UK HFCA

The case for Green Hydrogen

UK Hydrogen and Fuel Cell Association Position Paper

Key messages:

Green hydrogen **is essential** to the UK government's Net Zero ambitions

The UK can deploy **10GW of green hydrogen by 2030** and reach up to **80GW by 2050** with the right policy support,

A **price target of £2kg** as the average green hydrogen price across projects by 2030 is achievable if investments are made today,

Investing in green hydrogen today will create **significant long-term economic opportunities** for UK Plc,

The UK can become a significant green hydrogen exporter, thus supporting decarbonisation of other markets and generating income for the UK economy,

Short term thinking must be avoided to prevent the errors that encouraged offshoring of manufacturing opportunities for the wind industry,

A UK hydrogen strategy must have **green hydrogen at its core** and establish clear mechanisms to rebalance the current level of fossil fuel subsidies.

Green Hydrogen is essential to achieve Net Zero

Background

It is widely recognised that green hydrogen is an essential component of a future low carbon economy. This has been affirmed by the CCC, IRENA, IEA, Hydrogen Council, World Energy Council, BEIS itself and various trade groups such as the CBI, RenewableUK, UKHFCA and the Food & Drink Federation as a low carbon zero emissions at point of use fuel for the future. Several countries have published standalone hydrogen strategies, including the Netherlands, Germany, Portugal, France, Japan, and Australia, and others including Canada, the US and UK which will be publishing strategies over the coming months. The challenge is therefore to develop a clear roadmap that accelerates both the supply of green hydrogen and market demand.

We define green hydrogen as the generation of hydrogen from renewable resources. Most commonly this refers to the production of hydrogen from electrolysis and renewable power, but it also includes the production of hydrogen from wastes and other bioenergy sources through hydrocarbon reforming or pyrolysis. While we expect electrolysis will provide the bulk of green hydrogen production in the UK, bioenergy-sourced hydrogen offers a possible route to net-negative GHG emissions. This could apply to biogas reforming or pyrolysis projects generating no GHGs, or connected to carbon capture and sequestration infrastructure, which may deliver greater CO2 reductions than direct injection into the gas grid or combustion in single cycle turbines.

Image: ITM Power

Green hydrogen has the potential to become a leading sector in the UK for job creation and exports. The UK is currently a global leader in the manufacture and design of hydrogen electrolysis systems, with decades of expertise in hydrogen storage, transportation, and combustion technologies. Examples include the world's first PEM electrolysis Gigafactory built by ITM Power, membrane free electrolysers developed by CPH2, and high resiliency electrolysers built for the UK & French nuclear fleets by TP Group. Other emerging technologies Include Solid Oxide Electrolysers currently under development by CERES Power and HiiROC's plasma process technology. Supporting these highly specialised businesses and other innovative technology companies require highly skilled workers creating thousands of well-paid manufacturing jobs across the UK will provide a competitive advantage towards an emerging global market demand.

The UK faces one of the most ambitious energy transition timeframes ever attempted by a modern economy. In the next 30 years, this transition will require the conversion of over

20 million gas connected homes[1] to zero emission fuel, decarbonisation of more than 35 million passenger vehicles[2], reduction of industrial emissions without offshoring jobs and economic opportunities, whilst changing diets and consumer spending habits on the largest government debt-to-GDP ratio seen outside of wartime.

The economic and climate case for hydrogen in the UK should form a core plank of the Post-COVID economic "build back green" recovery. According to analysis conducted by the Hydrogen Taskforce, a commitment to hydrogen by the government and supported by appropriate measures, could create over 74,000 jobs and generate up to £18billion of GVA for the UK per annum by 2035. The FCU JU estimates that by 2030 the hydrogen economy could generate almost Eur 3 Billion in GVA for the UK and create up to 45,000 jobs[3], while the Offshore Renewable Energy Catapult estimated that by 2050 the hydrogen industry could generate up to £320billion for the UK economy and sustain up to 120,000 jobs[4].

Barclays for example, suggests that global electrolyser sales will increase to over $85 billion a year by 2050 (from under $2bn a year today). UK companies are well positioned to capture this significant opportunity if a sufficiently robust early market for green hydrogen can be developed locally.

74,000

jobs could be created from a commitment to hydrogen by the government and supported by appropriate measures

£320bn

could be generated by the Hydrogen industry for the UK economy

National Grid Future Energy Scenario (FES) 2020, UK green hydrogen capacity from electrolysis, and other Net Zero hydrogen, could grow by ~600,000 tonnes to

7.4m

tonnes per year by 2050

We highly recommend that the UK government support domestic hydrogen-focused businesses with sufficient national opportunities to allow them to achieve scale, at which they can compete internationally. In this context incentivising hydrogen production is essential. According to the National Grid Future Energy Scenario (FES) 2020, UK green hydrogen capacity from electrolysis, and other Net Zero hydrogen, could grow by ~600,000 tonnes to 7.4 million tonnes per year by 2050, which represents a total growth of 90% and 1100% from current installed capacity. An additional 250TWH of renewable electricity will need to be generated to meet this green hydrogen demand in the most ambitious scenario. These growth figures are conservative compared to other estimates, such as Aurora Energy who forecast between 7M to 21M tonnes per year by 2050.

1 ONS, 2020, https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families#:~:text=Families%20and%20households%20in%20the%20UK%3A%202019&text=In%202019%2C%20there%20were%2019.2,over%20the%20last%2010%20years.

2 Gov.UK, 2020, https://www.gov.uk/government/statistics/vehicle-licensing-statistics-2017#:~:text=In%202017%2C%20there%20were%3A,the%20end%20of%20the%20year

3 FH JU, 2020, https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20United%20Kingdom%20%28ID%209474120%29.pdf

4 OREC, 2020, https://ore.catapult.org.uk/press-releases/offshore-wind-green-hydrogen-economic-boom-ore-catapult-owic/

Ready to go policies to support green hydrogen

There are existing policies that, if amended, could deliver significant growth in green hydrogen production without requiring substantive and complex changes in policy.

These include:

- A ten-year moratorium on VAT for green, and Net Zero, hydrogen production,
- Enhanced Capital Allowances that apply to the whole CAPEX for an electrolysis, compression, storage and distribution project,
- A partial exemption for electrolysers from the use-of-system fees that apply to the electricity sector,
- Inclusion of rail, maritime, aviation and non-road machinery, within the RTFO mechanism,
- Allowing hydrogen produced from existing renewables, but which are curtailed to qualify for the RTFO even when the electrolyser is not connected via a private wire.
- Allowing hydrogen produced from grid-connected electrolysers via PPAs with renewable power providers
- Allowing hydrogen from biowaste, (with carbon capture) to qualify under the RFTO dRFTC mechanism.
- Extension of RTFO requirements on fuel suppliers after 2032.
- Allowing green hydrogen to qualify for the green gas levy, whether injected into the gas grid or consumed on client site in-lieu of other fossil fuels,
- Inclusion of hydrogen fuelling infrastructure for funding available from the Office of Low Emission Vehicles (OLEV), in addition to direct funding of hydrogen fuelling station (HRS) capital costs
- Co-location of green hydrogen production and HRS with EV rapid charging mega sites ,
- Learning best practise from other markets, e.g. Article 58 in the French Finance Law that encourages the use of green hydrogen in refineries.

Short- and Medium-term policies to support green hydrogen

To achieve the levels of green hydrogen production the UK necessary to meet the ambitions of the government, the CCC and industry, a mixture of supply side and demand side measures will be needed over the short and medium term to promote hydrogen across the three sectors with the greatest potential decarbonisation opportunities in the UK.

These are:

Transportation – Transport is the single largest source of UK emissions. Hydrogen will be crucial for decarbonisation road and off-road applications such as buses, commercial vehicles and heavy-duty transport, trains, maritime shipping, aviation and other non-road mobile machinery.

Industrial and domestic heat – Across Westminster and regional governments there is growing recognition of the role hydrogen can play in decarbonising heat. The UK Department for Business, Energy and Industrial Strategy has recognised that hydrogen presents the greatest industrial fuel switching potential compared to other technology alternatives5 for boilers, burners and other high temperature processes. Given the high energy density of hydrogen gas, there is an opportunity to reduce emissions from hard-to-decarbonize industrial and manufacturing

5 BEIS 2018 Industrial fuel Switching report

processes with high heat requirements. The CCC in its 6th carbon budget6 called for up to 25TWh of manufacturing fuel switching via hydrogen and electrification, with funding mechanisms to support Capex and Opex for hydrogen use in manufacturing from 2022. Similarly, the Government's Council for Science & Technology's letter from Sir Patrick Vallance (Chief Scientific Advisor) and Prof Dame Nancy Rothwell to Minister Kwarteng during autumn 2020, states "The two key sectors which appear to have the strongest potential for hydrogen application are 'point to point' road transport (e.g. buses, trucks) and home heating."

Industrial processes: Existing users of hydrogen – The UK produces approximately 700,000 tonnes of hydrogen per year, 99% of which comes from Steam Methane Reformation (SMR) of hydrocarbons and is associated with significant GHG emissions[7]. The bulk of this hydrogen is used as a process gas for the manufacturing and refining sectors. Green hydrogen can play a key role in reducing these emissions and creating new "green chemical" products in an existing hydrogen market. Examples include green steel projects in Sweden and Austria, as well as green ammonia in Australia and in the UK.

On the demand side it is essential that government starts to move the true economic cost of energy, when factoring in climate and CO_2 emissions, onto end users. Current government policies act as a tacit subsidy on fossil fuels, with some policies providing an overt subsidy such as the red diesel scheme and the continued deferral of planned fuel duty increases. Research conducted by BNP Paribas Asset Management suggests that for the EU to credibly meet its 2050 Net Zero goal it must impose a carbon tax of between Eur 79 - Eur 103 per tonne by 2030. As an example from elsewhere, Norway plans to raise its carbon tax from 590 krona (~£50) per tonne currently to 2,000 krona (~£170) per tonne by 2030, a three-fold increase, as part of targets to cut greenhouse gas emissions by 50-55% by 2030 compared with 1990 levels[8]. There is some early evidence that UK Treasury are supportive of this type of approach, and is amenable to the case made by the Zero Carbon Campaign that the UK should have an average carbon price of £75 a tonne by 2030. This would incidentally align with the BEIS Base Case forecasts for a UK carbon price of £80 a tonne by 2030 that have been used in their modelling assumptions for the past three years.

However, it is also clear that some form of supply side price support will be needed to avoid carbon offshoring by UK manufacturers and to ensure that climate policy supports, rather than undermines the government's economic strategy. To that end, it is essential that Treasury works alongside BEIS, OLEV and DfT to ensure that sensible mechanisms can be implemented in a phased approach that reflects the maturity of the industry as it scales, and the corresponding changes in the cost of green hydrogen production.

Wind to electrolyser okrney

6 CCC, 2020, https://www.theccc.org.uk/publication/sixth-carbon-budget/
7 Definitions of hydrogen colours - https://www.enapter.com/hydrogen-clearing-up-the-colours
8 https://www.reuters.com/article/us-climate-change-norway/norways-plans-to-raise-carbon-tax-draw-oil-industry-ire-idUSKB-N29D1BD

Image: BOC Limited, a Linde company

The most obvious supply side measure would be to facilitate electrolysers access to wholesale electricity prices, during low demand periods due to the rising penetration of variable renewables. Green hydrogen production can provide a substantial and firm market for low-cost renewable energy while also offering flexibility to the system operator, in managing the future high-RES grid without incurring curtailment fees. Co-location of new utility-scale renewable energy projects with electrolysers can also help maximize the economics of power projects. Beneficial supply policies could include partially waiving grid fees, giving preference in the electricity capacity market to flexible electrolysers over CO2-emitting gas turbines, and establishing favourable electricity tariffs for electrolysers that operate on a demand-response basis or only during designated periods.

An example is the removal of grid fees and levied charges for green hydrogen projects, similar to legislation enacted in Germany and Austria. This approach would not only improve existing project economics but would also ensure a stronger value for money approach for future green hydrogen projects that may be eligible for any future BEIS hydrogen support mechanism, notably a CfD (Contract for Difference). A worked example of this can be found in the appendix.

Additional new mechanisms could be introduced to bolster green hydrogen supply in the UK. The most tried and tested method for securing long term investment and rapid scale for non-transport projects is a direct production price support mechanism such as a Feed-in-tariff (FIT), which could incentivise gas grid operators to increase their share of renewable gas. Over the longer term, a CfD model for dedicated offshore wind to green hydrogen projects could deliver enormous volumes of 100% renewable hydrogen whilst also offering stability services for the power grid. Greater volumes of green hydrogen supply will drive down costs, offering an economic alternative to traditional hydrocarbon-based transportation fuels.

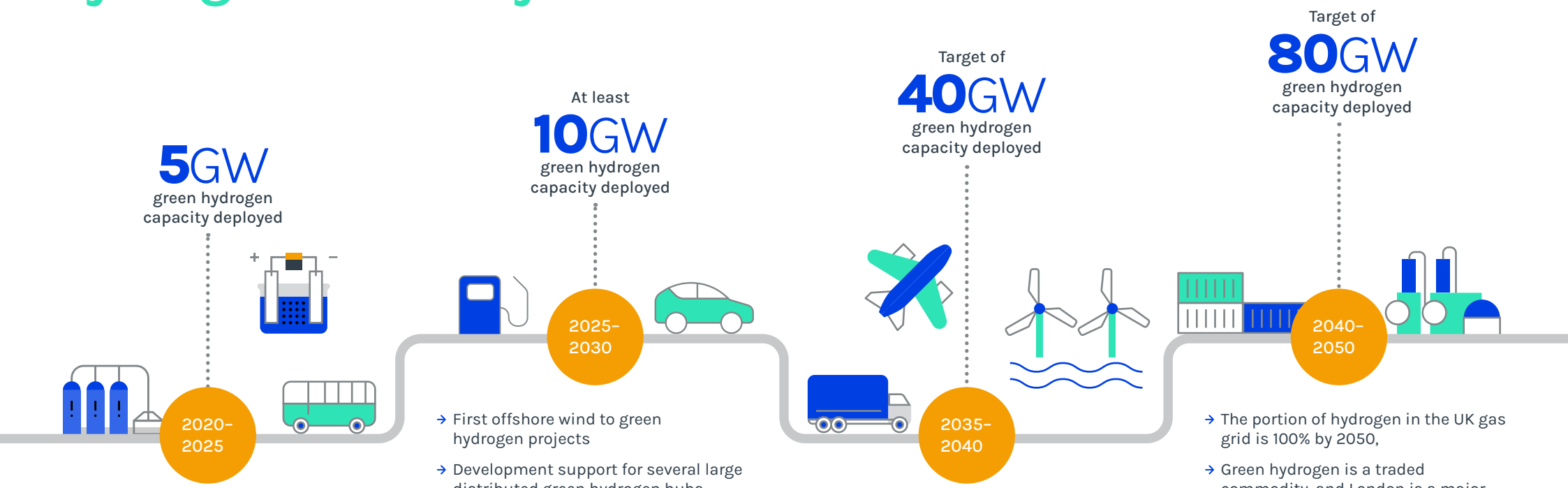
Green Hydrogen timeline

For the UK to retain its leading position in the green hydrogen economy, the government must put in place a series of actions and goals to support sector development between 2020-2025, 2025-2030 from 2030 onwards. By signalling government commitment through a well-developed strategy and specific implementation plan, a process where UKHFCA can provide support, the UK can create the business certainty needed for investors and companies to develop manufacturing and supply chain jobs in the UK. This should start with government procurement policies, such as the transition of public sector and government department vehicle fleets towards FCEVs as part of a broader hydrogen procurement mandate, to support the current government 25% ULEV (BEV) fleet target by 2022 and 100% by 2030.

We therefore advocate the following:

Rollout plan for a UK hydrogen economy

UK HFCA



2020–2025

5GW green hydrogen capacity deployed

- Targeted policy to expand small-scale and on-site distributed green hydrogen production:
  - Electrolysis for mobility and some industrial heat pilots before grid conversion,
  - Reforming of biogas for various end uses including mobility,
  - Displacement of grey hydrogen used in industrial processes
- Hydrogen supported via a production fixed price for fixed volume mechanism, preferably the non-domestic RHI/biomethane tariff expanded for heat and RTFCs extended to at least 2040 and a minimum price floor introduced.

2025–2030

At least **10GW** green hydrogen capacity deployed

- First offshore wind to green hydrogen projects
- Development support for several large distributed green hydrogen hubs, primarily in industrial clusters but also for smaller, off-grid communities
- Rollout of hydrogen fuelling infrastructure along major transportation routes
- Green hydrogen production support through capital grants, tariffs and a CfD-type mechanism on hydrogen for projects that will be producing from 2030.
- First new UK hydrogen storage caverns and large scale green ammonia storage capacity developed.
- First exports of UK green hydrogen begin

2035–2040

Target of **40GW** green hydrogen capacity deployed

- Complete phase-out of grey/brown/black hydrogen, and new supply limited to blue hydrogen or green hydrogen
- Hydrogen imports and exports act as part of the UK buffer
- Hydrogen constitutes 5%-10% of total final energy consumed in the UK
- The whole UK gas grid is 100% hydrogen tolerant, with blends reaching at least 20%

2040–2050

Target of **80GW** green hydrogen capacity deployed

- The portion of hydrogen in the UK gas grid is 100% by 2050,
- Green hydrogen is a traded commodity, and London is a major trading hub point for Europe.
- Mass hydrogen storage via ammonia, salt caverns or liquid hydrogen.
- Over 40% of heavy mobility is powered by hydrogen.

Next steps

The above timeline provides a clear route to developing a significant green hydrogen industrial base in the UK, which is necessary to ensure the country's leadership in hydrogen innovation. However, there remains considerable concern that Treasury and other parts of government are not grasping the opportunity that green hydrogen can offer. A reluctance by parts of government, notably the Treasury, to invest in wind energy in the early days resulted in large-scale offshoring of manufacturing jobs which has ensured a continued reliance on imports, much to the frustration of public and private sector stakeholders. This mistake must not be repeated with green hydrogen.

Instead, there is an opportunity for the UK to become a world leading exporter of electrolysis systems and other green hydrogen technologies. Through support for low-cost green hydrogen supply, the government could enable further developments in manufacturing and supply chain capabilities utilising existing skills and sites. This could result in jobs across sectors and applications including fuel cells for mobility and remote power, plus fuel for planes, ships, buses, commercial vehicles and rail, mobile generators, as well as thermal and hybrid energy systems such as CHP, dual fuel burners and boilers. The UK is already a net exporter in some of these applications.

We urge the UK government to consider the long-term outcomes of missing the green hydrogen window and global opportunity, particularly as post BREXIT and post Covid-19 'build back greener' and Clean Growth Strategy initiatives. This is especially important after the country's departure from the EU, which has set an ambitious hydrogen strategy, and had funded an initial major study on the green hydrogen opportunity in the UK through the Fuel Cell and Hydrogen Joint Undertaking (FCH JU). Instead of relying on a "buy it later at a cheaper price" approach, which will ensure that long term jobs, manufacturing and exports remain firmly shored outside of the UK, the government should invest in the incredible domestic opportunity that green hydrogen offers.

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Appendix:

About the UKHFCA:

The UK Hydrogen and Fuel Cell Association (UK HFCA) aims to ensure that hydrogen and fuel cell solutions can realise the many benefits offered across economic growth, energy security, carbon reduction and beyond. Through the breadth, expertise and diversity of our membership, we work to trigger the policy changes necessary for the UK to fully deliver the opportunities offered by emerging clean energy solutions and their associated supply chain requirements. We promote and represent our members' interests across the hydrogen and fuel cells space, and work to make the UK the best possible place for hydrogen and fuel cells across the full range of applications and opportunities.

Our members include the leading UK hydrogen and fuel cell players, as well as companies with wider energy interests, supply chain businesses, and materials and components suppliers, as well as service providers and universities.

Our members


ITM POWER
Energy Storage | Clean Fuel
Ingersoll Rand
JM Johnson Matthey
AngloAmerican
AIR PRODUCTS
Burges Salmon
ceres
BOC
Member of The Linde Group
AVL
BAKER BOTTS
CPH2
CLEAN POWER HYDROGEN
Diffusion Alloys
Coating at the Core
FUEL CELL SYSTEMS
HiiROC
AMES GOLDSMITH CEIMIG
HYDROGEN LONDON
Imperial College London
HYDAC
CLEAN ENERGY TECHNOLOGY
DCA
JREPrecision
kiwa
Logan Energy
LOW DEE
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AURIGA energy
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Rolls-Royce
SCOTTISH Hydrogen & Fuel Cell ASSOCIATION
SIEMENS
Ingenuity for life
Gen2 Energy
Swagelok
Swagelok Manchester
Sustainable Working Land Living Environments Ltd
T>E BUSINESS DEVELOPMENT
tfp
Thornton Tomasetti
ALCAZAR
tpgroup
UCL
ULEMCo
UNIVERSITY OF BIRMINGHAM FUEL CELLS GROUP
The University of Nottingham
Ulster University
Reynolds LOGISTICS
BayoTech ON-SITE HYDROGEN
PHOTOVOLT DEVELOPMENT PARTNERS
creo
Renewable Hydrogen Power Systems
bp

Why hydrogen and why now?

Outside of Westminster, UK regions of the United Kingdom have grasped and are taking steps to capture the scale of the hydrogen opportunity. Scotland has pro-actively driven hydrogen investment and support for regional initiatives, including the BIG HIT project in the Orkneys and the H100 project in Fife. In Wales, the government has recently launched a consultation on developing the hydrogen energy sector in Wales[9]. The consultation sets out a pathway for sector development, including the deployment of fuel cell buses, the creation of an early market / demand for fuel cell vehicles, ways to attract the zero-emission automotive industry to Wales and the demonstration of fuel cell trains. Across the country, local businesses in East Anglia are partnering with LEPs and local councils to assess opportunities to leverage the region's rich offshore wind experience to accelerate the hydrogen transition. In Northern Ireland, the first fuel cell double decker busses will soon roll out of factory lines and begin improving air quality across major UK cities. In the Midlands, South Yorkshire and greater Manchester have set ambitious plans for hydrogen as part of their broader emission reduction strategies. In the North East, which produces most of the UK's current hydrogen, a hydrogen transport Centre of Excellence is being set up and funded by the government, with local leaders having even wider hydrogen economy aspirations. Fuel cell manufacturing capabilities are being scaled up to support the world leading research and feasibility work of the H21 and HyNet projects. These distributed and bottom-up initiatives require coordination, and top-down support and guidance from Westminster, to better leverage the successes from current projects and mobilize additional resources to capture emerging opportunities.

6.3m

total CO2 emissions by 2030 (a reduction of 1.7 million)

The case for hydrogen is clear; the UK requires a zero emission fuel that is well understood, has extensive regulations and standards in place, is readily scalable and which can be used across multiple energy vectors. Hydrogen is that fuel. In the next decade alone, research by the FCH JU from Europe indicates that hydrogen could reduce CO2 emissions by 1.7 million to 6.3 million tonnes by 2030, supporting the further deployment of 1,800MW to 9GW of wind and 830MW to 4GW of solar. Further research by NREL in the US has shown that green hydrogen can help facilitate higher penetration of renewable energy into power systems, suggesting a doubling of wind and a 15% increase in Solar PV for the US grid by 2050. As recently as the 1970's, the UK produced approximately 700,000 tonnes of hydrogen each year to compliment onshore natural gas, illustrating the ease and precedent of hydrogen as a heating solution for industry and residential heat[10].

There are major technical and economic hurdles to meeting the UK's Net Zero goals without hydrogen, particularly for heating and transport applications. The country's gas grid supplies 3x more energy than the electricity grid today[11], and the transport sector accounted for over 1/3rd of final energy consumption in 2019[12]. While there is significant renewable power generation potential in the UK, notably from offshore wind, electrifying all heating and transport is likely to be an unsurmountable challenge by 2050. Mass electrification would

9 https://gov.wales/developing-hydrogen-energy-sector-wales

10 Research conducted by Protium, drawing on DUKES 2019 data and the IGU https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes and http://members.igu.org/old/gas-know-how/publications/igu-publications/mag/april10/pages%20198-220.pdf/@@download/file/pages%20198-220.pdf

11 ARUP, 2019 speech at the World Energy Council

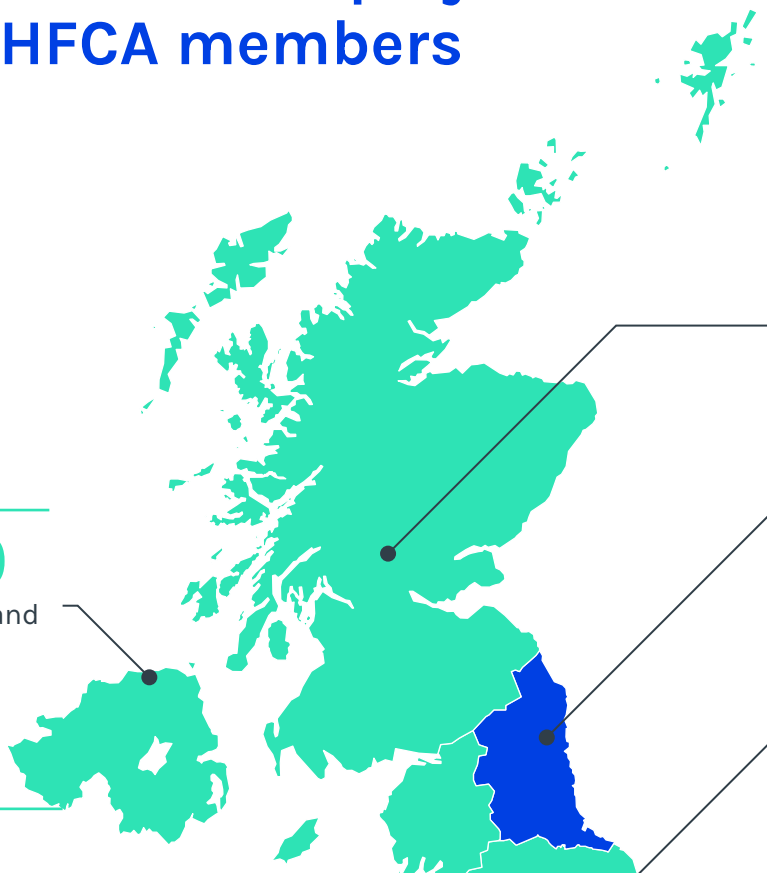
12 DUKES, 2019, page 5 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820277/DUKES_2019_Press_Notice_GOV.UK.pdf

require and overhaul of the current energy system, and massive scale up of batteries, improved transmission systems and smart metering. Alternatively, hydrogen can be integrated into current energy distribution and end-use systems, and utilize high renewables potential in the UK by converting green electrons into green molecules, that can be widely transported and stored seasonally. Mechanisms to store significant volumes of energy are important for coping with extreme environmental events like the infamous “Beast from the East”.

Image: Air Products

Lastly, hydrogen offers a pathway to revitalise manufacturing capabilities in the UK and improve the skill base for workers. The UK was a leader in discovering hydrogen and creating fuel cells, and today has several world leading manufacturers and supply chain businesses that with the right support could become global leaders and engines of economic growth for the UK economy. Using hydrogen, the UK could also become a global Centre of Excellence for hydrogen mobility and transport across land, maritime and aviation sectors. A brief glance at the UKHFCA’s own network of associations and the number of their employees across the UK gives a brief insight into this potential:

Estimated UK employment of UK HFCA members



830
Scotland

30
North East England

870
Yorkshire and the Humber

7,450
East Midlands

150
East of England

53,810
London

18,760
South East England

950
South West England and Gibraltar

7,380
West Midlands

10
Wales

760
North West England

1,670
Northern Ireland

Estimated employment of UKHFCA members across the UK

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Image 1: CPH$_2$

Image 2: BOC Limited, a Linde company

Image 3: ITM Power

Image 4: BOC Limited, a Linde company