



Department for
Business, Energy
& Industrial Strategy

Hydrogen Sector Development Action Plan



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Executive summary

When government published the UK's first Hydrogen Strategy in August 2021, we acknowledged that the UK has the geography, geology, infrastructure, and expertise to rapidly build a low carbon hydrogen economy. That ambition brings with it significant potential for investment into the UK, and opportunities for UK companies in the supply chain and our skills base, as well as wider economic benefits to all regions of the country.

Since then, it has become even clearer that hydrogen must be a core part of the UK's future energy security as well as plans to meet our legally binding commitment to achieving net zero by 2050. In the British Energy Security Strategy, we doubled our ambition from 5GW to up to 10GW of low carbon hydrogen production capacity by 2030. That commitment significantly increases the scale of opportunity for the UK to become a genuine world leader in the development, deployment and build-out of hydrogen infrastructure across the full value chain, covering production, transmission and storage, and the range of potential end uses for hydrogen, including power, heat, and transport. Analysis by BEIS suggests that the 10GW ambition could mobilise over £9 billion of private investment in production alone, and support more than 12,000 jobs by 2030 across production, distribution and storage, including domestic and exports. Significantly higher investment and jobs figures are expected across the wider supply chain.

The purpose of this **Sector Development Action Plan** is to highlight the nature and scale of opportunities across the hydrogen economy in the UK. It focuses on four key areas: investment; supply chains; jobs and skills; and exports. It sets out actions in those areas being taken by government and industry to maximise the benefits from scaling up the UK hydrogen economy.

On **investment**, we recap the progress government has made setting out support mechanisms to make hydrogen projects **bankable and investable** propositions in the UK. Where government can further support this investment through structured engagement with investors and industry, we lay out proposals for how, including investor profiling to help stakeholders understand where and when investment is most needed in the emerging hydrogen economy and digital tools to showcase UK projects to potential investors.

In our **supply chains** we have existing strengths and capabilities with the potential not only to drive the development and deployment of hydrogen at home – for example in electrolyser and fuel cell manufacture – but to promote exports to help build a global hydrogen economy. Actions to support supply chains focus on matching companies to opportunities through improving the visibility of project pipelines and companies' understanding of project specifications. Government will also ask industry to lead a process to voluntarily set levels of ambition for supply chains in UK hydrogen projects.

The Plan underlines the importance of adopting a holistic approach to supporting **jobs and skills** for a hydrogen economy and how that economy can benefit from the just transition for traditional sectors such as oil and gas. It sets out how government will use the resources of

bodies like the Green Jobs Delivery Group to ensure hydrogen benefits from the broad range of skills common to the net zero mission, as well as establish hydrogen-specific groups like the Hydrogen Early Careers Professional Forum to develop and help progress a diverse and talented workforce.

On **exports**, the Plan considers the growing global hydrogen economy, and the great potential for the UK hydrogen industry to export goods and services, including with support by instruments from UK Export Finance.

Maximising benefits for the UK in these areas relies, in part, on robust **monitoring and evaluation** to understand performance and inform policy development to improve results from the UK hydrogen economy. Utilising the Theory of Change framework, we illustrate metrics that can measure success against our sector development objectives and commit to developing these to keep step with the fast-moving nature of the hydrogen economy, giving us flexibility to update our actions and metrics and incorporate new data as they become available.

This Action Plan is not exhaustive, and government will not stand still. We will continue to work with industry, investors, and other stakeholders not only to develop, deliver and monitor these actions, but to agree new ones as our collective understanding of the UK hydrogen economy matures.

Chapter 1 – Investment

Key actions to support investment in the UK hydrogen economy

- ✓ *Government has produced an investment profile for the hydrogen value chain to summarise where and when investment will be needed and will work with investors and industry to update it as the hydrogen economy develops*
- ✓ *Develop tools to improve the visibility of the UK hydrogen project pipeline*
- ✓ *Host regular investor roundtables*

In July 2021, the Hydrogen Council estimated total global investment into the hydrogen economy at \$500bn by 2030, and that global opportunity continues to grow.¹ With the most attractive financial environment for investment in Europe², the UK is ideally positioned to unlock a significant proportion of this investment.

The [British Energy Security Strategy](#) makes clear that low carbon hydrogen will be essential for achieving net zero. Investment in hydrogen to de-risk early projects is expected to unlock over £9bn of private sector co-investment up to 2030 in production alone, with BEIS analysis showing that up to 100,000 jobs and £13bn GVA could be generated from the UK hydrogen economy by 2050 in a high hydrogen scenario.

This chapter sets out how government is engaging industry and investors to understand the investment needs and plans to support delivery of the UK's hydrogen ambitions and what actions government and industry can take to facilitate that investment.

1.1 The case for investment in UK hydrogen

In April 2022 BEIS published the [UK Hydrogen Investor Roadmap](#) to support investor engagement. The Roadmap showcases the UK as a world-leading investment destination: our first-class business environment, global reputation for advanced energy infrastructure and expertise, the world's largest offshore wind market and a highly developed gas infrastructure. Government recognises that creating the right environment to land early investment is essential to support supply chains and grow the domestic hydrogen economy. Our policy levers have been designed to unlock the necessary level of private finance through a strong investment proposition. Also published in April, the Hydrogen Investment Package will drive

¹ Hydrogen Council (2021) '[Hydrogen Insights An updated perspective on hydrogen investment, market development and momentum in China](#)'

² EY (2022) '[Why confidence in the UK's financial sector has hit a five-year high](#)'.

further investment into low-carbon hydrogen production in the UK and enable projects to begin construction in the next two years.

The Net Zero Hydrogen Fund (NZHF), which opened for applications on 25 April 2022, will provide up to £240 million to support the development and construction of new low carbon hydrogen production plants. The first electrolytic allocation round, which combines NZHF grants with hydrogen business model revenue support, will incentivise both production and use of low carbon hydrogen through the provision of ongoing revenue support, also opens this summer. We have also created the Industrial Hydrogen Accelerator, a £26 million innovation funding programme to support the demonstration of end-to-end industrial fuel switching to hydrogen in the UK. The overview of the [BEIS Hydrogen Funding Landscape](#), published alongside the [UK Hydrogen Investor Roadmap](#), includes a timeline for BEIS competitions that will support hydrogen projects.

Significant volumes of low carbon hydrogen are anticipated to be needed to achieve the UK's commitment to reach net zero by 2050, offering as it does an attractive decarbonisation option across many sectors, especially those which are harder to electrify. Analysis for the UK Hydrogen Strategy shows that low carbon hydrogen can play a key role in the UK energy system, potentially becoming comparable in scale to existing electricity use by 2050. Analysis by BEIS suggests hydrogen could make up 20-35 per cent of UK final energy consumption by 2050. Our drive for renewables makes hydrogen especially valuable: excess renewable electricity can be used to produce hydrogen, which can be stored over time and used to generate electricity when there is less sun or wind to power the grid. Government policies are designed to ensure hydrogen is well placed to integrate larger amounts of renewable energy onto the system, utilising otherwise wasted excess electricity, which can help to reduce potential grid constraints and system costs.

The UK's twin-track approach offers investment opportunities across a variety of low carbon hydrogen production methods, including electrolytic and CCUS-enabled hydrogen, with related opportunities across the UK in offshore wind, CCUS, and future potential for low carbon hydrogen production in nuclear, biomass, and other developing technologies.

The UK's mature oil and gas industry will play a central role in delivering CCUS-enabled hydrogen. Harnessing the power of the UK offshore oil and gas industry to deliver net zero by 2050 through the [North Sea Transition Deal](#) is expected to unlock investment, secure up to 40,000 energy jobs, reduce emissions by up to 60mn metric tons and promote domestic supply chains. The Deal commits the oil and gas industry to deliver investment of up to £14-16 billion by 2030 in new energy technologies, including both electrolytic and CCUS-enabled hydrogen production capacity.

Creating the right business environment to ensure investment lands where it is needed is essential to realising the rapid scale-up required to deliver this ambition, recognising that greater production capacity enhances investor confidence for long-term investments in the broader hydrogen value chain. Leading hydrogen production companies are already based in the UK currently working on hydrogen fuel cell technologies, ranging from micro spin-offs to multinational companies.

1.2. Investment needs across the hydrogen economy

Government recognises that 10GW production capacity by 2030 will demand rapid scale-up of both hydrogen production and investment, and that the investment needed across the value chain will evolve with sector maturity. **Government has produced a summary investment profile for hydrogen production, transport and storage and end use (see tables below). Working with investors, industry, finance providers and others the profile will be updated as it evolves to demonstrate where and when investment is needed.**

Figure 1.1: Tables summarising government’s current investment profiling

Production

Status	Investment Opportunities	UK Government Priorities	Forward Look
<p>Estimated £9bn of investment required for production by 2030.</p> <p>Equipment/technology already investible & raising significant funding.</p> <p>Domestic supply is a primary focus for investors.</p> <p>New hydrogen-specific investment funds’ potential role in growing supply chain base directly (or indirectly through project investment).</p>	<p>Production Electrolytic and CCUS-enabled hydrogen projects awarded Net Zero Hydrogen Fund and/or Business Model support contract with Industrial Decarbonisation and Hydrogen Revenue Support funding, when made available to meet up to 10GW ambition.</p> <p>Supply chain investment, and inward investment from established companies to strengthen the supply base.</p> <p>Electrolyser and fuel cell manufacturing capability, supporting UK technologies and innovation.</p>	<p>De-risk capital investment, addressing first-of-a-kind low carbon H2 production, relative costs to counterfactual fuels and nascent demand-side applications.</p> <p>Increase visibility of the pipeline and opportunities to investors and project developers.</p> <p>Engage industry stakeholders, including “anchor” sites, to understand investment challenges arising from being first-of-a-kind, and developing a framework to de-risk investment.</p> <p>Government recognises policy and regulatory certainty across full value chain are key to unlocking wider deployment, continued innovation funding and strong, regular domestic supply project pipeline.</p>	<p>Expected to be broadly investible by end 2023: economic and commercial frameworks in place, some infrastructure and market barriers remain.</p> <p>Hydrogen Business Models - developed and tested with investors to sufficiently manage volume and price risks to make these projects investible.</p> <p>Business Model allocations (alongside capex funding from Net Zero Hydrogen Fund) will reduce barriers to investment in UK production facilities.</p>

Transport & Storage

Status	Investment Opportunities	UK Government Priorities	Forward Look
<p>Strong interest from strategic and financial investors in a dedicated business model to support transport and storage infrastructure, and potentially grid blending.</p> <p>Initial hydrogen projects are expected to be developed close to their end users, with specified off-takers. As the H2 economy grows, dedicated infrastructure to transport and store hydrogen will be vital to connect as well as balance supply and demand.</p>	<p>Short/Medium/Long range storage provision to balance across seasons and provide resilience to broader market</p> <p>Cushion Gas for storage facilities</p> <p>Localised pipeline networks initially serving small number of large users but expanding as the hydrogen economy grows.</p> <p>Inter-Cluster transmission pipelines to connect industrial centres and provide resilience as well as facilitate inland market.</p> <p>Tube Trailers as a form of both small-scale storage and non-pipeline distribution to support initial hydrogen economy.</p>	<p>Unlock significant investment in infrastructure – new assets & repurposing existing natural gas assets – to unlock wider deployment in late 2020s/2030s.</p> <p>While small-scale infrastructure may be covered by the Business Model, subject to a number of factors, including necessity, value for money, and affordability, to avoid uncertainty/delays for production projects. However, we are designing new business models for Transport and Storage infrastructure by 2025.</p>	<p>Expected to reach partial investibility by end 2023: clarity on economic and commercial frameworks emerging, infrastructure and market barriers not present in all situations.</p> <p>Government is reviewing Hydrogen Transport & Storage requirements in the 2020s and beyond, including need for economic regulation and funding</p> <p>Government will design new business models for Transport and Storage Infrastructure by 2025.</p>

Industrial & End Use

Status	Investment Opportunities	UK Government Priorities	Forward Look
<p>Investment projections vary by end use/sector.</p> <p>Security of supply / gas price concerns are increasing interest in hydrogen.</p> <p>50+ projects exploring hydrogen in industry: smaller sites sourcing locally produced electrolytic hydrogen and larger sites on industrial clusters who have signed Memorandums of Understanding with large scale CCUS-enabled hydrogen producers.</p> <p>Electrolytic projects working with transport providers (e.g. buses) as early off-takers.</p> <p>Support for fuel switching provided through Industrial Energy Transformation Fund (industrial use) and Renewable Transport Fuel Obligation (transport use). Hydrogen village trialling first use of hydrogen for heat.</p>	<p>Industrial end-use projects, tied to Phase 1 of the CCUS cluster sequencing process:</p> <p>First cluster-based projects are expected to reach Final Investment Decisions in 2023 following cluster selection and will be unlocked primarily by business model funding.</p> <p>While equity investment is already secured in cluster projects, more will need to be unlocked, contingent on Government support.</p>	<p>Secure significant capital investment in:</p> <ul style="list-style-type: none"> • End use projects and associated infrastructure (e.g. refuelling stations) across transport (road, rail, shipping, aviation), industry, power and heating (subject to policy decisions) • Industry for innovation and deployment of process equipment to achieve the level of emissions reductions assumed in the industry Net Zero Strategy pathway • Enabling infrastructure to fuel switch to low carbon hydrogen. 	<p>Expected to reach partial investibility by end 2023: economic and commercial frameworks emerging, infrastructure and market barriers not present in all situations.</p> <p>Government recognises the need to stimulate hydrogen demand; end users want more information about where and when low carbon hydrogen will be available and its future cost.</p> <p>Hydrogen is currently limited to 0.1% in the GB gas networks, as outlined in the Gas Safety (Management) Regulations. The Government is exploring whether to enable blending of up to 20% hydrogen (by volume) into GB gas networks, targeting a policy decision in 2023, subject to the outcomes of ongoing economic and safety assessments and wider strategic considerations.</p>

1.3. Visibility of UK project pipeline

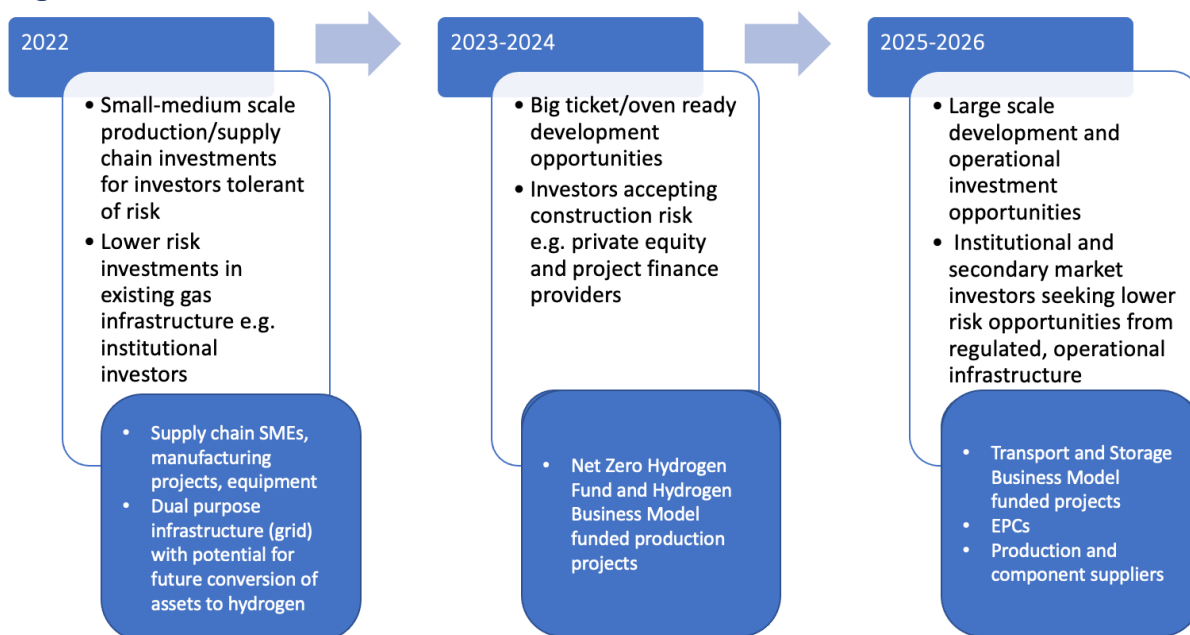
BEIS is working with the Office for Investment (OfI), the Department for International Trade (DIT), UK Export Finance (UKEF), and industry bodies to ensure investors have sight of opportunities as the sector ramps up. In the [Hydrogen Investor Roadmap](#) we included a map of potential UK projects in various parts of the value chain. This is the [latest version of the map](#); government will work with industry and DIT to continue to update this through time, introducing interactive formats as needed to complement the various tools currently being developed by industry. This will bolster existing initiatives such as [DIT's Investment Atlas](#), the [Hydrogen Valley](#) map produced by Fuel Cells and Hydrogen Joint Undertaking and Mission Innovation, and UKRI's [Portfolio](#), a searchable database of investment and collaboration opportunities with Innovate UK's most innovative businesses.

Government is also exploring creative approaches to galvanising investment and increasing knowledge sharing on investment opportunities to facilitate early-stage 'anchor' investments across the value chain and, as appropriate, ensuring that project consortia have opportunities to present their financing needs to the investment community.

Projected Hydrogen Sector Investment Timeline

From 2023, once hydrogen business model negotiations are underway with CCUS-enabled projects, investment opportunities in UK hydrogen are expected to transition from small-medium scale (£10m-£50m+) to larger scale development opportunities. The rapid scale-up of the sector will bring significant development and operational investment opportunities for increasingly large-scale production projects from 2025, such as opportunities in hydrogen-specific transmission and storage.

Figure 1.2



1.4. Engaging investors

In April 2022 government began a programme of industry and investor engagement to showcase UK hydrogen investment opportunities, understand the needs of different investors, and identify where government can do more to unlock the flow of private capital into the UK hydrogen economy, cascading the resulting intelligence across government to promote a policy, trade and regulatory ecosystem that supports rapid hydrogen scale-up.

The programme spans the value chain, engaging infrastructure investors, private equity funds and hydrogen-specific funds, project finance and advisory banks, as well as supply chain and industry investors. This engagement, in addition to existing forums such as the Hydrogen Advisory Council, has included Ministerial roundtables as well as regular engagement with key investors and industry bodies. Through these engagements government has heard consistent examples of where – with industry – it can take action to facilitate investment, including making the case for investment in UK hydrogen; setting out investment needs as the hydrogen economy develops in the 2020s and 2030s; and facilitating visibility of the UK project pipeline. **Going forward, government will host regular roundtables with a wide range of investors to take stock of progress made and make sure our policies are on track to mobilise the £9bn required to meet government's 2030 ambition.**

To showcase the UK hydrogen investment opportunity globally, we will support DIT, UKEF and the Foreign Commonwealth and Development Office (FCDO) in their international engagement work with overseas investors and industry stakeholders interested in developing projects in the UK.

Chapter 2 – Supply chains

Key actions to support the building of world-class, sustainable supply chains in the UK

- ✓ *Government will work with industry to continue mapping supply chain capabilities and opportunities as the hydrogen economy develops*
- ✓ *Providing visibility of future hydrogen projects and supply chain opportunities*
- ✓ *Government will work with trade associations and industry to deliver supply chain events, including future ‘Meet the Specifier’ events*
- ✓ *Government will ask industry to lead a process to voluntarily set levels of ambition for supply chain participation in UK hydrogen projects*

In the UK Hydrogen Strategy, government outlined its commitment to promoting the growth of world-class, sustainable supply chains to underpin deployment of early commercial-scale UK hydrogen projects over the 2020s, and to be ready to support expansion of the sector from the 2030s.

The level of ambition for hydrogen in the UK – up to 10GW of production capacity by 2030 – and globally, presents significant opportunities for UK companies and employees. The UK is already well positioned to grow and develop supply chain capabilities across the hydrogen value chain – covering production, transmission, distribution and storage and a wide range of potential end uses, including industry, power, transport and heat – but more work is needed.

This chapter sets out how our understanding of UK supply chains has progressed since publication of the Strategy – drawing on research commissioned by BEIS – and actions that government and industry will take to support supply chains to maximise the benefits from developing the UK hydrogen economy.

2.1 Understanding UK supply chains in the hydrogen economy

A BEIS-commissioned review of the UK supply chain has developed our understanding of what is needed to deliver a successful and prosperous hydrogen economy. [The research project](#) mapped economic opportunities based on projected demand, and explored existing capabilities, strengths, and gaps in the UK supply chain. The project also developed models to characterise the future UK hydrogen value chain. This is illustrated in figure 2.1, which shows associated products and services that could be needed from the supply chain.

As figure 2.1 shows there is a range of opportunities for UK companies to benefit from the domestic deployment of hydrogen and global export opportunities. This includes meeting future demand for products and services associated with the technical design and development of technologies and infrastructure, installation and commissioning, and

subsequent operation and maintenance. There will also be opportunities to draw upon the UK's wider expertise in research and development, education, professional services, finance, and other sectors.

This section presents findings from the research outlining supply chain opportunities to deliver initial projects in the 2020s. Additionally, it discusses how we can ensure that these supply chains are prepared to support significant ramp-up in deployment as the sector expands during the 2030s and beyond.

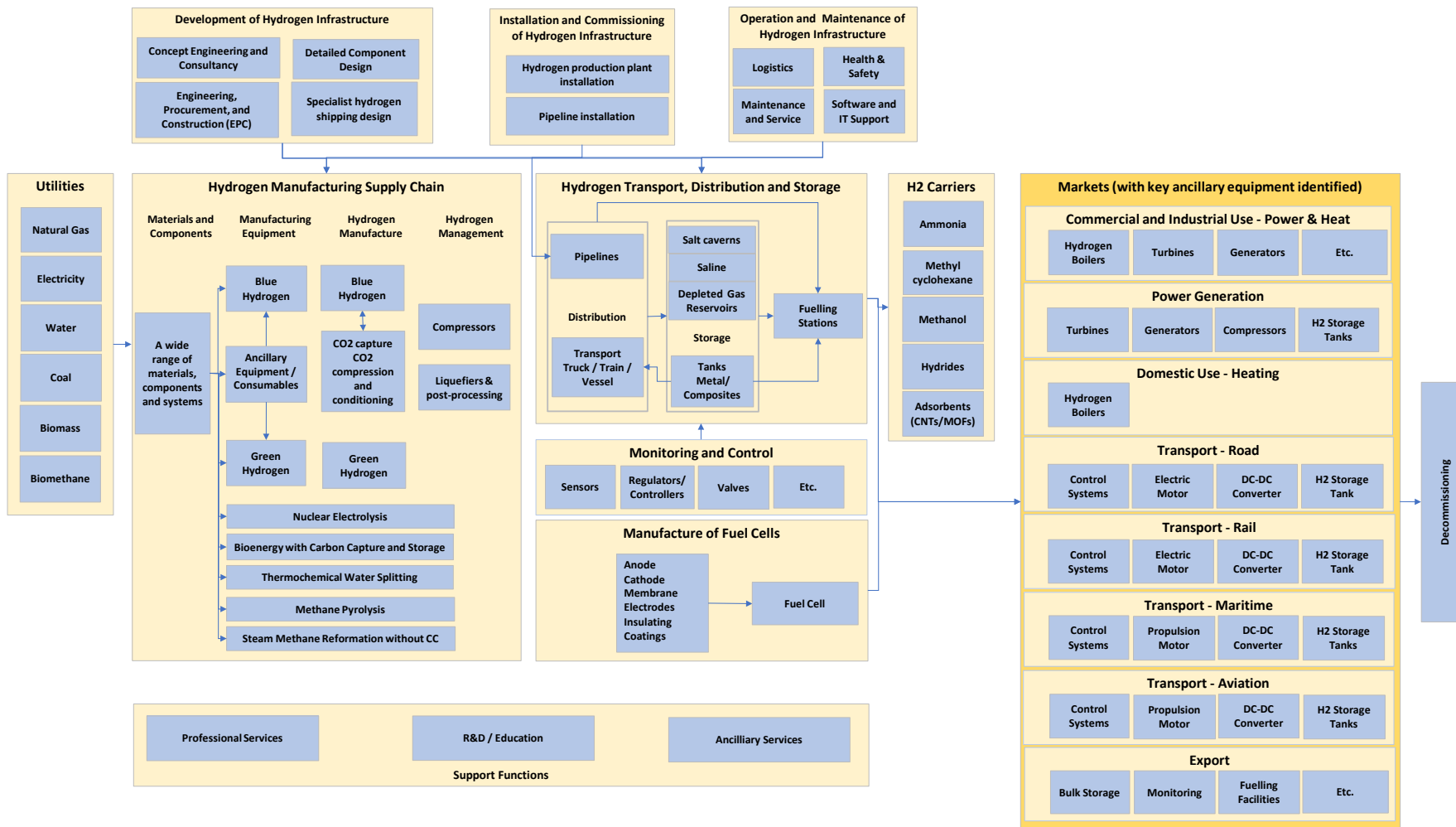


Figure 2.1 - Diagram outlining the hydrogen supply chain, based on research commissioned by BEIS

Production

Achieving the Government's ambition for up to 10GW of hydrogen production capacity by 2030 presents significant supply chain opportunities. Delivering production facilities for hydrogen requires a range of activities including regulatory and public enquiry; pre-licensing, technical and design costs; construction management and engineering services; equipment manufacture; construction and installation; commissioning services; operations and maintenance.

CCUS-enabled hydrogen production, primarily through natural gas reforming combined with CCUS, will play an important role in meeting the production ambition and presents a major opportunity to the UK supply chain. The research commissioned by BEIS shows that this could generate £0.7 - £3bn of turnover by 2030, and that the UK has world-leading expertise to draw upon – with two of the world's major process licensors for these projects based in the UK – and a mature supply chain to utilise from wider industries such as oil & gas and chemicals. Initial projects as part of the CCUS cluster sequencing process are therefore expected to play an important role in developing our supply chains.

Delivering more than half of the 2030 production ambition through electrolytic production capacity presents further opportunities to draw on leading UK capabilities. The cumulative turnover required to reach this level of electrolytic hydrogen could be £3-5bn by 2030³. Electrolysers are the single largest cost component of the electrolytic production process, potentially representing at least 40% of the cost. The research has shown that the UK has substantial expertise in electrolysers, and so is well positioned to play a key role in meeting this future demand. This includes being home to a range of developers of electrolyser technologies and a global leader in PEM electrolysers that are already exported globally. This makes the UK an ideal location for investment in the electrolyser supply chain to address the future global market.

There is a range of earlier-stage hydrogen supply technologies that could play a significant role in a future hydrogen system, including novel water-splitting approaches such as thermo-chemical splitting and plasmolysis; novel waste and bioenergy conversion technologies; and chemical cracking of ammonia and heavy fuels. The UK may be well placed to develop a strong supply chain for these technologies, based on our chemical and nuclear engineering expertise.

We are also continuing to work across government, academia and industry on wider environmental issues related to hydrogen production, for example on risks associated with availability of rare earth metals and other critical materials essential to supply chains for hydrogen production. This includes the Critical Minerals Expert Committee, which aims to leverage the UK's extensive research expertise. The committee discusses actions the government can take to secure sustainable sources of these critical materials to help maintain national security and meet net zero ambitions.

³ Includes turnover from manufacturing electrolytic hydrogen production equipment as well as plant construction, includes materials and services.

Transmission, distribution and storage

The future transport and distribution of hydrogen could involve the use of pipelines, road or rail transport of high-pressure gas within the UK, or international shipping of hydrogen carriers. In the UK this might include new dedicated networks for industrial users within clusters, upgrading and repurposing of the existing gas transmission and distribution networks for end use in buildings, and pipeline or non-pipeline distribution of hydrogen to transport and other potential users, dependent on the strategic decision by 2026 on the role for hydrogen for heat.

Constructing new pipelines, or replacing those that already exist, would require a variety of components and materials, surveys, construction and installation, pre-commissioning and commissioning, project management and engineering, and other various supply chain activities. Construction and installation activities are the most significant component of the overall cost, followed by the components and materials needed. Repurposing the existing gas distribution network would further require the replacement of a range of components and installation services, giving an opportunity for UK turnover and jobs in areas such as gas meters and detectors and replacement of pipelines.

Developing the compressors needed for high-pressure transmission of hydrogen also presents a significant opportunity. There is currently a shortage of suppliers for high-capacity compressors for hydrogen and this is a potential market that could be met by UK suppliers in future, drawing upon existing UK capabilities in smaller-scale compressors and wider strengths in high-value engineering.

Various forms of storage could also be needed for hydrogen including the potential use of salt caverns, depleted gas reservoirs, saline aquifers below-ground for long-term storage, or above-ground storage in high-pressure tanks. The research highlighted hydrogen compressor packages to be a major proportion of the value of storage projects, as are civil/structural materials, and construction and installation activities. The UK's geology is also well suited to addressing storage needs, with suitable geology for salt caverns in areas such as the Wessex Basin, Cheshire Basin and East Yorkshire and some caverns already used to store natural gas or liquefied petroleum gas. This presents various opportunities for the supply chain to support cavern construction and provide topside facilities. There could be opportunities for UK companies to develop specialist skills and capabilities in the design and engineering of storage infrastructure.

End use

The scope of the research included hydrogen production, transmission, distribution and storage and the manufacture of fuel cells. Therefore, the following analysis of the opportunities for supply chain growth in end use sectors is based on in-house knowledge and expertise.

i) Industry

Industry is expected to form a lead option for early hydrogen use, with demand from hydrogen fuel switching picking up from the middle of the decade and hydrogen playing a key role in industrial decarbonisation by the mid-2030s under Carbon Budget 6. Low-regret opportunities for conversion to hydrogen include steam boilers and combined heat and power processes for

chemicals, refineries and paper. In the longer term, hydrogen is also a promising option for high temperature direct firing.

Currently, the supply chain to enable fuel switching to hydrogen is at an early stage of development. New capabilities will be needed – for instance original equipment manufacturers (OEMs) who currently supply gas-fired industrial equipment will have to gain new capabilities in the manufacturing of hydrogen equipment. This challenge also presents an opportunity. It is likely to require the supply chain to reskill staff and has the potential to create new green jobs, driving economic growth across the UK. Furthermore, as the hydrogen sector develops globally, the market for hydrogen equipment and expertise developed domestically will become exportable.

ii) Power

Hydrogen-to-power is expected to be an important component of our future power system to provide flexible low carbon generation capacity as we integrate more renewables.

The use of hydrogen in power generation requires development of new capabilities and provides supply chain opportunities. This includes for example, the development of 100% hydrogen firing generation equipment, such as turbines, reciprocating engines, fuel cells, and boilers. Several OEMs currently have development programmes on-going in these areas.

iii) Heat in buildings

The UK domestic boiler market is one of the biggest in the world with nearly 1.76 million gas boiler sales in the UK between April 2020 and 2021.⁴ Gas boiler sales are likely to remain at a similar level in the immediate future, given they account for approximately 90% of the heating appliances in homes.

In the area of heating controls, there are several players with strong UK manufacturing and consumer bases. By drawing on the technical innovations of manufacturers and the skills of our workforce, this sector can drive inward investment to boost productivity while keeping household bills and carbon emissions as low as possible.

Low carbon hydrogen could be a key option for decarbonising heat in buildings. However, unlike other technologies such as heat pumps and heat networks, 100% hydrogen for heating is not yet an established option.

Government is working with industry and regulators to deliver a range of research, development and testing projects to assess the feasibility, costs and benefits of using 100% hydrogen for heating to enable government to make strategic decisions in 2026 on its role in heat decarbonisation.

This work includes a pioneering programme of hydrogen heating trials, which were announced in the Prime Minister's *Ten Point Plan for a Green Industrial Revolution*. The Ten Point Plan set out the aim to support industry to deliver a Hydrogen Neighbourhood trial by 2023, a Hydrogen Village scale trial by 2025 and plans for a potential Hydrogen Town Pilot before the end of the decade.

⁴ <https://www.hhic.org.uk/news/boilers-bounce-back-as-consumers-invest-in-home-renovation>

These projects have presented opportunities for UK boiler suppliers to explore the manufacturing of hydrogen-ready boilers for buildings, which would have the capacity to run on natural gas until hydrogen infrastructure is in place. Prototype 100% hydrogen boilers, cookers, meters and components have been developed under the £25m BEIS Hy4Heat programme. This programme sought to investigate if it is technically possible and safe to replace methane with hydrogen in appliances for residential and commercial buildings and evaluate the likely costs and performance.

iv) Transport

Low carbon hydrogen used in fuel cell electric vehicles could play an important role in decarbonising transport, particularly for heavy-duty applications such as HGVs and buses. Additionally, fuel cells or hydrogen derived fuels such as ammonia have applications in hard to decarbonise transport sectors such as aviation and shipping. The manufacturing of fuel cells requires a variety of components from the supply chain – including significant value associated with catalysts – and a wider range of equipment is required for their integration into vehicles. The UK has strong potential to compete in the upfront design, development, and IP-intensive stages of hydrogen transport solutions, making these areas where the UK could build upon its strengths and capabilities to successfully compete in emerging markets.

v) Cross-cutting opportunities

The UK also has wider cross-cutting capabilities and expertise that will be needed in a future hydrogen economy.

The UK already hosts one of the few globally recognised institutions for the qualification of materials used with hydrogen. The research suggests that these capabilities will become increasingly important to support the development of safe products and components for hydrogen and thus present a significant opportunity for expansion in future.

Established UK strengths and expertise in areas such as safety, planning, legal, professional and financial services will also be relevant to the developing hydrogen economy. Finally, there is a need for civil and structural materials across all areas of the supply chain, which could support jobs and generate turnover in the UK.

We will continue to map and assess supply chain capabilities against the emerging needs and opportunities of the hydrogen economy.

2.2 Support for UK supply chains

Raising awareness of the UK project pipeline

In the Hydrogen Strategy we committed to work with industry to raise awareness of the low carbon hydrogen project pipeline across the supply chain, learning from the success of initiatives in other low carbon sectors. Providing visibility of opportunities to supply chains through transparent procurement processes and early supply chain engagement will be key to ensuring that competitive UK companies are aware of opportunities and in a fair position to bid into projects.

Government worked with industry to produce a map of hydrogen production projects in development across the UK for the [Hydrogen Investor Roadmap](#). Work being delivered as part of the [North Sea Transition Deal](#) is further aiming to develop an understanding of near-term pipeline opportunities in hydrogen, CCUS and offshore sectors during the next 3-5 years to enable supply chain companies to pivot to these areas. Part of this has been the evolution of the North Sea Transition Authority's "Energy Pathfinder" tool to include energy transition projects. The tool provides early information about project location, type, and timings, giving visibility of carbon transportation and storage opportunities to potential suppliers.

Developing and improving UK supply chain capabilities

We anticipate that UK companies can become global leaders in the development and manufacture of technologies and infrastructure across the hydrogen value chain. However, given the hydrogen economy is in its early stages, supplier companies may be reticent to commit and invest, preferring to focus on more established markets. Therefore, there is a clear need to prepare supply chain companies for the anticipated ramp-up of demand as the business opportunities grow.

As well as a focus on transparent supplier selection processes for projects supported by the Net Zero Hydrogen Fund (NZHF) and hydrogen business model (HBM), a new approach to supply chain engagement is being developed through a partnership between industry and government. A programme of "Meet the Specifier" events aims to provide the supply chain with much earlier visibility of the technical specifications for hydrogen projects.

Accelerating supply chain development through early engagement

Industry and government are partnering to provide early supply chain engagement through a programme of “Meet the Specifier” events. These events will provide sight of the technical specifications of projects during the Front-End Engineering Design (FEED) stage, as much as 18 months before the actual procurement stage is launched. This programme will cover a range of projects across hydrogen and carbon capture, transport and storage. The first event in this programme was organised by DIT, the North Sea Transition Authority and ENI and it showcased the CO₂ transport and storage opportunities in the HyNet cluster providing details of the planned work packages in the project to supply chain companies.

This new approach to supply chain engagement is expected to see hundreds of companies, including local companies and those based in the UK, benefit from an understanding of opportunities much earlier in the development process, allowing them time to invest and adapt their offering to new requirements while enabling developers to de-risk their projects through access to a larger supplier base.

Developed through collaboration between industry, government, trade associations and local authorities, this provides a new model for engagement that can support the delivery of first-of-a-kind projects and the development of world-class clean energy supply chains in the UK.

Government will work with trade associations and industry to deliver supply chain development events, including future “Meet the Specifier” events.

Realising the economic benefits of hydrogen will require the right supply chain capabilities in the UK, including in other sectors that could pivot to hydrogen. The supply chain research found that a strong base of companies currently supplying equipment, materials and services for the oil & gas, petrochemical and power industries could apply their expertise to the hydrogen sector. Figure 2.2 presents potential market opportunities identified by the research, but also presents areas – for example in hydrogen and CO₂ compressors – where the UK may need to develop greater capability to enable deployment and realise benefits in the UK. Further information, including a SWOT analysis of the UK hydrogen supply chain, can be found in the supply chain research published alongside this Action Plan.

Supply Chain Segment	Category	Market Opportunity	UK Supply Chain Gap
Blue hydrogen manufacturing capacity	Civil and structural materials (including buildings)	✓	
	Construction and installation labour	✓	
	Reformer package manufacture	✓	✓
	CO ₂ compressors		✓
	Engineering services	✓	

Green hydrogen manufacturing capacity	Electrolysis package manufacture	✓	✓
	Electrical equipment and materials manufacture	✓	
	Cooling water package manufacture	✓	
Hydrogen manufacture	Green hydrogen manufacture	✓	
Hydrogen transport-gas grid repurposing	Hydrogen compressor package		✓
Hydrogen storage (cavern)	High pressure hydrogen compressor package	✓	✓
	Civil/structural materials (including buildings)	✓	
	Construction and installation (labour only)	✓	
Fuel cell manufacture	Membrane electrode assembly (MEA) manufacture	✓	
Several segments	High integrity valves		✓

Figure 2.2 – supply chain development opportunities taken from research commissioned by BEIS

It is important that government continues to build on this initial assessment to deepen and broaden understanding of the requirements to address these gaps and realise market potential. We will continue to expand data collection methodology to effectively monitor emerging capability gaps and identify where actions might be needed to address these.

Information regarding the UK supply chain in the early stages of the economy is being gathered throughout the application process for the NZHF and HBM. Having this information will allow us to support the involvement of the UK supply chain in hydrogen projects. More detail on the monitoring and evaluation of economic benefits can be found in Chapter 5.

Furthermore, government will draw upon wider work by trade associations and other organisations to continue to engage with supplier companies through pre-existing clean energy supply chain initiatives such as the Nuclear Advanced Manufacturing Research Centre's (NAMRC's) *Fit for Hydrogen* programme.

Fit for Hydrogen: Preparing UK companies to engage in the hydrogen supply chain

Building upon successful initiatives for nuclear and offshore renewables, the Nuclear AMRC, supported by the AMRC as part of the High Value Manufacturing Catapult, are developing Fit for Hydrogen and Fit for CCUS programme to help UK companies to access new supply chain opportunities.

Linked to Zero Carbon Humber, these programmes will focus on addressing UK supply chain capability shortfalls through driving business excellence and helping companies to develop the capabilities needed to become part of supply chains for hydrogen and CCUS.

Companies will be identified and selected to enter and progress through programmes informed by the Nuclear AMRC Supply Chain Readiness Level assessment tool and expressions of interest. Once selected, the journey to business excellence is facilitated by a team of regional industrial advisors. A mixture of company self-assessment and on-site engagement are used to assess companies against the business excellence elements of Fit 4 programmes, coupled with sector-specific assessment and development activities. A development plan is then created for companies to work through to be granted Fit 4 status, signifying to supply chain buyers and decision makers that companies are ready to enter or grow within hydrogen and CCUS markets.

These programmes could play a key role in helping companies to develop the business excellence and capabilities needed to engage in supply chains for hydrogen and CCUS, with the Fit for Nuclear programme having helped companies to win over £1.5 billion worth of new contracts in nuclear and other sectors.

We will continue to work with industry and others to develop such initiatives and explore what further actions could be taken to help UK companies to prepare for opportunities in hydrogen.

2.3 Supply chain participation in hydrogen projects

As indicated in this Plan, UK supply chains already have many of the capabilities needed to thrive in the hydrogen economy and government is investing millions to bring forward production projects through the Net Zero Hydrogen Fund and the hydrogen business model. But there is more to be done to ensure UK companies are among those most likely to succeed as projects begin to develop across the country.

Other sectors have addressed this issue through industry-led voluntary supply chain targets, for example in the North Sea Transition and Offshore Wind Sector Deals. The potential

participation of UK supply chains in hydrogen projects throughout the value chain is a complex issue. Hydrogen is not a 'sector' in the same way as other low carbon technologies like nuclear, solar or wind and the scale of opportunity for UK companies to provide products and services to projects and their capability to do so are likely to vary significantly depending on whether the project is in production, transmission, storage or any of the various potential end uses for hydrogen.

We want UK supply chains to have both the capabilities and opportunities to participate in UK hydrogen projects and we want developers of those projects to actively consider using competitive UK supply chains.

Therefore, government will ask industry to lead a process to determine appropriate levels of ambition for UK supply chain participation in hydrogen projects. We would expect this process to involve representation across relevant parts of industry, balancing producers, supply chains and government. By the end of 2022 we will provide an update on how this process will be conducted.

Chapter 3 – Jobs and Skills

Key actions to support jobs and skills

- ✓ *Drive forward action on hydrogen jobs and skills through the Green Jobs Delivery Group*
- ✓ *Launch the Hydrogen Early Career Professionals Forum by Autumn 2022*
- ✓ *Government will work with the Engineering Construction Training Board to develop understanding of capability and capacity across the skills needed for the hydrogen economy*
- ✓ *Continue to work with the devolved administrations to support the implementation of Skills Action Plans*

The UK Hydrogen Strategy outlined how kick-starting a hydrogen economy presents an opportunity to transform the UK's industrial heartlands and create secure, good quality green jobs across the UK.

Given the crosscutting nature of hydrogen, spanning as it does different sectors, professions, and supply chains, the economic opportunity from the hydrogen economy is vast. Government analysis suggests the UK hydrogen sector could be worth £900 million and support 12,000 jobs by 2030 across hydrogen production, transport and storage technologies for domestic and export markets.⁵ By 2050, in a high hydrogen scenario, the hydrogen economy could be worth up to £13bn and support up to 100,000 jobs.⁶

This chapter sets out what we have learned about jobs and skills for the hydrogen economy since publication of the Strategy, and actions government and industry can take to help ensure we have the right skills in the right place at the right time to secure the workforce needed to deliver our hydrogen ambitions and ensure a just transition for those currently working in high carbon sectors.

Many of the skills needed for a thriving hydrogen economy are shared by other low-carbon or 'green' technologies. The chapter therefore makes clear how skills for hydrogen can be progressed by the range of existing initiatives and policies designed to support the green economy in the UK, such as the *Net Zero Strategy* and *Skills for Jobs* white paper.

⁵ Internal BEIS analysis based on Energy Innovation Needs Assessment (EINA) methodology with updated scenarios for domestic and global hydrogen demand; figures consider the direct GVA and jobs linked to hydrogen production, transport and storage, and include jobs associated with both domestic and global hydrogen demand.

⁶ Internal BEIS analysis based on EINA methodology with updated domestic and global scenarios.

3.1 Understanding the skills landscape for the hydrogen economy

Transitioning skills – an opportunity for hydrogen

The Government's Green Jobs Taskforce report noted that demand for workers in growth sectors such as hydrogen and CCUS may make recruiting and training new talent challenging, meaning that support for the current energy workforce to transition into emerging green growth industries is a priority for government and industry.⁷

Many of the skills needed for the hydrogen economy already exist in the UK. Skills such as engineering, procurement, construction and maintenance, project structuring, design and manufacturing, health and safety, commercial finance and legal services⁸ are part of the rich portfolio of jobs across high-carbon sectors such as oil and gas, chemicals and wider engineering sectors. As these sectors make the crucial transition to net zero, a substantial source of skills for the hydrogen economy will become available.⁹ Work as part of the [North Sea Transition Deal's Integrated People & Skills Strategy](#), developed on behalf of the UK oil & gas sector by energy skills organisation OPITO – the global not for profit skills and standards body for the energy industry – will be key to further understand the future technical skills needs and safety standards as the hydrogen economy grows.¹⁰

Similarly, the UK has over 120,000 certified gas engineers with skills that could be applied to servicing hydrogen equipment and boilers, helping to ensure the UK retains this crucial capability and expertise.¹¹ Government is already working [with Energy & Utility Skills and the Institution of Gas Engineers & Managers \(IGEM\)](#) to develop the domestic and non-domestic hydrogen gas installation standards, competence frameworks and training specifications that would be required for any repurposing of existing natural gas systems for use with 100% hydrogen. This work is due to be completed by September 2023.¹²

As reaffirmed in the [North Sea Transition Deal \(NSTD\), One Year On](#) report, government continues to champion the role of the oil & gas sector and its workforce in the wider energy transition¹³. Relevant programmes developed in this area include the All-Energy Apprenticeship (AEA) being led by OPITO, as supported by the Energy Skills Alliance (ESA), a cross-energy industry and government group.¹⁴ This includes the creation of add-on modules for core apprenticeships, including an 'Introduction to Hydrogen' module.

The NSTD's *Integrated People & Skills Strategy* includes a commitment to provide workers in the UK oil & gas industry with access to a Digital Skills Passport by late 2023, underpinned by

⁷ Green Jobs Taskforce (2021), 'Green Jobs Taskforce report.'

⁸ Green Jobs Taskforce (2021), 'Green Jobs Taskforce report.'

⁹ Anecdotal evidence from the Hydrogen Sector Development Working Group.

¹⁰ OPITO (2022), North Sea Transition Deal: Integrated People & Skills Strategy.

¹¹ Gas Safe Register (2019), '[Ten years of keeping people gas safe.](#)'

¹² Energy & Utility Skills (2022), 'BEIS appoints Energy & Utility Skills and the Institution of Gas Engineers & Managers.'

¹³ Department for Business, Energy & Industrial Strategy (2022), '[North Sea Transition Deal: One Year On.](#)'

¹⁴ OPITO (2021), '[All Energy Apprenticeships.](#)'

the alignment and recognition of training and standards across the offshore energy industry.¹⁵ Through aggregation of specific skills and qualifications, this will make it easier for individuals to build cross-industry careers and transfer to energy industries such as hydrogen.

Government will continue to work with industry and education providers to explore what high-intensity up-skilling and re-training opportunities could be provided to support this transition, and ensure the workforce is equipped with the transferable skills to thrive in the net zero era.

Building the evidence on jobs and skills

While the transition of skills from high- to low-carbon industries like hydrogen presents an opportunity, early intelligence about job opportunities will be crucial for developing a long-term skills plan for the nascent hydrogen economy, and for understanding the significance for other emerging decarbonisation sectors, such as CCUS.

Information provided during Phase-2 of the Cluster Sequencing process for CCUS – including jobs, salaries, specific training requirements and investment in skills for hydrogen – is the first formal project-specific information government has received.¹⁶ It will be a useful indicator of the future skills, training and investment landscape necessary for CCUS-enabled hydrogen production, and will give an early indication of the projected number and type of jobs associated with projects of a particular size.

This information, collected as part of the application process to assess hydrogen production projects, will help inform our understanding of the jobs and skills requirements as government works with industry to develop an evidence base and robust labour market intelligence. Government has asked applicants for the 2022 hydrogen business model (HBM) and Net Zero Hydrogen Fund (NZHF): Electrolytic Allocation Round to provide evidence that demonstrates projects are investing in training to develop skills in hydrogen, for example, apprenticeships and retraining programmes.¹⁷ As part of this, government will evaluate the wage uplift generated via plans for future up-skilling using standard Green Book appraisal methods.

The data will also be essential for informing our commitments to monitoring and evaluation as we seek to realise the economic benefits of the hydrogen economy. More detail on this is in Chapter 5.

¹⁵ OPITO (2022), North Sea Transition Deal: Integrated People & Skills Strategy.

¹⁶ Department for Business, Energy & Industrial Strategy (2021) [Cluster sequencing for carbon capture, usage and storage \(CCUS\) deployment: Phase 2.](#)

¹⁷ Department for Business, Energy & Industrial Strategy (2022) <https://www.gov.uk/government/publications/hydrogen-business-model-and-net-zero-hydrogen-fund-electrolytic-allocation-round-2022>.

3.2 Support for UK jobs and skills

Working through others

Action to support jobs and skills for the UK hydrogen economy will be most effective when considered in and informed by the wider context of the net zero energy system. We recognise that the hydrogen economy shares opportunities and challenges facing many of the emerging clean growth sectors, and will need a harmonised approach to ensure the economy has the right skills in the right place at the right time.

i) Green Jobs Delivery Group

As the central forum through which government, industry and other stakeholders will accelerate action on green jobs and skills, the Green Jobs Delivery Group – co-chaired by Ministers and industry – will drive forward thinking on cross-cutting employment issues in sectors and places most crucial to the green economy. **We will work closely with the Group’s hydrogen industry representative to ensure the skills needs of the emerging hydrogen economy are addressed now and into the future.**¹⁸

Government will also continue to work with industry through forums such as the Green Jobs Delivery Group and the Hydrogen Advisory Council to drive forward action to understand the specific technical skills that may be needed to build the hydrogen economy and support our ambition for 12,000 jobs by 2030.

ii) Engineering Construction Industry Training Board (ECITB)

The work of the ECITB is pivotal in driving forward collaboration with employers, training providers and government to ensure the engineering construction workforce has the technical skills to deliver on our commitments to decarbonise existing industry and build new hydrogen facilities, in addition to building workforce capacity in other low carbon technologies.

¹⁸ H M Government (2022) [‘Green jobs delivery steps up a gear.’](#)

Case Study: ECITB - Supporting industry in its transition to net zero

As part of their 2023-25 strategy to support industry in its transition to net zero, ECITB are leading work to tackle skills gaps by developing, promoting, and funding training solutions for companies operating in the hydrogen sector (with a particular focus on the Industrial Clusters). The strategy will also lead work to enhance an understanding of the labour demand for hydrogen projects as they relate to engineering construction, through demand modelling and intelligence gathering activities.

This builds upon previous work to map the synergies and differences between the skill sets that will be required for engineers working on net zero projects - including hydrogen - in comparison to 'conventional' engineering projects. ECITB's 2020 report, [Towards Net Zero](#), found that skill sets will be broadly the same across many engineering occupations, particularly those involved in construction. For hydrogen, some upskilling may be required in areas such as equipment design for safety cases and hydrogen storage using salt caverns, as well as training towards new technical / safety standards for equipment repurposing (piping and pipelines).

ECITB is funded by an industrial training levy, which supports employers to train and upskill their workforce to industry standards.

Government will work with the ECITB to develop our understanding of the capability and capacity across specific skills needed to support the hydrogen economy, and how they interrelate with the wider net zero energy system.

Building the hydrogen workforce of the future

The nascence of the hydrogen economy means that a significant proportion of the future workforce is likely to come from talented young people currently in the education system, in addition to adults who may be looking at options for changing careers. To support these important career decisions, we need to ensure that the scale and nature of the hydrogen opportunity is represented in initiatives that support future talent pipelines.

The Sustainability and Climate Change Strategy committed government to harnessing young people's passion and interest in climate change and sustainability to enable them to develop the knowledge and skills – in both STEM and other key subjects – required to take advantage of this transition.¹⁹ It also committed to support adults already in work to retrain and re-skill in line with the needs of the green economy.

By 2023, the Government will co-host an International Green Skills Conference with the higher and further education sectors to exhibit the best of UK green skills and education opportunities at these levels, including hydrogen.

¹⁹ Department for Education (2022), '[Sustainability & Climate Change Strategy](#).'

Many current training and learning opportunities need to be recalibrated to green growth sectors to inspire the next generation to support our green recovery. The [Net Zero Strategy](#), published in November 2021, sets out in detail how the Government plans to reform the skills system to ensure training providers, employers and learners are supported and equipped to play their part in delivering the transition to net zero and can seize the opportunity of emerging sectors such as hydrogen.²⁰ This includes:

- Aligning apprenticeships and technical education to net-zero objectives through the Institute for Apprenticeships & Technical Education's (IfATE) Green Advisory Panel
- Continuing to roll-out T-Levels, based on the same standards as apprenticeships, supporting young people into green careers
- Driving STEM provision through our growing network of Institute of Technologies
- Expanding Skills Bootcamps so that adults can access training that will give them the skills that are needed in key green sectors.

This builds on commitments in the [Skills for Jobs White Paper](#), through which existing programmes – including Apprenticeships, Skills Bootcamps, Traineeships, and T-Levels – will continue to help us grow and inspire the next generation of net zero workers.²¹ The government has legislated through the Skills and Post-16 Education Act to ensure employer leadership of Local Skills Improvement Plans (LSIPs) accounts for the skills needed to help deliver net zero, adaptation to climate change, and other environmental goals.

It is also important that support for employers is available to ensure hydrogen is understood as an opportunity-rich and fulfilling area of the green economy. **Government will shortly initiate the Hydrogen Early Careers Professional Forum (ECP Forum) by Autumn 2022 to tackle such issues and drive forward work to create a more agile and diverse hydrogen workforce, helping to empower and inspire future generations across the country.**

²⁰ Department for Business, Energy & Industrial Strategy (2021), '[Net Zero Strategy: Build Back Greener.](#)'

²¹ Department for Education (2021), '[Skills for Jobs: lifelong learning for opportunity and growth.](#)'

Equality, Diversity and Inclusion

One example of an important issue we foresee the ECP Forum progressing is equality, diversity, and inclusion (EDI) where there is an opportunity to place EDI at the heart of the new workforce and take action to encourage participation across protected characteristic groups.

The Government recognises the importance of findings from organisations such as the International Energy Agency (IEA), which cites the energy transition as a key opportunity to mainstream policies and measures to address gender equality in energy and related sectors.²² This is also in line with recommendations from The Green Jobs Taskforce, which suggest industry should prioritise ensuring that people from all backgrounds can work in green jobs, building on existing good practise to drive the expansion of the talent pool and champion access to opportunity across the green economy.²³

Government has already taken action to ensure EDI is considered from the outset as the UK hydrogen economy is developed. Our aim is to incentivise project developers to demonstrate how they intend to grow relevant skills and support good quality jobs and equality of opportunity. **As part of the application for Strands 1 and 2 of the Net Zero Hydrogen Fund, applicants are required to complete an EDI survey to inform data collected on applicants' success rates.**²⁴ Applicants for Phase-2 of the Cluster Sequencing for CCUS deployment process were also required to submit EDI data.

UK-wide jobs and skills for the hydrogen economy

Developing the hydrogen economy in ways that provide well-paid jobs and bring on a healthy skills pipeline – as well as realising a wide range of local economic benefits – is a whole-UK story. A good example of action underway in the regions of the UK is the National Energy Skills Accelerator in Scotland.

²² [Energy and gender: a critical issue in energy sector employment and energy access.](#)

²³ Green Jobs Taskforce (2021), 'Green Jobs Taskforce report.'

²⁴ <https://www.surveymonkey.co.uk/r/ifsaccount>

Case Study: National Energy Skills Accelerator

The National Energy Skills Accelerator (NESA) is a collaborative initiative between Robert Gordon University, the University of Aberdeen and North East Scotland College and is supported by Skills Development Scotland and Energy Transition Zone Ltd. NESA is a not-for-profit organisation and was established in June 2021, with funding from ETZ Ltd.

NESA provides a 'one-stop shop' for the industry to access a wide range of training, skills development programmes and R&D capabilities aimed at preparing the workforce for the global energy transition. This includes specific programmes in offshore wind, hydrogen, carbon capture and storage as well courses aimed at decarbonising oil and gas activities.

NESA is aligned to the UK and devolved governments goals and is already actively engaged with a wide range of companies, consortia and industry stakeholders to provide access to the critical training and skills required to support the delivery of the UK's net zero ambitions.

We will continue to work with the devolved administrations to support the implementation of Skills Action Plans to maximise the benefits from new job and skills opportunities that will arise from the hydrogen economy right across the UK.

Chapter 4 - Exports

Key actions to support exports of the UK hydrogen economy

- ✓ *Position the UK as a future exporter of low carbon hydrogen*
- ✓ *Promote export opportunities to UK businesses in priority markets*
- ✓ *Ensure UK position on hydrogen is actively considered in trade negotiations*
- ✓ *Signpost supply chains and overseas buyers to finance support offered by UK Export Finance*

In a world transitioning to renewable energy, many countries have now signalled the importance of low carbon hydrogen in reducing emissions. The UK can play a leading role in the developing global market for trade in hydrogen. Moving quickly to develop a strong UK hydrogen economy by 2030 will enable UK companies to trade in international markets, leveraging UK expertise in skills, R&D, oil & gas, energy infrastructure, regulatory frameworks and creating world-leading supply chain networks.

This chapter sets out the export opportunities for UK businesses and what government is doing to support them at home and abroad to realise the potential benefits.

4.1 The export opportunity for UK businesses

The developing international market presents a huge opportunity for UK production, particularly to continental Europe where hydrogen ambition is increasing, alongside established energy trading with the UK. The current geopolitical situation is further raising the demand for alternative energy sources to traditional fossil fuels. According to current estimates, hydrogen sales could reach \$600bn by 2050 with the wider value chain becoming a \$11.7 trillion investment opportunity.²⁵ Together with our world-leading government funding schemes aimed at supporting domestic production, the increased UK ambition of up to 10GW of domestic hydrogen production by 2030 will also open up opportunities for companies to export UK hydrogen to a growing global marketplace in the 2020s, while domestic demand increases.

The Government considers the UK has strong potential as a future exporter of hydrogen while maintaining secure supplies for domestic use. We are therefore actively monitoring and engaging with international developments and considering emerging evidence to ensure our approach realises the greatest opportunities for the UK, in terms of both carbon reduction and economic growth.

²⁵ Financial Times (2021) and Goldman Sachs (2020) in Irena (2022) Geopolitics of the Energy Transformation: The Hydrogen Factor

Through collaborative working with a range of interested parties within and outside government – including UK exporters, trade organisations, DIT, UKEF and FCDO Overseas Networks – we will gather international market intelligence to provide an assessment of current and future priority markets as well as the opportunities and risks for UK business across the global hydrogen value chain. **Government will collate this intelligence in a Global Market Intelligence Tracker (GMIT), ensuring policy teams are cognisant of opportunities and risks, while developing relationships with future trading partners.**

4.2 Promoting UK hydrogen in international trade

Recognising there is currently no single internationally recognised definition for ‘green’ or ‘low carbon’ hydrogen, government aims to develop a Hydrogen Certification scheme, with a view to it becoming mutually recognised internationally with other schemes. This will help support the UK’s international trade of hydrogen, ensure hydrogen imported to the UK meets the same high standards as domestic production, and potentially support the move away from oil and natural gas across international markets.

Government will work to support UK hydrogen sector exports in new and renegotiated trade agreements, such as the WTO Net Zero regulations and the revised Energy Charter Treaty, by ensuring that UK Government negotiators are briefed on the needs of UK exporters as well as those of the expanding domestic hydrogen economy.

4.3 Engaging at home and abroad to support exports

Government will enhance its engagement on hydrogen exports on two fronts. Firstly, with industry to ensure the developing policy and regulatory framework supports UK exporters of hydrogen products and services. To this end we will develop a programme of engagement with trade associations and potential exporters to build a comprehensive picture of opportunities, barriers and risks to UK trade in global hydrogen.

Secondly, with international-facing parts of government like DIT, UKEF and FCDO to increase the global standing of UK hydrogen, actively developing and promoting international commercial and research partnerships, such as memorandums of understanding (MoUs) and research collaborations. We will prioritise these areas of cooperation in accordance with industry signals. For example, the Energy Industries Council (EIC) on behalf of the UK Energy Supply Chain Taskforce, produced analysis for the top export markets considered by UK supply chain companies for both blue and green hydrogen projects, which includes, among others, the Netherlands, the USA and Germany.

Government will also support UK industry to join pan-international supply chains by raising the UK’s overseas hydrogen profile and proactively engaging inward investors to make use of British expertise and products, championing UK exports of hydrogen-related goods and services while supporting the growth of our domestic hydrogen economy. We will work to signpost supply chains and overseas buyers to finance support offered by UKEF. These

endeavours will be supported by actions set out in this Plan, including on project pipeline visibility and supply chain events like 'Meet the Specifier' and UKEF supplier fairs which connect UK businesses with overseas buyers and international project opportunities.

To this end, government will conduct an international benchmarking exercise to understand UK comparative advantages relative to overseas competitors, and the competitiveness of UK Government levers for hydrogen, and from this develop a set of recommendations to further enhance UK hydrogen sector competitiveness.

UK Export Finance is the UK's export credit agency and a government department, working alongside the Department for International Trade in delivering government's export strategy. UKEF's mission is to ensure that no viable UK export fails for lack of finance or insurance, while operating at no net cost to the taxpayer.

UKEF helps UK companies to:

- ***Win*** export contracts by providing attractive financing terms to their buyers
- ***Fulfil*** export contracts by supporting working capital loans
- ***Get paid*** for exports by insuring against buyer default

*As an example, UKEF recently enhanced its Export Development Guarantee (EDG) to better support emerging clean growth sectors such as hydrogen, offering improved repayment terms for clean growth exporters **to support the development of hydrogen production for export and supply chains to build export capability**. Eligibility for the EDG has also been expanded to companies that do not currently export from the UK, including overseas companies seeking finance to internationalise or establish themselves here and export. By backing foreign companies to come to the UK, UKEF can support the development of the supply chain in areas of the hydrogen sector where the UK doesn't currently have a strong presence.*

Chapter 5 – Monitoring and evaluation

Monitoring and evaluating progress on the development of the UK hydrogen sector

- ✓ *Identify clear objectives and metrics to monitor sector development*
- ✓ *Assess and track the impacts of government funding and policies*
- ✓ *Work with Office for National Statistics on data collection for the hydrogen economy*

This plan includes actions that government, industry and others are taking or will take to support the development of the hydrogen economy in the UK. We want these actions to increase the chances of UK businesses realising the economic benefits from this development and we are therefore committed to monitoring and evaluating (M&E) progress.

To do that effectively it will be important for government to use a robust M&E framework to ensure we have good data and to help inform future decisions on potential interventions to ensure, for example, a fair playing field for UK businesses or to remove any barriers to investment in UK supply chains.

This chapter sets out an illustrative approach to M&E, including a framework for measuring success against sector development objectives, example metrics for monitoring progress, how we could track the impacts of government funding and policies, and how we will work with others to understand the wider development of the hydrogen sector.

5.1 Identifying clear objectives and metrics to monitor sector development

Theory of Change

Government proposes to use the Theory of Change model as the framework to monitor progress against our objectives for sector development. Figure 5.1 below shows an example of how the Theory of Change can be used to demonstrate how the actions in this plan can help achieve our objectives

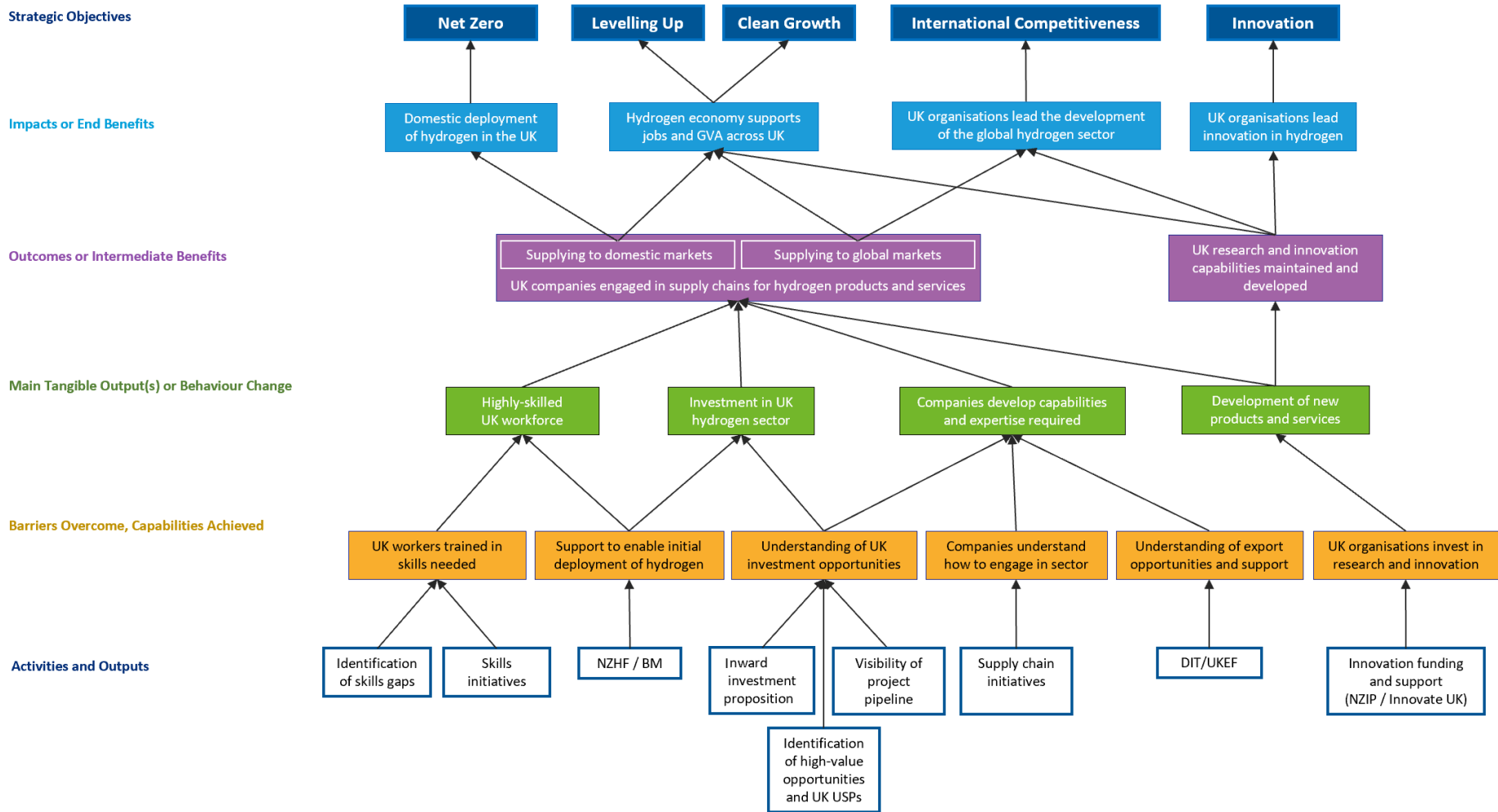


Figure 5.1 – Theory of Change for hydrogen sector development

Metrics and data collection

i) Metrics

To measure progress against our objectives, government is also considering a range potential metrics to track the extent to which UK businesses are benefitting as the hydrogen sector matures, the degree to which hydrogen is attracting inward investment, supporting jobs, skills development and equality of opportunity in the UK, and the role of UK organisations within global markets.

We will seek to monitor factors such as the number of companies working in hydrogen and their turnover, the number and type of jobs and skills linked to hydrogen, levels of investment in the UK hydrogen economy and the degree to which UK businesses are exporting to overseas markets.

Table 5.2 outlines the type of metrics we will use to track progress:

Theme	Example Metrics (UK-wide regionally)
Overall benefits	<ul style="list-style-type: none">• Deployment of hydrogen (e.g. GW of production capacity) Gross Value Added (GVA) and jobs linked to hydrogen
Supply chains	<ul style="list-style-type: none">• Number and turnover of companies active in sector• Number and turnover of companies engaged by initiatives
Jobs & skills	<ul style="list-style-type: none">• Number and location of different types of jobs in sector• Number of people trained/retrained in sector• Funding provided for skills development
Exports & investment	<ul style="list-style-type: none">• Exports value• % companies exporting• Inward investment figures• Investment in UK companies
Research & innovation	<ul style="list-style-type: none">• Funding for research & innovation• Patents

Table 5.2 – Possible metrics to support our monitoring and evaluation of sector development

Given the nascent nature of the hydrogen economy, it will be important for government to work with other organisations to better understand how we can monitor economy-wide impacts of hydrogen across the value chain.

ii) Data collection

As the hydrogen economy develops and grows in scale data will become more readily available, allowing more sophisticated and robust M&E. **In the meantime, government will engage with the Office for National Statistics (ONS) on their collection of data through the Low Carbon & Renewable Energy Economy Survey (LCREE) and wider surveys to understand levels of business and employment activity linked to hydrogen in the UK.** We will also work with industry bodies, trade associations and market intelligence organisations to understand what wider data could be collected to support sector monitoring.

5.2 Assessing the impacts of government funding and policies

A key component of government's policies to support the deployment of early hydrogen projects is maximising the chances of those projects leading to wider economic benefits, whether employment, skills development, export business or wider regional economic benefits.

Government is already working to assess and monitor the economic benefits linked to hydrogen production projects that receive funding through the Net Zero Hydrogen Fund and hydrogen business model through the Industrial Decarbonisation and Hydrogen Revenue Support scheme, which also supports projects as part of Phase-2 of the CCUS Cluster Sequencing process.

As part of funding applications, projects must demonstrate the potential economic benefits of their projects. Applicants for funding for a hydrogen business model through Phase-2 of the CCUS Cluster Sequencing process were required to submit the expected economic benefits of their project, such as the number and type of jobs supported and associated skills development. We are further looking to include economic benefits criteria for applications to the Net Zero Hydrogen Fund.

Phase 2 Cluster Sequencing for CCUS: supply chain deliverability and economic benefits

As part of the application process for revenue support for hydrogen production through the Hydrogen Business Model as part of the Phase 2 process, projects are required to demonstrate consideration of supply chain issues and procurement processes.

Applicants must provide evidence of access to the resources and capabilities needed to deliver their hydrogen production projects, including evidence of any contracts or engagement with prospective suppliers and any assessments of the ability of supply chains to deliver.

Alongside deliverability, projects must also provide evidence of the expected economic benefits of their projects – including the jobs impacts, transparency of procurement, investment in skills and wider benefits. A key aspect of this is the transparency of supply chain procurement processes, with projects needing to demonstrate how they will make procurement strategies transparent. This includes, for example, by identifying supply chain opportunities, advertising them as early as possible, and beginning meaningful engagement with hydrogen supply chain companies.

This approach to monitoring and evaluating the range of benefits from the UK hydrogen economy will develop and become more sophisticated as that economy evolves and will be used to inform future policy.

Similarly, this Sector Development Action Plan is not exhaustive, and government will not stand still. We will continue to work with industry, investors, and other stakeholders not only to develop, deliver and monitor these actions, but to agree new ones as our collective understanding of the UK hydrogen economy matures.