

HYDROGEN: **HOW SCOTLAND IS HARNESSING THE POTENTIAL OF CLEAN ENERGY**

**The regional hubs set to power the
Scottish energy transition**

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An introduction to hydrogen in Scotland

Renewable hydrogen is attracting considerable attention from governments and corporations globally due to the potential of the fuel to deliver energy security with zero emissions.

Factors that have intensified interest in hydrogen include the pathway to net zero by 2050 and the global energy crisis, which has exposed insecurities in existing supplies.

A zero-emission fuel that can be produced in a variety of locations from water using electrolysis, powered by renewable energy, and resulting in no emissions means that renewable hydrogen – also known as green hydrogen – is of considerable appeal.

However, it is a misconception to think of hydrogen as a like-for-like replacement for oil & gas that will have a similar number of applications. Hydrogen is a versatile energy vector but is best suited to certain sectors, particularly heavy industries that are more difficult to decarbonise such as freight transport and steel manufacturing. Hydrogen is also an important feedstock for many industrial chemical processes and existing hydrogen use must be decarbonised quickly using renewable and low-carbon hydrogen.

Nevertheless, there is a sharp climb projected for the global production of low-carbon hydrogen, which may also help resolve issues with energy storage.

Yet for all the talk surrounding the advantages of renewable hydrogen and what the future industry could look like, the industry is still very much in its infancy. Within a very short space of time, an entirely new industry needs to be established and scaled up to meet



the growing low-carbon energy demand. By 2030, the IEA suggests that global demand for hydrogen could reach 115Mt.

Those wishing to see how the hydrogen economy may work in practice should look to Scotland. The country hosted world leaders at COP26 in Glasgow in November 2021, which put hydrogen in the spotlight. And Scotland's growing hydrogen sector continues to attract global interest.

Scotland has set a legally binding target to reach net zero by 2045, five years ahead of most countries. Industry, academia, and government are all pulling in the same direction to get there. And low-carbon hydrogen forms an integral part of Scottish decarbonisation plans.

The country has numerous renewable and low-carbon hydrogen projects that are either in development or, crucially, actually proving the technology in real-world settings. Fuel for trains, fuel cells for trucks and buses, heating for homes and powering whisky distilleries are just a few examples of hydrogen uses in Scotland, with many more in development.

Scotland has big ambitions for hydrogen, with a target to install 5GW of renewable and low-carbon hydrogen production capacity by 2030 – half of the UK’s 10GW total target. This translates to approximately 450,000 tonnes of low-carbon hydrogen a year for domestic and international use by the end of the decade. And by 2045, Scotland’s hydrogen capacity ambitions soar to 25GW when the Scottish Government estimates that the nation’s hydrogen economy could be worth up to £25bn a year, supporting potentially hundreds of thousands of direct and indirect jobs.

The country has decades of experience in the oil & gas industry, gained in the unforgiving marine environments of the North Sea. Adding to this is the country’s history of ingenuity in engineering, world-class universities for research, and government backing for the new industry.

The backbone of Scotland’s hydrogen ambitions is more than a dozen regional hubs being planned, spanning the length and breadth of the country – from Shetland in the north to the Borders in the south. If all these planned projects come on stream within the current timeframes provided and perform as intended, then Scotland will surely become a global force in hydrogen production and technologies.

In the following white paper, we assess how the hydrogen economy is taking shape both globally and in Scotland. We will look at the Scottish Regional Hydrogen Hubs, with a focus on the industrial centre of Aberdeen, and the more sedate surroundings of Orkney – which has a strong claim to a series of world-firsts in hydrogen production and uses.

450,000

Tonnes of low-carbon hydrogen that Scotland aims to produce every year by 2030

5GW

The installed capacity of renewable and low-carbon hydrogen by 2030, which accounts for half of the UK’s 10GW total target

£25bn

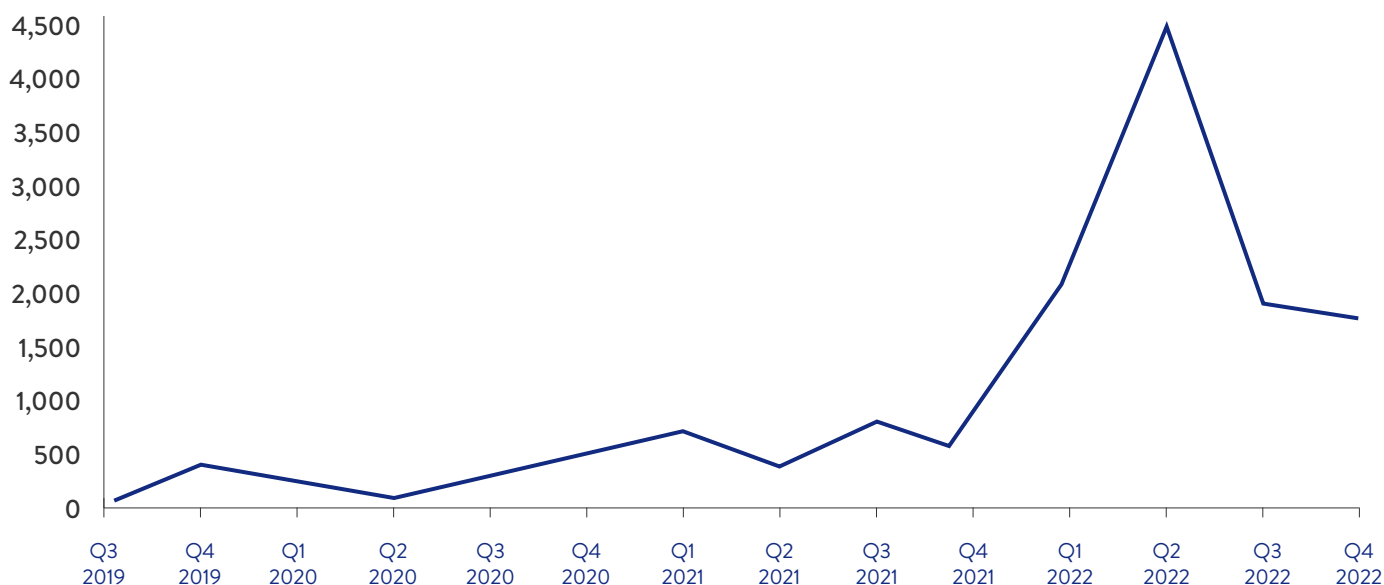
Potential estimates of the annual worth of Scotland’s hydrogen economy by 2045

Global growth in low-carbon hydrogen

Investments in low-carbon hydrogen are growing globally and 2022 saw growth reach unparalleled highs, with a year-on-year rise in investors of 183%. According to GlobalData figures, the two years from

Q2 2020 to Q2 2022 saw the number of identified investors in low-carbon hydrogen soar from around 100 in 2020 to more than 4,000 for the same period in 2022.

Number of Hydrogen Investors



Source: GlobalData Analysis, GlobalData Hydrogen Service, GlobalData Disruptor Intelligence Center

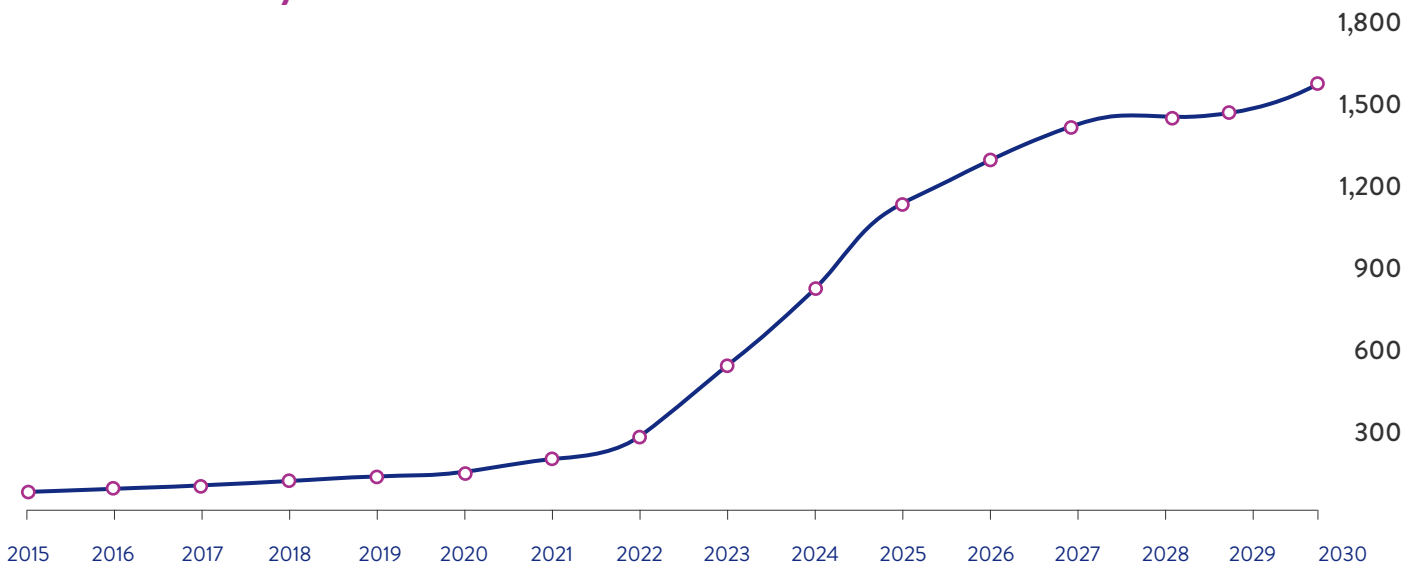
When Q2 2022 began, Russia had invaded Ukraine and global oil & gas prices were surging as nations and businesses searched for alternative suppliers of fuels. The war highlighted how susceptible economies are to geopolitical conflicts thousands of miles away and the

dangers of an overreliance on fuel supplies that may be in the hands of unreliable or hostile regimes. While the peak tailed off in Q3 and Q4 2022, the investor total was still considerably higher in Q2 2022 compared with Q2 2021.

For low-carbon and renewable hydrogen to fulfil its promise and help meet global energy demand, the sector is going to have to scale-up significantly. The majority of major economies around the world have developed a national plan or strategy to accelerate

development of the hydrogen sector and transition to low-carbon economies. Although some countries are more advanced than others in terms of what is already in operation. According to GlobalData projections, there will be 1,530 hydrogen plants worldwide by 2030.

Count of Plants by Start Year



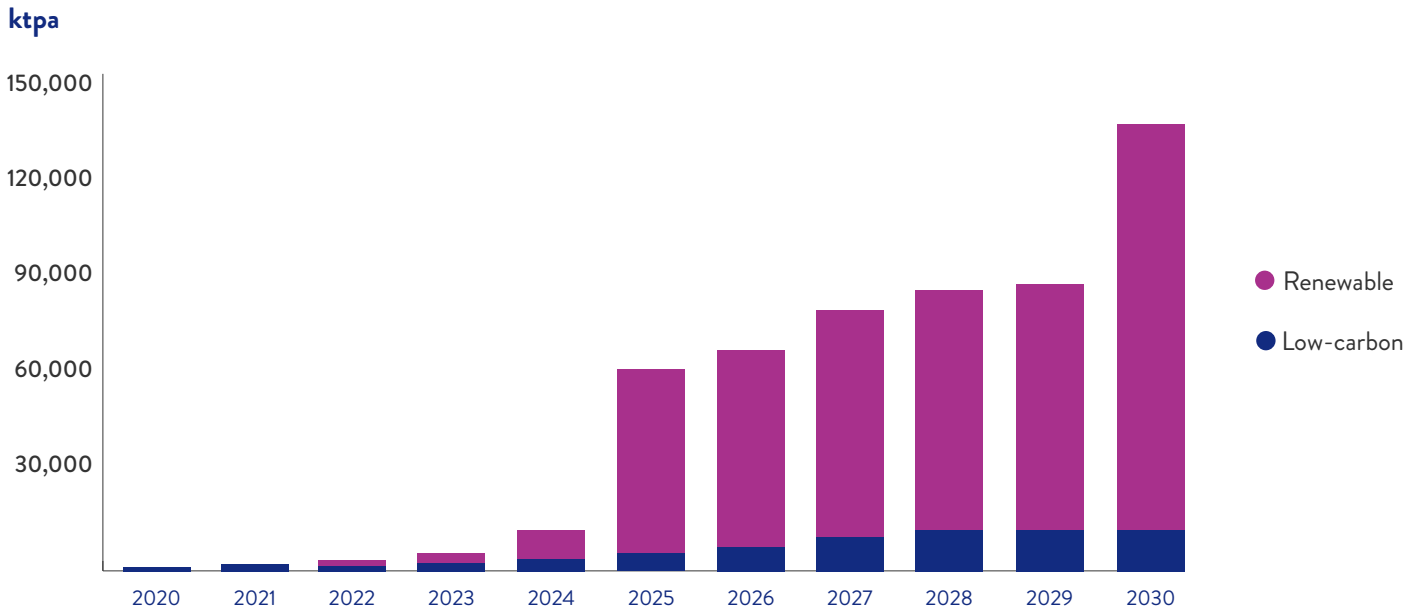
Source: GlobalData



In the long term, hydrogen made from renewables is projected to be the dominant fuel type in the sector globally. By 2030, GlobalData estimates that

11,122ktpa of low-carbon hydrogen will be produced a year compared with the 137,329ktpa of renewable hydrogen per annum.

Capacity by type and year



Source: GlobalData

At present, the amount of active low-carbon and renewable hydrogen capacity is very small. For low-carbon and renewable hydrogen to reach these projections illustrated above, the sector is going to have

to expand significantly within the next seven years at an unparalleled rate. And to get there, the solutions are being developed in Scotland.

Overcoming scale-up challenges with low-carbon hydrogen production

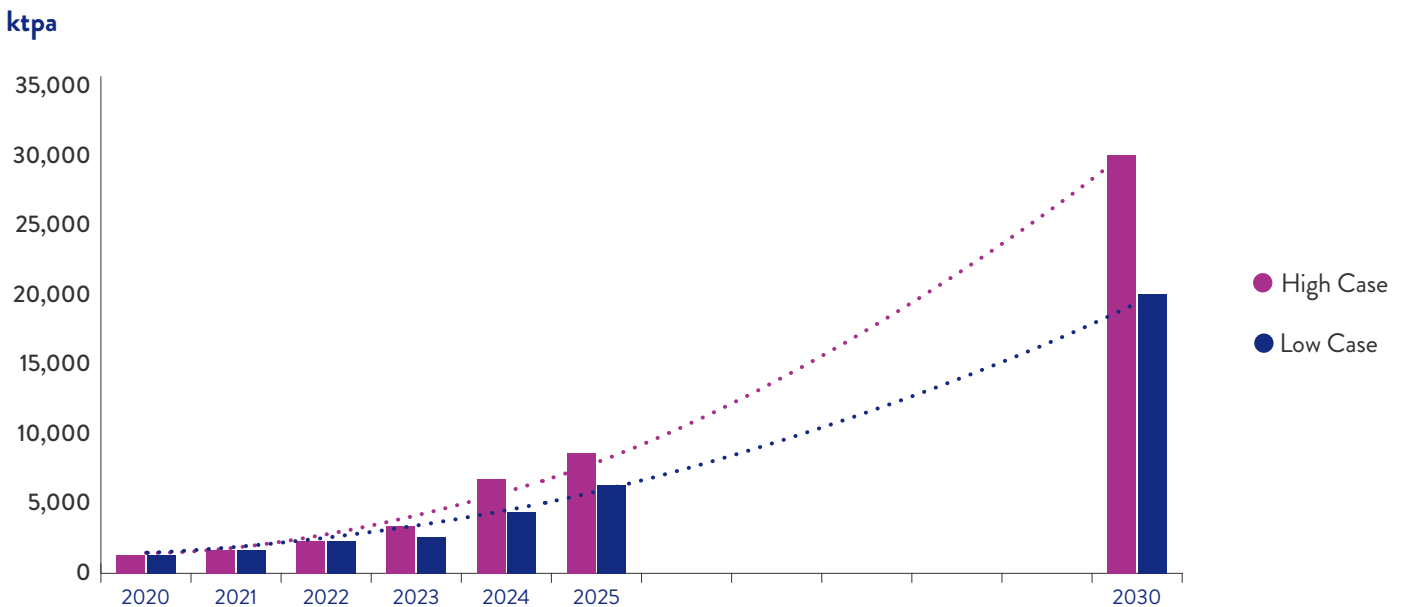
Despite hydrogen producing zero emissions at point of use, the established and most common production methods are far from clean. Currently, an estimated 90 million tonnes of hydrogen is produced a year from steam methane reforming of natural gas to create grey hydrogen, or using coal to fuel the process and create brown hydrogen. Production of grey and brown hydrogen emits approximately 800 million tonnes of CO₂ per annum. For context, this is the same annual carbon footprint as all of Germany. In fact, many projects testing hydrogen are using grey or brown types.

At present, just 2% of all hydrogen produced in the world is done so via electrolysis to create renewable hydrogen by splitting water into its chemical elements. To build capacity, low-carbon or blue hydrogen is going

to be an essential ‘stop gap’ solution. The production process is very similar to grey hydrogen in that it uses natural gas, with the key difference being that it uses carbon capture, utilisation, and storage (CCUS) technology to significantly reduce the environmental impact. Production of renewable hydrogen is reliant on electrolyzers, which are set to be one of the most in-demand industrial units within the next decade and beyond. Yet current suppliers of electrolyzers are nowhere near ready to meet demand, although this is expected to change dramatically by 2030.

The graph below illustrates the projected global capacity for electrolyzers based on high and low case scenarios up to 2030, with a significant uptick predicted to meet demand for renewable hydrogen production.

Hydrogen Electrolyzers, Global, Capacity Scenarios to 2030



Source: GlobalData (Power Database, May 2022)

In the Scottish Highlands, the **Gordonbush** hydrogen project is a notable site in terms of developing electrolysis at the scale required that can be replicated at lower costs than present levels. The project is being carried out by SSE Renewables and Siemens Gamesa Renewable with funding from the Scottish Government. While at Scottish Power's **Whitelee** wind farm near Glasgow, the UK's largest electrolyser is being installed to produce hydrogen from onshore wind generated at the site.

Aside from renewable hydrogen helping to curb carbon emissions, the fuel can also help to resolve issues relating to saturation of the electricity grid. The output from many Scottish wind farms is currently heavily curtailed as generated power essentially has nowhere to go. And similarly, many proposed wind farms have received planning permission, but difficulties in gaining grid connection are effectively halting development. Furthermore, connecting to the grid is expensive – particularly in Scotland compared to other parts of the UK.

However, using new renewable energy sites to produce renewable hydrogen solves this problem and can avoid the need to connect to the grid. Furthermore, using excess wind generated for production of renewable hydrogen can also help to balance supply and demand by providing energy storage. Renewable hydrogen production can help ensure that much higher volumes of wind energy generated are utilised. At present, renewable hydrogen remains expensive at \$4–6/kg, according to GlobalData analysis, compared with \$2/kg for grey hydrogen. But this could well change in a relatively short space of time. Given the sheer volume of projects focused on developing the fuel source, many are predicting that costs for renewable hydrogen will drop substantially.

“It is likely going to come down by at least half. I have seen some analysts saying that it could even go as



Wind turbines in North Ayrshire, Scotland. Onshore and offshore wind farms are integral to Scotland's renewable hydrogen ambitions.

low as 10% of its current price. It is potentially huge,” explains Jamie Robinson, hydrogen specialist in Scottish Enterprise's low-carbon transition team. “Assuming that the electrolyser capacity and the supply chain can keep up with it, then economies of scale are going to happen, and everything is going to come down in price.”

Building capacity with low-carbon hydrogen and carbon capture

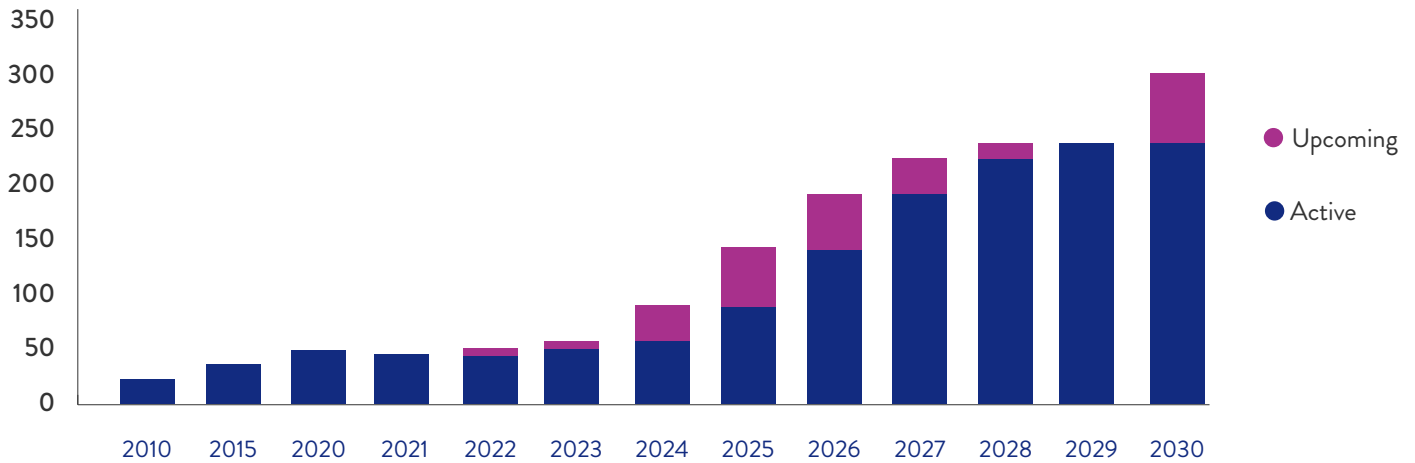
With obstacles to overcome for renewable hydrogen in terms of electrolysis, low-carbon hydrogen is considered an important ‘stepping stone’ fuel to help build hydrogen capacity and related infrastructure. Some even suggest that production processes for low-carbon hydrogen may mature more quickly in the short term.

“Blue hydrogen will be the ‘market-maker’ for any future hydrogen-based economy,” explains Mark Hughes, operations manager at NECCUS – a partnership between government and industry to cut carbon emissions. “The deployment of CCS technology and the attendant blue hydrogen production is likely to precede the ‘at scale’ production of green hydrogen.”

Much hope rests on carbon capture as a viable means to decarbonise numerous industries. GlobalData predicts that there will be a significant uptick in carbon capture projects up to 2030.

Global active and upcoming carbon capture capacity

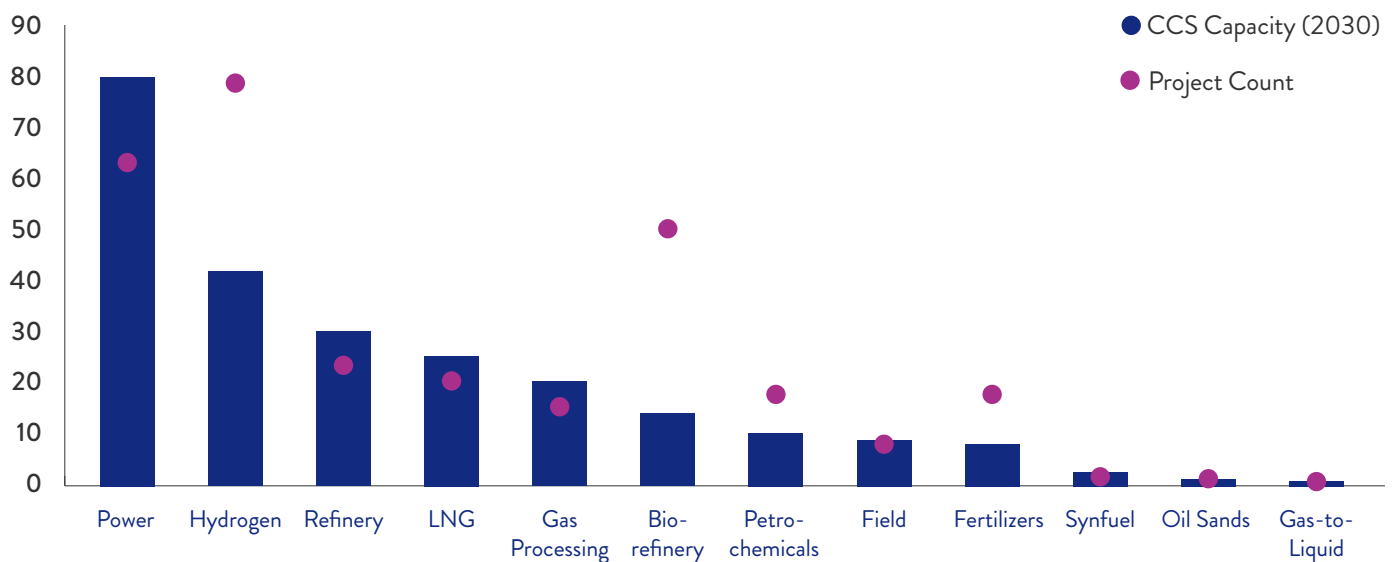
Capture capacity (mtpa)



Source: GlobalData, as of October 2022

Among industries, hydrogen production is expected to be the second highest use of CCS technology, behind power generation and above refineries.

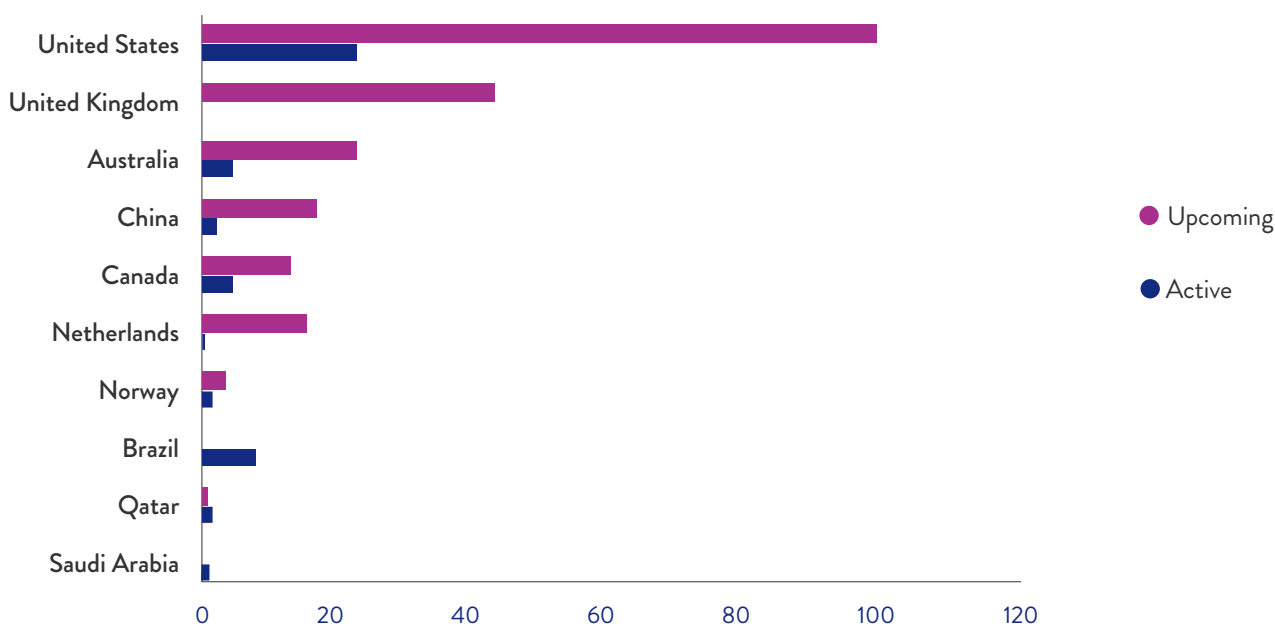
Global active and upcoming carbon capture capacity by sector, 2030



Source: GlobalData, as of October 2022

In terms of countries, the US is expected to top the global table for the most CCS projects by 2030, with more than 100 expected to be operational – with a number of projects already active. The UK is in second position with approximately 50 planned CCS projects by 2030.

Top 10 countries in active and upcoming CCS capacity, 2030



Source: GlobalData, as of October 2022

Integral to UK CCS initiatives is Scotland, which plans to sequester significant quantities of captured carbon underground and in depleted North Sea oil & gas fields. And a high proportion of captured carbon could come from low-carbon hydrogen production.

A significant CCS project lies approximately 30 miles north of Aberdeen at the site of St Fergus Gas Terminal where an estimated 35% of all UK natural gas enters the country. **Acorn Carbon Capture** is a licensed site for CO2 storage, with access to existing infrastructure and subsea pipelines. Overseen by Storegga, the facility is positioning itself as an international storage location for carbon and could import captured gas from other countries for treatment and storage. During Phase 1,

the target is to capture 300,000 tonnes of carbon a year. While an expansion in Phase 2 could see the amount of carbon captured jump to two million tonnes per annum. There are also plans to produce low-carbon hydrogen at Acorn. For Acorn Hydrogen, the plan is to eventually produce upwards of 7.7 terawatt hours of low-carbon hydrogen a year, with early 2027 set to see operations begin with the 300MW Unit-1.

To support CCS and hydrogen initiatives in Scotland, the Scottish Cluster comprises a Triple Helix approach of government, academia and business across key sectors that include energy, transport, chemicals, manufacturing, infrastructure, real estate, and whisky production.

Scotland's planned hydrogen hubs

Scotland's hydrogen industry already has multiple projects at various stages of development throughout the country. These concentrate on building capacity, supply chain capability, the necessary infrastructure, and industry use cases.

Central to the impending hydrogen economy in Scotland are the **Regional Hydrogen Hubs** in development. Scotland's Hydrogen Action plan defines a regional hub as a location "that is host to the entire hydrogen value chain, from production, storage, and distribution to end-use. Regional Hydrogen Hubs will include multiple end-users with applications ideally covering more than one sector".

These hubs will bring considerable economic benefits and potentially thousands of skilled jobs to the surrounding communities. In many instances, these sites are repurposing existing industrial land and energy infrastructure. And experienced oil & gas engineers can apply their expertise to the hydrogen sector.

These hubs will also bring energy production much closer to home. Fuel supplies may even be available from the same site as production. This further decreases the carbon impact by reducing requirements for fuel to be transported via freight traffic on the roads.



1. Aberdeen. Aberdeen has a long history in the North Sea oil & gas sector, and hydrogen looks set to become the city's next major industry. The city has two refuelling stations for hydrogen, along with one of the world's biggest vehicle fleets running on hydrogen and fuel cells, notably buses and council vehicles. The Energy Transition Zone will be a significant driver of decarbonisation research and action. And 30 miles or so north, there is the Acorn CCUS facility and Acorn Hydrogen project. *For more on the Aberdeen Regional Hub, see page 15.*

2. Argyll & Islands. Machrihanish Airbase on the Kintyre Peninsula is the site of a planned sustainable hydrogen production and distribution facility in a project managed by Machrihanish Airbase Community Corporation (MACC) Hydrogen Futures. The site is a former military airfield that has been converted into a community-owned business park covering approximately 1,000 acres. A hydrogen production project at Oban is also planned.

3. Ayrshire. The county of Ayrshire is becoming a hotspot for hydrogen activity. At the centre of this is the former Hunterston nuclear power station, which is being viewed as a potential renewable hydrogen production site that could take advantage of the energy produced from nearby offshore wind farms. Nearby Prestwick Aerospace is where one of Scotland's five planned spaceports is located. Aviation and space flight could be fuelled by hydrogen or hydrogen-derived fuels.

4. Cromarty. The North of Scotland Hydrogen Plan aims to establish an advanced hub for the production, storage, and distribution of renewable hydrogen that would be used throughout the region and the rest of the UK, as well as exported to Europe. The hub would tap into the nearby large-scale renewable resources to provide renewable hydrogen for distilleries, transport, and industry. The location's green freeport status will bring significant economic benefits to companies setting up in the region.

5. Dumfries & Galloway. The region already has a growing hydrogen cluster, including hydrogen-enabled industrial boilers. Its location enables easy access to the UK National Grid, the Scotland-Northern Ireland gas



pipeline, and European transmission networks. Notable areas include Chapelcross, which offers up to 500 acres of development opportunity.

6. Dundee. There are plans to establish renewable hydrogen production facilities, and refuelling infrastructure for zero-emission vehicle fleets, utilising the multiple offshore wind farms nearby. A key innovator will be Michelin Scotland Innovation Parc (MSIP), developing innovations in motoring through state-of-the-art research facilities.

7. Fife. Fife was ahead of its time for hydrogen, with research going back more than a decade. More recently, Fife is the home to the H100 project, which will break new ground by using renewable hydrogen produced from offshore wind to heat 300 homes. A planned Fife Hydrogen Hub at Mossmorran could decarbonise existing industrial sites. And a Hydrogen Accelerator at St Andrew's could unleash multiple innovations.

8. Glasgow. Whitelee wind farm will be home to the UK's biggest power-to-hydrogen energy storage project. A 20MW proton exchange membrane electrolyser will produce renewable hydrogen with power from some of the 215 turbines capable of generating 539MW. It is estimated that the electrolyser will be able to produce eight tonnes of renewable hydrogen a day, providing enough fuel for 550 buses to travel a return journey from Glasgow to Edinburgh.

9. Grangemouth. This location is one of the most significant sites for hydrogen development and decarbonisation innovations in Scotland. Late-2023 is expected to see the commissioning of a new energy plant that has been designed to run on hydrogen in the future. A large-scale low-carbon hydrogen plant could also be built, with captured carbon sent to the Acorn project for storage. Hydrogen could also be transported from Grangemouth to Edinburgh via an existing gas pipeline that can be repurposed. While INEOS has announced plans to build a low-carbon facility on the site that is set to open in 2030, which is claimed will cut emissions from its plant by one million tonnes a year.

10. Orkney. Possibly the first place in the world to export renewable hydrogen, Orkney is a real-world example of what the hydrogen economy may look like. The original BIG HIT project was aimed at demonstrating Orkney's capabilities as a replicable renewable and low-carbon hydrogen territory. The planned Flotta Hydrogen Hub is an industrial-scale production facility for renewable hydrogen in Orkney on the site of an existing oil terminal. Flotta will use energy from ScotWind to produce hydrogen for domestic use

and export. The site could also be a refuelling station for international shipping vessels. Then there is the research and innovations from the European Marine Energy Centre (EMEC) on the islands, which was a driving force behind the BIG HIT project. *For more on the Orkney Regional Hub, see page 17.*

11. Scottish Borders. The location is in a strong position for hydrogen production thanks to its vast array of onshore wind turbines, with strong connections to utilise the offshore wind farms off the East Coast. Another advantage is the main gas transmission pipelines that run through the area connect with England, opening up the potential to repurpose pipelines for hydrogen. Local engineering expertise could also see the area become a specialist manufacturing location for electrolysers.

12. Shetland. ORION Clean Energy Project will produce low-carbon hydrogen from natural gas and renewable hydrogen from renewable sources on Shetland such as wind, wave and tidal, with existing oil & gas infrastructure adapted, alongside the deep-water port. In another example of how islands are leading the way in proving technologies in the real world, Shetland has been running trials with tidal turbines to power a charger for electric vehicles. Tidal turbines could also be used for hydrogen production.

13. Western Isles. The Outer Hebrides Energy Hub could produce enough renewable hydrogen to meet the islands' energy needs by tapping into the considerable wind resources both offshore and onshore. The expected surplus would be sent to the UK National Grid and exported to international markets.

Aberdeen Regional Hydrogen Hub

Aberdeen holds multiple advantages as a location for a hydrogen hub, possessing the highest concentration of energy supply chain companies anywhere in the UK. Widely known as Scotland's gateway to the North Sea oil & gas industry for decades, Aberdeen has access to the necessary energy infrastructure and seasoned engineers with the essential transferrable skills to support the hydrogen economy. It is estimated that Aberdeen will be able to generate 1GW of renewable hydrogen by 2030.

But hydrogen is hardly a new area of industry for Aberdeen. As far back as 2015, the city was home to the UK's first hydrogen production and refuelling station for buses. And the city was also where the world's first hydrogen-powered fleet of double-decker buses began operations in 2021.

There are plenty of promising new hydrogen developments in and around Aberdeen. In partnership with Aberdeen City Council, BP will develop and operate a hub that uses solar energy to produce renewable hydrogen, along with a refuelling station for vehicles. Additionally, the joint venture will support development of the hydrogen supply chain, along with skills and training programmes. Initial production is slated for 2024.

Then there are the extensive renewable energy sources nearby. Of the 25GW of projects awarded licences in the latest ScotWind round, the majority are within 100 miles of the coast of Aberdeen. Much of this energy could be used to produce hydrogen.

Fifteen miles inland from Aberdeen, **Kintore Hydrogen** is a notable project. Statera Energy will develop a 3GW electrolyser that will use excess power from Scottish wind turbines to produce renewable hydrogen. Full production is targeted by 2030.

1GW

The estimated amount of renewable hydrogen Aberdeen will be able to generate by 2030

2015

The year Aberdeen was home to the UK's first hydrogen production and refuelling station for buses

2021

The year Aberdeen was the first city in the world to operate a hydrogen-powered fleet of double-decker buses

2024

The year production will start for the city's new solar energy powered renewable hydrogen hub

Hydrogen innovations

A significant development for renewable hydrogen is Vattenfall's **Hydrogen Turbine (HT1)** project at its 97MW wind farm off the coast of Aberdeen, known as the European Offshore Wind Deployment Centre. An electrolyser will be fitted directly on a platform at the base of an operational wind turbine tower. Hydrogen produced offshore will be sent via pipeline to Aberdeen Harbour. The developers estimate that one 8MW turbine will be able to produce enough renewable hydrogen for a bus to run for 24,000km. Operations are set to begin by 2025.

“Placing hydrogen electrolysers on offshore wind turbines is likely to be the quickest and cheapest way of providing fossil-free hydrogen at the scale needed to reduce emissions from heavy industries such as steel and chemicals,” stated Danielle Lane, UK country manager for Vattenfall. “There’s a lot of talk about hydrogen’s potential uses, but we need to urgently map out the development and delivery processes so we can quickly get to the stage where we can produce large quantities of fossil-free hydrogen cost-effectively. The HT1 project will focus on overcoming those barriers, in the real-world environment of an operational offshore wind farm.”

Another important innovation in harnessing offshore wind energy for hydrogen production is the **ERM Dolphyn** project. A 10MW deep-water floating wind turbine will power an electrolyser to produce renewable hydrogen from seawater that will then be sent back to the mainland via pipeline. A demonstrator project is due to begin operations towards the end of 2025. Provided it is successful, the first commercial production is scheduled for mid to late 2020s, with international scale-up planned for the early 2030s. According to ERM Dolphyn, if the project progresses as expected

then the technology will eventually be capable of providing enough hydrogen to heat more than 1.5 million homes with zero carbon emissions.

Aberdeen is also home to several research centres and specialist energy organisations that are working on decarbonisation projects such as the Centre for Energy Transition (CET), and the National Decommissioning Centre at the University of Aberdeen.

Robert Gordon University and the Net Zero Technology Centre (NZTC) are carrying out research into large-scale subsea storage of hydrogen through a National Subsea Centre (NSC) programme. “Using the high-pressure depths of subsea conditions, this project will help to store hydrogen at scale in a clean, efficient, and safe way,” stated Professor James Njuguna, Integrated Energy Lead at NSC. “It will also help to reduce carbon emissions by decreasing our reliance on fossil fuels to produce hydrogen and support manufacturing opportunities as we increase efforts to meet demand.”

Storing hydrogen requires high pressure and low temperatures due to the low density of the gas. And the experience of dealing with natural gas in the North Sea can be applied to hydrogen. NZTC is also currently leading work on developing plans for a hydrogen export pipeline that will connect Scotland to mainland Europe.

Finally, the **Energy Transition Zone** will be a significant driver of decarbonisation on a site spanning 40 hectares, carrying out research, and developing and manufacturing the new technologies required to meet net zero. The ETZ will host a renewable hydrogen test and demonstration facility and aims to become home to a large-scale electrolyser manufacturing site. It aims to establish Aberdeen as the net zero capital of Europe.

Orkney Regional Hydrogen Hub

Orkney may not have the same scale of industry and infrastructure as Aberdeen, but its contribution to the energy transition and renewable hydrogen is no less significant. Man-made energy islands are often spoken about for storage and distribution, but there is no need in Scotland, with more than 70 islands making up the archipelago in Orkney alone – and only 16 of these are inhabited.

In fact, Orkney is arguably leading the world in terms of what the hydrogen economy may look like. Hydrogen is already powering a variety of areas from whisky distilleries and schools, to small car ferries between the islands.

Orkney also has a strong claim to be the first place in the world to have exported renewable hydrogen. A recent high-profile recipient of this renewable hydrogen was a project seeking to decarbonise aviation. Rolls-Royce and easyJet were collaborating on a project using renewable hydrogen to power an adapted AE 2100-A jet engine as an alternative fuel to kerosene for zero-emission flights. Tests were successful, suggesting that renewable hydrogen is a viable and clean alternative to kerosene. It is now hoped that zero-carbon aviation will become a reality in the mid-2030s.

In another world first in 2017, the island of Eday successfully produced renewable hydrogen using an electrolyser powered by tidal energy. The European Marine Energy Centre (EMEC) is based in Orkney to test out further technologies that harness tidal and wave energy. Edinburgh's Heriot-Watt University also has an Orkney campus that offers several courses focused on renewables and the energy transition.

Orkney is likely amongst the world's biggest exporters of renewable electricity, bringing significant benefits to communities on the islands. For example, on the small island of Shapinsay, with a population of 300 people,

a single wind turbine brings in as much as £5,000 a day from generating electricity that is sold to energy companies.

The wind turbine produces so much electricity that the power cable taking electricity back to the mainland is often overloaded, meaning that energy is capped. To harness the considerable amount of stranded wind that would otherwise go to waste, an electrolyser is now connected to the turbine to produce renewable hydrogen. And the school on Shapinsay is now being heated by this renewable hydrogen.

#1

Orkney has a strong claim to be the first place in the world to have exported renewable hydrogen

2017

The year the island of Eday successfully produced renewable hydrogen using an electrolyser powered by tidal energy

£5,000

The amount of money a single wind turbine brings in each day on the island of Shapinsay

Increasing hydrogen production in Orkney

There is likely much more hydrogen set to be produced from renewables in Orkney. The array of renewables on the islands is impressive, comprising approximately 650 wind turbines, nearly 400 solar panels, and the most powerful tidal turbine in the world is providing electricity to 2,000 homes.

Orkney's status as a hub for renewables and sustainability has been years in the making, with the goal to make the islands both self-sufficient and carbon-neutral. "This isn't something that has come off the back of the energy crisis," explains Norma Hogan, senior development manager for wave, tidal, and hydrogen at Highlands & Islands Enterprise. "This is something that has been well thought through by islanders from their aspiration to become carbon-neutral and how they can achieve it."

One of the most significant hydrogen projects on the islands is **The Flotta Hydrogen Hub**, which is

a proposed industrial-scale renewable hydrogen production facility that would involve repurposing an existing oil terminal in Orkney. The site would produce renewable hydrogen from clean seawater via electrolyzers powered by offshore wind generated from turbines in the waters around Orkney where three large-scale offshore wind sites have been awarded under the Scotwind leasing round. Production from this facility could open up significant opportunities for exports, with another option being to send the hydrogen down to north east Scotland via pipeline to be blended with natural gas and injected into the UK gas grid. In addition, there are plans for Flotta to become a refuelling station for maritime vessels that run on hydrogen-derived fuels.

"The oil & gas sector is absolutely integral to make hydrogen work because hydrogen is at such an early stage in the UK at the minute," explains Hogan. "People working in the sector are using oil & gas equipment and employing the same principles when it comes to hydrogen."



Think Hydrogen, Think Scotland

Projections suggest that the global hydrogen industry could be worth more than \$200bn by 2030, and Scotland is well-placed to take a decent slice of the market.

There used to be a saying that every oil & gas rig around the world had a piece of equipment or component designed in Scotland. And this could also apply to hydrogen in the not-too-distant future.

The expertise in the oil & gas industry, a wealth of renewable energy, and innovations and talent from universities provide Scotland with all the necessary tools to be a global leader in renewable and low-carbon hydrogen production, distribution, and storage.

While the low-carbon hydrogen economy remains a work in progress, there is clearly enough happening in Scotland to suggest that the new energy sector is capable of fulfilling the immense promise. Delegations of officials from Europe agree, having visited Scotland to inspect facilities, signed agreements to collaborate on developing technologies for the hydrogen industry

and shown great interest in importing Scottish renewable hydrogen in future.

To realise this potential and grasp this opportunity, investment is essential. Crucially, the drive for hydrogen development has the full support of the Scottish Government, which is providing £100m in capital funding for renewable hydrogen projects. As part of this, the government has released a Hydrogen Action Plan to set out its targets and ambitions.

But to accelerate development, further capital investment is required. Scottish Enterprise and Scottish Development International are keen to speak to companies or investors that are interested in getting involved with the clean fuel of the future. The organisations can enable access to all the benefits Scotland has to offer, including making the necessary introductions with the right businesses and institutions.

For more information about Scotland's hydrogen sector, visit [the SDI website](#). Or to get in touch about investing in Scotland's hydrogen sector, [click here](#).

