National Centre for Universities and Business

Hydrogen: a fuel for the future

SHOWCASING COLLABORATION:

Highlighting university-business collaborations to tackle the energy crisis

Autumn 2022

Introduction

"Hydrogen: a fuel for the future" is the National Centre for Universities and Business' (NCUB) latest addition to our showcasing series, where we celebrate and share the best of NCUB member collaborations. In this edition, we showcase university and business collaborations that could help to meet the world's environmental pledges.

Joe Marshall
Chief Executive, National Centre for Universities and Business

One year on from COP26, we still face serious challenges in accelerating reductions in carbon emissions in the energy industry.

The world has become used to burning fossil fuels on a massive scale, but we know that it is having a dramatic effect on the global climate. This ultimately poses serious risks to natural environments and ecosystems, human health and political and economic security across the world.The first goal set by COP26 was to secure global net zero by mid-century and keep the 1.5 degrees increase in global temperature target within reach. To deliver on these aims, the environmental conference was clear that countries need to accelerate the process of phasing out coal, speed up the switch to electric vehicles and encourage investment in renewable energy.

If we want to make real inroads into these ambitious targets, we must act now to find the fuel sources of the future. We need to develop innovative solutions that draw on cutting edge, multidisciplinary scientific discoveries and insights and are developed and mobilised by existing and emerging industries. This complex and ambitious aim can only be achieved off the back of high value university-business collaboration.

The Government has made it clear through its 10-Point Plan for a Green Industrial Revolution[1] and the 2020 Energy white paper 'Powering our net zero future[2]', that developing alternative fuel sources is of paramount importance for UK energy policy. It has identified Low Carbon Hydrogen as a priority, noting that it is a clean energy source (its key by-product is water, not carbon dioxide) and the UK has important strengths in electrolyser companies and carbon capture and storage.

NCUB's innovation brokerage platform, konfer, is seeing an increasing number of collaboration calls featuring hydrogen. In this booklet, we have identified 10 university-business collaborations that are looking at how hydrogen can be developed safely and used for sustainable transport, as well as helping small and medium-sized businesses reduce their carbon output. They are working with state-of-the-art facilities, funded by both the public and private sectors, to find practical solutions to energy production and storage challenges. Many of these are also helping to create new economic activity in parts of the UK that are in the crosshairs of the UK Government's Levelling Up strategy, helping to create growth and new opportunities for local communities.

For so long we've been reliant on fossil fuels: travelling, cooking and heating our homes with coal, oil and natural gas has been a daily necessity. If we are to change to more sustainable, cleaner sources, it will be a big adjustment. Two of the projects detailed here are working on ways to explain hydrogen and its uses to the public through animations as well as written material. Public engagement is an essential part of innovation, particularly when it has the potential to transform how we live our lives.

The initiatives set out in this booklet provide an exciting snapshot of the range of university-business collaborations that together will help the UK to cement its position as a world leader in clean energy production, while also supporting the UK and the world to meet crucial global carbon reduction targets.

1 *The Ten Point Plan For A Green Industrial Revolution - GOV.UK (www.gov.uk)*
2 *Energy white paper: Powering our net zero future - GOV.UK (www.gov.uk*

Contents

SECTION 1: New technologies to deliver decarbonisation and sustainable energy 4
- Delivering long-term business sustainability within the hydrogen sector 5
- Transitioning from low-carbon to carbon-negative hydrogen 6
- Supporting industrial decarbonisation at a world-class research facility 7

SECTION 2: Cleaner greener transport 8
- A new dawn for hydrogen in transport 9
- Driving towards net zero emissions 10
- Showcasing the deployment of hydrogen in marine and rail sectors 11

SECTION 3: Social science in hydrogen thinking not 'added-on' but central 12
- Social acceptance of hydrogen 13
- Understanding the benefits of hydrogen as a fuel 14

SECTION 4: A regional boost to the hydrogen economy 15
- Developing hydrogen theory into practice 16
- Programme to put the Midlands at the forefront of hydrogen innovation 17

Conclusion 18

SECTION 1

New technologies to deliver decarbonisation and sustainable energy

One of the priorities raised at COP26 was for countries to accelerate their work in drastically reducing their carbon emissions. By developing energy sources that are zero-carbon, we can prevent further damage being done to the environment. Creating sustainable energy sources means that the United Kingdom will no longer be dependent on fossil fuels. University-business collaborations use state-of-the-art technology and innovation to develop the energy sources of the future.

#HydrogenForTheFuture

New technologies to deliver decarbonisation and sustainable energy

Delivering long-term business sustainability within the hydrogen sector

Teesside University has placed the research and development of new technologies to deliver decarbonisation and sustainable energy as an integral pillar of its corporate strategy.

Key to this is accelerating the move towards hydrogen; reducing barriers and creating opportunities for business and industry to implement hydrogen and net zero technologies.

The Tees Valley is responsible for more than 50% of the UK's production of hydrogen and innovation in this sector is predicted to be a huge driver of the region's economic growth. In 2018, a report by KPMG found that exploiting the opportunities of the hydrogen economy could add up to £7 billion to the Tees Valley economy by 2050 and create up to 1,000 high-value-added jobs.

As an anchor institution, helping to drive economic regeneration for the region, Teesside University has undertaken a range of initiatives to support the hydrogen sector and develop the skills and capabilities of the workforce.

One such initiative is the Tees Valley Hydrogen Innovation Project (TVHIP), which supports small and medium-sized enterprises (SMEs) to take advantage of the opportunities that exist as the UK moves towards decarbonisation.

Funded by the European Regional Development Fund (ERDF), TVHIP offers a range of services including consultancy and guidance to identify opportunities for businesses, creating stakeholder networks and designing and testing services towards developing a proof-of-concept product.

Billingham-based DarbyTech is a well-established and internationally recognised developer of educational equipment to support skills training and engineering across the chemical, energy, and process sectors.

Working with TVHIP, the company wanted help to explore opportunities to diversify its product range from the traditional oil, gas and petrochemical processes to develop a new product to support university research and teaching associated with clean energy and hydrogen production.

This included using its experience of bespoke design and manufacture of industrial training equipment to develop a multipurpose hydrogen demonstrator that can be offered to educational and training organisations.

TVHIP supported DarbyTech in creating an outline design report detailing the specifications for a modular apparatus with variable configuration as well as the lessons and outcomes needed for each module of learning.

The project then helped DarbyTech with the recruitment of a graduate, through additional support from the ERDF Grow Tees Valley programme (Growth Associate project), who helped design and build the prototype reactor with support from the TVHIP team. The graduate has since gone on to be offered a full-time position at the company.

The resulting prototype has been built and tested in the TVHIP laboratory at Teesside University and will allow DarbyTech to grow its business through new markets in the hydrogen industry.

Gary Lawson, the Managing Director of DarbyTech, said: "This new piece of equipment will allow us to explore new avenues within the hydrogen sector and contribute to the long-term sustainability of our business.

"Thanks to Teesside University we've been able to approach the design and build of the protype with an educator's eye, ensuring that it is a product that is fit for purpose that adds value to teaching.

"This is part of an ongoing relationship with Teesside University who we've always found an engaging and agile partner to work with."

Following the success of this project, Teesside University is working with DarbyTech's parent company, JBA Engineering, to explore the potential of a Knowledge Transfer Partnership researching remote automation capability.

TVHIP is one of a range of initiatives spearheaded by Teesside University to forge a smarter, greener industrial economy.

An £11 million research project, funded by Research England, is being led by Teesside University in collaboration with Durham University, to find ways to overcome the innovation challenges faced by industry in implementing hydrogen and net zero technologies.

Teesside University is also about to open a £16.4 million Net Zero Industrial Innovation Centre (NZIIC) to accelerate its rich history of industry-engaged research and innovation by providing facilities and expertise for scaling-up collaborative activity between the University and a growing network of industry partners.

#HydrogenForTheFuture

New technologies to deliver decarbonisation and sustainable energy

Transitioning from low-carbon to carbon-negative hydrogen

Building more solidity into energy supplies will be essential to realising a vision for a sustainable world that works in practice. That means having a strong set of complementary energy options, including hydrogen technology.

Hydrogen provides the opportunity to build a more ideal system that is rooted in diversity from the beginning with a mixture of large and small suppliers, a network that's no longer necessarily dependent on specific natural resources.

This kind of network will be critical in terms of meeting demand for a net zero energy solution across industries. Transport, aviation, steel, cement, paper: these are all sectors that would benefit hugely from tapping into supplies of clean hydrogen.

Cranfield University is home to a new government-backed project to design and in due course build the largest biomass hydrogen plant of its kind, demonstrating the potential for deploying clean hydrogen processes around the world. Bio-HyPER is a collaboration with Helical Energy, Bioenergy Infrastructure Group, GTI Energy, Petrofac, and Origen looking to demonstrate a state-of-the-art hydrogen process.

The plan is to upgrade and put into working operation a one megawatt thermal (MWth) hydrogen production pilot plant on campus, producing a new form of clean hydrogen (meaning an ultra-low release of CO2). The process underpinning HyPER for the direct production of hydrogen is compact and yet scalable to very large plants. It has the potential to produce high-purity hydrogen at up to 30% lower cost than conventional steam methane reforming methods that require CO2 capture as an additional and expensive step in the process. So far, conventional technologies have been limited in terms of the proportion of CO2 emissions that can actually be avoided without costs that ruin the viability of the model. A key benefit of the new process is that it could be more economical and efficient than other technologies.

Dr Peter Clough, Senior Lecturer in Energy Engineering at Cranfield University, said "This emerging technology (sorption enhanced reforming) with established biomass gasification will yield negative-carbon hydrogen."

Dr Ali Nabavi, Senior Lecturer in Energy Systems, at Cranfield University, said "BioHyPER project will demonstrate an expanded market opportunity by removing CO2 from the atmosphere, while producing valuable hydrogen and heat."

The role of Bio-HyPER is to look at the potential of using different feedstocks rather than natural gas: how the reactor performs, changes in efficiency, the potential for turning the resulting heat produced into electricity. In turn, researchers will be considering the bigger picture in terms of market viability, the economic and environmental potential of different syngas/biogas options, and any modifications needed to the reactor itself.

Cranfield University

Bio-HyPER

Supporting industrial decarbonisation at a world-class research facility

The University of Sheffield is home to some of the most exciting hydrogen research equipment and expertise in the UK.

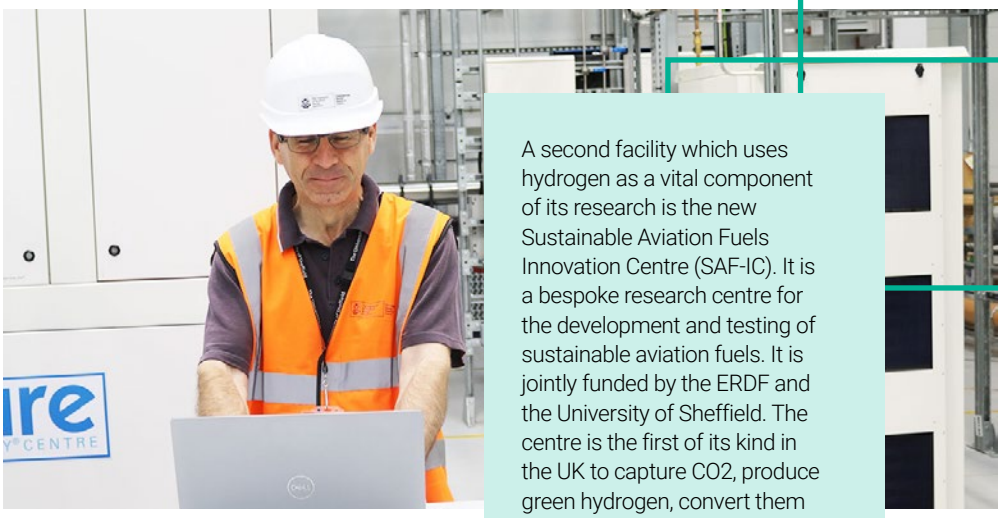
This includes its Energy Institute, hosting one of the largest energy research teams in Europe, and two new national research facilities, which house unique, state-of-the-art equipment.

The Translational Energy Research Centre (TERC) is one of the largest and best-equipped zero-carbon energy, hydrogen, bioenergy, carbon capture, usage and storage and sustainable aviation fuels research and development facilities in Europe. The new £21-million, national-scale research facility, part-funded by BEIS and the European Regional Development Fund (ERDF), enables researchers and industry partners to develop and test hydrogen and other low carbon technologies at pilot scale.

State-of-the-art equipment and a flexible energy management system in the centre can produce and utilise blue and green hydrogen. Its expertise can support industrial decarbonisation via hydrogen fuel switching research using a state-of-the-art hydrogen-fired 300kW combustion test rig, gas turbine and research into hydrogen as a sustainable aviation fuel.

The equipment can be used to enable the design of hydrogen burners and can assess hydrogen combustion performance and emissions using laser diagnostic facilities. It also includes a hydrogen-operated microturbine, which supports research into hydrogen heating systems.

The facility is continuing to add even more exciting hydrogen research infrastructure and testing equipment to its portfolio, making it a significant contributor to hydrogen research and innovation at a national and international level.



Professor Mohamed Pourkashanian, Head of the Energy Institute and Managing Director of TERC and SAF-IC said: "There has been a bottleneck in hydrogen utilisation and high-TRL research in the UK due to a lack of pilot-scale testing facilities. The specialist hydrogen R&D facilities in the newly-built Translational Energy Research Centre, and Sustainable Aviation Fuels Innovation Centre can alleviate this bottleneck by enabling the rapid transition of fundamental research into market-ready products."

TERC recently supported a local Sheffield SME, Clean Power Hydrogen (CPH2) through a project conducted by Dr Mohammed Ismail, l. Dr Ismail reviewed options for coatings of catalysts to improve durability and performance of CPH2's equipment. As a result, CPH2 has part-funded an EPSRC PhD project titled *Boosting the efficiency and durability of novel green hydrogen fuel-producing electrolysers.*

EIC's direct work with industry is beneficial not only to the industry itself, especially small companies and start-ups looking to conduct R&D and scale-up their product, but also for researchers who get to engage directly with industry and tackle real-world challenges, whilst making an impact on the fledgling hydrogen economy.

A second facility which uses hydrogen as a vital component of its research is the new Sustainable Aviation Fuels Innovation Centre (SAF-IC). It is a bespoke research centre for the development and testing of sustainable aviation fuels. It is jointly funded by the ERDF and the University of Sheffield. The centre is the first of its kind in the UK to capture CO2, produce green hydrogen, convert them into sustainable aviation fuels, characterise and analyse their chemical and physical properties, and carry out performance and technical suitability in one location.

Recently, Boeing became the founding member of the Energy Institute's newly-launched Energy Innovation Centre scheme, which offers industrial partners access to both TERC and SAF-IC.

With the first membership agreed with Boeing, the University of Sheffield hopes to welcome more industry partners to the Energy Innovation Centre (EIC), which could provide a major boost to regional and national efforts to decarbonise industrial processes and transport, enhance the innovation capabilities of UK businesses, and strengthen vital academic and industry partnerships.

The University Of Sheffield.

BOEING

SECTION 2

Cleaner greener transport

Developing alternative green transport options will help the United Kingdom to get closer to its goal of net zero carbon emissions.

Hydrogen has already been highlighted as a potential alternative to burning fossil fuels, which can extend to our use of transport. Whether by road, rail or sea, the emissions from many methods of transport cause serious damage to the environment and particularly air quality.

Using hydrogen, in conjunction with the call from COP26 for member countries to accelerate their move towards electric cars, will help us prevent further damage to the global environment.

University-business collaborations are already working towards solutions that could see improvements to vehicles of any size whether that's lorries on roads, freight trains or ferries.

A new dawn for hydrogen in transport

The 2021 UK Hydrogen Strategy identified a number of innovative UK start-ups operating in the area of advanced fuels cells. This included Bramble Energy, a spinout from University College London (UCL)

The company is exploring making 'green hydrogen' itself, by using proprietary electrolyser technology. Electrolysis is the process of using electricity to split water into hydrogen and oxygen, which if done with renewable electricity results in a zero-carbon hydrogen economy.

Professor Brett comments: "I think the key thing with hydrogen is that it's about connecting renewables. Where wind and solar energy is generated is often not where people are. You can use existing pipelines to move hydrogen around: it's a fantastic energy vector. It's much easier to move chemical fuel around than it is electrons in a wire."

Hydrogen fuel cells generate power from the electrochemical reaction of hydrogen, rather than combustion. This eliminates carbon emissions and produces only water vapour and heat as by-products. However, high manufacturing costs have meant their use to date has been limited.

To address this, Bramble Energy has developed a patented fuel cell that can be manufactured in almost all printed circuit board factories worldwide. This dramatically reduces the time and investment needed to scale up, compared with existing fuel cell designs.

Bramble's co-founder, Professor Dan Brett, from UCL's Department of Chemical Engineering, said: "It's a big time for hydrogen at the moment and I think everyone now realises that it has an important part to play, even those who have always favoured batteries. Batteries don't cut the mustard for haulage and freight, in terms of weight and range."

Bramble Energy was founded in 2016 by Professor Brett, Dr Tom Mason, also from UCL's Department of Chemical Engineering, and Professor Anthony Kucernak, from the Department of Chemistry at Imperial College London.

UCL Innovation & Enterprise has given a range of support to Bramble Energy during the company's development. Bramble has also been supported by UCL Business (UCLB), the university's commercialisation company (and part of UCL Innovation & Enterprise) and the UCL Technology Fund, which is managed by AlbionVC in collaboration with UCLB.

Five tranches of funding from the Engineering and Physical Science Research Council's (EPSRC) Impact Acceleration Account, managed by UCL Innovation & Enterprise, have supported various energy-related projects led by UCL. At an early stage of development, this funding enabled Dan and his team to develop a prototype fuel cell. This in turn led to the formation of Bramble Energy.

In August 2020, Bramble raised £5 million investment through a 'Series A' funding round. Investment company BGF led the round and was joined by existing investors including IP Group, Parkwalk Advisors, and the UCL Technology Fund. In six months, they then set up a new 13,500 square foot hydrogen-safe facility from scratch and grew the team to 30. Notably, eight members of the team are former postdoctoral researchers or PhD students from Professor Brett's lab, including current CEO Dr Tom Mason.

Bramble has recently worked in collaboration with industrial partners in automotive and marine sectors. Bramble launched a project in December 2020 with MAHLE Powertrain to put liquid-cooled fuel cell stacks into vehicles for the first time. The phase 1 demonstrator vehicle was launched at the Cenex Low Carbon Vehicle show in September 2021.

It is also exploring applications in maritime and shipping, working with company SEA-KIT to develop a 12-metre long, ocean-going uncrewed surface vessel (USV). This is through a Clean Maritime Demonstration Competition run by the Department for Transport and Innovate UK.

BRAMBLE ENERGY

UCL

#HydrogenForTheFuture

Towards zero emission public buses

With transport accounting for up to 34% of carbon dioxide emissions in the UK, the public transport sector will play a huge role in meeting net zero ambitions.

The UK Government "Road to Zero" strategy laid out its ambition for the UK to be at the forefront of net zero technologies, as well as schemes to encourage low emission public transport. Buses will play a vital role achieving these ambitious aims; one double-decker bus can potentially replace 75 cars on the roads.

For more than 25 years, Wrightbus - the UK's leading supplier of independent public buses - has collaborated with Queen's University Belfast in the development of next-generation bus technologies. This led to the establishment of the Wright Technology and Research Centre at Queen's in 2016. Understanding and managing energy consumption on these vehicles is critical to their success but is complicated by the large number of variables which need to be considered over a typical duty cycle. To overcome this, the partners have collaborated on the development of advanced physics-based approaches which can speed up development cycles, identify potential improvements in onboard energy management, forming a core part of the business customer advisory toolset.

With the emergence of new battery electric and fuel-cell technologies there are new challenges to address in what is the largest technological shifts seen in the industry in over a century.

In 2017, Wrightbus and QUB partnered on an Innovate UK funded IDP14 programme which developed the underpinning methods to both model and optimise energy consumption for fully electric single and double-deck bus drivelines. Wrightbus has successfully exploited outputs of this project to launch the Streetdeck Electroliner BEV, the world's most efficient double-deck battery-electric bus, with the first 80 Electroliners introduced into Belfast operated by Translink. In parallel, the partners have also worked together on an EPSRC funded Prosperity Partnership which has considered how other emerging technologies, such as advanced sensing and autonomous systems, could be used in the future to further enhance next generation vehicle performance.

Using the knowledge developed in these programmes, the team was able to translate its research into an Advanced Route to Market Demonstrator project in 2020 (funded by the Advanced Propulsion Centre) which produced the GB Kite Hydroliner, a brand-new single-deck bus powered entirely by hydrogen. In November 2021, Wrightbus announced that the Go-Ahead Group for Brighton & Hove and Metrobus ordered 20 Wrightbus single-deck GB Kite Hydroliner buses.

Building on these successes, the team have now turned their attention to strategies to underpin development of single and double-deck fuel cell electric buses. £11.2m of funding was secured through the Advanced Propulsion Centre in 2021, and the partners are now working on the development of a new common platform approach which will see increasing numbers of fuel-cell vehicles on our roads both locally and globally over the upcoming decade.

Professor Juliana Early said "Through our partnership with Wrightbus, we have been able to demonstrate how fundamental research undertaken in Queen's University can be applied to next generation zero-emission vehicle development. We are delighted to be a part of the team delivering these innovations and driving transformative change in underpinning zero-emissions technologies, which are seeing such positive impact in our economy."

Director of Engineering at Wrightbus, Dr Robert Best, said: "Wrightbus has a long-standing collaborative research relationship with Queen's University, and critical projects of this type are essential to stimulate R&D, generate employment and reinforce knowledge transfers."

Showcasing the deployment of hydrogen in marine and rail sectors

The University of St Andrews is renowned for its research in materials science. A particular area of expertise is materials for hydrogen technologies, predominantly for fuel cells and electrolyser systems. The development and optimisation of these novel materials is essential to the emerging hydrogen economy. This research, led by Professor John Irvine, has a strong influence on hydrogen industry and policy at a national and international level.

The Hydrogen Accelerator is hosted by the University of St Andrews to complement this influential research. It is a programme funded through Transport Scotland to catalyse the capabilities that will help Scotland exploit the economic opportunities from the shift to zero or ultra-low emission mobility solutions. It has been established to realise Scotland's hydrogen future by bringing together public bodies, industry, research organisations and higher and further education institutions. The work carried out by the Hydrogen Accelerator aligns closely with the University of St Andrews' own ambition to lead the way in research that addresses climate change and allows the university to achieve net zero in its operations by 2035.

The university has successfully led game-changing programmes showcasing the deployment of hydrogen in marine and rail sectors. HySeas III demonstrated hydrogen fuelled propulsion using a fuel cell electric drive system to power a ferry. The ferry design derived through the project has received approval from maritime regulators, Det Norske Veritas (DNV). The Scottish Hydrogen Train project successfully demonstrated the conversion and repurposing of Class 314 trains to a hydrogen fuel cell electric powertrain. The train was operated with passengers between Bo'ness and Kinneil outside Edinburgh in August 2022.

Projects like these are critical to ensure the ambitious Net Zero targets set by the Scottish and UK Governments are successfully met. Both projects address technical issues, such as system integration, critical to hydrogen deployment at scale. Importantly, issues such as safety and regulatory uncertainties and the skills required to implement these emerging technologies have also been explored and are necessary to address for widespread uptake.

These projects and other energy materials research have supported the university's initiative to develop an innovation centre, Eden Campus, near St Andrews. The vision for Eden Campus is to create a space in which academia and industry can work collaboratively on energy related projects to help shape a sustainable future. As part of its wider activities, the University received funding through a European Regional Development Fund (ERDF) funded project, Translating Hydrogen into Action. This funding is providing support for the university to assist companies throughout the hydrogen supply chain, from fuel cell manufacturers to energy specialists, to create a strong Scottish original equipment manufacturer-base. A project of this kind is pertinent as Scotland strives to achieve net zero targets and create jobs within the hydrogen sector. As part of this endeavour, the university is also developing laboratory and test and demonstration facilities that will enable industry-academic collaborations on hydrogen and other energy topics. These facilities will be launched in Autumn 2022.

H2A Hydrogen Accelerator

University of St Andrews

European Union gov.scot
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Investing in a Smart, Sustainable and Inclusive Future

SECTION 3

Social science in hydrogen thinking – not ‘added-on’ but central

For so long fossil fuels have been the way of life for our society. We are used to cooking with gas or electric, driving a petrol or diesel car and power stations that burn coal to create power. Asking people to switch to hydrogen, which they may not understand, could face some resistance. In conjunction with their business partners, Brunel University and Leeds Beckett University have developed programmes to explain the benefits of hydrogen to the public, making social science a central part of their project alongside the practical science.

Social acceptance of hydrogen

‘Perhaps we should add in some social science to the project?’ someone typically asks. A common approach – bolting on social science almost as an afterthought to a science and technology-led project.

Brunel University London, while historically known for its strong engineering and industrial design expertise, is taking a different approach. Rather than adding in social science as an optional extra, Brunel Hydrogen is starting with social science as a central part of a multi-disciplinary approach to its hydrogen research, hydrogen demonstrator, and future Hydrogen Engineering MSc.

How does making social science central rather than peripheral work in practice?

The UK government is currently stimulating the technology development and in parallel reports, seminars, webinars, trade shows, and organisations, all heavily technical, have grown hugely and very quickly in the past year.

But, during 2022, Brunel has been working with Beta Technology and Doncaster Council, which is planning to be a leading borough for the hydrogen economy. The collaboration is exploring the development of the infrastructure required. Brunel has brought social science in by developing an understanding of community acceptance of the introduction of hydrogen to Doncaster by answering questions such as ‘What are the key factors relating to knowledge of hydrogen’, ‘What are the key drivers of social acceptance of hydrogen’, and ‘What are the key drivers of community acceptance of hydrogen?’.

Social acceptance of hydrogen technology is a not just consumer preferences, but also community-level concerns about things like safety and employment opportunities. Visibility of use by others like local authorities or bus companies also helps and there is, on the whole, a positive relationship between how familiar people are with hydrogen, and how supportive they are of it. However, any hydrogen project should recognise that it is vital to address subjective perceptions fully and sympathetically, regardless of whether those perceptions are based in objective truth. Leaving out the social understanding (and how to address public and public concerns) runs the risk of failure. A perhaps uncomfortable, but essential conclusion for any infrastructure project.

Dr Averil Horton, Head of Business Development and Innovation at Brunel University London said: “Hydrogen is a key component of the UK’s commitment to reach Net Zero emissions by 2050 with significant infrastructure projects already underway. Recognising the value that integrating social science into engineering projects can bring and implementing its use will contribute to accelerating our journey to Net Zero; Brunel is delighted to innovate in this space.”

Social science in hydrogen thinking – not 'added-on' but central

Understanding the benefits of hydrogen as a fuel

The H21 suite of projects, led by Northern Gas Networks, seeks to understand a conversion of the gas network to transport 100% hydrogen in the place of natural gas. Part of work included research, conducted by social scientists at Leeds Beckett University (LBU) to understand public perceptions of hydrogen.

The aim was to gain insight into the public perception of hydrogen and understand feelings about using it for cooking, heating and travelling, rather than fossil fuels.

During phase one of the project, interviews with members of the public allowed researchers to understand how to communicate with people about hydrogen. Interview topics included understanding where energy currently comes from, choice of energy and possible responses to and questions about 'new gas'.

Following this, an online survey was conducted with respondents from across the UK, which explored geographic, socio-economic and gender differences. The results of the survey enabled reseachers to define people lying on different points on the hydrogen acceptance scale.

Finally, a series of workshops were held, the first of which concentrated on introducing participants to the H21 project and the 100% hydrogen concept. Initial views, questions and concerns were explored as well as how hydrogen is produced and the potential environmental impacts and safety. Participants were then asked to complete the task of interviewing a friend or family member explaining what they had learned about a hydrogen conversion.

At the second workshops the same participants met to explore their experience of the interview task. A blueprint for communication of the project and its aims was then produced by the participants to be used within communities and to inform the public.

Phase two of the research saw the H21 team hold virtual workshops with participants to co-produce text for an initial leaflet that members of the public may receive about a conversion to hydrogen. This addressed the key questions that the workshop participants would expect to be answered and used language that they believed would be informative and engaging.

The next stage of the research involved two co-production workshops where the script, visuals and voiceover for an animation, detailing how hydrogen can be produced using carbon capture usage and storage (CCUS) and how it would be transported to domestic properties were explored. Additionally, the script and images were adapted to produce an interactive display that can be utilised at events and educational sessions. The results of these workshops were then used by LBU to produce a set of golden rules for communicating about hydrogen.

The final stage of the project was an online survey that tested how the animation affected people's attitudes towards and acceptance of hydrogen as a domestic fuel. It also gathered learning about the beliefs that the public have about a hydrogen conversion.

Results from Phase 1 of the research demonstrated that with regards to a transition to hydrogen as a fuel the main concerns of the general public are an increase in cost, for example of new appliances and energy bills, and disruption to their homes and everyday lives. A report detailing the findings of the Phase 1 research is already available and a copy can be downloaded from the H21 website: www.h21.green

A subsequent report detailing the findings of Phase 2 of the research will be available at the end of this year.

SECTION 4

A regional boost to the hydrogen economy

Developing a hydrogen economy in a region where there isn't one, doesn't just mean the development of cleaner, sustainable fuel. University-business collaborations provide opportunities for local businesses to grow and develop. They bring investment and help businesses to achieve their goals. The benefits to the region include supporting the development of a highly-skilled workforce and a thriving economy.

Programme to put the Midlands at the forefront of hydrogen innovation

Keele University is leading a new programme designed to support and foster the creation of a new hydrogen economy in the Midlands.

Launched in 2022, 'HyDEX' brings together the university partners in the Energy Research Accelerator (ERA), with multinational businesses, SMEs and other partners, to accelerate innovation in hydrogen, build markets and the supply chain, and support the skills needed for the new hydrogen economy and ecosystem.

The aim of HyDEX is to address the challenge of building a thriving new business, industrial and manufacturing sector in hydrogen, where very little currently exists. The programme will allow businesses to accelerate the development and viability of new hydrogen products and associated intellectual property, while supporting the transition from declining industrial sectors and enabling the training and re-skilling required.

The £5 million three-year programme, funded via the Research England Development (RED) Fund scheme, part of UK Research and Innovation (UKRI), will see the ERA university partners making available their £111m worth of hydrogen facilities, large scale demonstration programmes, and research capabilities to regional businesses.

This will be supported by the expertise of leading industrial partners in transport, heating and manufacturing technologies, who are also involved in HyDEX. These include: Worcester-Bosch and Cadent (hydrogen boilers and gas networks); Intelligent Energy (fuel cells); Toyota (hydrogen vehicles); FAUN Zoeller (heavy vehicles); Cenex, EQUANS (Hydrogen Networks); Progressive Energy, ITM Motive (hydrogen generation and transport respectively); Siemens and EQUANS (hydrogen production and storage).

The universities involved in the programme are from the Midlands Innovation consortium and include Keele (project lead), Aston, Birmingham, Cranfield, Loughborough, Nottingham and Warwick, while civic partners such as Midlands Engine, Local Enterprise Partnerships (LEPs), local government and local authorities, will also contribute to support the creation of a market for low-carbon hydrogen solutions as part of the net-zero transition.

HyDEX will also facilitate links with growing international markets in countries such as China, Australia and South Korea, in order to build commercial opportunities that reach beyond the Midlands and the UK.

Professor Mark Ormerod, Deputy Vice-Chancellor and Provost of Keele University, and Institutional Lead for Sustainability said: "We are very excited to be launching the HyDEX programme and leading it from Keele University. At Keele we have been leading the way in researching the use of hydrogen in the domestic gas heating system and in smart energy systems. This experience and expertise, when combined with the wealth of knowledge and expertise in the ERA partnership and our collaborators will enable HyDEX to have a really significant impact on the use of hydrogen in the future as part of our transition to a low carbon society."

Keele has already played a crucial role in demonstrating the potential of hydrogen, with the landmark HyDeploy project which ran on campus during 2020. The project, run in partnership with Cadent, saw hydrogen successfully blended into Keele's campus gas network to show the potential for hydrogen to significantly reduce the carbon emissions associated with domestic and business heating and cooking.

A regional boost to the hydrogen economy

Developing hydrogen theory into practice

Cardiff University has been engaging with international partners for the development of advanced hydrogen and ammonia gas turbines.

This molecule can provide large amounts of hydrogen whilst also ensuring both simple storage and easy distribution. Cardiff University is one of the leading universities in the program FLEXnCONFU (Flexible Combustion Power Cycle Powerplant through Power-to-X Solutions using Non-Conventional Fuels), an EU-funded £12.5 million programme that seeks to develop knowledge and demonstrative tools to evaluate the production of hydrogen and/or ammonia during off-peak power periods of a power plant located in Portugal. These fuels are then consumed to partially replace natural gas during peak consumption times, thus reducing CO2 and improving the plant's flexibility.

One of the objectives of the program is to develop and demonstrate the use of both hydrogen and ammonia in gas turbine systems at large power scale. Baker Hughes, the main industrial partner of this task, has actively engaged with Cardiff University to explore the use of various blends of these two gases. Through experimentation they have been examining how natural gas could be replaced with these renewable fuels. Current research has denoted that the use of hydrogen and ammonia under conditions representative of gas turbine engines can mitigate unwanted nitrogen oxide (NOx) whilst also providing stable operation. These results represent a pinnacle in the use of hydrogen for gas turbine combustion, as it is the first time that pressurised, highly turbulent, high temperature conditions have been successfully experimented and adequately modelled worldwide.

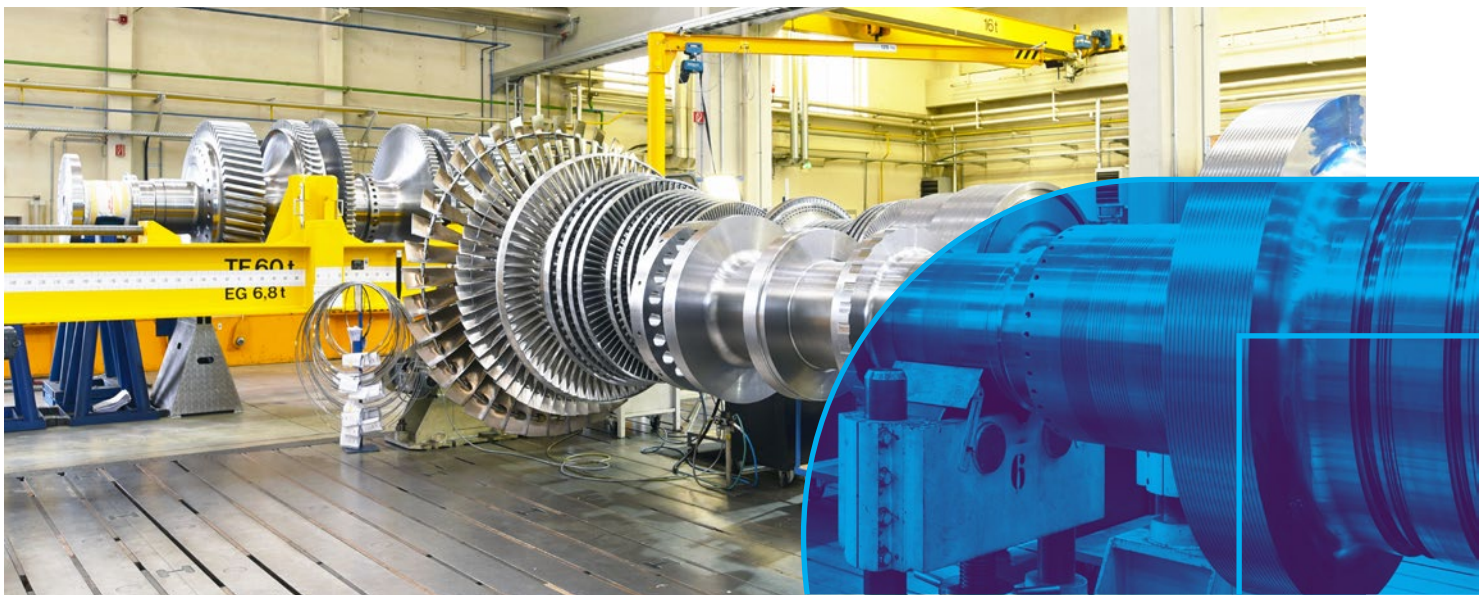
Professor Agustin Valera-Medina, Director of the Net Zero Innovation Institute, Cardiff University, said: "The FLEXnCONFU project is a fantastic platform that has enabled us to collaborate with companies such as EDP (Portugal) and Baker Hughes in projects of high relevance for the progression towards a hydrogen-based economy.

"Not only have we attracted companies from all around the globe interested in knowing what we are doing, but we have also signed many international and national projects to keep developing technologies on this fascinating subject of combustion science.

"We believe that the expertise of our group and the support from our industrial partners will ensure that Wales remains a major player in the context of hydrogen-based combustion systems for large power applications in gas turbines."

"The use of hydrogen/ammonia will ensure that we obtain zero carbon e-fuels from far away locations, or we produce our own e-fuels to increase resilience, reduce external dependencies and decarbonise the economy.

"Further, the combination of the molecules will bring down storage and distribution costs, whilst also minimising capital expenditure on larger facilities. Finally, the deployment will prompt the creation of new jobs in the energy sector, with the potential for the replacement of fossil fuels for power and heat distribution."



CONCLUSION

The future of the hydrogen economy

Urgent action is required if we want to make a big impact on climate change.

Reducing carbon emissions across the whole economy – energy, food and transport, for example – has to be a priority.

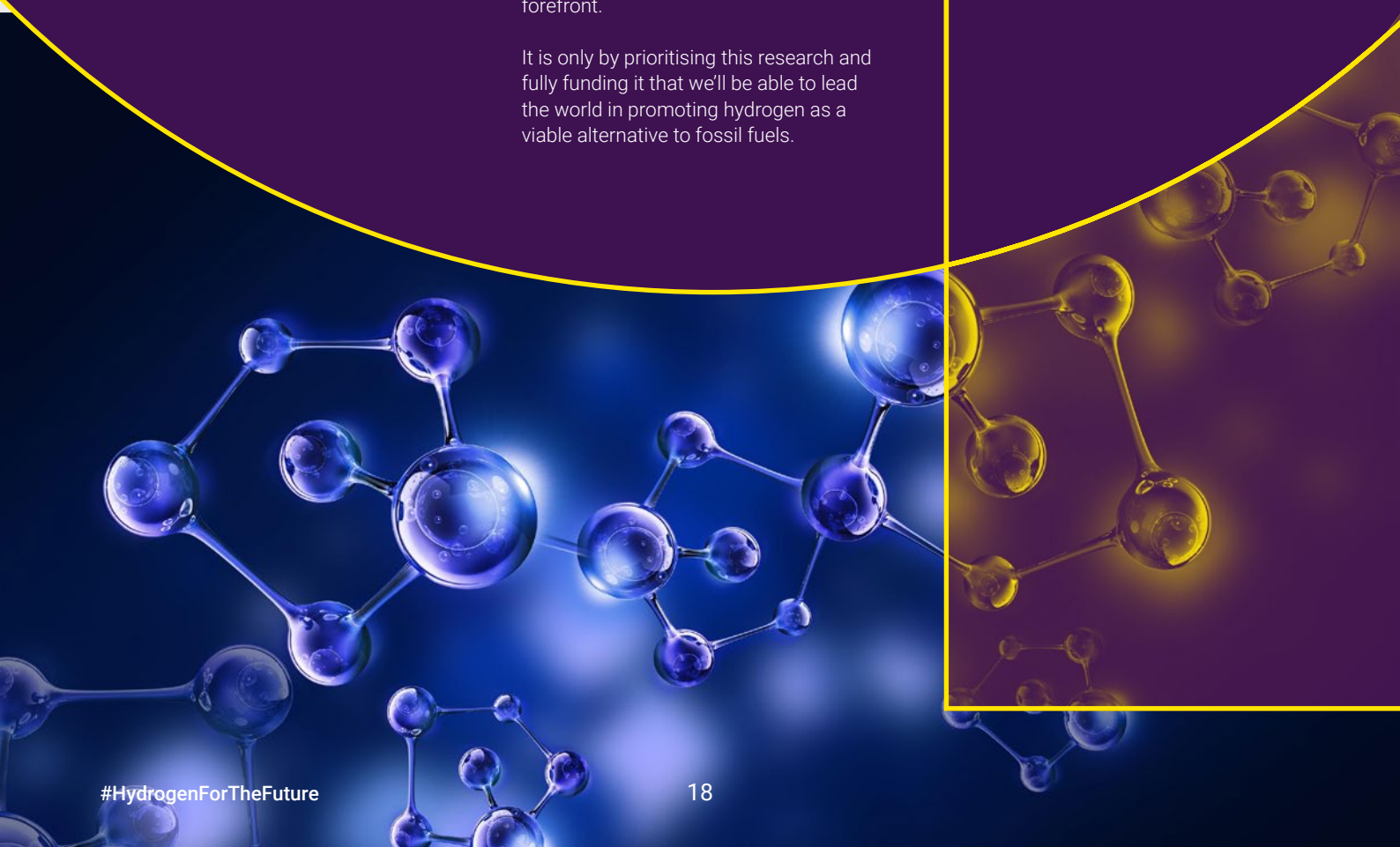
In the search for cleaner, greener forms of energy, hydrogen could be a more sustainable way for us to cook, heat our homes and travel. However, there are major scientific, logistical and technological challenges in beginning to use it.

University-business collaborations are already working on innovative solutions to these challenges, using state-of-the-art technology and highly-skilled staff.

These partnerships demonstrate the importance of research and development (R&D) and show why continued investment, both private and public funding, is vital.

It comes back to the fact that if we are to reach the net zero target set out at COP26, then the UK's R&D will be at the forefront.

It is only by prioritising this research and fully funding it that we'll be able to lead the world in promoting hydrogen as a viable alternative to fossil fuels.



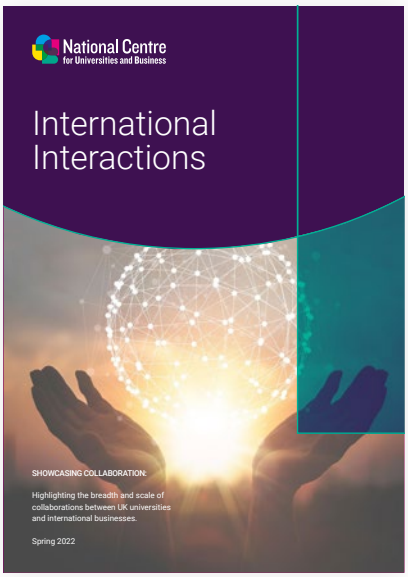
‘Hydrogen for the Future’ is the latest in the NCUB’s quarterly showcasing booklet.

Each quarter we focus on a different theme and celebrate and share the excellence of our member collaborations.

In the past year we’ve highlighted the work of our members in collaborating with local businesses, forming relationships with international partners and furthering community wellbeing by enhancing the quality and sustainability of social care services.

Find out more about the successes of these collaborations by reading these publications.

> READ MORE



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Get in touch:
For more information please contact NCUB at:

info@ncub.co.uk
www.ncub.co.uk
@NCUBtweets