



**Western Gateway** Porth y  
**Gorllewin**

## **The Western Gateway Hydrogen Ecosystem**

Providing the nation with a testbed for developing  
the UK hydrogen economy.

# **Powering a greener, fairer future**

## The Rt Hon. Greg Hands MP Minister of State for Energy, Clean Growth and Climate Change

“Developing a thriving UK low carbon hydrogen sector is a key part of our government’s plan to build back better with a cleaner, greener energy system. It’s great to see the Western Gateway leading the way, developing a Hydrogen Ecosystem to highlight investable assets, encourage collaboration and drive innovation across the many areas of our economy that could decarbonise through use of this abundant fuel.

“This pan-regional partnership between south Wales and western England is a key part of our plans to create growth across the union whilst working together to reach net zero. I look forward to working with them to help reach our climate change targets and capitalise on their ambition to build a Green Energy Super Cluster.”



The Rt Hon. Greg Hands MP

## The Rt Hon. Robert Buckland KBE QC MP Secretary of State for Wales

“South Wales and Western England are already leading the way in developing Hydrogen as a clean fuel to help the world decarbonise to reach Net Zero. Through the Western Gateway Partnership, this new Hydrogen Ecosystem is helping to bring together the best of what these areas have to offer across the wide range of potential uses and helping to supercharge this work to meet the challenges we face.

“The Western Gateway Partnership is a key part of the government’s plans to level up communities, using cross-border collaboration to deliver those big opportunities which can transform lives. I look forward to working with them to take this work to the next level in the future.”



The Rt Hon. Robert Buckland KBE QC MP

# Foreword

**The Western Gateway is home to world leading industries, renowned universities, and highly innovative clusters.**

We are a partnership that brings together leaders from the public sector, business, and research to drive inclusive growth, unleash our innovation potential, become the UK's first Green Energy Super Cluster and power the transition to Net Zero.

Hydrogen is at the heart of our ambitions to decarbonise our economy.

From Swansea to Swindon, the Western Gateway is home to a hive of activity dedicated to unlocking the power of low carbon hydrogen. From low emission air travel, transitioning our gas networks to hydrogen, or turning industrial carbon dioxide into green methane gas, companies, businesses, and research organisations across the Western Gateway are leading the way.

It shouldn't be a surprise that we are home to the research excellence, innovation and industrial clusters that will bring the UK's ambitions to become a productive hydrogen economy to life. Hydrogen energy has a long history here, with the first hydrogen fuel cell being developed by Swansea's Sir William Grove over 150 years ago.

To realise the full potential of our hydrogen future, we will need to drive forward development of multiple uses across a range of sectors at the same time. By building different technologies and business models in tandem, sharing successes and solutions, we can provide an innovation ecosystem capable of powering a full system transformation. The Western Gateway's strengths in discovery-

driven research through to commercialisation mean that within a relatively small geography we are perfectly positioned to do just this.

This prospectus starts the process of laying out our vision for how we can deliver a clean, green hydrogen fuelled future.

As a first step, we have collaborated with our strategic partner, the GW4 Alliance, to map the activity across our combined areas to demonstrate the breadth of expertise and provide the evidence to back up our claim.

I welcome this prospectus for our partnership as we stand ready to build the hydrogen economy we need, meet the Government's ambitions, and deliver a cleaner fairer future for all.



Katherine Bennett CBE,  
Chair of the Western Gateway Partnership

# Western Gateway

**The Western Gateway is the UK's first pan-regional economic powerhouse to span two countries. Extending across South Wales and Western England, the partnership brings together Local Authorities, a Combined Authority, City Regions, Local Enterprise Partnerships and Governments (in Wales and Westminster) to work together on the big challenges their communities face.**

The partnership is committed to ensuring that its 4.4 million residents benefit from fairer, greener economic growth and can access opportunities across our area. This is reflected in our five missions:

- contribute £34 billion to the UK economy by 2030;
- attract inward investment and increase exports by £4 billion;
- decarbonise our economy;
- connect communities; and
- unleash innovation.

When it comes to decarbonising our economy, the Western Gateway has all the elements needed to become a productive and nationally significant Green Energy Super Cluster. Our natural assets, talent and resources mean we are uniquely poised to unlock the clean energy potential of solar, wind, tidal and nuclear (including fusion) energy technologies across our area. Acting to realise our future hydrogen economy is an integral part of this.



# Our hydrogen future

## Strategic ambition

Low carbon hydrogen generation will make a significant contribution to tackling climate change; it is complementary to electrification but with different routes to market and different scales of technology, policy, and market challenges. It provides a means not only to decarbonise land, water, and air transport, but to do the same for electricity generation, heating, and many high-emitting industrial processes. For this reason, creating a thriving low carbon hydrogen sector is a core pillar of the UK Government's Ten Point Plan for a Green Industrial Revolution. Published in 2020, this set out an ambition for 5GW of low carbon hydrogen production by 2030.<sup>1</sup>

But the case for hydrogen sustainably fuelling our economy extends beyond climate change. International energy supply uncertainty has led to major economies and international energy companies committing to further reducing their reliance on fossil fuels and to investing in clean, local, and reliable sources of energy. The UK is no exception. In April 2022, the UK Government doubled its 2030 low carbon hydrogen production target to 10GW as part of its Energy Security Strategy.<sup>2</sup>

National energy security and decarbonised energy production also offers the potential to reduce the cost of energy generation, supply and use across domestic and industry settings; an imperative if we are to meet the growing and pressing challenge of preventing the incidence of long-term fuel poverty.

The Welsh Government's consultation on its hydrogen strategy clearly demonstrates that hydrogen is set to be a key enabler of its work to accelerate progress to a net zero energy system.

Its 'Hydrogen in Wales' pathway recognises significant opportunities to decarbonise heavy industry, reduce emissions in transportation and create economic growth.

The UK Government has committed to raising investment in R&D to 2.4% of GDP by 2027.<sup>3</sup> Recognising the potential for hydrogen to generate long-term, sustainable economic impact, it has also committed to investing in hydrogen innovation. It recently announced a £240 million Net Zero Hydrogen Fund designed to stimulate the production of low carbon hydrogen. Further investment is set to follow together with supportive business models for hydrogen development.

The scale of the investment needed to create a global hydrogen ecosystem extends beyond R&D and includes technology commercialisation, infrastructure and more. The Western Gateway has the potential to benefit from this and to continue to be at the leading edge of hydrogen development due to its significant research and innovation assets in academia, research and technology organisations, and industry.

The benefits of investing in our hydrogen future are unarguable. A productive hydrogen economy would make a substantive contribution to meeting the country's commitment to net zero emissions by 2050, contribute materially to energy security, position the UK to capitalise on global supply chain opportunities and create tens of thousands of jobs. There can be no doubt, however, that delivering on the ambitions of the Governments in Westminster and Wales will need a coordinated, collaborative and 'whole of UK' effort. The Western Gateway is at the forefront of this.

<sup>1</sup> <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>

<sup>2</sup> <https://www.gov.uk/government/publications/british-energy-security-strategy>

<sup>3</sup> <https://www.gov.uk/government/publications/uk-research-and-development-roadmap/uk-research-and-development-roadmap>

# Our commitment

**Our partnership is committed to harnessing the potential of hydrogen to power clean, inclusive growth across our area and maximise our hydrogen assets and capabilities which can be found across our entire area.**

**The Western Gateway's independent review of the economy identified a host of expertise in the development of hydrogen as an alternative energy source. This included activity along the M4 from the hub in Swindon to Cardiff, the South Wales Industrial Cluster, academic research centres at Baglan, Hy-RES and the UK Energy Research Centre in Bath, investments by industry-leading firms as well as pioneering projects as part of Cardiff Capital Region and Swansea Bay City Deal to name a few. These present opportunities for the Western Gateway to become a market leader in developing and supplying this alternative to hydrocarbon-based fuel sources.<sup>4</sup>**

This prospectus provides an overview of this broader landscape and illustrates how our research, innovation, and public and private sector organisations are investing in the talent and technologies needed to transition our developing Hydrogen Ecosystem into a productive hydrogen economy.

Using our convening power, the Western Gateway Partnership will broker connections and catalyse collaborations to create hydrogen-fuelled, fairer growth across our area and level-up our economy.

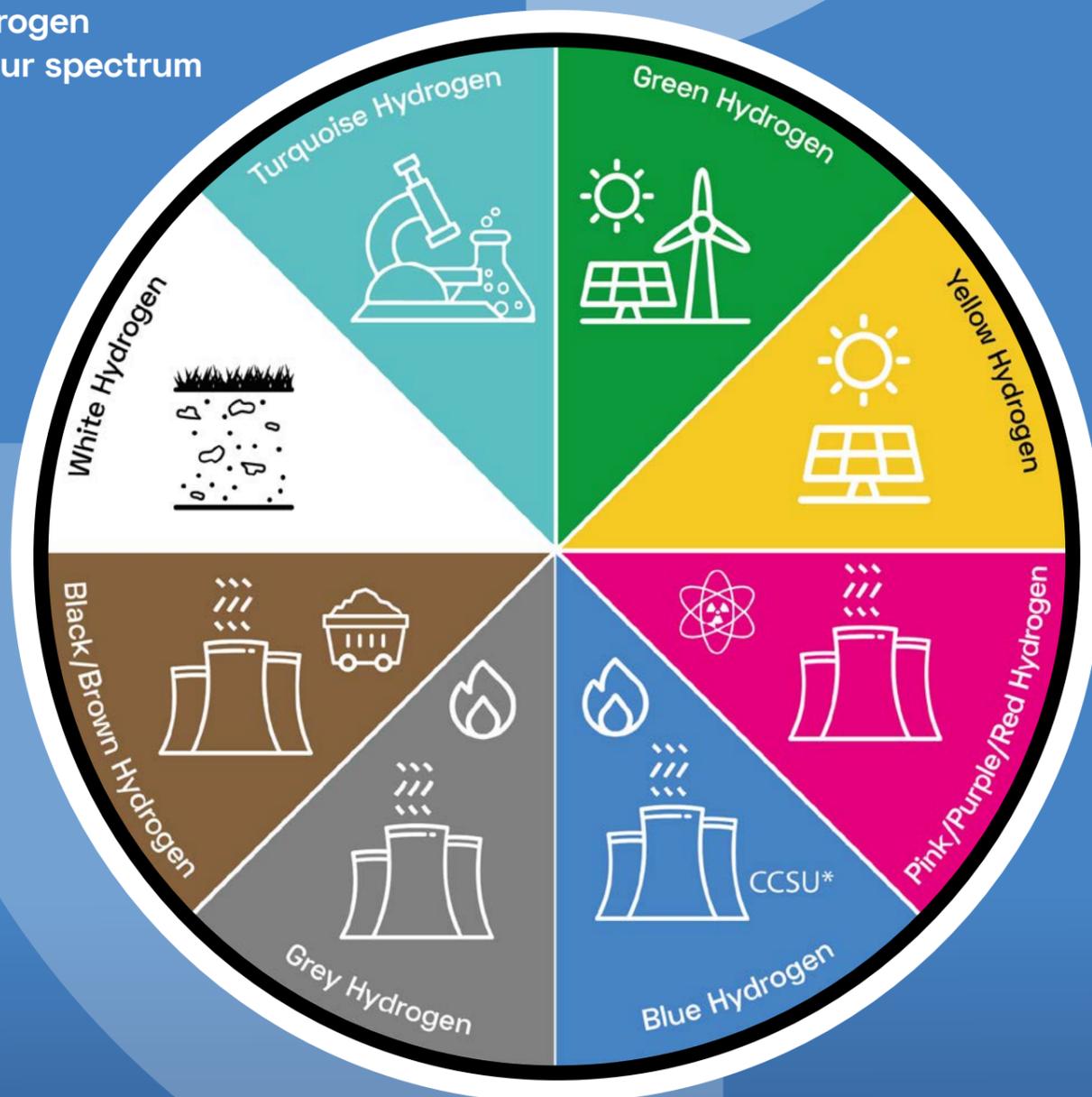
<sup>4</sup> <https://western-gateway.co.uk/sites/default/files/2022-02/IER2-Report-FINAL.pdf>

# Hydrogen explained

## Colour spectrum

Hydrogen might be a colourless gas, but its production is usually referred to by a colour as a informal shorthand for its method of production and associated carbon footprint.

## Hydrogen colour spectrum



\* carbon capture, storage and usage (CCSU)

## Green hydrogen

Green hydrogen is made by using electricity from renewable energy sources, such as solar or wind power using electrolysis.

## Yellow hydrogen

Yellow hydrogen is made through electrolysis using solar power as a low carbon source of energy.

## Pink hydrogen

Pink hydrogen is generated through electrolysis powered by nuclear energy. Hydrogen produced using nuclear power can also be referred to as purple hydrogen or red hydrogen depending on the process used.

## Blue hydrogen

Blue hydrogen is produced mainly from natural gas using a process called steam reforming. Blue hydrogen entails using carbon capture and storage solutions for carbon dioxide (CO<sub>2</sub>) emissions.

## Grey hydrogen

Grey hydrogen is produced from natural gas, or methane, using steam methane reformation but without capturing the carbon dioxide (CO<sub>2</sub>) emissions.

## Black and brown hydrogen

Black or brown is produced using bituminous coal (black) or lignite coal (brown) using gasification. This process releases carbon dioxide and carbon monoxide into the atmosphere which is not captured.

## White hydrogen

White hydrogen is naturally occurring and can be found within rocks underground. There are no current plans in the UK to progress the capture of white hydrogen.

## Turquoise hydrogen (experimental)

Turquoise hydrogen is produced using a process called pyrolysis which splits natural gas or biomethane using renewable electricity to produce hydrogen and solid carbon.

It has not been produced at scale and is experimental.

Organisations across the Western Gateway area are leading the development of low carbon sources of hydrogen across a wide range of sectors to help decarbonise future economies.<sup>5</sup>



Associated British Ports: Tidal Harbour

<sup>5</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1067392/low-carbon-hydrogen-standard-guidance.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067392/low-carbon-hydrogen-standard-guidance.pdf)

## Versatility

Hydrogen is incredibly versatile. It can be used as a feedstock, a fuel, energy carrier and/or energy store. This means a multiplicity of applications are emerging now across the sectors which are the most challenging to decarbonise industry, transport, power, and heating:

- **industry** – for example, decarbonising the production of cement, ammonia, methanol, glass, and steel;
- **transport** – for example, in fuel cells and hydrogen-based fuels for cars, trucks and heavy goods vehicles, buses, coaches, rolling stock, ships and planes;
- **heating** – for example, direct use of hydrogen in space heating. This could also make use of the existing gas network to more cost effectively transport hydrogen to decarbonise domestic and industrial heating; and
- **power** – for example, in gas turbines to increase power system flexibility. Ammonia could also be used in coal-fired power plants to reduce emissions.

## Sector coupling

Sector coupling refers to the opportunity to break down the traditional boundaries between the transport, heating, power, industrial, and housing sectors. This is one of the unique opportunities afforded by a hydrogen economy. It offers the potential to rethink and redesign centuries old infrastructure to better meet the needs of our society. It also means that all sectors and all use cases are on the cusp of simultaneous and not sequential transformation.

The linking or 'coupling' of hydrogen supply, transport and demand across sectors and use cases means that the burden of investment is shared and the cost of decarbonising our economy reduced. This can be envisaged at a local level, with, for example, the use of surplus electricity to produce hydrogen for localised use such as district heating, to fuel transport or as an energy store.

# The Western Gateway: Powering our hydrogen future

Pioneering, discovery-driven research, innovation, and commercialisation activity is underway across the Western Gateway area placing it at the forefront of activity at every point along the technology readiness pipeline. For example:

## Research

- **The GW4 Alliance** is a research and innovation consortium between the universities of Bath, Bristol, Cardiff and Exeter. By coming together as GW4, the Alliance aims to enhance research collaboration; address global, societal, and industrial challenges; and inform policy at national and international levels. GW4 is focused on responding to global challenges facing society today, such as reaching net zero. The Alliance is working with academics and industry to respond to the challenges of using hydrogen as an alternative fuel source. Collaborations include research into electrolysers, new composites, smart nanomaterials, hydrogen storage batteries and clean transportation as well as world leading novel propulsion systems.
- **Sustainable Environment Research Centre, University of South Wales:** Undertakes world-leading research into sustainable hydrogen production, storage and application at its Hydrogen Research Centre at the Baglan Energy Park in Port Talbot and its Laboratories in Pontypridd.

## Innovation

Our area is home to nationally significant and globally leading innovation centres and capabilities including:

- **National Composite Centre (NCC):** is the UK's world-leading advanced composites research and development facility that focuses upon solving some of the world's most complex engineering challenges using digitally optimised, sustainable composites.

It is interested in developing the next generation of hydrogen storage and transportation solutions to enable net zero global energy transition. As part of the High Value Manufacturing Catapult, the NCC is a key part of a multi-partner collaboration called the Hydrogen Innovation Initiative, which brings together the strengths and capabilities of the Catapult Network and partner innovation centres to accelerate innovation, develop growth in the UK hydrogen supply chain and overcome technology and integration challenges to establish an effective UK hydrogen economy.



Aerial view from Cardiff Bay

- **Institute for Advanced Automotive Propulsion Systems (IAAPS):** is a centre of excellence for research, innovation, enterprise, and education supporting the future direction of the propulsion industries. Its green hydrogen production and storage facility becomes operational in Spring 2023 and will support research and innovation in sustainable propulsion and the built environment delivering net zero. It will form the centre piece of its newly created Hydrogen & Sustainable Transport Economic Acceleration Hub at the Bristol and Bath Science Park.

IAAPS is developing a Hydrogen Enterprise and Education Hub to allow development of a cluster supporting SMEs focussed on hydrogen and sustainable transport. IAAPS will also support the formation of a local green ecosystem by investing in education and skills focussed on hydrogen, net zero and sustainable technology.



IAAPS

## Commercialisation

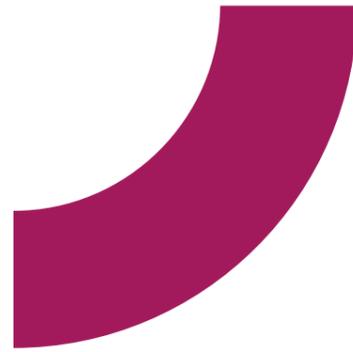
National and international organisations across the Western Gateway are investing in our hydrogen future and they are also collaborating through industry-led partnerships. For example:

- **Hydrogen South West:** is a partnership focused on growing a hydrogen economy for the production, storage, transportation and use of hydrogen and alternative fuels. Its partners include leading businesses easyJet, Airbus and EDF (Hynamics); industrial heavyweights GKN; consultants and engineers Costain and Wood; and regional leaders Bristol Airport, Bristol Port, and Wales and West Utilities. This combination of industrial experience, delivery expertise and regional knowledge presents a formidable opportunity to accelerate the development of the Western Gateway's Hydrogen Super Cluster and support the UK's transition to hydrogen power.

Innovations in technologies and business models are also being driven by a vibrant ecosystem of start-ups, scale-ups and small and medium sized enterprises. For example ZeroAvia and its mission to produce the world's first practical zero emission aviation powertrain and Riversimple and its ambition to offer customers affordable hydrogen powered cars.

To best understand and present the breadth and scale of hydrogen activity across our area, and to help leverage investment, we have developed an interactive map in partnership with the GW4 Alliance. This 'live' tool will be used to develop a knowledge base from which to identify common areas of interest, share knowledge, broker new collaborations and showcase the breadth of the opportunity.





**The GW4 Alliance connects four of the most research-intensive and innovative universities in the UK: Bath, Bristol, Cardiff, and Exeter.**

The GW4 institutions make a substantial contribution to the global knowledge economy and have a combined research income over £420m, a turnover over £2.2bn, employ over 12,700 academic staff, and provide training for over 25,000 postgraduate and 77,000 undergraduate students. Our strategic partnership with the Western Gateway brings our universities together with business and government from both sides of the union to create new opportunities that can level up our communities and drive green and economic growth.

A major strength of GW4 is our ability to foster collaborations across areas of complementary expertise to develop research communities at scale which address major global and industrial challenges; from net zero, climate change and sustainability to antimicrobial resistance. By partnering with the Western Gateway, we have built upon our commitment to pursuing research and innovation that helps the world achieve a net-zero carbon economy faster.

A developing hydrogen economy and ecosystem is dependent on an innovative community that draws on the collective strengths of research, industry, local authorities and government. The GW4 Alliance is a ready-made vehicle with the ability to deliver research and innovation at pace and scale with world class facilities, over 1,700 items of shared cutting-edge equipment, and a highly skilled workforce to support the demands of a developing hydrogen ecosystem.

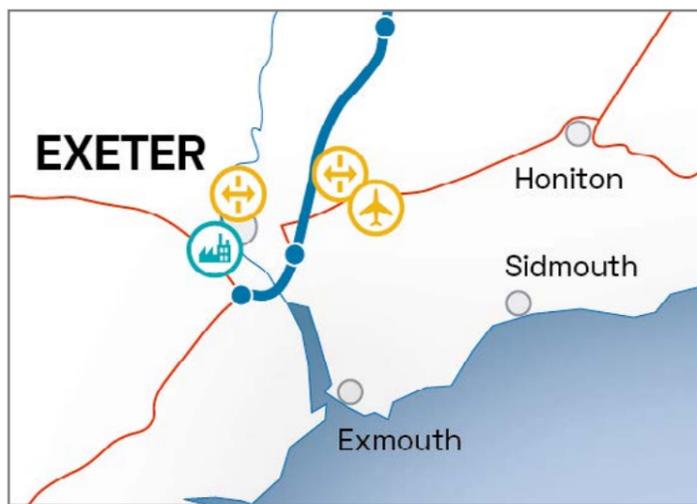
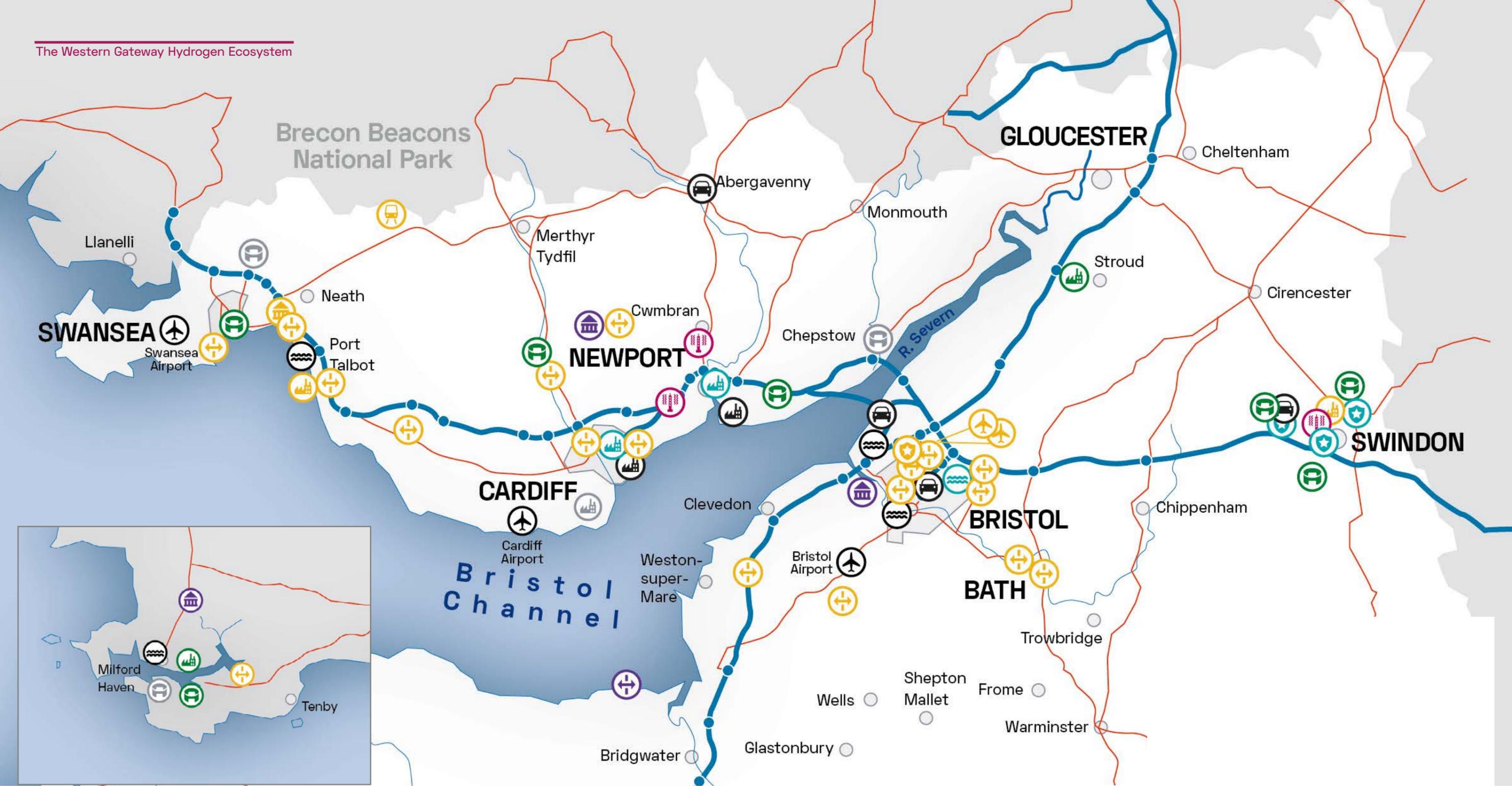
There is real power in partnering with the Western Gateway to unlock the potential of our region as a Green Energy Super Cluster by convening and connecting our research, innovation and commercialisation communities to create a shared understanding of the opportunities to reach our ambitions.

Working together, we can enhance connectivity across the region through our diverse expertise and knowledge to catalyse discovery and innovation. Collaboration lies at the heart of the GW4 Alliance and we believe our partnership offers a unique opportunity to combine our breadth of skills and research capacity to support a thriving hydrogen economy and achieve net zero commitments.



Professor Lisa Roberts, Chair of GW4 Council, and Vice-Chancellor and Chief Executive at the University of Exeter





**Key**

- |                           |                                     |  |   |                     |                               |                                  |
|---------------------------|-------------------------------------|--|---|---------------------|-------------------------------|----------------------------------|
| Green Hydrogen Production | Grey Hydrogen Production            | Research & Development Rail                    | Equipment supply Equipment manufacturer | Offtaker Road       | Other Collaborative R&D       | Utilities Storage & distribution |
| Green Hydrogen Industrial | Grey Hydrogen production Industrial | Research & Development Industrial              | Research & Development Industrial       | Offtaker Industrial | Other Sub-national government |                                  |
|                           |                                     | Research & Development Collaborative R&D       | Equipment Supply Marine                 | Offtaker Marine     |                               |                                  |
|                           |                                     | Research & Development Sub-national government |   | Airports            |                               |                                  |
|                           |                                     | Research & Development Aviation                |   |                     |                               |                                  |

The full updated interactive map is available on the Western Gateway website. Go to: [www.western-gateway.co.uk](http://www.western-gateway.co.uk)

# The Western Gateway: A developing Hydrogen Ecosystem

## A differentiated, integrated cluster

Clusters can be powerful drivers of innovation and productivity growth by fostering linkages and relationships between universities, government institutions, industry, and business. They attract talent and are at the heart of dynamic regional economies.

The Western Gateway's hydrogen interactive map brings to life the scale of our rapidly evolving hydrogen ecosystem. It is one that encompasses all the use cases a future hydrogen economy would need to serve; road, rail, maritime, aviation, domestic heating, and industrial processes. It is also one that is perfectly placed to develop the technologies and talent needed to deliver on the Government's ambition for at least half of the 10GW 2030 hydrogen production target to be from electrolytic hydrogen.

**Aviation:** The Western Gateway is home to 14 of the 15 biggest global aerospace companies as well as the UK Global Technology Centre jointly funded by GKN Aerospace and the Aerospace Technology Institute (ATI). This globally significant cluster is already spearheading work to deliver the UK Government's Jet Zero Council's ambition for "a laser focus on UK production facilities for sustainable aviation fuels and the acceleration of the design, manufacture and commercial operation of zero-emission aircraft."<sup>6</sup>

- **University of Bristol:** The University has strengths in the research and development of materials for storage and the purification and distribution of hydrogen, particularly for aviation. Research is underway at the Faculty of Engineering into nanocomposites to provide safe and efficient means for hydrogen storage. This includes a specialist research team fabricating, characterising, and testing nanomaterials for sustainable energy storage and energy use, helping to provide the technologies that will allow alternative energy vectors such as hydrogen to come into widespread use.

<sup>6</sup><https://www.gov.uk/government/news/prepare-for-lift-off-jet-zero-council-to-deliver-carbon-free-flight>



- **ZeroAvia:** A leading innovator in zero-emission commercial aviation, is putting the UK at the forefront of international efforts to tackle the climate impact of aviation from its R&D base in Gloucestershire. ZeroAvia's research and development facility at Cotswold Airport is the base for its development of a hydrogen-electric engine capable of powering up to 19-seat aircraft by 2024. As well as R&D on zero-emission propulsion, the site near Cirencester is now home to Europe's first landside-to-airside hydrogen airport pipeline and a full refuelling ecosystem from electrolytic production to refuelling, demonstrating a significant infrastructure advancement for the industry and the region.
- **Airbus:** From a site in Filton, Airbus will launch a Zero Emission Development Centre for hydrogen technologies to develop a cryogenic fuel system and will work on hydrogen propulsion, with ground testing in 2023 and flight testing from 2026 to develop the world's first zero-emission commercial aircraft by 2035. Airbus already operates a full-scale wing testing facility (AIRTeC) jointly funded by Airbus and the

UK Government's Aerospace Technology Institute (ATI) programme. A key area of study is the Wing of Tomorrow programme, in support of future hydrogen aircraft designs. The work undertaken through this research will play an important role in the future of the aviation industry as new concepts are developed which utilise lower carbon fuel solutions.

- **DragonFLY project, Cardiff University:** From the newly established Hydrogen Electric Propulsion Research Centre at St Athan, the main aim of the DragonFLY project is to develop a scalable technology demonstrator to prove the concept of a hydrogen electric hybrid propulsion system. The project integrates two novel advanced battery and hydrogen fuel cell systems on a single platform to overcome the main barriers faced by the industry and test its performance capabilities on a regional scale flying testbed. The project is partially funded by eight industrial partners, the European Regional Development Fund (ERDF), and Welsh Government.

**Maritime:** Hydrogen and hydrogen-based fuels such as ammonia and methanol are being trialled to power a low-carbon maritime industry of the future. The Government has established the UK Shipping Office for Reducing Emissions (UK-SHORE) to accelerate this transition, transforming the UK into a global leader in the design and manufacturing of clean maritime technologies and fuels, unlocking investment and tackling supply- and demand-side barriers.

In addition to demand for hydrogen for shipping, our ports will generate demand for clean fuels to power the movement of people and goods and provide the enabling infrastructure to import or export hydrogen to neighbouring regions.

- **The Centre for Future Clean Mobility (CFCM):** Anchored at the University of Exeter, CFCM is helping lead the development of clean maritime propulsion. The centre partners with businesses in developing low-emissions, high-efficiency integrated power systems for use within marine, off-road, rail, defence, and energy sectors. The centre is developing innovative hydrogen propulsion solutions and working with Ecomar Propulsion Ltd to design and optimise a commercially viable electric and hybrid powertrain for marine applications. CFCM is fast becoming the “go-to” research group for clean maritime propulsion systems.
- **Bristol Port:** Poised to play a key role within a future hydrogen economy as a node for maritime, road and rail transport and its proximity to major potential industrial and domestic users. The port could be central to green hydrogen and ammonia production, storage and supply, contributing to the decarbonisation of the Western Gateway area and the UK as a whole. As the marine industry converges on a clean alternative fuel solution likely to include ammonia and/or hydrogen, the port could become a large regional offtaker. Coupling this with the confluence of infrastructure which most ports enjoy, along with space for development, and proximity to multiple users the port is a prime location for future hydrogen and ammonia production and distribution.

- **Associated British Ports:** Own and operate the ports of Swansea, Port Talbot, Barry, Cardiff, and Newport within the Western Gateway region. These industrial ports have an integral role as part of a hydrogen ecosystem through their ability to import and export energy vectors, as well as providing land to support renewable energy generation. Port Talbot is a nationally significant asset, combining deep-water access, large-scale development land, and infrastructure connections with a skilled labour force. This means that the port will play a critical role in the decarbonisation of manufacturing, transport and logistics, and energy generation. Plans are being developed for production and distribution of low-carbon fuels, CO2 shipping and new port-centric manufacturing facilities, as well as major hub for Floating Offshore Wind in the Celtic Sea.



Bristol Port

**Rail and road:** Hydrogen offers the potential to power zero emission vehicles for uses where the adoption of battery electric vehicles is less suited, for example, buses, inter-city coach travel, rail, long-haul road freight.

- **Cardiff University:** Research groups are investigating the use of hydrogen as a fuel; either directly or as a feedstock for conversion to ammonia in a number of projects. Examples include investigating the use of green ammonia, the development of ammonia and hydrogen fuelled gas turbines, internal combustion engines, furnaces and drones, fundamental research and development of plasmas and injection systems, and hydrogen/ammonia blends as fuels for HGVs, trains, as well as aeroplanes and vessels.
- **Riversimple:** Is a pioneering sustainable vehicle manufacturer and provider of mobility services based in Wales. It is producing hydrogen vehicles that will offer customers a complementary option to Battery Electric Vehicles in the mission to decarbonise personal transportation. Riversimple is currently trialling its vehicles with customers in Abergavenny, Monmouthshire and Milford Haven, Pembrokeshire and will look to expand deployment with infrastructure partners and other hydrogen vehicle providers across the UK starting with markets in the Western Gateway region.
- **Hydrogen refuelling:** One of the UK’s first hydrogen refuelling stations was installed at the USW Hydrogen Research Centre at Baglan Energy Park in 2009, and the UK’s first open access refuelling station opened in Swindon in 2011. Places across the Western Gateway are actively pursuing opportunities to transition public sector fleets to hydrogen, develop the road hydrogen refuelling infrastructure and explore route options for hydrogen trains. The Global Centre for Rail Excellence which will open in South Wales in 2025 will be a purpose-built facility with the potential to transform the railway industry including the use of hydrogen for rail. A reliable refuelling infrastructure is increasingly important as projects come onstream, for example the Welsh Government’s aim to deploy 200 hydrogen fuel cell buses and establishing Wales as an early market for commercial fuel cell vehicles.



Riversimple vehicles



Wales & West Utilities: Swindon plant

**Heating:** In the UK, it is expected that most of the heating in homes will be decarbonised by one of three low carbon technologies: heat pumps; hydrogen and/or heat networks.

- The Supergen Energy Networks (SEN) Hub:** This brings together industrial and academic partners to gain a deeper understanding of the interactions and inter-dependencies of energy networks. The SEN Hub utilises a holistic method for studying multi-vector energy network infrastructure. Harnessing the combined expertise and resources of the SEN Hub in GW4 universities and the Wales & West Utilities pathfinder model, this project aims to identify pathways towards net zero in the Western Gateway area, considering transport, industry, and residential energy demands, and revealing the interdependencies and critical uncertainties in our current system.
- The Science Museum Group:** Is committed to sustainably developing its Science and Innovation Park, Wiltshire, as a place for low-carbon technology research and development, with renewable energy generation at its core. Building on successes in utilising solar for electricity generation, biomass for conditioning storage buildings and hydrogen fuel for vehicle operations at the site, the Science Museum Group is now exploring combining established renewable electricity technology with green hydrogen production at the Science and Innovation Park to ultimately decarbonise its entire

UK estate and reach net zero by 2033. Feasibility work into green hydrogen production using electrolysis from a solar array was completed in 2022 with support from the South West Energy Hub and the Swindon and Wiltshire Local Enterprise Partnership.

- Wales & West Utilities (WWU):** Consider hydrogen as fundamental to delivering a net zero energy system for industry, transport and home heating. The company is working with other UK gas networks to develop evidence on the transition from natural gas to hydrogen for heat, industry, transport and power generation, including through industry-wide work towards allowing up to 20% hydrogen blends into local gas grids from 2023 and delivering 100% hydrogen village trials in 2025. Wales & West Utilities is also working on a number of other hydrogen projects to support the decarbonisation of heavy industry in South Wales and South West England. In 2021 Wales & West Utilities was granted permission by the Health and Safety Executive (HSE) to inject gas containing up to 1% hydrogen into their network in Swindon, working with Swindon based Bio-Substitute Natural Gas (BioSNG) producers ABSL. This was the first authorized usage of natural gas with a high hydrogen content in the gas grid.

**Industrial decarbonisation:** Clusters of large industrial plants have developed near our ports and estuaries. The UK Industrial Decarbonisation Challenge (IDC) of the Industrial Strategy Challenge Fund (ISCF) aims to establish four low-carbon clusters by 2030 and the world's first net zero carbon industrial cluster by 2040. The South Wales Industrial Cluster is an area of focus for transformation. The Industrial Decarbonisation Research and Innovation Centre (IDRIC) has been formed to support the IDC through funding a multidisciplinary national research and innovation centre. Academic and industrial organisations throughout the Western Gateway area are conducting ground-breaking decarbonisation research through IDRIC.

- University of South Wales (USW):** USW's Sustainable Environment Research Centre (SERC) has developed a range of innovative biotechnology approaches, including biological processing of industrial CO<sub>2</sub> waste with hydrogen to produce valuable platform chemicals and 'green' methane gas. This technology could be integrated into the gas and electricity grids for energy storage to enable more deployment of renewable energy. USW is also working with Costain and Dwr Cymru Welsh Water through the HyValue project to convert methane from sewage sludge at sewage treatment plant into hydrogen while also collecting carbon dioxide.
- NCC:** Works with industry and a broad stakeholder network in the UK and internationally, developing world leading capability and innovation across generation, distribution and consumption markets. The NCC has focussed on the development of storage and pipeline technologies that require composite technology in the near term as well as future technologies such as sustainable tanks. NCC has aspirations to work with key stakeholders within the Western Gateway to help them to understand the potential use case and deployment of hydrogen through first of a kind technology demonstrator projects or deployment in a system perspective,

for example, the NCC has successfully reclaimed continuous carbon fibres and re-used them to manufacture a new pressure vessel which was a significant milestone in the development of the UK's hydrogen capability.

- Johnson Matthey (JM):** Is a global leader in sustainable technologies. JM is active across the hydrogen value chain, supplying catalyst coated membranes (CCM) for PEM electrolyzers and providing award winning LCH™ Technology for blue hydrogen production. Transporting hydrogen is challenging, its process technologies help transform hydrogen into energy carriers and back again. Finally, on the consumption side, JM has been developing fuel cell CCMs and membrane electrode assemblies (MEA) for decades, underpinned by the development of closed-loop recycling systems for CCMs.



University of South Wales, Newport Campus

## A cluster of collaboration

The Western Gateway Hydrogen Ecosystem demonstrates the connectivity and inter-dependencies between business, industry research and the public sector with new collaborations and partnerships being established as the potential of hydrogen economy is better understood.

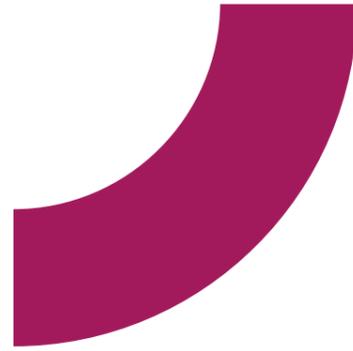
- **UKRI Hydrogen Research Challenges (UK-HyRES):** This aims to tackle research challenges blocking the wider use of low carbon hydrogen and alternative liquid fuels in the UK. Based at the University of Bath, UK-HyRES is a collaborative project with the aim to establish a national centre of excellence in 2023. The UK-HyRES project will work across disciplines, thematic areas and locations, to engage with academics, industry, business and policy communities to identify and prioritise hydrogen research challenges. UK-HyRES will focus on the potential for hydrogen and alternative liquid fuels to decarbonise transport, electricity generation, domestic and industrial heating and high-emitting industries such as steel, glass and cement manufacture.
- **FLEXIS:** A consortium of five strategic partners: Cardiff University, Swansea University, The University of South Wales, Neath Port Talbot Borough Council and Tata Steel UK. With £24 million of funding, including a portion from the European Regional Development Fund via the Welsh Government, the vision of the five-year project is to achieve a resilient, affordable, secure energy system across Wales with the potential for global application.

To date, the FLEXIS project has generated a further £36 million in investment income, supported 153 employees and recruited 106 researchers.

- **Milford Haven Energy Kingdom (MH:EK):** is a consortium of partners including the Port of Milford Haven, Pembrokeshire County Council, Catapult Energy Systems, Wales & West Utilities, Riversimple, Arup, and others within the South Wales Industrial Cluster (SWIC). MH:EK has developed plans to use hydrogen as part of a decarbonised smart local energy system alongside ambitious plans to harness offshore wind and tidal energy. The port of Milford Haven is one of UK's largest energy ports and is central to realising this initiative. It is home to the import and generation of 25% of the UK's energy and benefits from a natural harbour, vast offshore wind potential and the grid transmission infrastructure and as such, the area is well positioned to become a significant UK and European hub for hydrogen. The Milford Haven: Energy Kingdom project is paving the way to a renewables and hydrogen future for the Haven waterway and the Western Gateway.

- **The South Wales Industrial Cluster (SWIC):** A partnership between South Welsh industry, energy suppliers, infrastructure providers, academia, legal sector, service providers and public sector organisations, was formed to help plan and shape a route to net zero for industries in South Wales. The aim of the group is to develop a world-leading, truly sustainable cluster benefitting the societal, economic and energy needs for now to 2050, and beyond. The Cluster aims to fuel the future of heavy industry, using South Wales' available resources, by exploring the feasibility and possibilities for the decarbonisation of the region, including creating a hydrogen economy. SWIC is progressing major multi-megawatt blue and green hydrogen projects such as those included in the Pembroke Net Zero Centre.

These collaborations build capabilities and generate commercial pull through, creating a single 'place' in which to develop and prove technologies and develop hydrogen business models across a range of sectors that can be replicated across the UK and overseas.



## A complementary cluster

**Our Hydrogen Ecosystem map brings to life the extent of the Western Gateway area's leading hydrogen strengths with planned hydrogen production distributed across urban, rural, and coastal communities and economic clusters in England and Wales.**

The landscape of hydrogen production across the Western Gateway adds a new perspective to existing UK industrial hydrogen trials. Our ambition is to develop a network of distributed, primarily green, and, in relative terms, smaller hydrogen production capabilities to feed hydrogen into the grid or for localised use. Investing in the Western Gateway's hydrogen ecosystem would be complementary to those in development, for example, HyNet in the North West and the Teeside decarbonised industrial cluster.

A diffuse, commercially viable network of hydrogen production will need:

- efficient distribution and local storage solutions. Users to be confident in a secure supply, for example, a reliable national re-fuelling network. Brokering enduring connections between future generators and off-takers will be key to resolving this;
- a knowledgeable and supportive regulatory environment and planning regime;

- clarity over the Government's hydrogen business model and supportive financial institutions;
- clarity on the VAT applied on hydrogen for different end users;
- reliable international supply chain in terms of parts, equipment and fleet; and
- knowledge and skills development across institutions and trades.

## A cluster of innovation and talent

**Creating our future hydrogen workforce is an ambition shared by partners across the Western Gateway. Skills for the future at all levels will be needed. To best understand and meet these future needs, partners across our area are working together to develop and deliver future-focused and complementary skills initiatives from the NCC, Business West and the Institute of Technology to USW working with SWIC and the Swansea Bay City Region, and Cardiff Capital Region's Skills Partnership.**

New skills will be required to support the development of the UK's hydrogen economy and balancing their supply and demand across the Western Gateway will be integral to the development of our thriving Hydrogen Ecosystem. The need for investing in skills development is broad from technology development, equipment installation, maintenance and use, though to skills within public authorities and wider stakeholders which will need to invest in developing new competences in planning, regulation and health and safety to support project delivery and investment decisions.



# A Green Energy Super Cluster

## Hydrogen at its core

The Western Gateway's ambitions to deliver a greener, fairer future for our people and places extend beyond harnessing the power of hydrogen. We believe our area has all the elements needed to become a world-leading Green Energy Super Cluster including significant natural assets in solar, tidal, marine, and wind power and leading capabilities in aerospace, nuclear and industrial decarbonisation. Hydrogen will be at the core of this super cluster, providing a means by which to store energy, smooth demand curves and deliver a decarbonised net zero economy by 2050.



By capitalising on these strengths, we will demonstrate international leadership to deliver new clean and renewable energy solutions to help decarbonise our economy, opening up new opportunities for local people in the process.

### Creating a productive hydrogen economy

The Western Gateway is becoming an exemplar area by showcasing how hydrogen can be used to realise both regional and national net zero ambitions when strengthened and underpinned by investment, industrial scale innovation and distributed generation. We will continue to work with partners to deliver on their ambitions and our partnership's missions:

- **invest and innovate:** to create greener, fairer, hydrogen-fuelled growth across our area and add £34 billion to the UK economy by 2030;
- **convene and connect:** research, innovation and commercialisation communities to generate a shared understanding of the opportunities and challenges, and to create the collaborations and secure the investment needed to meet these. By bringing together future generators with future users it might be possible to work towards balanced production and supply;

- **local impact:** align roadmaps being developed by individual companies and sectors across our area to develop a shared strategy, undertake a gap analysis and identify opportunities to advance our ambitions with more pace;
- **national impact:** the Western Gateway aims to make a material contribution to delivering the UK Government's ambition for half of its 10GW low carbon hydrogen production to be from electrolytic sources by 2030. Stimulating and connecting supply and demand for hydrogen will be essential to creating a future hydrogen economy, as will working with stakeholders across our area to create the skills, investment and regulatory environment needed to realise this; and
- **internationalise opportunities:** raise the profile of our area globally as an attractive investment location, showcase our innovation and technology assets, export technologies developed within our area and contribute to closing our £4 billion export gap.



**The Western Gateway  
Hydrogen Ecosystem:  
the ideal place to develop a UK  
hydrogen economy**