



Department for  
Business, Energy  
& Industrial Strategy

# UK public sector support for hydrogen research and innovation



July 2022



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# Foreword

The UK government has put research, innovation and ‘learning by doing’ at the heart of its approach to developing a thriving UK hydrogen sector – as set out in the 2021 **UK Hydrogen Strategy**. Research and innovation (R&I) will be vital to accelerating the growth of the UK hydrogen economy: it can help de-risk current technology while next generation technology is developed, drive efficiencies and cost reductions, address risks, and help answer key outstanding socio-economic and environmental questions relating to hydrogen to ensure a holistic approach.

The UK is already a world leader in trialling how hydrogen can be integrated into current energy systems and testing its many potential applications in projects across the value chain. The UK hydrogen sector development action plan published alongside this document highlights the importance of R&I in developing the hydrogen economy and capturing economic potential for the UK. UK public sector investment in internationally recognised hydrogen R&I projects has already enabled the development of many key hydrogen technologies. This includes projects developed by UK firms such as Bramble Energy, Ceres Power and ITM Power, who have positioned themselves at the forefront of the global shift to hydrogen.

The UK public sector hydrogen R&I ecosystem will also be central to developing the hydrogen technologies necessary to reach net zero. HMG’s **Net Zero Research and Innovation Framework**, published in 2021, identifies the main net zero R&I challenges for the UK over the next 5 to 10 years and is a guide to the research and technologies needed to reach net zero by 2050,

including hydrogen. The framework emphasises the importance of pursuing a whole system, evidence-based approach to public sector R&I and provides information for businesses and academics working on net zero related research, including hydrogen technologies.

To make this vibrant ecosystem easier to navigate, this brochure signposts the major UK public sector stakeholders that provide support for hydrogen R&I across technology readiness levels (TRLs). It also features case studies throughout, showcasing past successful publicly-funded R&I projects which have helped to boost the UK hydrogen economy.

This brochure is not exhaustive; there are other organisations working to create a thriving hydrogen R&I ecosystem which are not listed here. This includes public and private sector organisations. While this brochure focusses on public sector investment in hydrogen R&I, private sector investment is key to driving the UK hydrogen R&I landscape and will be central to delivering a thriving hydrogen economy.



**Professor Paul Monks**  
BEIS Chief Scientific Advisor








# The UK public sector hydrogen research and innovation ecosystem

The UK public sector hydrogen research and innovation ecosystem is vibrant, with a number of public and publicly-backed organisations possessing unique capabilities, expertise, know-how, testing facilities, and available funding. Collectively, they support UK hydrogen R&I across the whole value chain and TRLs, from discovery and applied research to innovation, demonstration and deployment.

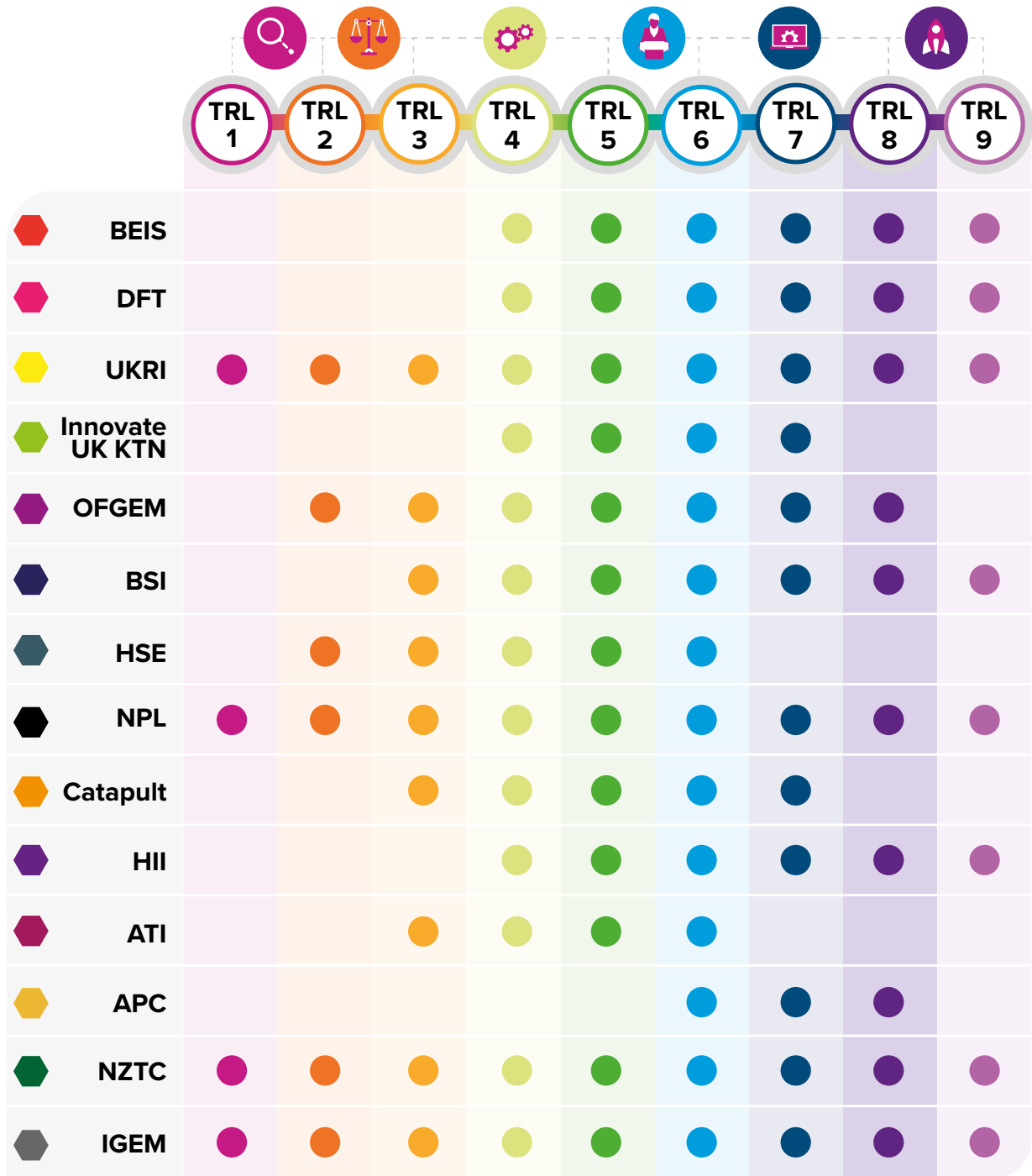
The infographic visualises this ecosystem and shows where public sector organisations with major funding and support for UK hydrogen R&I sit in relation to the support they can offer across TRLs. While some organisations support distinct parts of the hydrogen value chain and technology development, many operate across boundaries. Indeed, some organisations can provide support across all TRLs. Further detail on these organisations and the type of R&I support they can, and have, offered is provided in the following section.

The R&I journey is iterative, meaning that feedback loops and knowledge exchange between researchers, innovators and funders in the ecosystem are crucial and must occur every step of the way. This is often supported through knowledge exchange and collaborations between organisations, an equally important part of the hydrogen public sector R&I ecosystem.

## Key stakeholders – UK

-  Business, Energy and Industrial Strategy
-  Department for Transport
-  UK Research and Innovation
-  Innovate UK Knowledge Transfer Network
-  Office of Gas and Electricity Markets
-  British Standards Institution
-  Health and Safety Executive
-  National Physical Laboratory
-  Catapult Network
-  Hydrogen Innovation Initiative
-  Aerospace Technology Institute
-  Advanced Propulsion Centre
-  Net Zero Technology Centre
-  Institution of Gas Engineers and Managers
-  R&I feedback loops

## Public sector hydrogen R&I



**Key**

- Basic technology research
- Research to prove feasibility
- Technology demonstration
- System development
- Technology development
- System, test, launch, operation



# Government

The UK government sets and implements UK hydrogen policy and is the backbone of the UK public sector R&I ecosystem. Government departments set the UK's hydrogen R&I strategic direction and provide funding for hydrogen R&I (directly or through public bodies) to support the development of a thriving hydrogen economy domestically and internationally.



H<sub>2</sub>

**The Department for Business, Energy and Industrial Strategy (BEIS)** leads on UK hydrogen policy, providing strategic direction, policy development and funding for hydrogen R&I. Funding for hydrogen R&I is largely provided through the £1 billion Net Zero Innovation Portfolio, which funds programmes including the £60 million **Low Carbon Hydrogen Supply 2 Competition** and the recently announced **Industrial Hydrogen Accelerator Programme**, a £26 million innovation funding programme to support the demonstration of end-to-end industrial fuel switching to hydrogen in the UK. To support commercial deployment of hydrogen production, BEIS is launching the £240 million **Net Zero Hydrogen Fund** and designing a **Hydrogen Business Model**. BEIS works alongside industry and academia via the Hydrogen Advisory Council and also plays a key part in government's Net Zero Innovation Board, which provides strategic direction on net zero R&I across government departments.

**TRL focus: 4+**



**The Department for Transport (DfT)** leads on transport-related hydrogen policy. DfT is responsible for road, rail, maritime, and aviation policy and infrastructure. DfT's 2021 **Transport Decarbonisation Plan** cites hydrogen as a potential solution for decarbonising large road, rail, marine and aviation vehicles.

DfT is overseeing ongoing plans to support policy development of hydrogen solutions for each of these transport modes, alongside industry.

**TRL focus: 4+**



**The Department for International Trade (DIT)** is responsible for encouraging economic growth and a green industrial revolution across all parts of the UK through attracting and retaining inward investment, and securing international trade agreements between the UK and foreign countries. The department works to ensure global businesses can invest successfully in the UK, whether directly in creating a UK entity or indirectly investing capital in a UK business or development. DIT can support commercially operating UK businesses with a hydrogen focus to find international success. DIT can also help overseas companies set up their research and development (R&D), including in hydrogen, in the UK.

**The Foreign Commonwealth and Development Office (FCDO)** is responsible for pursuing the UK's national interests abroad, safeguarding the UK's security, defending UK values, reducing poverty, and tackling global challenges. FCDO and BEIS stimulate international R&I through jointly funding the UK Science and Innovation Network (SIN), which has over 100 offices in over 40 countries. SIN works to build international partnerships and collaborations on science and innovation in thematic areas, including clean energy, with a view to creating mutual benefits to the UK and the host country.



# Case study

## Making zero emissions shipping possible

**Originally announced in the Prime Minister's Ten Point Plan for a Green Industrial Revolution, DfT launched the Clean Maritime Demonstration Competition (CMDC) in March 2021, which allocated over £23 million of R&D funding to 55 projects. 17 out of 55 projects in the competition are related to hydrogen or hydrogen derived fuels, such as ammonia.**

This competition supports the design and development of zero emission shipping technologies and greener ports through a series of technology trials and feasibility studies to accelerate maritime decarbonisation. This one-year 'springboard programme' will lay the foundation for a network of real-world projects, gearing up maritime decarbonisation in the UK.

The Shipping, Hydrogen & Port Ecosystems UK project (SHAPE UK), led by Plymouth University, was allocated approximately £1.2 million in government funding as part of the CMDC. The project aims to demonstrate an achievable

modular green hydrogen generation system within Portsmouth International Port, delivering a decision support tool that will enable port managers to determine the environmental and economic use cases for hydrogen generation and utilisation. Another project is the Carnot Marine Vessel APU feasibility study, allocated approximately £370,000 of government funding to develop ultra-efficient hydrogen-electric powertrains consisting of ceramic engines as prime movers for generators.

**TRL focus: 3 to 7**







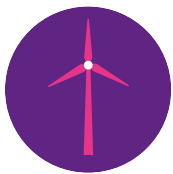
## Case study

### FCDO exploring the potential for green hydrogen abroad

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The FCDO is exploring the potential, challenges and opportunities of green hydrogen transitions in low-income countries via some initial rapid surveys through the Climate Compatible Growth programme. This work is expected to inform our understanding of where the

key opportunities lie geographically, technically, and from a climate and energy access impact perspective, with a view to further possible research, development and demonstration work under the Ayrton framework and alongside others in UK government.



## Case study

### Funding R&I to lower the cost of producing hydrogen

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The BEIS Hydrogen Supply Competition was part of the programme preceding the Net Zero Innovation Portfolio (NZIP) and supported projects at a TRL of four to seven to help lower costs. It is similar to the current Low Carbon Hydrogen Supply 2 Competition.

ITM Power's Gigastack project was one of five projects given substantial demonstration funding from this competition. The funding took ITM Power's feasibility stage concepts through to a preliminary design for a 100MWe-scale electrolyser system using renewable power from an offshore wind farm to provide renewable hydrogen for Phillips 66 Limited's Humber Refinery. As a result of the technology and production

improvements developed through this project – and a separate move into its new Gigafactory in Bessemer Park, Sheffield (now the world's largest electrolyser production facility) – ITM expect to achieve a 40% reduction in costs for electrolyser stacks over the next three years.

See <https://www.gov.uk/government/publications/hydrogen-supply-competition>

**TRL focus: 4 to 7**





# Devolved administrations

From innovative partnerships to dedicated funding, Scotland, Wales and Northern Ireland have a range of support available for hydrogen research and development for businesses, investors and academics in the devolved administrations.





**The Scottish Government** provides support for research, innovation and demonstration of technologies along the entire hydrogen value chain. This includes the Scottish Hydrogen Innovation Fund to be launched in 2022 to support innovation to decrease costs and improve the efficiency of robust and replicable green hydrogen solutions which can be applied across our energy system. Targeted funding is also provided to support critical hydrogen research, for example through the **RSE Scotland-Germany Hydrogen Research Scheme** launched in 2021. Through the **Energy Technology Partnership**, an alliance of world-class academic institutions, the Scottish Government also funds PhD projects tackling innovation challenges across the energy sector as well as a Hydrogen Business Development Service to facilitate collaboration between industry and the academic research community to stimulate innovation in the hydrogen sector.

Contact: [hydrogeneconomy@gov.scot](mailto:hydrogeneconomy@gov.scot)

**The Welsh Government's Hydrogen Pathway Report** (December 2020) sets out 10 recommendations for action to drive hydrogen deployment nationally. More detailed policy work is now focussing on the long-term approach to hydrogen deployment projects and supporting skills, innovation and qualification frameworks. Wales' HyBRID (Hydrogen Business Research and Innovation for Decarbonisation) SBRI initiative, with a budget of £2 million (2021-22), is supporting a spectrum of feasibility and front end engineering design (FEED) stage demonstrating projects across Wales, and the Welsh Government are committing comparable funding for further higher level TRL activity in the next financial year.

Contact: Smart Living at **BywnGlyfar**.  
[SmartLiving@gov.wales](mailto:SmartLiving@gov.wales)

**Northern Ireland's** Department for the Economy (DfE) published a new energy strategy in 2021, **The Path to Net Zero Energy**, followed by the **energy strategy action plan** in 2022. These provide the comprehensive strategic framework to substantially reduce carbon emissions and deliver an affordable, secure, resilient and sustainable energy system. In March 2022 DfE also introduced a £4.5 million pilot Green Innovation Challenge Fund. The fund, delivered by the Centre for Advanced Sustainable Energy (CASE), will help support development of the disruptive technologies and innovative projects, including hydrogen-related projects.

Contact: **Invest Northern Ireland (Invest NI)** is the first point of contact when it comes to R&D support in Northern Ireland.



# Case study

## Scottish Government helping make H100 Fife project possible

Scottish Government provided £6.9 million of capital funding for Scottish Gas Networks H100 Fife project. The H100 Fife project, as set out in the UK government’s 2020 Ten Point Plan, will construct and operate a hydrogen gas network system in Fife to deliver the world’s first hydrogen-to-homes gas network, servicing around 300 houses from the end of 2022. The hydrogen will be produced locally by a dedicated electrolysis plant, powered by an existing 7MW offshore wind turbine situated off the coast of Leven in Fife, and will be a world-first demonstration of an end-to-end 100% hydrogen energy system for generation, storage and transportation

of hydrogen sourced from renewable energy. It will also test and validate the regulatory, technical, social and operational viability of transitioning from natural gas to 100% hydrogen for heating and cooking, and provide evidence to assess consumers’ experience of using hydrogen in the home. Scottish Government’s capital funding was used to enable the acquisition of land and long lead in items including an electrolyser and hydrogen storage tanks.

**TRL focus: 4 (project start date) to 8 (anticipated at project end).**



# Case study

## Northern Ireland funds a ground-breaking electrolyser

The installation of a 1MW membrane-free electrolyser by Northern Ireland Water at their Waste Water Treatment facility at Duncrue in Belfast is the first project of its type across the UK. Not only will the electrolyser produce green hydrogen (powered by a wind turbine), but the oxygen produced will be utilised to improve the efficiency of the waste water treatment process via oxygenation. This will increase the throughput capacity of the works and reduce its electricity

consumption. As a first of its kind proof of concept, the project received 100% support funding from DfE in Northern Ireland (funding was preceded by a proof-of-concept electrolyser project supported by a Small Business Research Initiative grant from the UKRI and IUK).

**TRL focus: 8 to 9**





# Case study

## Welsh Hydrogen Business Research & Innovation for Decarbonisation SBRI (HyBRID 1.0)

HyBRID is a new £2 million Small Business Research Initiative (SBRI) funded by Welsh Government Smart Living, addressing opportunities for deployment of hydrogen through developing innovative and research solutions based on the ten objectives of the Wales Hydrogen Pathway report and the national second carbon reduction plan, Net Zero Wales CB2 – 2021-2025. HyBRID Phase one (December 2021 – March 2022) supported 17 projects at feasibility and prototyping levels. These range through studies of micro electrolytic hydrogen generation, hydrogen production in rural areas, Sustainable Aviation Fuel (SAF) production, vehicle market development, community-based H2 production and H2 electrocoagulation, and a Digital 1-Stop-Shop Hydrogen Advice & Networking Platform.

Prototyping is also supported for hydrogen rail design work for diesel power systems conversion (Ballard Motive Solutions) and tool design and development for a micro grid and domestic micro-communal hydrogen heating system in Milford Haven (Passiv UK). Successful projects will soon be selected for a fully funded HyBRID Phase two focussed on further prototype development and evaluation work until March 2023.

**TRL focus: 4 to 9**





# Public bodies

The UK's public bodies, sponsored by government, are integral to the UK's hydrogen R&I ecosystem. These bodies provide funding and support for hydrogen R&I right across the hydrogen value chain and along TRLs, from early research to implementation. Funding and support from public bodies has already helped a handful of UK firms become world-leaders in key hydrogen technologies.



## UK Research and Innovation

**(UKRI)** is a non-departmental body sponsored by BEIS and is the UK's largest public funder of research and innovation (R&I) across the TRLs with a budget of over £8 billion. A significant portion of UKRI activity is targeted towards solving global energy challenges. UKRI sees hydrogen R&I as a key tool to grow the hydrogen economy and for the UK to reach net zero emissions by 2050. This is reflected in its interdisciplinary approach to a wide-range of funding and support across research, innovation and skills activities across the whole hydrogen value chain and system.

**UKRI's research councils** work in partnership to lead research and skills in hydrogen.

**Innovate UK** supports hydrogen business growth and innovation, including through Innovate UK KTN (below).

**TRL focus:** UKRI support ranges across all TRLs, with research councils generally supporting projects from 1 to 4, and Innovate UK from 4 and above, although this is not fixed.



Contact: Research & Skills:  
**energy@epsrc.ukri.org**

Business Growth & Innovation:  
**hydrogen@iuk.ukri.org**

**Innovate UK KTN** exists to connect innovators with new partners and opportunities beyond their existing thinking to accelerate real-world solutions, with over 46,000 organisations and 230,000 innovators in their network. Their Hydrogen Innovation Network is a non-competitive group working to validate views on the current challenges to local clean hydrogen uptake, and to find innovative solutions to those challenges.

**TRL focus: 4 to 7** (typically), but direction and guidance will be given at any level.



Contact: **<https://ktn-uk.org/>** (KTN general); KTN Hydrogen: **<https://ktn-uk.org/energy/hydrogen/>**



# Case Study

## From research, to innovation, to successful commercialisation

Founded in 2015, **Bramble Energy (BE)** is reinventing transport, lighting, and appliances through novel Proton Exchange Membrane (PEM) hydrogen fuel cells based on new technology. BE develops and sells a patent protected, high-volume manufacturable fuel cell – the PCBFC™ – and have sold fuel cell power generators to at least four major international companies. With the ability to be made to any shape or size and last weeks longer than conventional batteries, they are enabling fast, affordable, and mass-volume production across sectors.

Arising from fundamental materials chemistry research by academics at Imperial College and University College London, BE is a great example of holistic R&I support from fundamental research to innovation and through to commercialisation.

**TRL focus:** Support provided by UKRI's EPSRC and Innovate UK, the Carbon Trust, and Climate KIC has allowed them to bring the technology to market and ultimately secure private investment of over £35 million in 2022.





## Case study

### **Driving cross technology and cross sector engagement for innovation acceleration**

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In June 2021, the KTN Hydrogen and Cross-Sector Battery Systems Innovation Networks brought their communities together for the first time in a joint webinar and workshop for off-highway applications. KTN demonstrated that hydrogen decarbonisation solutions come from a technology mix and that we need to a holistic viewpoint to ensure hydrogen technologies and applications are complementary. The webinar explored zero carbon solutions in the construction, defence and agriculture sectors. Participants heard about the carbon emissions of the agriculture sector, the decarbonisation challenges that the construction sector is facing, followed by a summary of the key technical challenges for the defence sector. Innovative companies then had an opportunity to pitch their solutions.

In the second part, a smaller group came together for an interactive workshop. Participants were then split into four breakout groups to identify the technical and non-technical challenges, map out the innovation activity and list the remaining gaps.



# Regulatory and standard- setting bodies

The UK's regulatory and standard setting bodies establish national standards, regulations and best practice for hydrogen technologies, helping to drive R&I, ensure safety, and deliver successful deployment.





**The Office of Gas and Electricity Markets (Ofgem)** is Great Britain's independent energy regulator. It sets price controls to determine the funds that the gas distribution and transmission companies receive, including innovation funding. These funds come from network consumers' energy bills and can be used to support R&D on hydrogen where the learnings will benefit the wider network consumer base connected to these public networks.

**TRL focus:** Ofgem's network innovation funds can support innovation projects from TRL level 2 to 8\*.



\*As funds are part of a price control of the regulated gas networks, innovation projects must be led by a gas distribution or transmission network.

Contact: Contact information for energy network companies leading projects can be found on the **Energy Network Association's Smarter Network Portal**.



## Case study

### Demonstrating safety of hydrogen blending

In 2016, Ofgem provided £6.8 million Gas Network Innovation Competition funding for the first HyDeploy trial, to demonstrate on Keele University's private network that natural gas containing levels of hydrogen (10% to 20%) beyond those permitted by the current safety standards can be distributed and utilised safely. This trial was completed successfully in 2021. In 2018, Ofgem provided £13.3 million for the second phase of HyDeploy to trial blending of hydrogen on public networks. The second phase of HyDeploy is now live in Winlaton, Gateshead. This

community - comprising 668 homes, a church, primary school and several small businesses - is playing an important part in the future of hydrogen use by being the first community to receive a hydrogen blend via a first public network. Blending started in August 2021 and will last around 10 months, with up to 20% hydrogen supplied in the gas supply.

**TRL focus: 7 to 9**



**The British Standards Institute (BSI)** is the UK's national standards body, responsible for developing and maintaining a wide range of national, European and international standards. BSI supports hydrogen by facilitating collective innovation, aiding the development and adoption of best practice, and providing global leadership through international standardisation.

**TRL focus:** BSI's work supports agile standards thinking and development across TRLs 3 to 9. From TRLs 5 and 6 BSI can develop full, formal standards.



Contact: **Website:** <https://www.bsigroup.com/>; Email: [hydrogen@bsigroup.com](mailto:hydrogen@bsigroup.com)



## Case study

### Enabling hydrogen heating trials

Working with industry and other stakeholders to develop consensus-based, market-relevant hydrogen standards and guidance, BSI is contributing to BEIS Hydrogen Skills and Standards for Heat Programme to enable the UK's future hydrogen village trial and a potential town pilot. The BSI work looks to establish an agreed set of principles, requirements and guidance on functionality, safety, operating and servicing requirements for ancillary equipment, pipework, materials, meters, and appliances through the development of an initial suite of three PAS standards.

It builds upon the 2020-published PAS 4444, offering guidance on the development and construction of hydrogen-fired gas appliances, which has been key to demonstrating that hydrogen appliances can comply with relevant regulations and receive certification.

**TRL focus:** This work is creating a pathway for appliances to be certified as they move out of the lab and into trials with TRLs up to 8.



## The Health and Safety Executive

**(HSE)** is Great Britain's regulator for health and safety. HSE also

offers research and consultancy services, independent from its regulatory and policy functions, underpinned by 20 years of science into the safety of gaseous and liquid hydrogen. This evidence informs risk management advice that HSE can provide on the management of hydrogen risk for production, distribution and in applications across power, heat and transport.

**TRL focus:** All, and specialises in levels 2 to 6



Contact: <https://solutions.hse.gov.uk/safe-net-zero>



## Case study

### Developing safety standards for deployment of liquid hydrogen

HSE's 550-acre Science and Research Centre houses a team of the world's leading experts in liquid hydrogen safety who are applying their knowledge and know-how to advance the understanding of the safety issues associated with LH2.

Their ability to design and construct bespoke testing facilities, handle LH2 safely and work closely with others in the hydrogen safety community positions HSE as a key partner in projects such as PRESLHY, an EU-wide research and innovation activity conducting pre-normative work for the safe use of liquid hydrogen as an energy carrier.

The project aims to identify and close knowledge gaps on safety critical issues and specific standards by developing and validating new appropriate models and engineering correlations. These will help to evaluate efficient mitigation concepts and reliable, consistent safety distance rules for liquid hydrogen-based technologies.

**TRL focus:** Research is in the low TRL region (below 2) as it is developing models and tools for the standards and wider deployment of liquid hydrogen technology. This will allow the development of safety standards for the deployment of technology in late TRL stages (TRL 7 to 8).



## The National Physical Laboratory

**(NPL)** supports the development of hydrogen technologies, and the deployment of hydrogen as an alternative fuel, by carrying out pre-normative research required to support stakeholders in the safe, efficient and sustainable development of a UK hydrogen economy. NPL's research primarily focuses on developing measurement standards and test methods that can eventually be taken forward and used by technical committees to develop technical standards. As such, NPL represents the UK on numerous national and international hydrogen-related technical standards committees.

**TRL focus: 1 to 9**



Contact: <https://www.npl.co.uk/national-challenges/energy-environment/contact-us>



## Case study

### Increasing the lifetime of hydrogen technologies

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Hydrogen fuel cells and electrolyzers play an important role in the implementation of a sustainable energy infrastructure. However, the performance of fuel cells and electrolyzers can suffer if the chemical reaction that creates energy is not uniformly distributed across the cell. To better characterise reaction distributions in fuel cells, NPL developed an innovative reference electrode for polymer electrolyte membrane (PEM) fuel cells and electrolyzers which allowed, for the first time, the accurate mapping of electrode potential across the active area of the cell. This work has changed

the approach of industry to materials qualification for hydrogen applications, and has been adopted by UK manufacturers Intelligent Energy, Johnson Matthey, ITM Power, Acal Energy, and Amalyst. An independent Technologia case study estimated that the impact of this innovation would lead to equivalent carbon savings of 0.4 megatonnes.

**TRL focus: 3 to 6**





# Supporting publicly-backed organisations

A diverse range of organisations provide support for hydrogen R&I across TRLs. Some of these organisations focus on distinct aspects of the value chain, while others work across it. Still others coordinate hydrogen R&I activity or act as a repository for hydrogen knowledge. Collectively, these organisations are an integral aspect of a connected, thriving hydrogen R&I ecosystem.



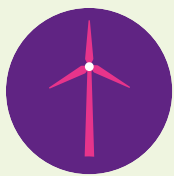
**The Catapult Network** brings together nine leading technology and innovation centres spanning across over 40 UK locations, each providing world-class specialist infrastructure, expertise and market-shaping capability helping innovators accelerate the development, deployment and adoption of new technologies in several sectors of strength. Catapults drive hydrogen development and innovation through expertise in areas including offshore renewable energy,

high value manufacturing, energy systems, connected places, digital and compound semiconductors. Catapults are independent, not-for-profit private organisations established and supported by Innovate UK.

**TRL focus: 3 to 7**



Contact: [www.catapult.org.uk](http://www.catapult.org.uk)



## Case study

### Designing a local hydrogen energy system

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The Energy Systems Catapult and Offshore Renewable Energy Catapult have collaborated supporting the Milford Haven: Energy Kingdom, part of Innovate UK's Prospering from the Energy Revolution programme to design a local hydrogen energy system for the Milford Haven Waterway. The project includes a trading platform to enable efficient use of hydrogen-ready hybrid heat pumps and hydrogen fuel cell vehicles, and optimising the use of local solar and wind power generation within a novel system architecture to allow integration of current gas and future large-scale hydrogen infrastructure from national to local network levels.

**TRL focus:** the project covers a range of technologies at various readiness levels.

## The Hydrogen Innovation Initiative

**(HII)** is a new strategic collaboration formed by members of the Catapult Network (including High Value Manufacturing Catapult, Energy Systems Catapult, Offshore Renewable Energy Catapult, Connected Places Catapult, Compound Semiconductor Applications Catapult, National Physical Laboratory, Net Zero Technology Centre, Advanced Propulsion Centre UK, and the Aerospace Technology Institute). HII was developed to support connected innovation across each major industrial sector. Through leveraging the partner organisations' strengths, facilities and diverse regional footprint, this first-of-its-kind virtual initiative fosters a connected hydrogen innovation ecosystem. HII aims to accelerate the development of the hydrogen economy through its work with industry to connect end-to-end innovation across generation, distribution and consumption hydrogen markets.

**TRL focus: 4 to 9**



Contact: [HIIenquiries@hvm.catapult.org.uk](mailto:HIIenquiries@hvm.catapult.org.uk)

## The Advanced Propulsion Centre

**(APC)** helps position the UK at the forefront of vehicle decarbonisation, facilitating funding to UK-based research and development projects developing low-carbon emission vehicle technologies, including fuel cell and hydrogen combustion projects across the supply chain. They also manage the Automotive Transformation Fund on behalf of UK government.

**TRL focus: TRL 6 to 8** – through large Collaborative Research and Development Programmes; **TRL 4** upwards through Technology Developer Accelerator Programme (TDAP).



Contact: **Funding – Advanced Propulsion Centre** ([apcuk.co.uk](http://apcuk.co.uk)) and [info@apcuk.co.uk](mailto:info@apcuk.co.uk)



## Case study

### Tackling range anxiety in battery powered trucks

With a total project value of £12.2 million (£5.7 million funding through APC), Tevva Motors' SANGREAL project (Essex) developed battery-powered, hydrogen fuel cell range extended trucks delivering a 100% reduction in CO<sub>2</sub> for the commercial delivery sector, tackling range anxiety while delivering a lower total cost of ownership as compared to existing diesel vehicles.

This project designed and tested an innovative transaxle and vehicle control system for large commercial vehicles (7.5 to 19 tonnes), further developing and commercialising Tevva's existing battery module and pack design. A substantial part of the investment went towards developing an advanced vehicle control to ensure safe and reliable performance for both on and off-road applications.

TRL focus: 6 to 8



**The Aerospace Technology Institute (ATI)** is transforming aerospace through technology and innovation. Working closely with BEIS, Innovate UK and the UK aerospace sector to deliver clean growth, the ATI portfolio funds projects to meet the objectives and priorities of the UK Aerospace Technology Strategy with a growing focus on hydrogen technology development. The ATI has recently concluded the ground-breaking **FlyZero feasibility project**,

finding that green liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft utilising fuel cell, gas turbine and hybrid systems.

Contact: <https://www.ati.org.uk/>

**TRL focus: 3 to 6 (primarily)**



## Case study

### Supporting small and large scale hydrogen powered aviation

**ZeroAvia**, supported through the ATI programme, achieved the world's first flight of a commercial-scale hydrogen-electric aircraft on their **HyFlyer I** project. The aim is to decarbonise medium range, small passenger aircraft by replacing conventional piston engines in propeller aircraft with a hydrogen fuel cell powertrain. Subsequent support has been agreed for HyFlyer II, which will develop and demonstrate a 600 kilowatt hydrogen-electric powertrain for 10 to 20 seat aircraft, for distances of up to 500 nautical miles. GKN aerospace is leading the ground-breaking UK collaboration programme **H2GEAR**, developing a hydrogen propulsion system for sub-regional aircraft, supported by £27 million of ATI funding, matched by GKN aerospace and its industrial partners.

**TRL focus: 3 to 6**



## The Net Zero Technology Centre

**(NZTC)** develops and deploys technology for an affordable net zero energy industry. It accelerates the energy transition by closing the gap in net zero technologies, including those for low carbon hydrogen, that will reduce emissions, unlock the full potential of an integrated energy system, propel the energy industry towards a digital, automated future, and champion clean energy start-ups to build a thriving supply chain.

**TRL focus:** NZTC supports project across all TRLs when there is a path to deployment.



Contact: <https://www.netzerotc.com/about-us/contact-us/>





## Case study

### The Hydrogen Backbone Link project

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The NZTC have recently kicked off a project which will position Scotland and the rest of the UK in a leading role for the development of pan-European hydrogen infrastructure including export capability.

Phase one of the project is being delivered in 2022 by a diverse industrial collaboration. The project is undertaking concept studies and subsequent technology development for the re-purposing and optimisation of existing pipeline infrastructure both on and offshore for hydrogen transportation. It focuses on export route identification, high level safety analysis, and identification of technology gaps to support the infrastructure build out of this strategic link. Phase two of the project will focus on technology pilot and demonstration ahead of phases three and four build out.

**The Institution of Gas Engineers and Managers (IGEM)** is the professional engineering institution supporting individuals and organisations connected with the global gas industry. With a mission of engineering a sustainable gas future, IGEM is demonstrating how hydrogen and other low-carbon gases will have a key role to play in the energy transition across buildings, industry, transport and power generation.

**TRL focus:** IGEM offers support to everyone connected with the gas system, from network infrastructure operators and supply chain companies to young engineers looking to gain a foothold in the sector.

Contact: To find out more, visit **www.igem.org.uk**. You can also email [general@igem.org.uk](mailto:general@igem.org.uk) or call +44 (0)1509 678150.



## Case study

### Bringing together hydrogen knowledge

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IGEM's world-leading Hydrogen Knowledge Centre was launched in March 2021 with the aim of creating a world-class digital repository dedicated to the advancement of hydrogen learning globally, and the transition to a net zero carbon emissions future.

With initial support from the BEIS Energy Innovation Programme, the repository, which is the first of its kind, is now home to over 2,800 hydrogen resources from 320 sources across 70 countries. Resources include academic journal articles, conference papers, technical reports, policy papers, project documents, presentations, and videos. With hydrogen expected to play a pivotal role in global decarbonisation efforts, the need for information sharing has become

increasingly important. With the support of our collaborators, IGEM has developed a carefully curated, comprehensive repository of hydrogen resources which is helping to advance hydrogen knowledge across the UK and internationally.

# International Initiatives

The UK plays an active role in many of the key institutions driving multilateral collaboration on hydrogen R&I to drive rapid development of hydrogen technologies domestically and globally.



**Mission Innovation (MI)** is a global initiative of 22 countries and the European Commission (on behalf of the European Union) working to accelerate clean energy innovation. MI's **Clean Hydrogen Mission (CHM)**, co-led by the UK, seeks to accelerate the development of a global hydrogen economy by identifying and tackling key technology and policy barriers to the production, distribution, storage and use of hydrogen at gigawatt scale.

CHM is driven by its overall goal to reduce the costs of clean hydrogen to the end user to US\$ 2 per kilogram by 2030, and deliver at least 100 large-scale integrated hydrogen valleys worldwide.

**The International Energy Agency (IEA)** works with governments and industry to shape a secure and sustainable energy future for all. The **IEA Hydrogen Technology Collaboration Partnership's** goal is to accelerate hydrogen implementation through facilitating, coordinating, and maintaining innovative research, development and demonstration (RD&D) activities through international cooperation and information exchange.



## Case study

### Growing confidence in a clean hydrogen economy

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The Clean Hydrogen Mission is part of MI's commitment to a decade of clean energy innovation, aiming at advancing more competitive end-to-end clean hydrogen value chains and infrastructure. The goal of the Mission is to increase the cost-competitiveness of clean hydrogen by reducing end-to-end costs to US\$2 per kilogramme, considered to be the tipping point in unleashing its full potential to reduce global emissions. It is at this tipping point that the clean hydrogen will start to become cost-competitive with other vectors in different industries across production, transportation, storage and end-use. To facilitate the tipping-point, the Mission seeks to stimulate innovation, knowledge exchange, and international cooperation, and facilitate investment in specific areas of research, innovation, development and demonstration to

accelerate progress towards a global clean hydrogen economy. The Mission's activities are organised into three key pillars targeting the promotion of research (development and innovation across the entire clean hydrogen value chain), larger scale demonstration through integrated hydrogen valleys, and facilitating the creation and dissemination of non-technological and non-commercial knowledge and create positive engagement from relevant stakeholders.

The UK is using its role as one of five co-leads of the Clean Hydrogen Mission, and one of the coordinators of its R&I pillar of activities, to showcase UK R&I expertise, leverage its outputs to spur further global technological progress, and ensure innovation is successfully commercialised.

