finnCap GROUP

Energy | Insights

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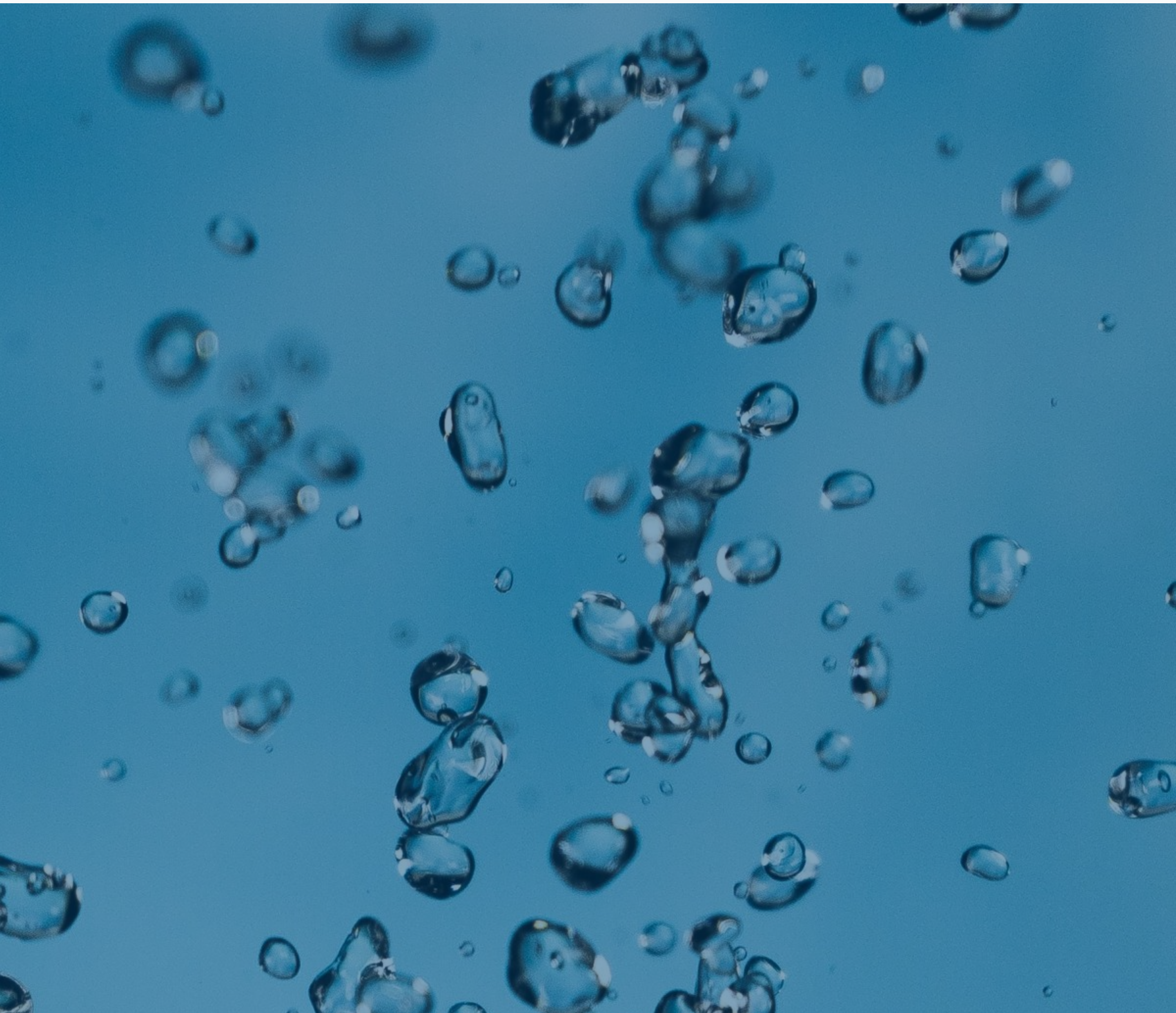
Hydrogen – This time it's for real



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1. Highlights this quarter

Topic of the quarter

Hydrogen – this time it's for real. Replacing fossil fuels throughout the global energy chain is no small task. Renewables and lithium-ion batteries can only get us so far towards net zero by 2050. Hydrogen is increasingly viewed as the missing link in the energy transition, offering a complementary decarbonisation pathway for the global energy system, especially in hard-to-abate sectors. It can be used for long-cycle energy storage and when combined with fuel cells provides reliable, stable energy at grid scale. It has many other possible applications across industry, transport, power, building and residential sectors. Critically, it does not emit CO2 and has almost no air pollution. After many false dawns, hydrogen finally looks set for wide-scale adoption throughout the global energy chain.

Unstoppable momentum. The incoming Biden administration is a potential game changer for US and global climate ambitions, and should give an unstoppable momentum to the shift away from the reliance on fossil fuels. Countries accounting for more than 60% of global energy-related carbon emissions now have stated net-zero ambitions.

Moreover, a strong convergence of government policy support for hydrogen, large-scale private sector investment, and advancements in both fuel cell and electrolyser technology paves the way for an acceleration of the development of the hydrogen economy.

'**Green' hydrogen costs are falling.** Currently, neither renewable hydrogen nor fossil-based hydrogen with carbon capture are widely cost-competitive against fossil-based hydrogen. However, costs for 'green' hydrogen are falling rapidly and are already competitive in locations with the lowest renewable electricity costs. Electrolyser costs have come down by 60% in the last decade and are expected to halve again over the next. As with renewable power generation, scale-up and technology improvements are seen as key to delivering competitive low-carbon solutions across a wide range of applications by 2030.

Hydrogen can ease UK infrastructure pressures. The UK's electricity distribution network will struggle under the additional demands of the heat and transport sectors as we decarbonise, especially as each is currently supported by its own separate infrastructure. Hydrogen can help. The UK national gas grid could be repurposed for hydrogen, with hydrogen hubs developed around large industrial sites. Public and private partnerships alongside fiscal inducements and a suitable regulatory framework are needed to allow nascent technologies to successfully evolve.

Rocket fuelled. We highlight 12 clean-tech companies that provide exposure to the hydrogen theme via fuel cell and/or electrolyser technologies. Four of these are UK listed – **AFC Energy (AFC)**, **Ceres Power (CWR)**, **ITM Power (ITM)** and **Proton Motor Power Systems (PPS).** This 'clean dozen' has delivered rocket-fuelled performance, rising over 550% on average since the start of 2020. Given that, plus lofty valuations, it is tempting to view this as just another bubble.

However, we are still in the early stages of a deep rooted and powerful structural global theme and valuation will likely continue to play second fiddle to momentum. With any emerging technology, there will be winners and losers, although the scale and breadth of the potential market suggests there is the room and the need for multiple players and approaches.

2. Hydrogen – this time it's for real

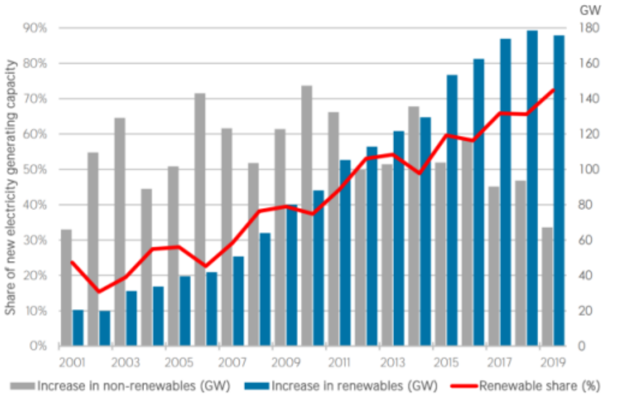
In 2019, the UK government amended the Climate Change Act to become the world's first major economy to target net zero emissions by 2050, making full decarbonisation a legal requirement.

The rapid growth in the renewable energy space globally is well documented, with the UK at its forefront – in Q1 2020 almost 50% of the UK's power generation came from renewables, with coal completely side-lined.

According to the International Renewable Energy Agency (IRENA), at the end of 2019, global renewable generation capacity amounted to 2.54 GW and represented 72% of the net generation capacity additions that year.

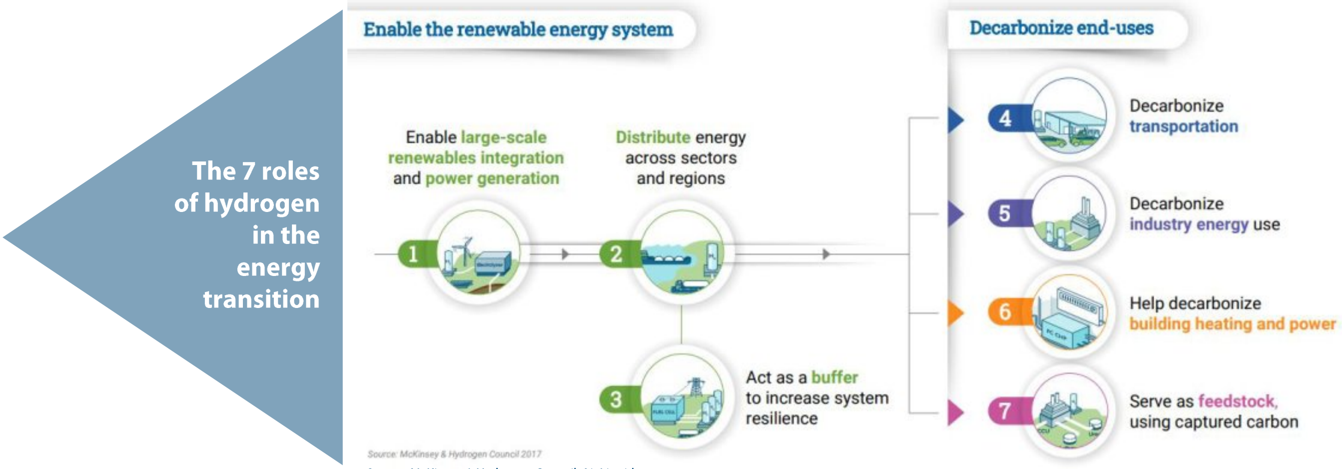
This growth is set to continue as globally renewables only represented 10% (26% including hydro) of total electricity generation in 2019. The IEA's latest Renewables 2020 report estimates that there will be record renewables power capacity additions in 2020 and 2021 despite the pandemic, reaching 200+ GW and representing 90% of all energy generation additions.

Renewable share of global annual power capacity expansion



Source: IRENA

In particular, the newly converted European integrated oil companies are taking on the current utility incumbents in a race to reshape and decarbonise their portfolios, with ambitions to develop over 250 GW of renewable generation capacity by 2030 from almost a standing start.



Source: McKinsey & Hydrogen Council, Air Liquide

- **BP** aims to develop 50 GW of renewables capacity by 2030.
- **Eni** plans to reach 5 GW of renewable generation capacity by 2025 and 15 GW by 2030, from 0.2 GW in 2019.
- **Equinor** intends to become an "Offshore Wind Major" and has ambitions to grow its offshore wind capacity from 0.5 GW currently to 4-6 GW by 2026 and 12-16 GW by 2035.
- **Galp** is targeting 10 GW of installed capacity by 2030.
- **Repsol** has a development pipeline of projects that will drive renewable generation capacity to over 5 GW by 2025 and over 12.5 GW by 2030, from 1.1 GW currently.
- **Total** is targeting 35 GW of gross renewable capacity in 2025 with an ambition to add around 10 GW per year beyond that.
- We will be hearing more about **Shell**'s renewables growth ambitions in February, but it currently has 1.6 GW of installed capacity and over 7 GW in development.

2. Hydrogen – this time it's for real cont.

However, electrification in itself can only get us so far on the journey to net zero emissions. Renewable energy from solar and wind can be intermittent and is not dispatchable. It therefore needs storage to smooth out any demand-supply imbalances, providing flexibility and preventing the need for curtailment of renewable energy generation.

This is normally provided by pumped-hydro or batteries, but hydrogen can also be used. Batteries are better suited to short-cycle storage of up to a few hours/days due to their high cycle efficiency and simplicity. Hydrogen is more suitable for long-cycle storage.

Hydrogen combined with fuel cells can provide reliable, stable energy at grid scale.

Heavy industries, such as refineries, use large quantities of hydrogen in their chemical and petrochemical manufacturing processes. Replacing the current fossil-based hydrogen with hydrogen produced from renewable energy can dramatically lower their CO2 footprint.

Hydrogen is also seen as key to decarbonising hard-to-abate sectors such as steel, cement, and building heating. It will also likely play a role in heavy-duty road transport (fuel cells), shipping (via Ammonia) and short-distance aviation.

There is a growing consensus that hydrogen is the missing link in the energy transition, offering a complementary decarbonisation pathway for the global energy system, especially in hard-to-electrify areas. It has many possible applications across industry, transport, power and buildings sectors. Critically, it does not emit CO2 and has almost no air pollution.

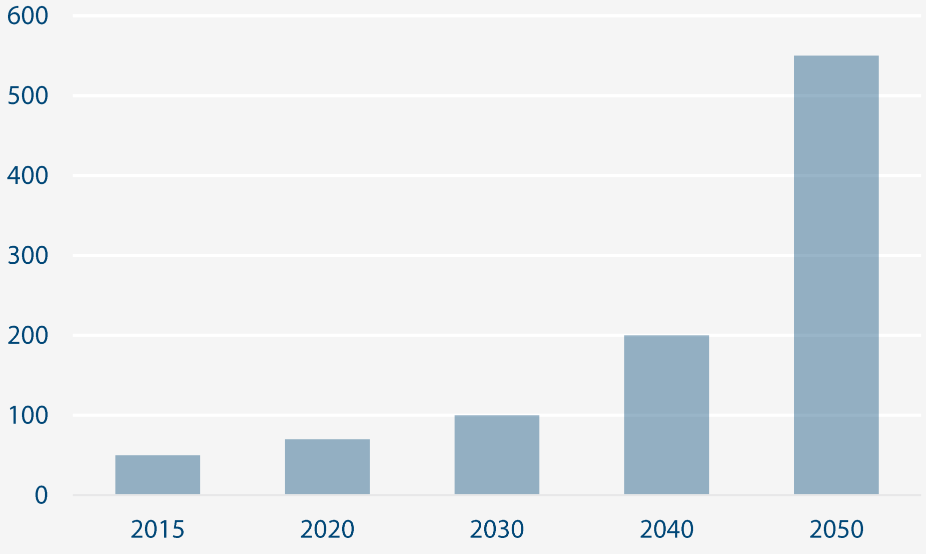
After many false dawns, hydrogen finally looks set for wide scale adoption throughout the global energy chain.

The numbers are vast too. Air Liquide estimates that by 2050, hydrogen demand in a +2°C scenario will increase 8-fold to 78 exajoules (550 MT), abating over 6 GT of CO2 annually, generating over US$2.5tn in annual sales and creating over 30 million jobs…something for everyone there!

The IEA expects a slower, but still impressive growth trajectory, forecasting global demand of 287 MT in 2050 versus Air Liquide's 550 MT projection. This still represents nearly a six-fold increase relative to 2019 demand.

As governments and vehicle manufacturers move away from conventional combustion engines, the IEA expects the transportation sector to become the largest consumer of hydrogen. Hydrogen demand in this segment is forecast to reach 66 million tonnes by 2050, from a standing start.

Global demand* for Hydrogen 2015 – 2020 (million tonnes)



Source: Air Liquide
* Projected global demand for hydrogen in a +2°C global warming scenario
Assumes HHV energy content of 1kg of hydrogen of 141.9 MJ

3. Governments are acting

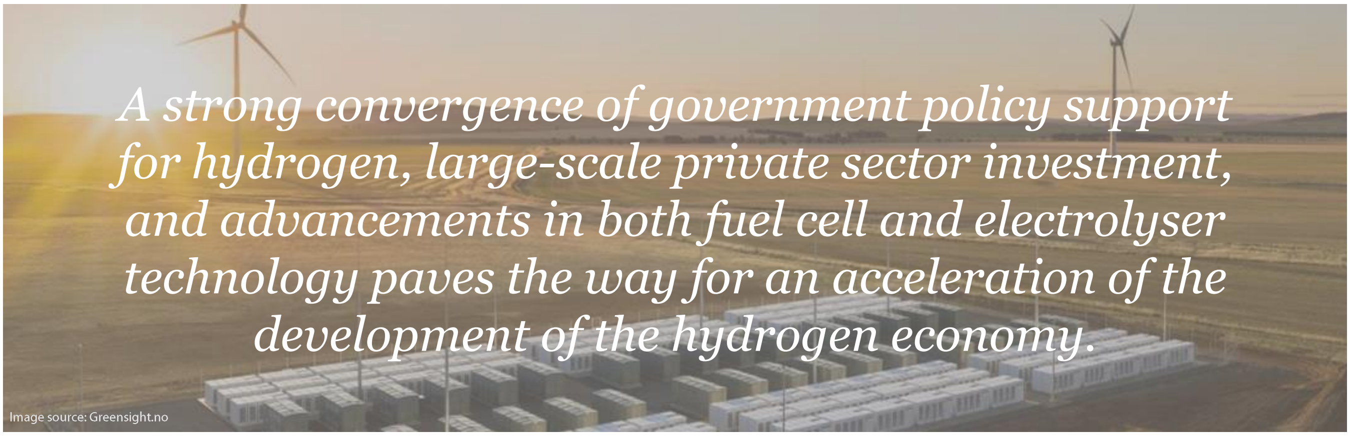


Image source: Greensight.no

The incoming Biden administration is a potential game changer for US and global climate ambitions. Biden has already signalled that his first act as president will be to re-enter the US into the Paris Climate Agreement, which the Trump administration left the day after the nation went to the polls. 'Climate' is one of the four top priorities singled out by his transition team, with Biden expected to push major countries to raise their domestic climate ambitions.

Biden has proposed a US$2tn green stimulus package to help cut emissions to net zero by 2050 and has set a goal of decarbonising US electricity generation by 2035. He has also nominated long-time renewables supporter, Jennifer Granholm, as his new energy secretary.

The democrats recently taking control (just) of the Senate in the Georgia run-off elections should help smooth the path. The Democrats now have control of both Congress and the Senate (just), which will make wide-ranging initiatives easier to deliver.

This should give an unstoppable momentum to the shift away from the reliance on fossil fuels, with Europe, China, and the US, amongst others, all now targeting net zero carbon emissions by 2050-2060. Countries accounting for more than 60% of global energy-related carbon emissions now have stated net-zero ambitions.

Governments are playing their part, announcing as of the end of October 2020 US$470bn of energy-related stimulus packages targeting hydrogen production and consumption via rebates, grants, loans and tax incentives/exemptions.

EU strategy for a climate-neutral economy

The EU launched its strategy for a climate-neutral economy in July, with hydrogen playing a central role. Renewable electricity is expected to decarbonise a large portion of the EU's energy consumption by 2050, but not all of it. Hydrogen has the potential to bridge this gap.

Hydrogen produced via renewable energy is the priority, although the EU recognises that in the interim other forms of low-carbon hydrogen are needed to cut emissions and encourage the development of a viable hydrogen market. Germany declared the creation of a European hydrogen infrastructure as one of the biggest priorities of its EU Council presidency.

To achieve this, the EU aims to support the installation of at least 6GW of electrolysers and the production of 1 MT of renewable hydrogen by 2024. This commitment rises to 40 GW and 10 MT in 2030, respectively. The European Commission estimates that cumulative investments in renewable hydrogen in Europe could be up to €180-470bn by 2050.

Five European governments have now stated explicit electrolyser targets for 2030: France 6.5 GW, Germany 5 GW, Spain 4GW, Holland 3-4 GW and Portugal 2 GW. Germany has committed the most to its hydrogen strategy as it looks to wean the country off coal power, which in 2019 still represented 18% of primary energy supply.

In June, the German government announced a target of 5 GW of hydrogen production capacity by 2030 and 10 GW by 2040. It has committed €7bn to make Germany a leader in hydrogen technology, plus a further €2bn to build alliances with other countries, as it will need to import green hydrogen due to its more limited renewables potential.

3. Governments are acting cont.

UK – playing catch-up

By contrast, the UK government is only expected to publish a national hydrogen strategy this quarter, putting it behind France, Germany, the Netherlands, Portugal, Spain, Japan, South Korea and China.

However, in last November's 'Ten Point Plan for a Green Industrial Revolution', one of the key tenets is driving the growth of low carbon hydrogen. The aim is for the UK to develop 5 GW of low-carbon hydrogen production capacity by 2030.

This will be supported by a £240m Net Zero Hydrogen Fund, hydrogen business models and a revenue mechanism to attract private sector investment, initial details of which will be laid out in this year's hydrogen strategy. The aim is to encourage over £4bn of private investment up to 2030.

This was re-iterated in December's Energy White Paper, which also highlighted plans to:

- Set up a UK Emissions Trading Scheme (ETS) from 1 January 2021 to replace the EU's version post-Brexit.
- Invest £1bn in state-of-the-art carbon capture storage in four industrial clusters by 2030 and at least one fully net zero cluster by 2040.
- Shift away from fossil-fuel boilers by the mid-2030s, with all newly installed heating systems to be low carbon or convertible to a clean fuel supply.
- Spend £1.3bn to accelerate the rollout of EV charge points, supporting plans to phase-out the sale of new petrol and diesel cars by 2030.

It is also backing a £100m low-carbon hydrogen production fund to help the UK focus on blue and green hydrogen, with blue hydrogen deemed necessary for scaling up production.

The UK Hydrogen Taskforce, a coalition of hydrogen industry players set up in 2020 to promote large-scale deployment of hydrogen across the UK, has called on the government to commit £1bn of capex funding. Industry has also indicated it stands ready to invest £1.5bn in UK hydrogen projects alongside the government.

3. Governments are acting cont.

Canada

Canada has recently unveiled its hydrogen strategy, which is underpinned by a C$1.5bn investment fund for low-carbon and zero-emission fuels. Canada is one of the top 10 global hydrogen producers already and this strategy is designed to encourage additional investment and partnerships to make it a global leader in hydrogen.

China

In a 15-year plan for new-energy vehicles released in November, China's State Council indicated the focus will be on building the fuel-cell supply chain and developing hydrogen-powered trucks and buses. The government is investing in hydrogen transport in Beijing, Shanghai and Chengdu and has a target of 1 million hydrogen cars and 1,000 refuelling stations by 2030. Wuhan is to become the first 'Chinese hydrogen city' with up to 100 fuel cell automakers and related enterprises by 2025.

Japan

Japan's Basic Hydrogen Strategy was established in 2017 and set out an action plan for the period up to 2030 to reduce GHG emissions and develop a hydrogen-powered society. Japan is at the forefront of hydrogen technology, particularly in fuel cell vehicles, and has a target of 800,000 units by 2030. There is also a big emphasis on reducing electrolysis costs in order to commercialise power-to-gas technology.

South Korea

South Korea's Ministry of Trade, Industry and Energy recently laid out its plan for electricity supply and demand to 2034, reaffirming the intended move away from coal and nuclear power towards renewables. It is targeting almost 42% of power generation capacity from renewables by 2034 versus 6.5% last year, with coal's contribution falling from 40% last year to ~10% at the end of the period.

South Korea's Green New Deal has committed £46bn as part of a wider national strategy to tackle climate change, meet the government's renewable energy plans and to shape the hydrogen future. It is targeting 15 GW of fuel cell power generation capacity alongside over 6 million hydrogen cars and 1,200 fuelling stations by 2040.

For the first time, the strong convergence of government policy in support of hydrogen, large-scale private sector investment, and advancements in both fuel cell and electrolyser technology should pave the way for companies to start accelerating development of the hydrogen economy.

After many false dawns, hydrogen finally looks set for wide-scale adoption throughout the global energy chain.

4. Hydrogen production

Hydrogen is a carrier of energy. It can be used as a replacement for fossil fuels, as a feedstock for industry and chemicals, and as a way of supporting renewable power and heat. It is the most abundant element on earth but is rarely found in its pure form. Today, over 95% of dedicated hydrogen production comes from natural gas or coal.

The most common form of hydrogen production is steam methane reforming (SMR), which combines natural gas and water at high temperatures (900°C) to produce hydrogen, carbon monoxide and carbon dioxide. It can also be made via coal gasification.

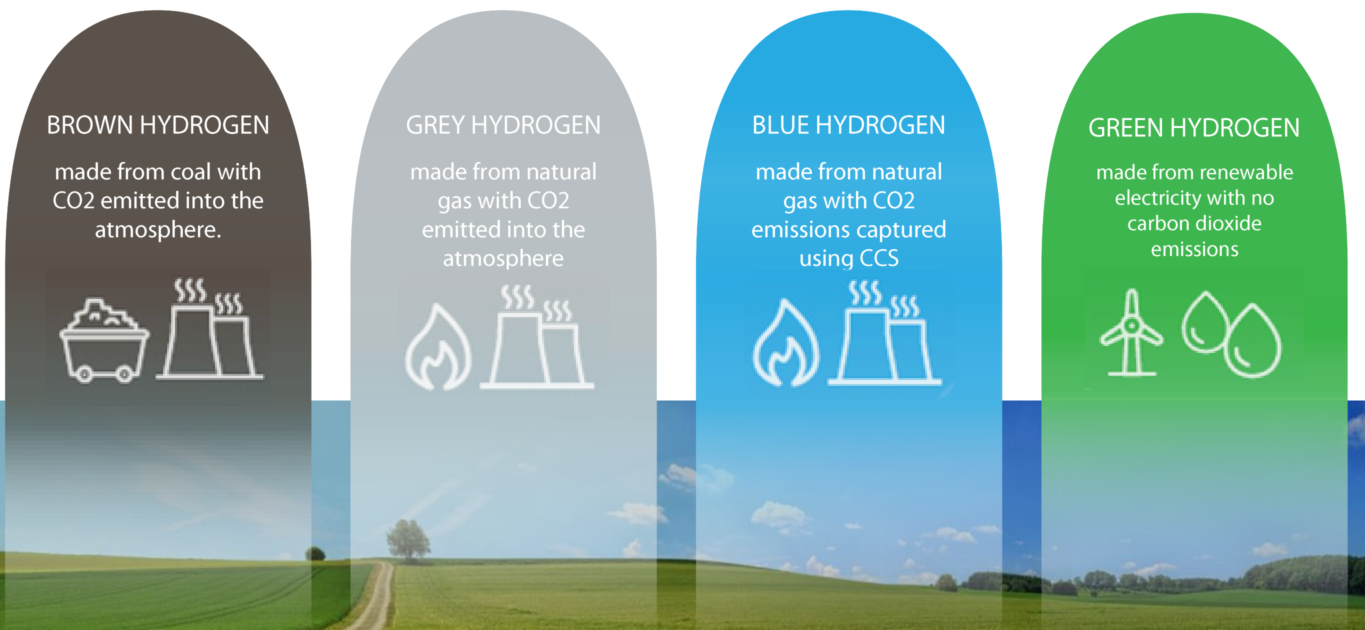
The use of fossil fuels to produce hydrogen yields undesirable waste greenhouse gases. However, these processes can be combined with carbon capture and storage (CCS) technology to store the waste emissions produced, preventing them reaching the atmosphere.

Alternately, renewable energy can be used to convert water to hydrogen via electrolysis, which is then stored in pressurised vessels or geologically, in aquifers, salt caverns or depleted natural gas fields – a process termed 'power-to-gas'.

An electrolyser uses electricity to split water into hydrogen and oxygen. This has the advantage of working at low temperatures (20-100°C) and giving off no greenhouse gas emissions. As long as it is powered by renewable sources, this is a carbon neutral system.

The different colours of hydrogen

Industry has denoted different sources of hydrogen with different colours:



While green hydrogen is the ultimate goal, deployment of blue hydrogen is viewed as necessary in the interim to help develop the overall market for hydrogen, as green hydrogen is typically 2-5x more expensive. The big challenge for this approach will be the economics of carbon capture and storage.

Costs for 'green' hydrogen are expected to decline as the technology evolves and economies of scale emerge with wider adoption. Any future taxes on CO2 emissions will also help level the playing field.

Source: Arrival. 1) Based on multiple sources

4. Hydrogen production cont.

Scale-up needed for hydrogen to become competitive

Currently, neither renewable hydrogen nor fossil-based hydrogen with carbon capture are widely cost-competitive against fossil-based hydrogen.

However, costs for renewable hydrogen are falling rapidly. Electrolyser costs have come down by 60% in the last decade and are expected to halve over the next, to under €500/kW, as the technology improves and is more widely adopted.

Research by the Hydrogen Council, a global industry initiative, suggests that ‘scale-up’ will be the biggest driver of the cost reduction in the hydrogen value chain, delivering competitive low-carbon solutions across a wide range of applications by 2030.

However, that scale up comes at a price. The Hydrogen Council estimates that achieving competitive green hydrogen from electrolysis by 2030 requires the development of 70 GW of electrolyser capacity, with a cumulative US$20bn required to fund the gap in production costs with grey hydrogen until cost parity is achieved.

Including blue hydrogen, transportation, building and industry heating, the economic gap between hydrogen and low-carbon alternatives is estimated at US$70bn.

A recent report by the International Renewable Energy Agency (IRENA) looked at Green Hydrogen cost reduction. The major cost component for green hydrogen is the electricity supply, where cost declines are already underway through the competitive deployment of renewables.

IRENA argues that green hydrogen can be cost-competitive with fossil-based hydrogen today in ideal locations with the lowest renewable electricity costs. However, the report finds that to widen the potential locations for green-hydrogen production, procurement and construction costs need to be reduced and the performance and durability of the electrolysers increased.

Policy support in recently unveiled hydrogen strategies in many countries is mostly in the form of explicit electrolyser capacity targets, which have not yet translated into specific regulatory instruments. IRENA also believes that these fall short of what is needed to achieve a decarbonisation pathway in line with the 1.5°C Paris climate goal.

Levelised cost of Hydrogen (LCOH2)

Studies by energy consulting, testing and certification company DNV GL have compared the expected cost of producing hydrogen using Steam Methane Reforming (SMR) and Electrolysis in 2017 and 2050.

The cost of producing hydrogen via SMR assumes a natural gas feedstock and takes into account the cost of carbon (€6/ton in 2016, €54/ton in 2050).

Two operating modes for the electrolyser were considered in 2050: continuous operation (8,000 hr/yr, €29/hr renewable electricity cost) and surplus hours operation (3,000 hr/yr, zero electricity cost). Under these scenarios, it is expected that electrolysis will compete with carbon-taxed SMR in the future as electrolyser technology improves and economies of scale are captured. DNV GL expects the break-even point to be reached before 2035.

Repsol is more optimistic and sees hydrogen electrolysis being competitive with hydrogen from fossil fuels by 2030, or sooner if the right regulatory framework is in place.

4. Hydrogen production cont.

Transporting hydrogen

While hydrogen has one of the highest energy densities by mass, it is not very energy dense by volume. High-pressure (200 bar) hydrogen gas is 18 times less energy-dense than gasoline. Even liquid hydrogen has a quarter the energy density of gasoline.

Liquefaction of hydrogen is more expensive than natural gas as it requires a lower temperature: -253°C vs -162°C. However, existing natural gas pipelines in the UK gas grid can potentially be used to transport hydrogen, connecting offshore generation/storage with businesses and homes.

High pressure transmission lines will need to be modified as steel can be damaged by high pressure (>7 bar) hydrogen (hydrogen embrittlement).

The distribution system is lower pressure, so the existing infrastructure can be utilised, although hydrogen leaks easily so connections will need testing.

Hydrogen burns at a higher temperature than natural gas, so boilers will require modification. This is a massive logistical undertaking – when the UK switched from town gas to natural gas, modification of gas appliances in 40 million homes took 10 years.

One interim suggestion to reduce GHG emissions is to mix hydrogen with natural gas. Blending 20% hydrogen into the gas mix would not require any equipment changes and could reduce CO2 emissions by ~6%.

Another option for transporting hydrogen is to convert it into liquid ammonia, which is seen as particularly suitable for the shipping industry. Ammonia provides high hydrogen storage densities as a liquid with mild pressurisation and cryogenic constraints. It can also be stored as a liquid at room temperature and pressure when mixed with water. Ammonia (NH3) releases hydrogen in an appropriate catalytic reformer, which can be combined with a fuel cell system.

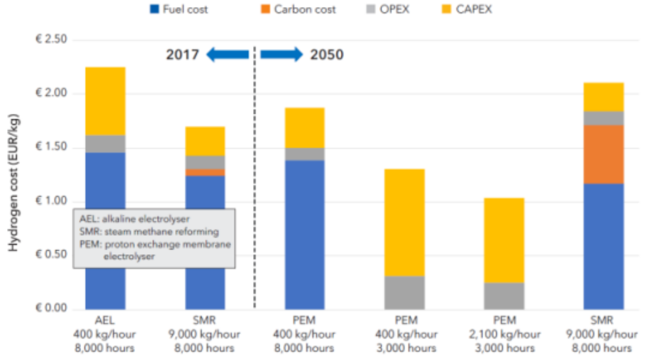
Hydrogen can ease UK infrastructure pressures

The UK's electricity distribution network has been sized according to the UK's power supply and demand profile. It cannot manage the demands of the heat and transport sectors as well, each of which have greater energy requirements and are currently supported by their own separate infrastructure.

Hydrogen can help. It offers a complementary alternative in hard to abate sectors, sharing many of the properties that make natural gas well suited to meet heat demand, whilst not containing carbon.

It also offers a viable mechanism for managing demand swings by providing a large-scale, long-term energy storage solution.

Global demand* for Hydrogen 2015 – 2020 (million tonnes)



Source: Air Liquide
* Projected global demand for hydrogen in a +2°C global warming scenario
Assumes HHV energy content of 1kg of hydrogen of 141.9 MJ

The UK has an established national gas grid, which could be repurposed for hydrogen, with hydrogen hubs developed around large industrial sites. This requires both public and private involvement alongside fiscal inducements and the regulatory framework to allow nascent technologies to evolve, much in the same way as renewable energy has been encouraged by the UK Contracts-for-Difference (CfD) scheme.

4. Hydrogen production cont.

Hydrogen combined with fuel cells is suitable for peak-load

Hydrogen can be used as a fuel, like natural gas, to generate electricity via conventional technologies, such as the internal combustion engine or gas turbines. Alternatively, it can be electrochemically converted in a fuel cell.

Fuel cells generate direct current and need an inverter to convert hydrogen to alternating current suitable for the pubic electricity grid. They promise highly efficient, emission-free power generation, fast start-up and shut-down and good part-load efficiency.

DNV GL estimate that by 2050 fuel cell generated electricity will be competitive with gas-turbines and that it is a suitable peak-load technology.

Source: tractebel-engie.com

Offshore hydrogen potential

Engineering company, Tractebel, part of the Engie Group, has developed a technology to produce hydrogen from offshore wind power at an industrial scale using electrolysis. The design utilises a repurposed North Sea offshore platform to deliver up to 400 MW of power and produce ‘green’ hydrogen. This includes the electrolysis units and transformers for the conversion of the electricity supplied by the offshore wind turbines into hydrogen, along with desalination plants for producing high-purity water required for the electrolysis.

Offshore-generated hydrogen can be transported in both pipelines and ships, allowing further expansion of wind turbines without straining limited electrical grid capacity.

Such technology could provide yet another lease of life for ageing North Sea oil and gas infrastructure, some of which dates back 45 years. Adoption is being slated for as soon as 2025, with the German federal government preparing invitations to tender for test fields for the conversion of electricity into hydrogen in its regional development plan for the North Sea and Baltic Sea.

The OYSTER project consortium, which includes ITM Power, Ørsted, Siemens Gamesa, and Element Energy, was recently awarded €5m by the EU to study offshore green hydrogen production. The award will be used to investigate the feasibility of a combined offshore wind turbine and electrolyser pilot system for transporting renewable hydrogen to shore.

The consortium is pursuing hydrogen produced from offshore wind at a cost that is competitive with natural gas, including a ‘realistic’ carbon tax, to unlock bulk green hydrogen markets. The project is planned to start in 2021 and run to the end of 2024.

5. Major hydrogen projects

The UK

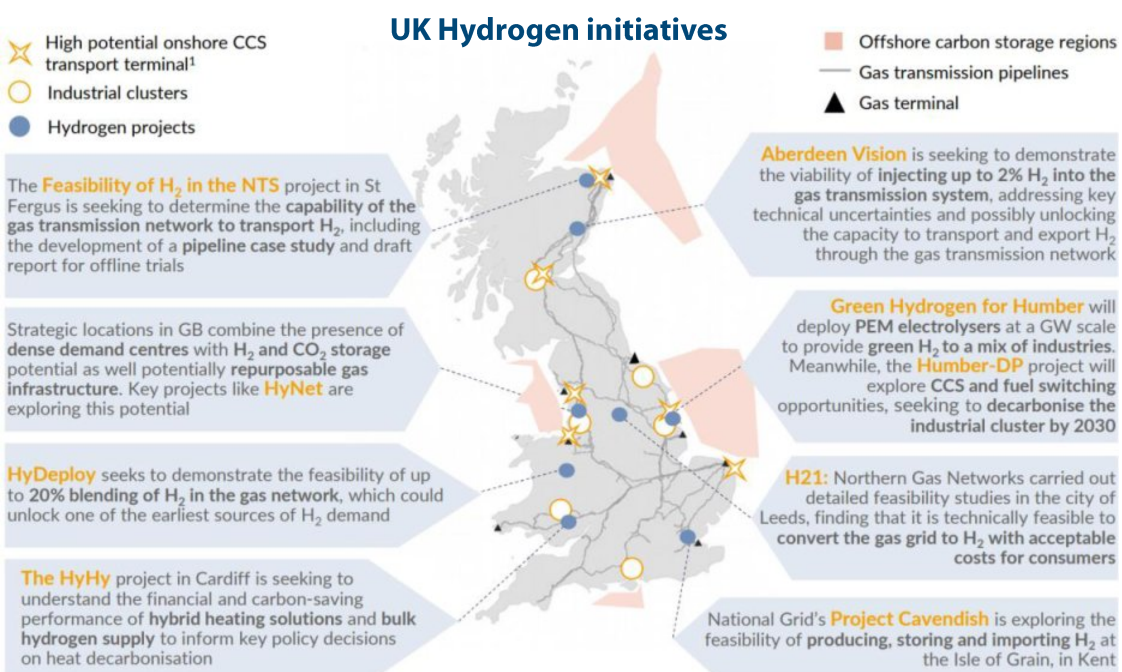
Around the UK numerous projects are underway aimed at decarbonising the UK's industrial regions. To date, these projects have focused on carbon capture and storage (CCS) in the industrial heartlands of Grangemouth, Humberside, Merseyside, Teesside and South Wales.

- HyNet North West will capture and store over 1 MTPA of carbon dioxide from industry in North West England and North Wales and store this offshore in depleted gas fields in Liverpool Bay. HyNet will also subsequently produce hydrogen as a fuel for both heating, power and transport. The first phase is expected to be operational by 2024.
- Zero Carbon Humber (ZCH) plans to capture CO2 from industrial processes around the Humber industrial area and sequester it using CCS under the Southern North Sea.
- Similarly, Net Zero Teeside (NZT) aims to decarbonise a cluster of carbon-intensive businesses around Teeside using CCS.
- The South Wales Industrial Cluster consortium have submit a public and private bid for a project to scope out a route to decarbonise industry in the South Wales region, the UK's second largest industrial emitter of carbon dioxide.

In the Orkney Islands, the BIG HIT project is aiming to create a hydrogen territory through a fully integrated model of hydrogen production, storage, transportation and utilisation for heat, power and mobility.

A number of UK projects, including HyDeploy and Hy4Heat, are looking to establish whether it is technically feasible, safe and convenient to replace natural gas with hydrogen in residential and commercial buildings and gas appliances. HyDeploy aims to prove that blending up to 20% volume of hydrogen with natural gas is a safe and greener alternative.

The Gigastack project involving ITM Power, Ørsted, Phillips 66 and Element Energy, aims to demonstrate the potential for renewable hydrogen derived from offshore wind, developing a blueprint for deploying scalable electrolyser technology across the UK. It was awarded £7.5m of funding from the Department for Business, Energy and Industrial Strategy last year for a Phase 2 FEED study on a 100MW electrolyser system.



1. Hydrogen Supply Chain Evidence Base – Element Energy

Source: Aurora Energy Research

5. Major hydrogen projects cont.

Global

Globally there are an ever-increasing number of pilots and projects emerging, some of the larger and more ambitious of which are summarised below. We have focused on larger industrial scale projects, but the removal of fossil fuels from the energy mix needs to occur all the way through the energy chain, right down to the boilers in your house. Small-scale and pilot projects investigating this 'last mile' end of the transition are becoming increasingly widespread.

REFHYNE project

This is a pan-European project involving the installation of a 10 MW hydrogen electrolyser at Shell's Rhineland Refinery in Wesseling, Germany. The project will utilise an ITM Power PEM electrolyser, the largest of its kind to be deployed on an industrial scale so far. The electrolyser design has been finalised and construction is underway.

The project is funded by the European Commission's Fuel Cells and Hydrogen Joint Undertaking (FCH JU) and will investigate the feasibility for wider adoption and determine the possible technical, economic and environmental benefits of the technology.

NorthH2 green hydrogen project

In February 2020, a consortium of Gasunie, Groningen Seaports and Shell launched the NortH2 green hydrogen project. Equinor has also recently joined the consortium.

NortH2 is an ambitious plan that aims to develop the first European Hydrogen Valley, linking new wind farms in the North Sea with a large electrolyser facility in Eemshaven, the Netherlands, potentially complemented with offshore electrolysers. The ambition is to generate around 3-4 GW of wind energy for hydrogen production before 2030, rising to 10 GW by 2040. Green hydrogen production is expected to be around 800,000 tonnes per annum by 2040.

Gasunie's natural gas infrastructure will transport the green hydrogen to industrial customers in the Netherlands and Northwest Europe. A feasibility study is expected to be concluded this year.

Lingen Green Hydrogen

BP and Ørsted signed a Letter of Intent to jointly develop industrial-scale production of green hydrogen. The proposed Lingen Green Hydrogen project involves an initial 50 MW electrolyser at BP's Lingen Refinery in north-west Germany. This will be powered by renewable energy generated by an Ørsted offshore wind farm in the North Sea and the hydrogen produced will be used in the refinery.

The electrolyser is expected to produce ~9,000 TPA of green hydrogen, sufficient to replace around 20% of the refinery's current hydrogen consumption and saving 80,000 tonnes of CO2 equivalent emissions a year.

BP and Ørsted plan to make a final investment decision in early 2022, with the project operational by 2024. The project is also intended to support a longer-term ambition to build more than 500 MW of renewable-powered electrolysis capacity at Lingen.

H-vision Rotterdam

The H-vision project includes 16 companies and organisations collaborating in a detailed study to explore the large-scale production and application of 'blue' hydrogen in the Port of Rotterdam industrial area, decarbonising natural gas and coal. It is also studying how residual gases from the refining and chemical industry can be utilised to further enhance sustainability.

Masshylia project

TOTAL and Engie are planning to build France's largest renewable hydrogen production site at TOTAL's La Mède refinery near Marseilles. The 40 MW electrolyser will be powered by 100 MW of solar farms and produce 5 tonnes of green hydrogen a day, avoiding 15,000 TPA of CO2 emissions. Construction is expected to start in 2022 with start-up planned for 2024.

5. Major hydrogen projects cont.

Global

Enel and Eni electrolyser pilots

Enel and Eni are jointly studying two pilot projects to supply green hydrogen to qualified Eni refineries. The two pilot projects will involve electrolysers of around 10 MW each and are expected to start generating green hydrogen by 2022-2023.

AquaVentus

RWE Renewables plans to produce green hydrogen directly at two 14 MW offshore wind turbines in the German North Sea using electrolysers directly integrated with the turbines. This is a pilot phase for the AquaVentus initiative, which has the long-term goal of a 10 GW offshore wind to hydrogen hub by 2035.

Longship CCS

In September, the Norwegian government proposed the Longship carbon capture and storage (CCS) project, which aims to capture CO2 from cement and waste-to-energy plants in Oslo, storing it offshore via the Northern Lights CCS project. The government has committed US$1.8bn to the project.

Fukushima Hydrogen Energy Research Field

In Fukushima Prefecture, which is still recovering from the devastating earthquake of 2011, the Fukushima Hydrogen Energy Research Field (FH2R) started up in March 2020 and is the world's largest-scale hydrogen production facility to date. It uses 20 MW of solar power to drive a 10MW electrolyser, capable of producing 1,000 TPA of hydrogen.

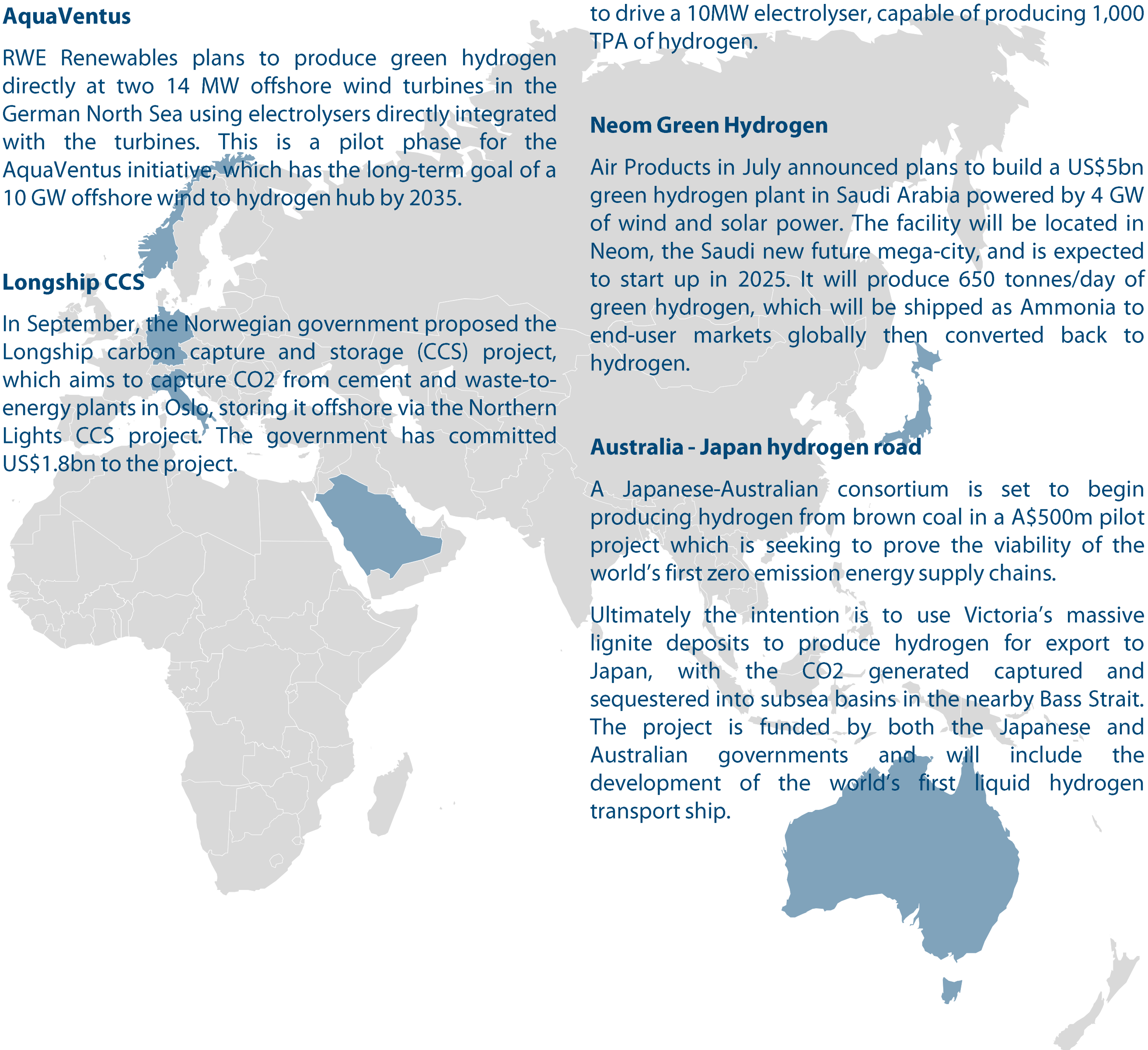
Neom Green Hydrogen

Air Products in July announced plans to build a US$5bn green hydrogen plant in Saudi Arabia powered by 4 GW of wind and solar power. The facility will be located in Neom, the Saudi new future mega-city, and is expected to start up in 2025. It will produce 650 tonnes/day of green hydrogen, which will be shipped as Ammonia to end-user markets globally then converted back to hydrogen.

Australia - Japan hydrogen road

A Japanese-Australian consortium is set to begin producing hydrogen from brown coal in a A$500m pilot project which is seeking to prove the viability of the world's first zero emission energy supply chains.

Ultimately the intention is to use Victoria's massive lignite deposits to produce hydrogen for export to Japan, with the CO2 generated captured and sequestered into subsea basins in the nearby Bass Strait. The project is funded by both the Japanese and Australian governments and will include the development of the world's first liquid hydrogen transport ship.



6. Fuel Cells and Electrolysers

The origins of fuel cells date back to the early nineteenth century, with the term ‘fuel cell’ first used in 1889. In 1932, Cambridge professor Francis Bacon developed the first alkaline fuel cell, but it took until 1959 for him to demonstrate a practical 5 kW fuel cell system. Before that, in 1955, General Electric’s Willard Grubb and Leonard Niedrach produced the first hydrogen- and oxygen-fuelled proton exchange membrane (PEM) fuel cell, which was ultimately used in NASA’s Gemini space programme in the mid-1960s.

A fuel cell produces electricity from a chemical reaction between hydrogen and oxygen using a catalyst, usually platinum. Fuel cells are unique in terms of the variety of their potential applications; they can provide power for systems as small as a laptop computer or as large as a utility power station.

A fuel cell is composed of an anode, a cathode, and an electrolyte membrane. Hydrogen is passed through the anode and oxygen through the cathode. At the anode site, the hydrogen molecules are split into electrons and protons. The protons pass through the electrolyte membrane, while the electrons are forced through a circuit, generating an electric current and excess heat. At the cathode, the protons, electrons, and oxygen combine to produce water molecules.

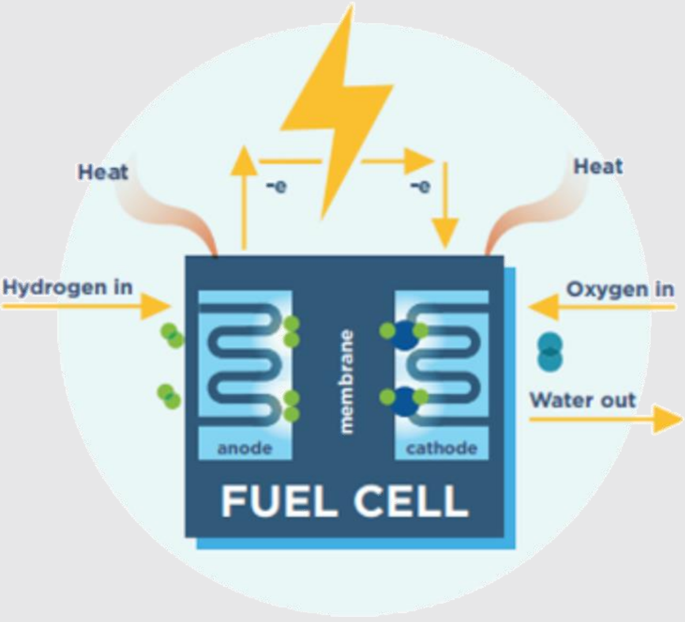
How fuel cells work

1 The hydrogen atoms enter at the anode.

2 The atoms are stripped of their electrons in the anode.

3 The positively charged protons pass through the membrane to the cathode and the negatively charged electrons are forced through a circuit, generating electricity.

4 After passing through the circuit, the electrons combine with the protons and oxygen from the air to generate the fuel cell’s by-products: water and hear.



Source: Fuel Cell & Hydrogen Energy Association

About a third of hydrogen produced today is a by-product from industrial processes. This hydrogen is not suitable for most fuel cells without further treatment as it contains small amounts of other gases and is not of high enough purity.

Fuel cells have a growing range of applications in both the stationary and transport markets. Stationary fuel cells provide clean, efficient, and reliable off-grid power to homes, businesses, telecommunications networks, utilities, and others.

Hydrogen fuel cells are well suited to long-haul trucking as hydrogen fuelled trucks have a similar range and refuelling time, but produce no harmful emissions.

Hydrogen trains have been running in Germany since 2018 and there are plans to introduce them in the UK and Japan.

This rise in Fuel Cell Electric Vehicles (FCEV), alongside Battery Electric Vehicles (BEV), means it is just a matter of time before the internal combustion engine is relegated to the status of the steam engine – a museum piece.

6. Fuel Cells and Electrolysers cont.

Fuel cell types

Fuel cells come in numerous guises including Polymer Electrolyte Membrane or Proton Exchange Membrane (PEM), Alkaline (AFC), Solid Oxide (SOFC), Phosphoric Acid (PAFC), Direct Methanol (DMFC), Molten Carbonate (MCFC) and Zinc Air (ZAFC). We shall focus on the first three as this encompasses most of the current investable companies.

Fuel cell technology characteristics

Fuel Cell Type	*Common Electrolyte*	*Operating Temperature*	*Typical Stack Size*	*Efficiency*	*Applications*	*Advantages*	*Disadvantages*
Polymer Electrolyte Membrane (PEM)	Perfluoro sulfonic acid	50-100°C 122-212°F Typically 80°C	<1kW-100kW	60% transportation 35% stationary	– Backup power – Portable power – Distributed generation – Transportation – Specialty vehicles	– Solid electrolyte reduces corrosion & electrolyte management problems – Low temperature – Quick start-up	– Expensive catalysts – Sensitive to fuel impurities – Low temperature waste heat
Alkaline (AFC)	Aqueous solution of potassium hydroxide soaked in a matrix	90-100°C 194-212°F	10-100kW	60%	– Military – Space	– Cathode reaction faster in alkaline electrolyte, leads to high performance – Low cost components	– Sensitive to CO_2 in fuel and air – Electrolyte management
Phosphoric Acid (PAFC)	Phosphoric acid soaked in a matrix	150-200°C 302-392°F	400kW 100kW module	40%	– Distributed generation	– Higher temperature enables CHP – Increased tolerance to fuel impurities	– Pt catalyst – Long start-up time – Low current and power
Molten Carbonate (MCFC)	Solution of lithium, sodium, and/or potassium carbonates, soaked in a matrix	600-700°C 1112-1292°F	300kW-3 MW 300kW module	45-50%	– Electric utility – Distributed generation	– High efficiency – Fuel flexibility – Can use a variety of catalysts – Suitable for CHP	– High temperature corrosion and breakdown of cell components – Long start-up time – Low power density
Solid oxide (SOFC)	Yttria stabilized zirconia	700-1000°C 1202-1832°F	1kW-2 MW	60%+	– Auxiliary power – Electric utility – Distributed generation	– High efficiency – Fuel flexibility – Can use a variety of catalysts – Solid electrolyte – Suitable for CHP & CHHP – Hybrid/GT cycle	– High temperature corrosion and breakdown of cell components – High temperature operation requires long start-up time and limits

Source: US Department of Energy

PEM fuel cell

Polymer electrolyte membrane or proton exchange membrane (PEM) fuel cells are the most commercialised type of fuel cell today. PEM fuel cells use a solid polymer as an electrolyte and porous carbon electrodes containing a platinum or platinum alloy catalyst. They need only hydrogen, oxygen from the air, and water to operate. They are typically fuelled with pure hydrogen.

Their low operating temperature (50-100°C), short start time and use of atmospheric air make PEM ideal for mobility solutions. They are durable, deliver high power density and have the advantage of low weight and volume compared with other fuel cells. PEM fuel cells have been used in most prototype and production FCEV cars, of which ~130,000 have been sold worldwide.

Disadvantages include the catalyst cost (typically platinum) and the fact that it is also sensitive to carbon monoxide poisoning, making it necessary to employ an additional reactor to reduce carbon monoxide in the fuel gas if the hydrogen is derived from a hydrocarbon fuel, adding to cost.

PEM fuel cells are used primarily for transportation applications and some stationary applications. Due to their fast start-up time and favourable power-to-weight ratio, PEM fuel cells are particularly suitable for use in passenger vehicles, such as cars and buses.

6. Fuel Cells and Electrolysers cont.

Fuel cell types

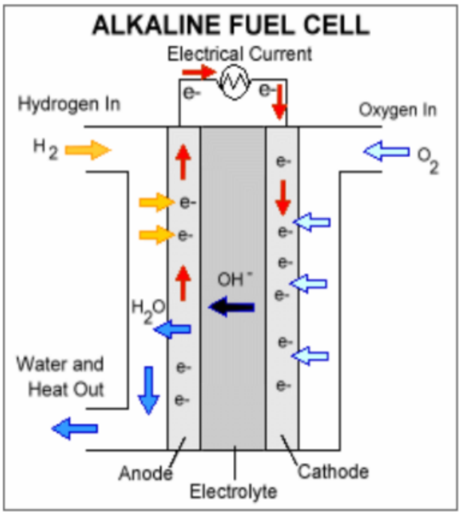
Alkaline Fuel Cells (AFC)

AFCs use alkaline electrolytes, such as potassium hydroxide solution, and a variety of non-precious metals as a catalyst at the anode and cathode.

The cell operates at 150-200°C and can generate anywhere from 300 W to 5 MW. AFCs' high performance is due to the rate at which electro-chemical reactions take place in the cell and they have demonstrated efficiencies above 60% in space applications.

AFCs have a better fuel tolerance, allowing use of lower purity, cheaper hydrogen. They also have the advantage of low-cost materials and manufacturing steps and a long operational life cycle. However, a key challenge for this fuel cell type is its susceptibility to CO2 poisoning, which affects cell performance and durability due to carbonate formation.

To address some of the issues dealing with liquid electrolytes, AFCs that use a polymer membrane as the electrolyte have also been developed. These are closely related to conventional PEM fuel cells except they use an alkaline instead of an acid membrane.



Source: US DoE

Solid Oxide Fuel Cell (SOFC)

SOFCs use a hard, non-porous ceramic compound as the electrolyte. Because of the electrochemical process and the resistance in the solid ceramic electrolyte, heat is also generated. SOFCs are 60%+ efficient at converting fuel to electricity, and in waste heat co-generation applications can top 85%.

SOFCs operate at very high temperatures, up to 1,000°C, which removes the need for precious-metal catalysts, reducing cost. They are also the most sulphur-resistant fuel cell type and are not poisoned by carbon monoxide. This allows SOFCs to use a wider range of fuels than just hydrogen, including natural gas, biogas, and gases made from coal.

High-temperature operation has disadvantages too. It results in a slow start-up and requires significant thermal shielding to retain heat and protect personnel, which makes it less suitable for transportation. The high operating temperatures also place stringent durability requirements on materials.

The development of low-cost, durable materials at cell operating temperatures is one of the key technical challenges. SOFCs have been developed that have operating temperatures below 700°C (e.g. Ceres Power, Elcogen), which means fewer durability issues and lower cost materials.

Fuel cell stacks and systems

Single fuel cells provide limited amounts of power and are therefore combined into stacks. A stack consists of multiple single cells, which are separated by similarly shaped metal interconnector plates. These connect single cells in series and contain channels for air and fuel distribution. One or multiple stacks can be integrated into a fuel cell system.

A fuel cell system also contains various components for fuel distribution, thermal management, power conversion, controls etc., which are known as the Balance of Plant (BoP). These systems can generate efficient power in multiple applications – residential, commercial, industrial and transportation.

PEM fuel cells currently dominate the market, accounting for over 80% of shipments in the first nine months of 2019, according to consultants, E4tech. In the last five years, fuel cell growth has been driven by the transport sector in particular.

6. Fuel Cells and Electrolysers cont.

Electrolysers

Electrolysers are essentially fuel cells working in reverse, using electricity to break water into hydrogen and oxygen. The electrolysis of water occurs through an electrochemical reaction that does not require external components or moving parts. It is very reliable and can produce ultra-pure hydrogen (>99.999%) in a non-polluting manner when combined with renewable energy.

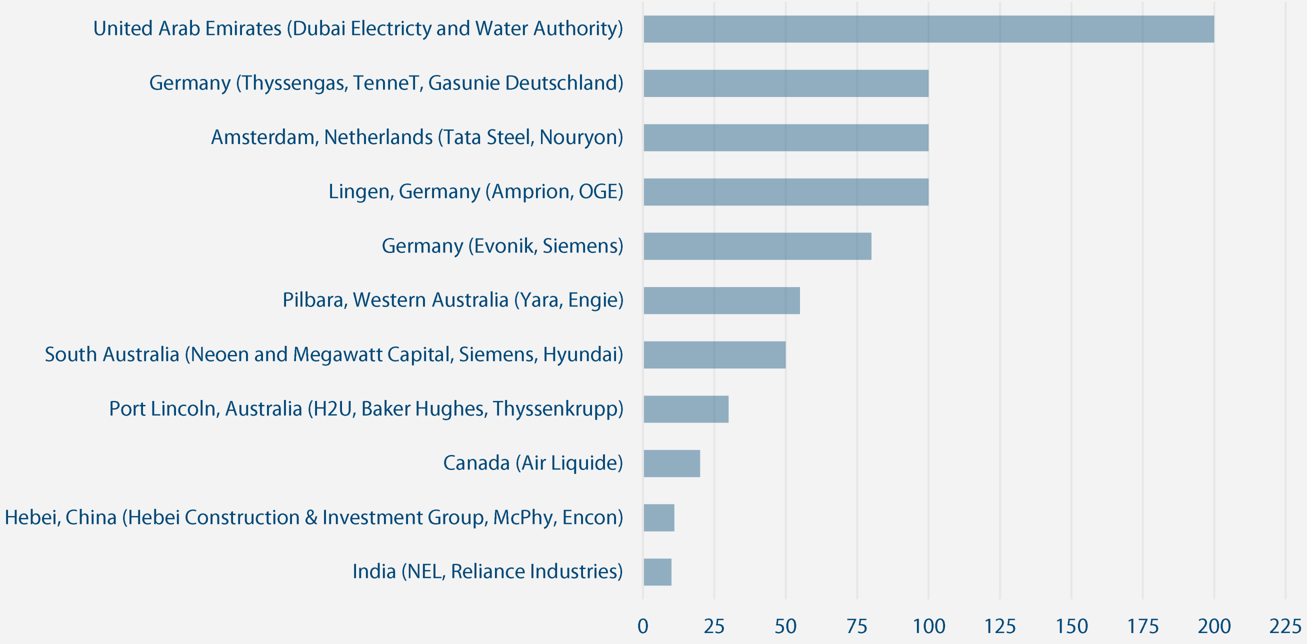
Electrolysers are typically divided into four main technologies: Alkaline, Proton Exchange Membrane (PEM), Anion Exchange Membrane (AEM) and Solid Oxide (SO). As with fuel cells these are distinguished based on the electrolyte and temperature of operation, which in turn determine material and component selection.

Many variations within each technology exist, with the largest differences related to cell design, variation within components, and degree of technology maturity. SO and AEM have high potential, but are less mature technologies, with only a few companies and original equipment manufacturers (OEMs) involved in their manufacture and commercialisation, mostly based in Europe.

Hydrogen produced from electrolysers is perfect for use with hydrogen fuel cells. The reactions that take place in an electrolyser are very similar to those in fuel cells, except the anode and cathode reactions are reversed. In a fuel cell, the anode is where hydrogen gas is consumed, and in an electrolyser, the hydrogen gas is produced at the cathode.

According to the Fuel Cell & Hydrogen Energy Association (FCHEA), there are 11 hydrogen electrolyser projects in development globally with an expected capacity of over 10 MW. A solar-driven project by the Dubai Electricity and Water Authority is expected to have a capacity of 200 MW by 2025 and would be the largest hydrogen electrolyser.

Global hydrogen electrolyser projects* (MW)



Source: FCHEA, Statista
* Largest proposed hydrogen producing sites as of 2020, with expected installed capacity by 2025

7. The Clean Dozen

Ways of gaining pure play exposure to the hydrogen clean tech theme both in the UK and globally are limited. This is still a nascent business and many companies pursuing hydrogen technology are held within larger conglomerates or are still private.

Below we highlight a dozen companies listed globally with electrolyser/fuel cell technology that plays into the hydrogen economy theme. Four of these are listed in the UK:

AFC Energy (AFC-GB, Mkt cap US$672m) – AFC provides Alkaline Fuel Cell systems for clean energy generation via its patented Hydrogen Power (H-PowerTM) systems. It has also developed an EV fuel cell charging platform – CH2ARGE™.

Ceres Power (CWR-GB, Mkt cap US$3.4bn) – Ceres' fuel-flexible SteelCell® solid oxide fuel cell technology generates power from conventional fuels like natural gas and from sustainable fuels like biogas, ethanol or hydrogen.

ITM Power (ITM-GB, Mkt cap US$4.7bn) – ITM manufactures electrolyser systems for green hydrogen gas production based on Proton Exchange Membrane (PEM) technology.

Proton Motor Power Systems (PPS-GB, Mkt cap US$1.1bn) – Proton develops its own PEM fuel cells and combines them with selected, tailor-made components for integration-ready fuel cell and hybrid systems for stationary, mobile and maritime applications.

McPhy Energy (MCPHY-FR, Mkt cap US$1.1bn) – McPhy manufactures alkaline electrolysers for on-site hydrogen production and modular hydrogen refuelling stations for powering all forms of transport.

NEL ASA (NEL-NO, Mkt cap US$5.2bn) – NEL supplies scalable electrolysers utilising alkaline and PEM technologies, modular hydrogen refuelling stations and renewable energy storage solutions for industrial / energy purposes.

PowerCell Sweden (PCELL-SE, Mkt cap US$2.5bn) – PCELL develops and produces PEM fuel cell stacks and systems for automotive, marine, and stationary applications. They are designed to work on natural gas as well as pure hydrogen.

SFC Energy (F3C-DE, Mkt cap US$402m) – SFC supplies direct methanol and hydrogen PEM fuel cells for stationary and mobile hybrid power supply solutions for Clean Energy & Mobility, Defence & Security, Oil & Gas and Industry markets.

Ballard Power Systems (BLDP-CA, Mkt cap US$10.3) – Ballard manufactures PEM fuel cells systems and services for stationary, mobile and maritime applications.

FuelCell Energy (FCEL-US, Mkt cap US$6.9bn) – FCEL develops distributed baseload power solutions through proprietary molten-carbonate fuel cell technology. It develops turnkey distributed power generation solutions and provides comprehensive services for the life of the power plant.

Plug Power (PLUG-US, Mkt cap US$31.9bn) – PLUG produces PEM fuel cell systems for electrical applications across a broad spectrum of high-asset utilisation transportation, robotic, aerial, and stationary power applications.

Doosan Fuel Cell Co. Ltd (336260-KR, Mkt cap US$3.7bn) – Doosan supplies phosphoric acid fuel cell systems for the stationary fuel cell market.

The share prices of these companies have exploded over the last two years, rising by over 1300% on average. Performance accelerated last year as the energy transition and hydrogen economy picked up an unstoppable momentum. Since 2020, the companies are up over 550% on average, 3.5x the S&P Global Clean Energy index performance.

7. The Clean Dozen cont.

Valuation of these hydrogen clean tech companies is challenging as, despite electrolyser/fuel cell technology being around for a long time, it is largely still in development and the market lacks scale. As such, profitability is low, but if electrolyser/fuel cell technology follows the same cost curve as wind and solar as it scales up, that should change rapidly.

We have focused on EV/Sales for the valuation as there are very few consensus EBITDA or earnings estimates. This reflects the size of the companies, their maturity and the uncertain financial outlook – few currently make any profits. Even then, they trade on an average EV/Sales multiple of over 80x 2021 and 50x 2022.

There are outliers. **Doosan Fuel Cell of Korea** is the most mature company and generates the highest forecast revenues, which at over US$850m in 2022 is multiples of the peer average. The next largest by revenues, **Plug Power**, now trades at 47x 2022 EV/Sales after the share price doubled in a week after announcing a tie-up with Renault! Both of these companies do have consensus EBITDA estimates, although at 42x and 280x 2022 EV/EBITDA respectively, I am not sure that means a great deal.

At the other end of the spectrum, **AFC Energy** and **Ceres Power** trade at 80-110x 2022 EV/Sales. This is pure theme investing. All investors can do at this stage is pick a technology and a management team to deliver on a growth strategy and take something of a leap of faith. There really is little in the way of valuation to justify an investment, with further technical advancements and scale-up needed to improve profitability.

Given historic performance and valuations, it is tempting to view this as just another bubble. However, we are still in the early stages of a deep rooted and powerful structural global theme and valuation will likely continue to play second fiddle to momentum – just look at Tesla.

With any emerging technology, there will be winners and losers, although the potential scale and breadth of the market suggest there is the room and the need for multiple players and approaches.

Scale up is often the most challenging aspect, from a technical, timescale and funding perspective. Publicly listed players face competition from larger technology players like GE, Siemens Energy, Cummins, Aisin Seiki, Mitsubishi Heavy Industries, Panasonic, Kyocera and Sumitomo. Schlumberger has also entered the market, forming a new private-public venture, Genvia, to focus on the development and industrial deployment of solid oxide electrolyser/fuel cell technology.

These companies/partnerships will have access to deep engineering resources and established supply chains while access to growth capital can be easier, although that didn't prove the case in 2020.

7. The Clean Dozen cont.

Funding activity

In the UK market, AFC Energy raised £35m last year, Ceres Power raised £49m in April and ITM £135m in October 2020. Funding activity has been even greater in North America. FuelCell Energy has raised US$234m in two deals since September. Ballard Power Systems raised C$522m last November. Plug Power raised over US$1.3bn in 2020, the most recent US$845m last November, and saw SK Group recently inject US$1.5bn into the company for a 9.9% stake.

UK players use extensive partnerships

Strategic partnerships and licensing agreements with OEMs are widely used strategies to augment or improve technical, manufacturing and distribution capabilities. The UK's **AFC Energy**, **Ceres Power** and **ITM Power** have used this approach to good effect.

AFC Energy partnered with **De Nora** for development and mass manufacture of fuel cell electrodes, **Advanced Plastics Ltd** for mass manufacture of its fuel cell flow plates, and **Rolec Services** to integrate its EV charger system with Rolec's charge point infrastructure.

More recently it signed an agreement with **BK Gulf** to scale up manufacturing capacity of the containerised fuel cell balance of plant for its fuel cell system. It also recently formed a strategic partnership with **ABB** to develop a high-power EV charging product.

Ceres Power has strategic collaborations with **Bosch** and **Weichai Power**, both of which have taken an ~18% stake in the company. It is working with Bosch to develop and manufacture solid oxide fuel cell (SOFC) systems and Weichai to create a fuel cell manufacturing JV in China and a license agreement to transfer key technology to the JV.

It also has strategic partnerships with **Japan's Miura Co**. for combined heat and power and **Doosan** for utility scale fuel cell stacks. Most recently, Ceres signed a strategic partnership with powertrain engineering consultancy, **AVL**, for development of SOFC technology for numerous transportation, stationary or other applications.

ITM Power formed a 50/50 JV with **Linde AG** to focus on delivering green hydrogen to large-scale industrial projects, with Linde taking a ~18% strategic stake in ITM. It collaborates with **Iwatani Corp** for the deployment of multi-MW electrolyser based hydrogen energy systems in North America and has a strategic partnership with **Sumitomo Corp** for the development of multi-MW projects in Japan.

More recently, ITM entered into commercial partnership with **Snam**, making it the preferred supplier for the first 100 MW of PEM electrolysis projects ordered by Snam. ITM's strategic partner, Linde, has also signed an MoU with Snam to jointly develop clean hydrogen projects and related infrastructure in Europe.

ITM also formed a strategic partnership with **ScottishPower Renewables** and **BOC** (a Linde company) called **'Green Hydrogen for Scotland'**. The intention is to create new green hydrogen production facilities with clusters of refuelling stations across Scotland. It also has a UK hydrogen refuelling collaboration with Shell, which runs until 2024.

A number of private players are also waiting in the wings. In Europe, this includes:

- **Elcogen** in Estonia, which manufactures solid oxide fuel cells and stacks that have achieved a world record primary energy conversion efficiency to electricity of 74%.
- **GreenHydrogen** in Denmark, which utilises modular alkaline electrolysis technology in hydrogen supply systems for refuelling stations, power-to-X installations, and industrial facilities. It is PE backed by Nordic Alpha Partners.
- The VC backed team at **Convion** in Finland have been developing solid oxide fuel cell technology since 2000 and are developing integrated SOFC systems for distributed power generation.

M&A shouldn't be ruled out either as larger players or new entrants seek to get a foothold or advance their strategic positions. **Plug Power** acquired **Giner ELX** in June 2020, a producer of PEM electrolyser stacks and systems.

Find out more about **The Clean Dozen** companies covered in this report, their performance and operations

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Photo by Matt Howard on Unsplash

finnCap

Selected Energy transactions

Clofina

secured senior debt facilities from

fiRST first financial bank

REFINANCING

Energy

SAVANNAH

£2.3m Placing

£26.6m Market Cap

NOMAD AND BROKER

September 2020

PRESIDENT ENERGY

£3.1m Placing

£30m Market Cap

NOMAD AND BROKER

June 2020

Kazera Global

£750k Placing

£4.6m Market Cap

NOMAD AND BROKER

June 2020

GEMFIELDS

Dual listing on AIM

£130m Market Cap on admission

NOMAD AND BROKER

February 2020

SAVANNAH

£5m Fundraise

£23m Market Cap

BROKER

September 2019

IOG INDEPENDENT OIL & GAS PLC

£18.6m Fundraise and Open Offer

£15m Market Cap

NOMAD AND JOINT BROKER

April 2019

IOG INDEPENDENT OIL & GAS PLC

adviser in defence from hostile bid by

ROCKROSE ENERGY

TAKEOVER

March 2019

PRESIDENT ENERGY

£3.5m Fundraise

£88m Market Cap

NOMAD AND JOINT BROKER

March 2019

Europa Oil & Gas

£4m Fundraise and Open Offer

£5m Market Cap

NOMAD AND BROKER

November 2018

CHARIOT OIL & GAS

£10.7m Fundraise

£41m Market Cap

NOMAD AND JOINT BROKER

February 2018

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Measuring your sustainability?
There's an app for that

For businesses today, the smart investment increasingly favours companies committed to sustainability and ESG. Indeed, it is only a matter of time before this becomes obligatory.

More and more, companies have a need to understand their ESG impact and be able to report on it to investors.

Our partnership with WWG

finnCap Group is partnered with leading sustainability fintech World Wide Generation (WWG), combining the powers of our ESG Scorecard with WWG's new digital sustainability monitoring and measurement app, Company Tracker, to create a sustainability reporting tool.

finnCap's recently launched ESG Scorecard provides small and mid-cap quoted companies with an objective means of measuring their ESG performance against key policies, standards, and frameworks. These metrics are incorporated into Company Tracker.

About the WWG Company Tracker app

- Company Tracker is an App on a global multi-stakeholder platform, G17Eco
- Empowers companies to monitor and measure their sustainability risks and opportunities
- Enhances credentials with investors who increasingly demand companies prove their impact on society, the economy, and the environment
- These impacts are mapped to Sustainable Development Goals (SDGs)

The launch of Company Tracker follows new research highlighting that SMEs' recognition of the importance of ESG has not translated into action. This new partnership between finnCap and WWG aims to close this gap, facilitating the coherent and evidence-based reporting of ESG activities that investors want from firms.

To find out more about implementing WWG Company Tracker, please contact:

John Paul (JP) Hamilton at WWG, jp.hamilton@worldwidegeneration.co , T: +44 (0) 20 8103 2030

WWG is the technology partner for the UK Government and City of London backed Sustainable Development Capital Initiative. Further to the finnCap partnership, WWG has been securing major global partnerships to support the whole ecosystem of companies (big and small), assurers, rating agencies, data providers, investors. Most recently the United Nations Data Hub has also mandated WWG as their technology partner for cities and governments to also report their sustainability data through the G17Eco platform.

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