

The University of Nottingham is home to world-leading expertise in powertrain research and hydrogen storage solutions, with impressive, purpose-built hydrogen laboratories situated in the Research Acceleration and Demonstration building on the Net Zero Flagship Jubilee Campus. Our HyDEX demonstrator is focused on the development of the “Flex Fuel” engine, which has the ability to flex between hydrogen (H2) and ammonia (NH3) as a retrofit solution for existing heavy duty diesel engines using advanced technology. Retrofitting existing diesel engines enables key sectors such as maritime and rail to achieve very significant carbon reduction goals without having to scrap their long-life engine assets, thus ensuring a smoother transition to a lower carbon future. The demonstrator engine system is being modified to take advantage of state-of-the-art low-pressure, solid state hydrogen storage that offers multiple advantages over high pressure gaseous hydrogen tank systems.

THE FLEX FUEL ENGINE DEMONSTRATOR

It demonstrates how existing large diesel engines used by heavy transport such as ships, boats, trains, trucks and off-road construction, quarrying and agricultural vehicles can be retrofitted to use alternative fuels such as hydrogen and ammonia to reduce/eliminate carbon emissions and other pollutants whilst maintaining/enhancing efficiency and performance. This means those sectors can keep their existing assets, many of which have a lifetime of several decades, until they are ready to switch to an alternative propulsion system but still contribute meaningfully to carbon reduction goals. We have lifecycle analysis and technoeconomic assessment intelligence to demonstrate the environmental and economic credentials of the technology.

HOW CAN IT HELP BUSINESSES?

The demonstrator is based at the University of Nottingham in the Powertrain Research Centre. Companies can use it in collaboration with research staff to experiment with different fuel types and set-ups to gain confidence that the technology might be right for them. Once they are ready, the university can work with them to develop real-world trials in specific end use applications. The hydrogen storage applications could be developed both in conjunction with the end use application or separately as an element of wider infrastructure such as refuelling stations.

The University of Nottingham has strong links with the maritime sector and rail/road freight companies who are all potential end users. The university also work closely with the technology providers. This covers engine technology developers/manufacturers and the hydrogen/ ammonia storage systems companies.

WHAT’S ON OFFER?

The University of Nottingham is currently offering site visits to see the demonstrator and discuss the project including some initial results of the first experiments. In 2023, the university will be looking for companies that want to run live trials in their end use applications (such as ships, trains, trucks).

CONTACT

Simon Gerrard
Corporate Partnerships Senior Executive
Industrial Biotechnology and Sustainable Chemistry
University of Nottingham
Telephone: **+44 (0)115 748 4360**
Email: **simon.gerrard@nottingham.ac.uk**

FURTHER INFORMATION ON RELATED HYDROGEN PROJECTS

Hydrogen storage solutions for the net zero energy transition
bit.ly/UoNH2Storage

Transforming research into energy solutions
bit.ly/UoNEnergyInst

The University of Warwick

The University of Warwick is a world-leading university with a dynamic, enterprising approach to solving global challenges. It has earned a reputation for independent thinking and academic excellence.

Warwick is ranked 7th in the UK Research Excellence Framework and was *The Times* and *Sunday Times* University of the Year in 2014. It has an excellent track record of working alongside business regionally and internationally to connect research, innovation and economic growth and seeks to provide a tireless yet supportive environment to enable all in its community to make an impact.

University of Warwick researchers are looking at how UK industries can increase their usage of green hydrogen.

BACKGROUND

Warwick's focus is on exploring and demonstrating how to use renewable sources to produce hydrogen. A novel green hydrogen production system has been found to be more efficient than current methods of hydrogen production. The evaluation of the technical and economic performance of this system is a core theme in its work which will upscale this innovative green hydrogen production to full commercial scale.

GREEN HYDROGEN DEMONSTRATOR

The Green Hydrogen Demonstrator is demonstrating a hybrid green hydrogen technology which can deliver 90% efficiency.

Hydrogen and hydrogen-based, low-carbon liquid fuels, such as ammonia, are essential for the UK to reach net zero greenhouse gases by 2050.

Hydrogen production will need to increase significantly to accommodate the UK's newly energy strategy. Warwick University is investigating how the UK could increase its use of hydrogen and alternative liquid fuels in an effort to develop the low-carbon economy.

The team is focusing on research to tackle the challenges of using hydrogen and low-carbon liquid fuels such as ammonia as the key energy vectors to help decarbonise transport, electricity generation and domestic and industrial heating, to develop low-carbon economy.

The University of Warwick team brings together expertise in hydrogen production (electrolysers), hydrogen end use (fuel cells) and ammonia related technologies (ammonia synthesis and cracking catalysts, ammonia electrolysers and fuel cells).

HOW CAN IT HELP BUSINESSES?

It can be integrated into suitable applications to meet their business specifications. This will be of help to energy providers, engineering and technology solution providers, engineering equipment manufacturers, and energy users such as manufacturing and transport.

We have been working with a range of companies involved in hydrogen production, including Clean Hydrogen Ltd, Green Gas Catalysts Ltd, Fluor, Green Fuels and others.

WHAT'S ON OFFER?

Technical advice for highly efficient green hydrogen solutions, process scale-up.

CONTACT

Professor Sai Gu
Deputy Pro-Vice-Chancellor (China)
Professor of Chemical Engineering
University of Warwick
Email: **sai.gu@warwick.ac.uk**

FURTHER INFORMATION ON RELATED HYDROGEN PROJECTS

Find out about green hydrogen at Warwick:
bit.ly/WarwickGreenH2

Contact us

To find out more about the demonstration facilities in this document, or to discuss any other ideas you may have, please get in touch

hello@hydex.ac.uk
hydex.ac.uk

@HyDEXMidlands hydex

If you would like to discuss collaboration opportunities with the HyDEX partnership, please contact:

Dr Katherine Mycock
HyDEX Business Development and Impact Manager

katherine.mycock@nottingham.ac.uk
+44 (0)7977 672926

Funded by UKRI Research England

Delivered by ERA Energy Research Accelerator