How the UK's hydrogen sector can help support the UK's economic recovery

APPG on Hydrogen report

All Party Parliamentary Group on

Hydrogen

This report was researched by Connect and funded by Baxi Heating, Bosch, Cadent, EDF, Energy and Utilities Alliance, Equinor, National Grid, Northern Gas Networks, SGN and Shell.

The APPG on Hydrogen is sponsored by:

Foreword

Jacob Young MP
Chair
APPG on Hydrogen

The UK is a global leader in hydrogen technology and innovation, but with many countries now pressing ahead with national hydrogen strategies, we must quickly set out our plan or risk falling behind.

The UK Government was the first world leader to boldly establish a 2050 net-zero carbon target, but our ambitions will be unachievable without embracing hydrogen as an alternative fuel. The longer we wait to develop our hydrogen strategy, the more difficult achieving net-zero becomes.

The All-Party Parliamentary Group (APPG) on Hydrogen has compiled this report based on our inquiry into the next steps the UK Government must take in order to see growth in the sector and enable the transition between innovation and commercialisation.

The APPG received almost 100 responses to its call for evidence and held three oral evidence sessions focusing on industry, local, regional and Government priorities. We have listened to organisations about how they are contributing to a greener future and what steps need to be taken to ensure that hydrogen can play a more prominent role in this.

We believe that hydrogen is the solution to decarbonisation in industry, power, heat and transport. It has the potential to create and sustain hundreds of thousands of high-quality jobs across the country, and aid in the Government's plans to "level-up".

Hydrogen will play a key role in shaping our future economy and our ability to meet our net-zero targets, the only question that remains, is when.

If you would like more information on the APPG, please contact the secretariat on appghydrogen@connectpa.co.uk and follow us on Twitter @HydrogenAPPG.

Introduction

The APPG on Hydrogen is chaired by Jacob Young, MP for Redcar and has a total of 31 parliamentary members. It provides a forum for MPs and Peers to engage with leading businesses and organisations that are working to enable the UK to meet its decarbonisation targets through the implementation of hydrogen projects, and to discuss policy options to support these.

The APPG's sponsors are Baxi Heating, Bosch, Cadent, EDF, Energy and Utilities Alliance, Equinor, National Grid, Northern Gas Networks, SGN and Shell.

A large-scale conversion to hydrogen has the potential to:

Position the UK as a global leader in hydrogen technology

The UK is already seen to be the most advanced in its research and testing into the potential of hydrogen. We must move fast to solidify this position and ensure we are not left behind.

Drastically cut carbon emissions

30% of UK greenhouse gas emissions are from the heating of homes and businesses, which hydrogen can help reduce.

Create and sustain many thousands of skilled jobs in all parts of country

Parliamentarians from all areas of the UK are members of the APPG, and why unions such as UNISON and GMB are strong supporters of hydrogen.

Unlock innovation in other sectors

Hydrogen technology can lead to greater production and rollout of hydrogen cars, trains, buses, lorries and ferries, as well as in heavy industry and domestic appliances.

The APPG would like to thank all contributions to the inquiry and the parliamentarian panellists who supported the Chair with the evidence sessions:

- Lia Nici MP
- Lord Oates
- Alex Sobel MP
- Alex Stafford MP
- Richard Thomson MP

We would like to pay thanks to the Minister for Business, Energy and Clean Growth, Rt Hon Kwasi Kwarteng MP and Business, Energy and Industrial Strategy officials for their contribution.

We would also like to thank those who gave evidence to the APPG in our panel discussions:

- Julie Cox, Head of Gas Markets, Energy UK
- Chris Gent, Policy Manager, CCSA
- Ben Houchen, Mayor of the Tees Valley
- David Joffe, Head of Carbon Budgets, Committee on Climate Change
- Ben Madden, Director, Element Energy, representing UKH2 Mobility
- Cllr Lisa Mulherin, Executive Member for Climate Change, Transport and Sustainable Development, Leeds City Council
- Henri Murison, Director, Northern Powerhouse Partnership
- Cllr Gillian Wood, Deputy Portfolio Holder for Low Carbon and Renewable Energy, Liverpool City Region

Recommendations

The Hydrogen APPG believes the Government should take a number of steps in both the short term and long term to support and accelerate the growth of the UK's hydrogen sector.

1. A cross-departmental hydrogen strategy must be developed between Government and industry. This must provide an opportunity to hydrogen producers, end-users, and the associated supply chain and research community to develop capability.
2. The Government should accelerate research in hydrogen technology, otherwise we risk our place as a global leader.
3. In order to increase green hydrogen production, a new regulatory framework must be established to support early deployment and help to commercialise renewable hydrogen.
4. Interim targets for low-carbon hydrogen production should be set by 2030 alongside the introduction of a Low Carbon Obligation to enable investment in low carbon forms of heating such as hydrogen, as well as heat pumps, biomethane and hybrid systems.
5. Implementing measures similar to Offshore Wind, such as Contracts for Difference to incentivise industry and scale-up a hydrogen economy.
6. Invest in developing the first Carbon Capture and Storage (CCS) network by 2025, in line with the 2019 Conservative Party manifesto commitment.
7. Policymakers and industry must ensure any funding models developed deliver investment and economic jobs directly to the UK.
8. The Government and industry should work with local and regional authorities already exploring hydrogen's potential and support the uptake and commercialisation of existing projects.
9. Use regulatory levers to unlock the private sector investment required, thereby minimising the impact on the public finances. For example, amend Gas Safety (Management) Regulations (GSMR) to enable hydrogen blending and undertake community trials in the gas network, and introduce a Low Carbon Obligation to enable investment in low carbon forms of heating such as hydrogen, as well as heat pumps, biomethane and hybrid systems.
10. The Government should work with industry, through a formal working group, to incentivise the public uptake on hydrogen-ready boilers and mandate hydrogen-ready boilers by 2025.
11. In transport, subsidies should be created to help stimulate hydrogen vehicle purchases or a subsidy per kg of hydrogen sold. This can be further supported by establishing incentives such as capital investment grants and business rate relief on hydrogen refuelling stations.
12. Continue to invest in hydrogen alternatives and incentivise organisations and customers who produce, purchase or use hydrogen HGVs, buses and trains. Also, expand the remit of the Bus Service Operator Grant for hydrogen buses and create greater flexibility with the Renewable Transport Fuels Obligation.
13. Work with industry to develop a public engagement strategy to ensure the public are aware of and educated on the opportunities and challenges of a hydrogen economy.
14. The UK must set more ambitious policies and financial targets on hydrogen to meet net-zero by 2050 ahead of other international competitors, to support this, the UK hydrogen industry should play a major role at COP26, allowing the UK to inspire other nations and sell our products and services to do so.
15. There should be stronger incentives for energy-intensive industrial sectors to decarbonise more effectively and efficiently than international competitors.

Baxi Heating

case study

In the UK and Ireland, Baxi Heating has a portfolio of some of the best-known brands in the heating industry, with a proud history of UK manufacturing for over 150 years.

As part of BDR Thermea Group, Baxi Heating makes considerable capital investment in research and development resources, focusing on energy saving and low carbon technologies to tackle the decarbonisation of heat, including pioneering work in the development of hydrogen boilers.

Baxi Heating Hydrogen Combination Boiler (R&D Laboratory, Preston UK)

This ground-breaking development initiative has produced prototype wall hung combination and system boilers designed to operate on 100% hydrogen, thereby producing zero CO_2 and CO emissions during operation.

The boilers use the same outer case dimensions and pipe connection points as existing natural gas boilers in order to facilitate as much as possible a “like for like” changeover. Crucially, this means that installation of ‘hydrogen ready’ boilers could begin long before 100% hydrogen is available within a locality by utilising the existing natural gas network, with a simple conversion process needed at the point of network changeover.

An initial trial of an operational hydrogen boiler in a real-life situation began in Rozenburg, Netherlands, in 2019. Further refinement and development of the hydrogen boiler concept will be demonstrated in the UK through the Hy4Heat programme.

What is hydrogen, how is it produced and why is it important for the UK?

Hydrogen is a gas that can be combusted in a way that produces no greenhouse gas emissions. It can be produced through a number of methods, but the primary methods are electrolysis of water or by reforming methane, where the carbon dioxide generated can be captured and stored.

Many organisations are currently looking at hydrogen as a source of low carbon energy and as a key solution towards supporting the Government's net-zero targets. Some businesses assessing hydrogen's potential are exploring the creation and delivery of blue hydrogen. Many see this as a pathway towards green hydrogen. There are also other alternative methods of producing hydrogen such as through nuclear power.

The UK has the potential to become a world leader in this sector. It has a long history of leading in developments on gas technology, has a large workforce linked to the gas industry as well as an excellent safety record. It also has experience in gas conversion and an integrated gas network largely already adapted to be hydrogen ready.

Reasons why the UK should become a global leader in hydrogen technology

- Existing infrastructure for gas storage with an excellent safety record
- Demonstrable achievements in scientific and engineering innovations
- Skilled professionals, resources, companies and academic research facilities
- UK financial services and proximity to European markets

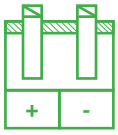
Blue hydrogen

natural gas

steam reforming

Green hydrogen

renewable electricity



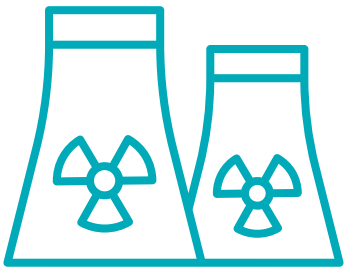
electrolysis

What is Blue Hydrogen?

Blue Hydrogen takes carbon dioxide from the hydrogen making process and uses carbon capture and storage (CCS), to contain this. CCS is a technology that can capture up to 90% of the carbon dioxide emissions produced from the use of fossil fuels in energy generation, preventing it from entering the atmosphere and damaging the environment. Although this hydrogen is not fully green it is a "leaner" version that can be readily available and is a step in the right direction to vastly reducing dangerous gasses. **Blue hydrogen projects have an important role to play in supporting the reduction of carbon emissions in the immediate future and this is something that is welcomed and should be promoted by the Government.**

What is Green Hydrogen?

Green Hydrogen is made by electrolysis using renewable electricity. The current challenge for the time being is that both solar and wind power do not have the existing infrastructure for large-scale green hydrogen to work. External analysis provided to Ørsted indicates that renewable hydrogen will be compatible in cost with gas+CCS by around 2030. As recognised by the British Compressed Gasses Association, the potential to make hydrogen by green electrolysis of water is limitless given the right infrastructure. ITM Power is shortly opening a new factory in Sheffield, making it the largest electrolyser factory in the world. Increasing electrolyser production capacity in the 2020s to meet an exponentially rising global demand for green hydrogen is a key opportunity for UK jobs growth and wealth creation by boosting export income. **In order to increase green hydrogen production, the Government must work to establish a regulatory framework to support early deployment and help to commercialise renewable hydrogen.**



How can we use nuclear to produce hydrogen?

Nuclear energy has the potential to support hydrogen production, either through electrolysis or from the use of heat from nuclear power stations. Evidence received from the nuclear industry supports the creation of hydrogen in this way as it is an option that does not rely on unproven technologies and suggests that this would lead to the rapid development of the hydrogen sector. The Nuclear Industry Association, responding to the APPG inquiry, explained that nuclear is the only currently available at-scale option for clean hydrogen production and can make full use of the existing nuclear infrastructure.

In responding to our inquiry, EDF, who own and operate all of the country's existing nuclear fleet, believe that a truly net-zero outcome will require hydrogen production to switch to electrolytic methods based on zero carbon power from nuclear and renewables. They referred to the Committee on Climate Change's report that hydrogen produced through electrolysis could be as low as 15g of carbon per kilowatt hour compared to around 30-100g of carbon per kWh using CCS.

Rolls-Royce in response to the inquiry recognised that compact small modular nuclear (SMR) power stations can be the source of electricity in order to help produce hydrogen at scale. Their evidence estimates that a combined SMR/hydrogen fuel production facility would cost under £2bn and could produce around 190 tons of hydrogen per day, enough to power 65 return flights to Europe or keep 90,000 homes warm on a typical winter day.

As highlighted by Catapult, there is the potential for the UK to play a leading role in the development of hydrogen technology given the significant renewable energy potential for green hydrogen production and domestic gas reserves for blue hydrogen production. **Further investment is needed from the Government to accelerate the research in this area or we risk our place as a global leader.**

Summary

- Blue hydrogen projects have an important role to play in supporting the reduction of carbon emissions in the immediate future and this is something that is welcomed and should be promoted by the Government.
- In order to increase green hydrogen production, the Government must work to establish a regulatory framework to support early deployment and help to commercialise renewable hydrogen.
- Further investment is needed from the Government to accelerate the research in hydrogen technology or we risk our place as a global leader.

EDF

case study

EDF has around five million customers, is the largest energy supplier to business and is the UK's largest producer of low carbon energy through our eight nuclear power stations and 35 windfarms. We see an important role for hydrogen in decarbonising our economy, especially for heavy industry and transport, and meeting our climate targets by 2050.

To gain the full benefits of hydrogen, we believe the UK must develop a strategy which involves hydrogen being created commercially using low carbon generation methods such as via renewables or nuclear power. Hydrogen created using electrolysis in this way will be significantly lower carbon than many alternatives and be important if we are to become a truly net-zero carbon economy.

EDF is exploring the long-term role hydrogen could play as part of a low carbon energy hub linked to our Sizewell C new nuclear development in Suffolk and the possibility for a demonstration project at the Sizewell B site ahead of Sizewell C completion – we are considering a range of ways which nuclear generation could support low carbon hydrogen production and help the UK build a clean, resilient economy which allows the country to take control of its energy supply.

Meeting net-zero targets

There is a growing urgency to tackle climate change and a strong recognition that the UK's economic recovery must be focused on a green future. Hydrogen has a significant role to play in ensuring the UK meets its net-zero targets but for this to become a reality it requires large-scale implementation of hydrogen technologies across a range of sectors.

This is further supported by the Committee on Climate Change which has outlined that the UK will not meet its net-zero targets without significant investment in the hydrogen economy. In addition to this, the Centre for Policy Studies has said in their recent report, '*Driving change, how hydrogen can fuel a transport revolution*', that investing in hydrogen as a fuel source is essential for Britain to meet its net-zero target and clean up its air.

The Energy Networks Association (ENA) has explained that there is no realistic scenario whereby the UK is able to achieve net-zero carbon emissions by 2050 without Blue and Green hydrogen playing a key role in the decarbonisation of large emitting sectors such as industry, transport, power and heat. **The development of a networked system of supply, transport and end-use for hydrogen in the UK at this scale would require significant research and development investment in the 2020s**. This has the potential to support economic recovery, clean growth and job creation.

Delivering a hydrogen economy will contribute in tackling climate change through:

- Reduction in carbon emissions
- Improved air quality
- Developing the UK's green economy through the creation of skilled green jobs
- Strengthened energy security

In order to make this a reality, **the Government should set interim targets for low-carbon hydrogen production by 2030 and introduce a Low Carbon Obligation to enable investment in low-carbon forms of heating such as hydrogen, as well as heat pumps, biomethane and hybrid systems**. There should be an ambition for a future hydrogen economy to have net-zero emissions by 2050 in line with net-zero targets.

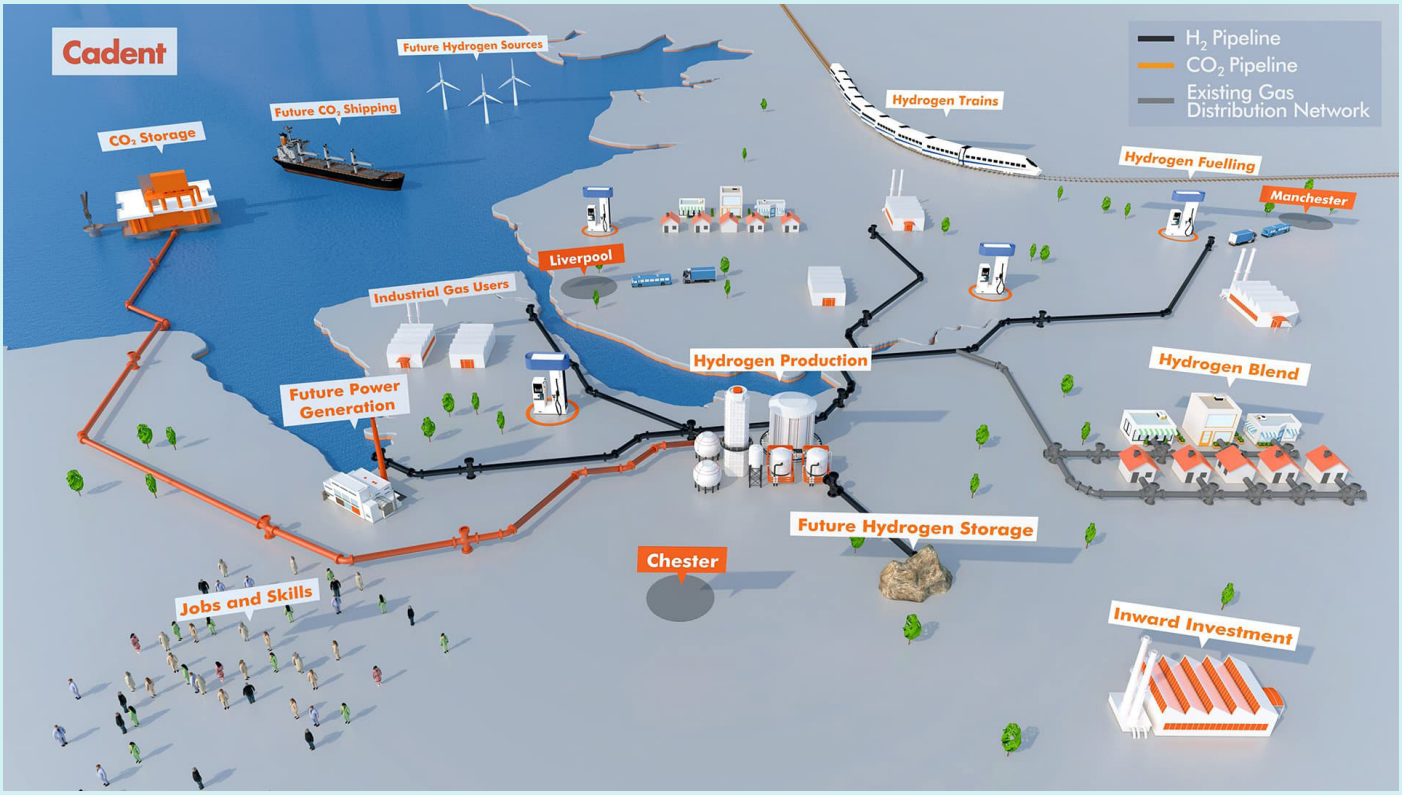
It is time the UK moves away from small pots of funding to large-scale commitments and projects. We urgently need a **cross-departmental hydrogen strategy, designed in collaboration between Government and the industry, to kickstart and grow a green job creating hydrogen economy across the country**.

Summary

- Significant Research and Development investment is required to create a hydrogen economy.
- The Government should set interim targets for low-carbon hydrogen production by 2030 and introduce a Low Carbon Obligation to enable investment in low carbon forms of heating such as hydrogen, as well as heat pumps, biomethane and hybrid systems.
- A cross-departmental hydrogen strategy must be developed in collaboration between Government and the industry.

Cadent - HyNet

case study



HyNet is a combined hydrogen and CCUS project in the North West that has gained significant support to date from industry and the public sector. It utilises existing oil and gas infrastructure for CO_2 transport and storage and is a low-cost route to initial deployment of CCUS in the UK.

Cadent was responsible for initiating the HyNet concept back in 2017 with development partner Progressive Energy and since 2017 the project has gained significant momentum and is now viewed as the leading hydrogen and CCUS project in the UK today. This is due to its ability to capture and store 400,000 tCO_2 per year, the equivalent of 200,000 cars being taken off the road, or 200,000 domestic heating systems being transitioned to low carbon.

HyNet is the only industrial cluster to include hydrogen distribution at this stage and consists of incremental projects that present a clear pathway to up to 10 $MtCO_2$ per year. Cadent has developed and consolidated a core consortium which is comprised of Cadent, Progressive Energy, Essar, CF Fertilisers and the ENI. These are the partners that will deliver the project.

Hydrogen: employment, skills and levelling up

Hydrogen, in conjunction with other technologies, represents a significant opportunity for the UK to decarbonise the energy system and generate jobs. As we transition to a cleaner recovery from the impacts of Covid-19, existing jobs within the energy sector must not be lost. The development of a large-scale hydrogen infrastructure throughout the UK will help to sustain and create high quality, green jobs to grow this sector and support economic growth in all parts of the country. Crucially, the creation of a hydrogen economy will play a prominent role with the Government's levelling up agenda. The hydrogen industry will require numerous types of occupations, experience and skills from entry level to long-term on-the-job training, as well as trade certifications, including scientists, engineers, chemists, managers and technicians.

The employment potential is something that has been recognised by the trade unions, UNISON, GMB, Prospect and Unite. The gas industry is an important source for stable, skilled and relatively well-paid employment, these jobs must be preserved as part of the UK's economic recovery. Hydrogen is the best energy alternative path for utilising the skills of the existing workforce.

For example, current estimations for projects like H100 Fife, Acorn CCS and Aberdeen Vision could create and support around 1,500 high-value jobs from 2020/21. The UK's 300,000 high-value jobs in the oil and gas industry can be leveraged and retained to support the development of hydrogen and the transition away from fossil fuels.

The Hydrogen Council also estimates the global market for hydrogen could be $2.5tn by 2050 and support 30 million jobs by 2050. A study by Element Energy estimates that in a scenario where the UK becomes a world leading decarbonised economy with significant hydrogen deployment and export of hydrogen to Europe, the development of a hydrogen economy could create 221,000 jobs and contribute to £18bn to GVA in the UK per year.

Hydrogen has the potential to benefit employment across the UK, whilst a number of hydrogen projects have been focused in the north, project Cavendish, a partnership between Arup, Shell, Uniper, National Grid and SSE, is aiming to establish a large-scale blue hydrogen production facility in Kent. The ambition for the project is to create a low-carbon economically viable hydrogen production facility providing London, and parts of South East England, with over 7 gigawatts of low-carbon energy for transport, industrial use, power and heating, as well as supporting economic growth.

In order for jobs to be created there must be incentives from the Government to encourage industry to invest in hydrogen. **Implementing measures similar to Offshore Wind, such as Contracts for Difference could incentivise industry and scale-up a hydrogen economy.**

Evidence from GMB recommends that any

incentives that are implemented must also be scrutinised. The GMB has called for stronger scrutiny of existing funding mechanisms on workforce grounds. **In order to create jobs locally, policymakers and industry must ensure any funding models developed deliver investment and economic jobs directly to the UK.**

Training for new skills will be required, and some job tasks currently remain unknown since many of the technologies are still evolving.

To further support employment, deploying CCS infrastructure and integrating this with hydrogen projects will be vital to ensure large volumes of low-carbon hydrogen can be produced in the 2020s. There are five proposed CCS clusters looking to develop in the early 2020s, all of which we envisage playing a role to support jobs locally and will be key to industrial job retention and growth, especially in the North of England. A Summit Power report, '*Clean Air, Clean Industry, Clean Growth: How Carbon Capture Will Boost the UK Economy*', found that developing a network of CCS projects along the East Coast of the UK, including Teesside capturing 75 million tonnes of CO_2 per year, would provide £163bn of economic benefits and 225,000 jobs, cumulatively, through to 2060. The CCSA believes that development of infrastructure in the three storage regions (East Irish Sea, Central North Sea and Southern North Sea) by 2030 will also be essential to support jobs.

Summary

- Invest in developing the first CCS network by 2025, which is in line with the 2019 Conservative Manifesto commitment.
- In order to support local jobs, policymakers must ensure any funding models developed deliver investment and economic jobs directly to the UK.
- Create Contracts for Difference for hydrogen projects, similar to those previously set for Offshore Wind.

EUA

Supporting a hydrogen future

case study

A number of high-profile projects are underway to explore the feasibility of hydrogen. Owing to its position within the industry, The Energy and Utilities Alliance (EUA) has used its knowledge and expertise to support a number of these projects in finding practical solutions to delivering a decarbonised gas supply.

Specifically, the Heating and Hotwater Industry Council, HHIC- a division of EUA- has worked in collaboration with boiler manufacturers, to develop 'hydrogen ready' products, together with guidance on the effects of introducing a blend of hydrogen into the natural gas supply. Their members have been at the forefront of 'Hydrogen for Heat' development with several of the members already having hydrogen ready appliances that can be converted to hydrogen in under an hour, with little or no difference to upfront consumer costs.

EUA is also an active participant in a range of Hydrogen studies such as Hy4Heat, THyGA, and HyDeploy.

EUA and its utility network members have already started working on gas networks innovation trials such as Hynet, H21, and the Freedom Project. The industry is poised to deliver.

The flexibility offered by the gas networks, together with the innovative work of the domestic and commercial boiler manufacturers, and green gas transport providers, all supported and coordinated by EUA, means that hydrogen offers a solution to meeting UK climate goals whilst maintaining demand.

Regional and local government

The APPG's inquiry held an oral evidence session with local and regional authority leaders alongside the Northern Powerhouse Partnership and outlined the work they are undertaking to support a hydrogen economy.

There was a recognition amongst those giving evidence that the Government and industry both have an important role to play in making hydrogen a reality. In order to support this, they must collaborate and work in partnership alongside local and regional authorities to ensure hydrogen technologies are sufficiently developed to meet net-zero targets. This could be done by supporting a local supply chain for hydrogen production.

There was an agreement amongst panellists for stronger commitments from the Government to develop innovative research to a stage where it could be commercialised. Those giving evidence were eager to move into scaled opportunities, which demands an ambitious and wide-ranging strategy from the Government.

Protecting existing jobs in fossil fuel industries and allowing these workers to transition into greener jobs was also recognised as a crucial step in supporting a hydrogen economy. Ben Houchen, Mayor of the Tees Valley, highlighted that there are many industrial jobs in Teesside, including in the chemical industry which will be at risk unless the Government works to help these jobs transition. Investment in skills was also an issue that must be prioritised.

It was recognised that regional and local authorities have a key role in transitioning to a green economy. **For this to be accelerated, there needs to be greater trust, investment and decision-making powers given to local and regional authorities and a grassroots approach is required to prioritise decarbonising energy in their own areas.** The management of energy policy in Whitehall can be seen as being a lengthy process and powers should be handed to local authorities to progress more quickly with projects.

A suggestion from the discussion involved the creation of a 'national centre for hydrogen', which would act as a centre for research and progressing commercialisation. The centre would involve business, higher education institutions and local government, bringing together hydrogen projects whilst establishing a collaborative approach.

It was brought to the APPG's attention that the creation of a Government hydrogen strategy could risk slowing the progress of rolling out hydrogen technology, but it was also recognised that a national strategy does have a part to play as long as it supports local and regional authorities' own strategies. It was also recommended that the position of a Hydrogen Minister should be created to work across Government departments to coordinate the UK's hydrogen strategy.

Regional representatives were clear to point out that there are many sectors that can make significant short-term progress with hydrogen technology, **however the Government needs to introduce market incentives, and investment, to realise these benefits**.

Timing is essential, now is the moment to move from research to the commercialisation of hydrogen. Hydrogen technology has already been used across sectors in England, particularly in the North, and should be considered a technology with a history of uses and successes. **Investment in "shovel-ready" projects such as hydrogen fuelled trains and existing hydrogen projects, if given full backing by the Government, could support the pathway towards the commercialisation of hydrogen.** We are aware that there are investors ready to back such projects, but this has been delayed or funds have been restricted as organisations are deterred by having to wait until funding rounds or competitions become available from Whitehall. This restricts investment from the private sector and **the Government should work with local government to support localised, targeted commercialisation of hydrogen that they deem are most appropriate their areas**.

Summary

- There needs to be greater trust, investment and decision-making powers given to local and regional authorities and a grassroots approach is required to prioritise decarbonising energy in their own areas.
- The Government needs to introduce market incentives, and investment, to realise these benefits.
- The Government and industry should work with local and regional authorities already exploring hydrogen's potential, and support the uptake and commercialisation of existing projects. The Government should work with local government to support localised, targeted commercialisation of hydrogen that are most appropriate for their areas.

National Grid

case study

National Grid look to repurpose the existing gas transmission system to hydrogen

Currently, gas networks transport three times the energy that electricity networks do. Transporting hydrogen in pipelines could create similar flexible benefits that linepack currently provides in the gas networks to respond to demand. Against this backdrop, National Grid launched 'HyNTS', a programme of work to identify the opportunities and challenges of transporting hydrogen within the gas NTS.

The 'HyNTS FutureGrid' project aims to test transmission network assets with flows of hydrogen blends between 20-100% at transmission pressures for the first time. The project intends to work in conjunction with Northern Gas Networks' ongoing H21 project at Spadeadam.

NTS assets, which are due to be decommissioned early in the RIIO 2 regulatory period (2021 – 2026), will be reconstructed to create a test network that can be used to answer some of the fundamental questions on safety and operation of a converted network, and inform later research requirements, such as through the Government's Hydrogen Programme Delivery Group (HPDG). Flows of hydrogen/natural gas blends, up to 100% hydrogen, will be tested for the first time in Britain at transmission pressures. This system will connect to the existing H21 distribution network test facility at Spadeadam to prove a complete beach-to-meter network can be decarbonised, supporting the HPDG goal to develop a comprehensive programme for the hydrogen transition.

Equinor

case study

Equinor is leading a project to develop one of the UK's – and the world's – first at-scale facilities to produce hydrogen from natural gas in combination with carbon capture and storage (CCS). The project, called Hydrogen to Humber Saltend (H2H Saltend), provides the beginnings of a decarbonised industrial cluster in the Humber region, the UK's largest by emissions.

H2H Saltend supports the UK Government's aim to establish at least one low-carbon industrial cluster by 2030 and the world's first net-zero cluster by 2040. It also paves the way for the vision set out by the Zero Carbon Humber alliance, which Equinor and its partners launched in 2019.

The project will be located at Saltend Chemicals Park near the city of Hull and its initial phase comprises a 600 megawatt auto thermal reformer (ATR) with carbon capture, the largest plant of its kind in the world, to convert natural gas to hydrogen. It will enable industrial customers in the Park to fully switch over to hydrogen, and the power plant in the Park to move to a 30% hydrogen to natural gas blend. As a result, emissions from Saltend Chemicals Park will reduce by nearly 900,000 tonnes of CO_2 per year.

Heating homes and businesses

Currently around 23 million homes in the UK, around 80% of the population, use natural gas for heating and cooking. The emissions from this account for nearly a third of the UK's total greenhouse gas emissions. As the UK has an integrated gas network largely already adapted to be hydrogen ready and a supply system that has managed many supply challenges like this successfully, hydrogen has an important role to play in heating people's homes.

In the 2019 Spring Statement, the Chancellor announced that from 2025, new homes should use low-carbon heating, this may cause developers to be tempted to build properties not connected to the gas network. If current trials using blended or 100% hydrogen in the gas network continue to be successful, then hydrogen should be considered as a priority solution for heating homes and businesses. There is a recognition that using a singular energy source for heating people's homes is not the answer, the form of energy used will depend on locations and proximity towards supply, but hydrogen must be considered in the mix of this.

The Gas Distribution Networks have an essential role to play in supporting the use of hydrogen in heating homes and businesses.

For example, below highlights a small number of projects being undertaken by the gas distribution networks including:

- H100 - SGN's project is planning to build the UK's first 100% hydrogen network for supply of green hydrogen to households and businesses in Levemouth, Fife which will be a critical towards decarbonising heating in the UK.
- H21 - A suite of pioneering gas industry projects led by Northern Gas Networks, focused on demonstrating the existing UK gas grid can be repurposed to carry 100% hydrogen, in order to meet the 2050 objectives. H21 has recently expanded to Teesside for its next phase involving trials on a decommissioned section of network, to further establish that the domestic gas grid can be used to safely transport hydrogen to homes and businesses.
- HyDeploy - Led by Cadent Gas Network as part of the HyDeploy Consortium, it is the UK's first trial of supplying a hydrogen blend (up to 20%) to domestic properties. The aim of the project is to demonstrate to Government and regulators that blended hydrogen can safely supply the existing gas network, with no changes to gas appliances required, which will help to reduce carbon emissions from heating immediately.

When it comes to upgrading properties, there will be logistical challenges for upgrading to low-carbon technology. In order to tackle this, the Government should look at introducing hydrogen-ready boilers, being created by companies such as Bosch and Baxi Heating. This early intervention would support a smoother, more cost-efficient transition to low-carbon energy whilst supporting the maintenance of a safe gas grid. This would not require replacing out household appliances such as radiators or having two parallel systems and would also support the training of an existing gas workforce to work with hydrogen appliances as they are fundamentally gas appliances. **The Government could promote this by working with industry to incentivise the public uptake on hydrogen-ready boilers and mandate hydrogen ready boilers by 2025.** There is potential for this to be produced at scale, however at present, there has been no firm commitment from the Government to use hydrogen in the gas network in the future and this needs to swiftly be addressed.

To make these changes there will also need to be updates to existing regulations. As part of its economic response to the Covid-19 crisis, the Government must align decisions by the energy regulator, Ofgem, on funding settlements for energy network infrastructure. It must also **amend regulations such as the GSMR to enable hydrogen blending and undertake community trials of blended hydrogen in the gas network**.

The sector can deliver a full hydrogen economy but needs the green light from Government to unlock the full investment which would allow it to happen.

Summary

- Regulations such as the GSMR should be amended to enable hydrogen blending and undertake community trials in the gas network.
- The Government could promote this by working with industry to incentivise the public uptake on hydrogen-ready boilers and mandate hydrogen ready boilers by 2025.

Bosch

case study

At Bosch we are focused on exploring and demonstrating the exciting potential of using hydrogen to de-carbonise the heat network. Domestic heating accounts for 15% of total UK CO2 emissions and the UK has a unique infrastructure for gas, with 85% of homes connected to the gas network.

Bosch has developed a prototype domestic boiler to run on pure hydrogen at our R&D site in Worcester.

It is now widely accepted that the route to decarbonisation will be a combination of electric heat pumps, particularly in new build properties and boilers developed to run on pure hydrogen for existing buildings. The UK is one of the largest heating markets in the world with around 1.6 million boilers installed a year and a thriving manufacturing industry for boilers.

The worldwide market for gas boilers is 13.8 million units a year with a value of £6bn. It is estimated that 145 million domestic boilers are installed worldwide. In the event of a transition to hydrogen, the UK can – if it acts now – be in a world leading position in exporting hydrogen boilers. For instance, in China 3.6 million boilers are sold per year, whilst in South Korea it is 1.2 million.

Although the UK has an advantage, this will be quickly eroded unless the Government unequivocally backs this technology with support and funding. The Department for Business, Energy and Industrial Strategy is already supporting early stage development of domestic hydrogen-ready technologies, but more government support is needed to bring these to market.

Hydrogen's role in transport

The UK has positioned itself as one of the leading countries for hydrogen mobility. Hydrogen has a number of advantages as a transport fuel, for example it has high energy density, which means it is suited to even challenging applications such as heavy use vehicles. As a gas, hydrogen can be pumped onto a vehicle in roughly the same time it takes to refuel a conventional vehicle making it particularly suitable to use for many hours per day, this may be beneficial for emergency services such as ambulances.

It can also be affordable if commercialised, a recent study by the Hydrogen Council explained that by 2030 commercial vehicles, trains, and long-range transport applications will compete with low-carbon alternatives due to reductions in cost driven by scaling up the hydrogen mobility sector. Submissions to the inquiry suggest that transport is the ideal option to "go-first" because of its value of energy is highest in the transport sector, but in order to fully support this, a wider hydrogen infrastructure should be created around industry and heat.

Hydrogen Buses and HGVs

Hydrogen has an essential role to play in supporting heavy duty transport vehicles, a recent study by McKinsey and the Hydrogen Council shows that hydrogen will be cost effective in heavy duty transport within three years, when compared to battery electric and diesel.

Evidence from a number of organisations agreed that buses are the logical starting point for unlocking the UK's hydrogen economy, due to their back-to-depot refuelling and their production. There are already hydrogen projects undertaken in this area, for example Wrightbus has developed a hydrogen fuel cell electric bus, which costs the same as a battery electric bus.

All three UK bus manufacturers produce hydrogen buses which creates potential for quick scaling up of production, lower costs and greater export opportunities.

The Government has already set aside £3bn to support the introduction of 4,000 zero emissions buses within this Parliament. This funding should be brought forward as soon as possible to maximise the opportunity for job creation.

Hydrogen Fuel Cells

Fuel cells can materially improve air quality and represent a significant opportunity to support domestic British businesses that have pioneered the development of fuel cells and today are in need of support to compete with companies in other nations that benefit from significant state support.

The Government also has a role to play in funding and accelerating the uptake of hydrogen fuel cell electric vehicles by investing in infrastructure and stimulating demand, similar to what has been done with other electric vehicles.

Examples could include **incentives such as capital investment grants and business rate relief on hydrogen refuelling stations or looking at subsidies, similar to what has been delivered in California**.

Shell

case study

Hydrogen is one of the most abundant elements in the universe and could play a significant role in the transition to a clean and low-carbon energy system. Shell has a growing network of hydrogen stations in Europe and in North America, where it is part of several initiatives to encourage the adoption of hydrogen in transport.

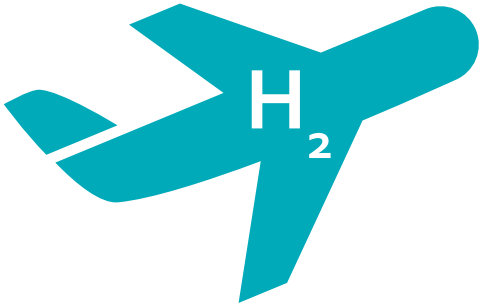
In Germany, Shell is part of a joint venture called H2 Mobility with industrial gas manufacturers, Air Liquide and Linde', car manufacturer, Daimler, and energy companies, Total and OMV, to develop a nationwide network of hydrogen refuelling stations and is expanding this in the UK.

In 2017 Shell became the first branded fuel retailer to sell hydrogen at one of its retail sites in the UK. The hydrogen refuelling stations in Cobham and Beaconsfield, in partnership with ITM, use hydrogen produced on site using electricity from renewable sources.

As a global organisation, Shell has also been part of a Californian consortium to develop three new large-capacity refuelling stations for heavy-duty hydrogen fuel-cell trucks being developed by Toyota and Kenworth Truck Company. One of these stations will use hydrogen made from biogas, which is natural gas made from renewable sources.

In 2017, Shell published a study on the future of hydrogen in the transport sector and concludes that in 2050, 113 million fuel cell electric vehicles (FCEVs) could save up to 68 million tonnes of fuel and almost 200 million tonnes of carbon emissions, making a significant contribution to reducing energy consumption and greenhouse gas emissions in the transport sector.

Collaboration between vehicle manufacturers, energy companies and government is vital for progressing the infrastructure to make any emerging fuel a viable alternative. Hydrogen is no exception.



Hydrogen and trains

It is recognised that rail is already an environmental, efficient means of public transport but still contributes to greenhouse gas emissions. There are currently 2,400 diesel powered vehicles on the rail network, which the Government is committed to removing by 2040. Hydrogen makes an ideal replacement for diesel, and hydrogen trains could easily take the place of half that fleet.

A hydrogen fuel cell powered train, can operate on both green and blue hydrogen, however the production of green hydrogen at present, is currently the most expensive means of producing hydrogen. Alstom already has exciting projects underway in rail, which includes converting their Breeze trains to hydrogen powered trains. They estimate that their first fleet production would create approximately 200 jobs and if the demand continued, so would the employment opportunities. In 2019, Porterbrook launched HydroFLEX, the UK's first hydrogen-powered train. It is the first train in the world to be retrofitted with hydrogen power. Creating hydrogen powered trains would create additional local jobs where each fleet was deployed, fuelling and maintaining the trains.

Hydrogen and planes

The Covid-19 pandemic has severely affected the aviation industry and there is now a clear opportunity to create greener flights through using hydrogen technology. There is still more work to be done in this area but there is huge potential for the industry which should not be overlooked. This was also recognised by the Prime Minister and his ambition for '*Jet Zero*'.

Over the last five years, the hydrogen mobility sector has received less than £40m in support for deployment from the UK Government. **It is now time to move from ad hoc competition based support to commercialising support schemes. The Government should look at creating a subsidy to help stimulate hydrogen vehicle purchases or a subsidy per kg of hydrogen sold. Regulation must be changed, the Renewable Transport Fuels Obligation (RTFO) is inflexible and not designed to help boost hydrogen itself. Amending these rules alongside reforming the Bus Service Operator Grant to favour zero emissions would help support the creation of a hydrogen economy.**

Summary

- Establish incentives such as capital investment grants and business rate relief on hydrogen refuelling stations, or consider subsidies, similar to what has been delivered in California.
- Move from ad hoc competition based support to commercialising support schemes. The Government should look at creating a subsidy to help stimulate hydrogen vehicle purchases or a subsidy per kg of hydrogen sold.
- Regulation must be changed, the Renewable Transport Fuels Obligation (RTFO) is inflexible and not designed to help boost hydrogen itself. Amending these rules alongside reforming the Bus Service Operator Grant to favour zero emissions would help support the creation of a hydrogen economy.

Northern Gas Networks

case study

H21 is a pioneering hydrogen research and demonstration programme supporting conversion of the UK gas networks to carry 100% hydrogen.

Led by Northern Gas Networks, in partnership with Cadent, National Grid Gas Transmission, SGN and Wales & West Utilities, H21 began in 2016 as a feasibility study.

Based on a city the same size as Leeds, this proved that conversion of the networks was technically possible and financially viable. Four years later, H21 is establishing the critical safety evidence proving that a hydrogen gas distribution network is equally as safe as the natural gas network heating UK homes today.

Phase 1: H21 received £9 million of Ofgem Network Innovation funding in 2018 for the first phase assessing the suitability of the network to carry hydrogen. We have since developed facilities at DNV GL's base at Spadeadam, Cumbria and the HSE's site at Buxton to undertake asset testing.

We have also delivered a social sciences workstream, led by Leeds Beckett University, to understand public perceptions of hydrogen and awareness of its use as an energy source. This study found that customers were generally supportive of converting gas networks to hydrogen. A full report for Phase One will be released in summer 2020.

Phase 2: An additional £6.8 million of NIC funding was granted for H21 Phase Two, to further develop the evidence base.

This work will focus on simulating network operations and involve testing at an unoccupied (decommissioned) section of the gas network, an essential prerequisite to live trials. One of the key outputs of Phase 2 is the development of the Quantitative Risk Assessment which will bring together findings from Phase 1 as well as the Hy4Heat programme, exploring hydrogen's use in buildings and appliances.

Further social sciences research will focus on developing communications resources to enable consumers to make informed choices on their future energy.

Phase 3: Following Phases 1 and 2 and enabled by the Quantitative Risk Assessment delivered through Phase 2, Phase 3 will deliver a 100% live trial to approximately 670 customers. We are currently developing a more detailed scope for this project but are targeting commencement of the trial by mid-2022.

Public perceptions of hydrogen

In order to kickstart a hydrogen economy, it is essential that the public is at the heart of the conversation. Consumers must be included in each phase of the energy transition discussion. Without public support, making hydrogen a reality will be impossible.

Leeds Beckett University along with members of the H21 team have looked at understanding the general public's perception of 100% hydrogen conversion. The research found that support of a hydrogen conversion is possible once key issues around the environmental benefits, safety, cost and minimal disruption to people's lives were discussed.

Cost will be a key factor to the public and incentives must be introduced to encourage demand for hydrogen in order to create a cleaner economy. The quicker hydrogen is commercialised, the more cost efficient this will be, as recognised by the Energy Networks Association in their *Hydrogen: Cost to Customer* report. Their evidence shows that over the forecast period (2020-2050), there could be a net benefit to customers of £89bn by 2050, if investment into the development of a hydrogen economy in the UK is made now. Any delays would lessen the benefit to energy customers of developing a hydrogen economy.

In response to the APPG's evidence, Citizens Advice point out that questions will need to be answered when introducing hydrogen to heating people's homes. It is vital that the public's needs are at the heart of any plans for using hydrogen in homes. The 'consumer journey' must be considered from the outset: this is a new technology and there are many unknowns.

A public engagement strategy should be adopted, it is crucial that the public are informed of the benefits of hydrogen and educated on some of the myths. Evidence submitted by Tees Valley Combined Authority outlined that a starting point of building public support of a hydrogen economy should be developed in regions where the process sector is well established and supported.

This is further supported by EDF who state that hydrogen should particularly focus on providing reassurance around issues of safety in the home and the workplace. Prioritising the genuinely lowest carbon forms of hydrogen will assist that process.

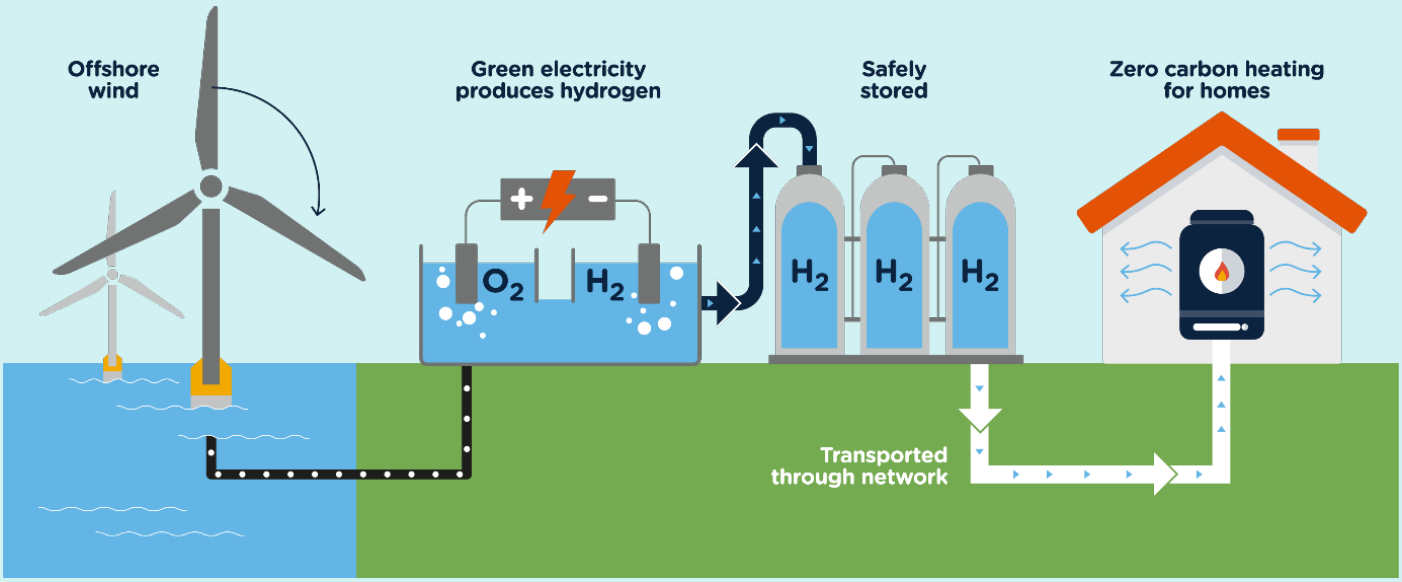
Providing people with the right information, advice, protection and support will be crucial if hydrogen is to be adopted as a source of low carbon heat for homes.

Summary

- Develop a public engagement strategy to ensure the public are aware of and educated on the opportunities and challenges of a hydrogen economy.
- Create public campaigns, highlighting the benefits of hydrogen and its future role with UK energy.

SGN

case study



H100 Fife will be the world's first 100% green hydrogen-to-homes network for heating if proposals are approved by the energy industry regulator Ofgem. An initial 300 homes in Levenmouth, Fife, will have access to hydrogen for heating and cooking within two. The project will start construction in late 2020/early 2021 and is intended to provide critical evidence for a zero carbon energy source, helping to inform the UK's long-term policy decisions for decarbonisation of heat.

The project will see a new 100% zero-carbon hydrogen network be built, using zero carbon hydrogen produced through electrolysis powered by an offshore wind turbine (The Levenmouth Demonstration Turbine is owned by ORE Catapult, the UK's leading technology innovation and research centre for offshore renewable energy) . The proposed hydrogen production, storage and network will run along-side the current natural gas system, demonstrating every aspect of a hydrogen-to-homes, end-to-end system to support plans for large scale roll-out in the future.

The system will be designed and built to ensure at least the same safety and reliability standards expected from the current gas system. On site storage will hold enough hydrogen to ensure supply won't be disrupted during even the coldest weather conditions.

The project aims to provide critical insight into hydrogen demand and supply management, security of supply and real world asset operation. As well as testing technical and engineering capabilities, the project will provide valuable insights into customer appetite and behaviours. Eligible residents can participate on an opt-in basis, meaning they will have the choice to switch to hydrogen, or remain with their existing natural gas supply. A demonstration facility within the project is proposed to allow customers to interact with hydrogen appliances in a home-like setting prior to opting in.

Hydrogen across the world

The UK is well-positioned to become a global leader in the technology and attract a significant proportion of that market. However, without action, the UK risks being left behind as other countries bring forward comprehensive hydrogen strategies and signal significant investment.

Germany, Australia, Canada, and Japan have already published commitments and are deploying funding, and the European Commission recovery plan includes billions of Euros for kick-starting a clean hydrogen economy in Europe.

Over two hundred thousand homes are already powered and heated by hydrogen in Japan and Germany has set aside €7 Billion to fund its emerging hydrogen strategy. **The UK is well placed to develop a strong, exporting hydrogen supply chain but this requires a strategy, investment and certainty for investors, being more ambitious than our international competitors.**

In May this year, gas network companies set out proposals for £904m of investment in hydrogen related projects across Great Britain between now and 2026, under the Gas Goes Green Zero Carbon Commitment. Decisions on energy network investment are made by the energy regulator, Ofgem, but those decisions are dependent on wider Government policy. Respondents to the APPG inquiry have called on the Government to unlock that investment by ensuring that its economic policy response to the Covid-19 crisis supports the establishment of a hydrogen economy, both in terms of short and long-term impact.

With the UK hosting COP26 in November next year it has never been more important for the Government and industry to demonstrate their commitment to hydrogen. **There should be stronger incentives for energy-intensive industrial sectors to decarbonise more effectively and efficiently than international competitors.**

As stated by Baroness Brown of Cambridge, Vice-Chair of the Committee on Climate Change, '*the UK missed the boat on wind technology and missed the boat on battery technology*' [where China now holds 73%, and rising, of the world's lithium cell manufacturing capacity]. *We cannot afford to miss the boat on hydrogen*'.

Summary

- The UK is well placed to develop a strong, exporting hydrogen supply chain but this requires a strategy, investment, and greater certainty for investors. We must be more ambitious than international competitors.
- There should be stronger incentives for energy-intensive industrial sectors to decarbonise more effectively and efficiently than international competitors.

Contributions

The APPG would like to thank the below organisations for their contributions in evidence. All evidence referenced in the APPG report can be found published on our website.

Aberdeen City Council
AC Chemical Systems Ltd
Alstom
Anglo American
Arup
Atkins
Baxi Heating
Ballard
Bosch Thermotechnology
British Compressed Gases Association
Cadent
Carbon Capture and Storage Association
Cavendish Nuclear
Chemical Industries Association
Citizens Advice
Clean Power Hydrogen Group
Colin Megson
Committee on Climate Change
Decarbonised Gas Alliance
Deep Branch Biotechnology
Drax
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Pale Blue Dot Energy
Patrick Venn
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Penultimate Power UK
Progressive Energy
Porterbrook
PowerHouse Energy Group PLC
Protium
Rolls-Royce
RWE
Ryse/ Wrightbus
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The Hydrogen and Fuel Cell Research Hub
The Nuclear Innovation and Research Office
The Offshore Renewable Energy Catapult
The Oil and Gas Technology Centre
The Scottish Hydrogen and Fuel Cell Association
The Shetland Energy Hub Project
Tom Baxter
TÜV SÜD National Engineering Laboratory
UK H2 Mobility
UK Hydrogen and Fuel Cell Association
UK Onshore Oil and Gas
UNISON
University College London - Institute for Sustainable Resources
Urenco
Vattenfall
Westinghouse
Wood PLC

About the APPG

The APPG on Hydrogen provides a forum for MPs and Peers to engage with leading businesses and organisations that are working to enable the UK to meet its decarbonisation targets through the implementation of hydrogen projects, and to discuss policy options to support these.

The Group was established in July 2018. It is a cross-party group of MPs and Peers that focuses on raising awareness of, and building support for large scale hydrogen projects – such as conversion to a hydrogen domestic gas grid – that will enable the UK to meet decarbonisation targets.

Contact the group


appghydrogen@connectpa.co.uk


connectpa.co.uk/appg-hydrogen/


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