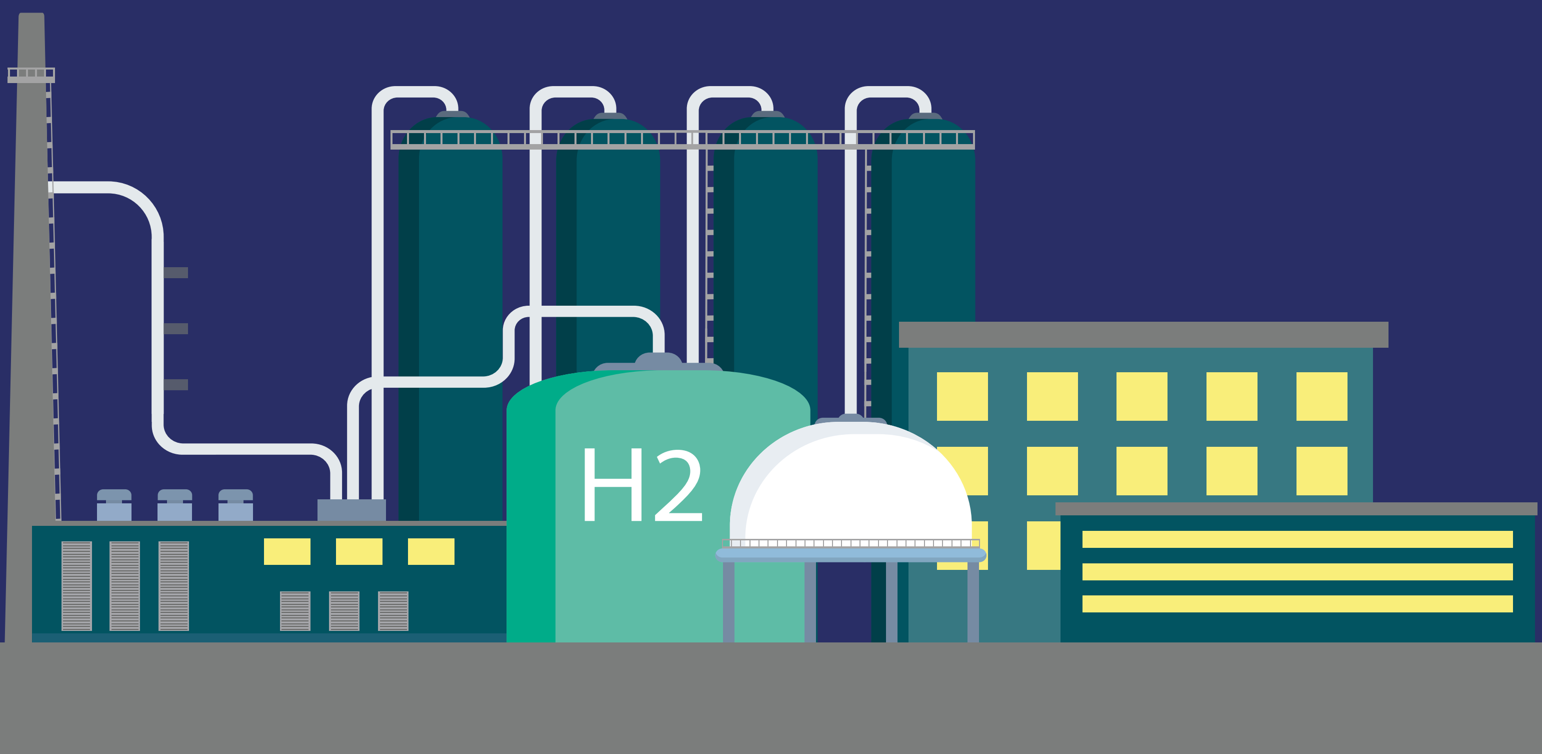
January 2025

Hydrogen UK

Hydrogen to Power Report

Written by
Power Generation Working Group



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Executive Summary

The UK has set an ambitious target of delivering clean power by 2030. Low carbon dispatchable power generation using hydrogen will play a key role in a clean power system, by providing flexibility and other services for system operability, and also by providing supply adequacy during extended periods of low renewable output, decarbonising the role currently performed by an aging portfolio of unabated natural gas power generation.

While some 100% hydrogen to power (H2P) commercial projects are already being deployed globally using multi megawatt fuel cells, alongside blending hydrogen into existing gas turbines and new hydrogen ready turbines, industrial scale 100% H2P projects face additional challenges of deploying new technology into a nascent system, one which requires significant volumes of hydrogen storage with long lead times.

To achieve the 2030 clean power system ambition, and lay the foundations for a clean, resilient and secure power system beyond 2030, it is critical that the new government takes resolute actions now to support H2P at scale. A **clear strategic plan** should be developed within the first 12 months of the new administration, with clarity being given on **policy**, **business models**, and **deployment rates** for hydrogen to power **(H2P)** and its **enabling infrastructure**.

This report, produced by Hydrogen UK's Power Generation Working Group, explores the role that H2P will play in the decarbonised power system of the future, the barriers to deployment, and recommendations for overcoming them.

H2P in the UK energy system

Integrating H2P into the wider hydrogen and power systems

Figure 1 shows how the decarbonised power system of the future will look, with multiple energy vectors integrated into a single system. H2P projects will be at the heart of this integrated system, playing a role in both electricity supply and demand. They will range from small scale standalone projects isolated from other energy infrastructure, right up to industrial scale assets with extensive cross-chain connections for hydrogen production (both electrolytic and CCUS-enabled), transport pipelines and storage assets (both hydrogen and CO_2), and the electricity grid itself.

The current fleet of gas turbines providing dispatchable power generation to the UK grid includes units up to approximately 900MW in capacity. Such a unit running on hydrogen would consume around 45 tonnes of hydrogen every hour. And in the Holistic Transition (HT) Pathway of the Future Energy Scenarios 2024: Pathways to Net Zero report, from which its Clean Power 2030 advice to Government was based, the National Energy System Operator (NESO) identified a requirement for 1TWh of hydrogen storage in 2030 to support H2P and other users of hydrogen.

Given the large volumes of hydrogen feed and flexible operating mode, industrial scale H2P requires very specific large-scale geological stores such as salt caverns and depleted oil and gas fields. These storage sites are in fixed locations, and therefore H2P assets will also rely on transport infrastructure to connect them to the upstream production sites and the storage sites. The National Infrastructure Commission in its 2023 Second National Infrastructure Assessment[1] recommended that a core network of hydrogen pipelines is connected to 8TWh of hydrogen storage by 2035 for balancing the energy system.

"New geological salt cavern stores have relatively long lead times of about eight years to develop, so it is essential that government acts now to facilitate their development, while assessing the shorter-term tactical options ahead of 2030." [2]

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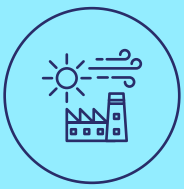
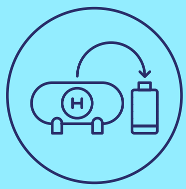
Figure 1: Hydrogen to power in the decarbonised UK power system



Low carbon hydrogen will be produced in industrial clusters, in areas of abundant renewable generation, and with connections to the electricity grid.

Hydrogen will be transported via pipelines from production centres to geological storage facilities and offtakers, including H2P plants.

When renewable electricity generation capacity exceeds electricity demand, hydrogen can be produced and stored for long durations (days, weeks, months).



When electricity demand exceeds renewable and short duration generation capacity, such as extended periods with little to no sun or wind, hydrogen can be withdrawn from storage and converted back to electricity to feed the grid.

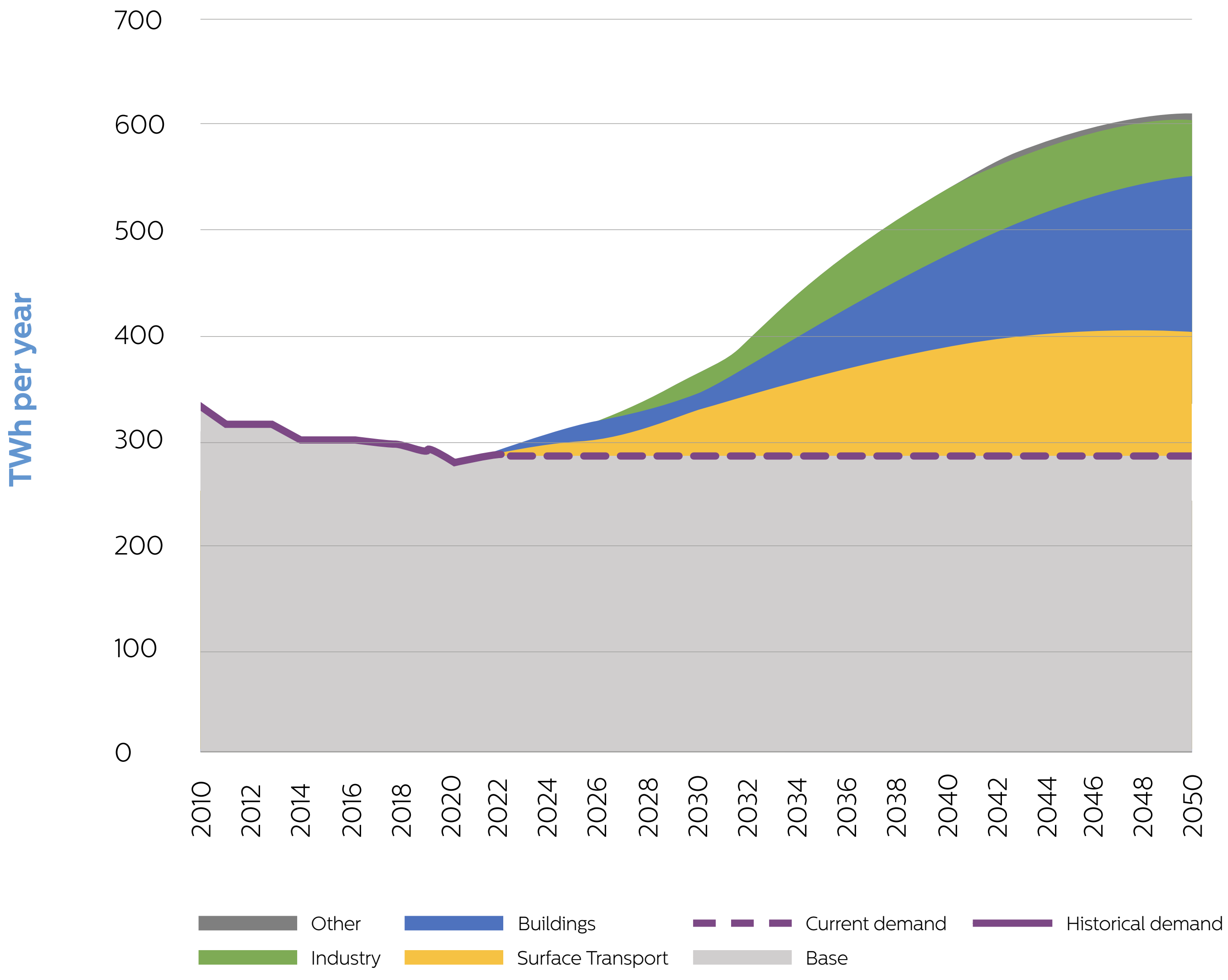
The role of H2P in a Clean Power System

What is driving the need for H2P

The growing demand for electricty

Electrification is occurring at pace in the UK in sectors such as building heating (heat pumps) and surface transport (electric vehicles). As a result, the trend of falling UK power demand observed since the early 2000s is set to reverse. Even with ongoing improvements in energy efficiency, demand for electricity is set to grow by 25% between 2025 and 2035[3]. And it is not only the total demand that is set to increase, but also the peak demand on the power system. The electrification of these additional loads will only deliver decarbonisation if the power generation itself is decarbonised, including peaking which is currently provided by unabated gas.

Figure 2: UK electricity demand is set to double between now and 2050



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The expansion of intermittent renewable energy generation capacity

Government has promised that by 2030 the UK will double its onshore wind capacity, triple its solar power, and quadruple its offshore wind capacity as part of the mission to achieve clean power[4]. However, whilst renewable sources of electricity such as wind and solar are crucial in achieving net zero, they are also inherently intermittent; we can't rely on the sun to shine and the wind to blow at the times the system most needs electricity, nor can we always accurately predict the weather. Storage technologies such as batteries will play a role, with dispatchable generation also needed to address the larger and/or longer durations of supply deficit that will exist in the renewables-dominated power system of the future.

The need for more flexible capacity by 2030

Demand for electricity is increasing due to the electrification of large sections of the energy system, at the same time policy and legislation is accelerating the deployment of variable renewable electricity generation to meet our social and legal mandates for net zero. The combination of these factors presents a new and unique challenge to the power system – we need to produce more electricity, whilst the electricity we produce is becoming increasingly more variable, unpredictable, and weather-dependant. This has the potential to cause severe issues for the reliability of the UK power grid if not managed effectively, and at substantial cost to the UK consumer. This is why deploying a diverse combination of ow carbon flexible power generation technologies, including hydrogen, will be crucial to ensure that:

- Electricity supply and demand is balanced effectively over time
- The electricity grid remains stable and reliable
- Security of supply is maintained
- Delivery of a clean power system is supported
- Cost to the consumer is minimised

The exact mix of low carbon dispatchable generation is still unknown, and will depend on a wide range of factors including technology, infrastructure and cost. In their 2023 report, the CCC estimated a range of 12-20GW of low carbon dispatchable generation, a mix of hydrogen and gas with CCS, will be required across all scenarios.

"A renewables-based system, complemented by a suitable portfolio of low-carbon flexibility, canprovide a secure and reliable supply of energy."

Climate Change Committee

The importance of flexibility

Balancing supply and demand

When there is a mismatch between the total power demand of the grid and the level of inflexible electricity supply available, this is known as 'residual demand'. In cases of positive residual demand (i.e. generation deficit) flexible technologies such as energy storage, demand side response, and unabated gas fill the gap. Negative residual demand (generation surplus) poses a different challenge, and usually results in low-cost electricity going into storage or being wasted ('curtailed').

With greater overall power demand and a greater output of renewable power providing the bulk of this power supply, **the power system will become much more sensitive to weather-derived swings in renewable output**. These could be the result of regular intra-day variations, longer term / seasonal weather patterns, extreme weather conditions, electricity network constraints, and intrinsic modelling limitations due to the complexity of the system, amongst others. Modelling performed by Afry in 2023 on behalf of Committee for Climate Change (CCC) displayed that both the frequency and severity of residual demand events are set to increase substantially between now and 2035, such that:

- Residual demand could peak at 73GW in 2035, in comparison to 21GW in 2025.
- The proportion of hours with negative residual demand (generation surplus) could rise from 1% to 36% between 2025 and 2035.

However, these figures are based on the needs and ambitions of the former government to achieve a net zero power system by 2035. It is likely that the impacts would be felt sooner or more severely with the greater rates of renewable deployment targeted by the new government to meet the Clean Power 2030 mission.factors including technology, infrastructure and cost. In their 2023 report, the CCC estimated a range of 12-20GW of low carbon dispatchable generation, a mix of hydrogen and gas with CCS, will be required across all scenarios.

Figure 3: Modeling for 2025 and 2035 shows an increase in the frequency and severity of residual demand events.

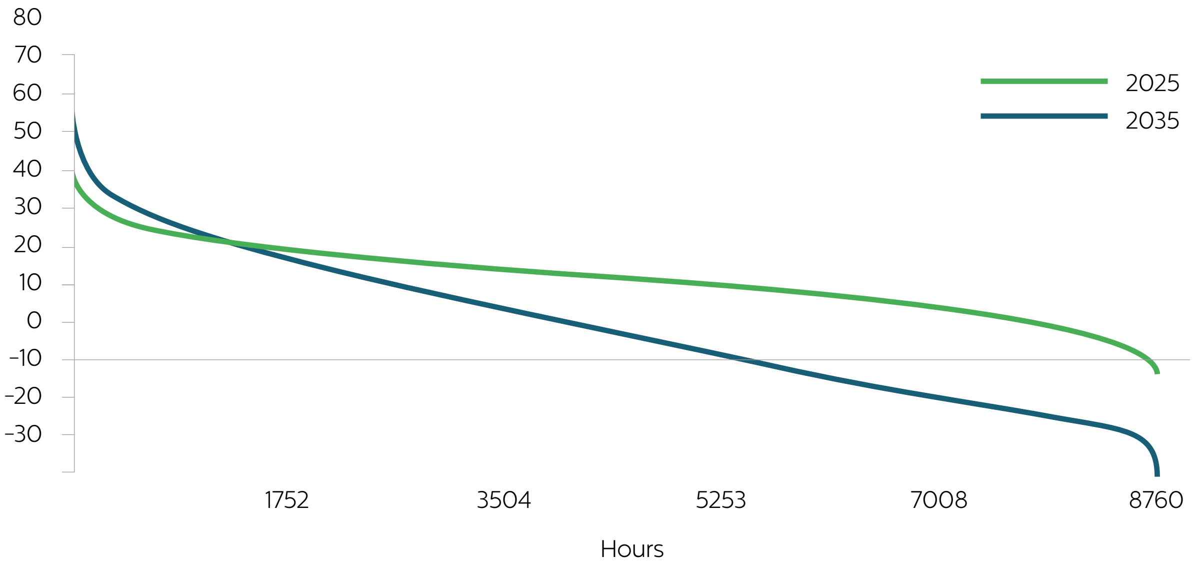

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Figure 4: Flexible generation with long duration energy storage is required to bridge the gap between supply and demand.

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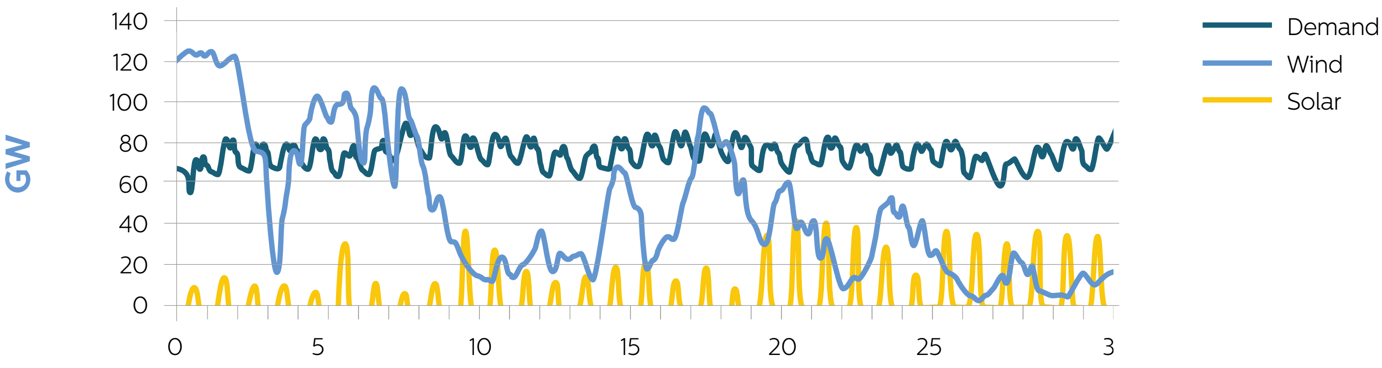

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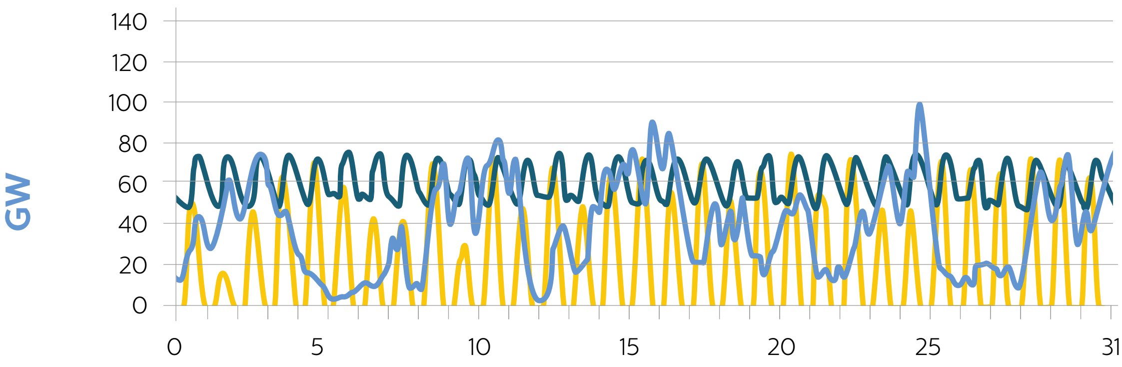

Stabilising the grid

Electricity grids are very complex and are extremely sensitive to changes in the composition of the power mix at any given time. As a result, there are a variety of additional services that flexible power technologies can provide to the grid to ensure that it remains stable across different points in the network. Such services include voltage and frequency management, reserve contingency, and synchronous inertia. The intermittency and unpredictability of renewable energy sources does not lend itself to managing such behavioural features of the grid and thus significant investment into appropriate flexible technologies to aid in maintaining security of supply.

Categorising flexible technologies

Balancing residual demand is not only important to consider on a second-by-second or intra-day basis, but also the cumulative effect of residual demand over longer durations ranging from weeks all the way up to yearly variations. There are a range of technologies that can produce flexible responses in power generation, however, some are better than others in terms of maintaining high volumes of response capacity over long durations, whilst others are more suited to responding very rapidly to within-day fluctuations in renewable output.

We can broadly categorise the suitability of specific technologies by:

1. Response Duration: the maximum length of time that a technology can perform a balancing action.

2. Response Speed: the minimum length of time that a technology requires to perform a balancing action.

Dispatchable power generation can provide flexibility at a range of speeds, ramping up their output rapidly from a cold start, starting within a few minutes for fuel cells, and 15-30 minutes for engines and gas turbines.

However, where dispatchable generation excels is in response duration. When coupled with adequate levels of hydrogen production and storage, H2P can provide large volumes of firm and flexible dispatchable low carbon power generation to help make up any prolonged shortfalls in renewable electricity generation over the course of weeks or seasons, a role that is currently and most economically filled by unabated natural gas power generation.

Hydrogen power generation technologies

There are multiple technologies in which hydrogen can generate dispatchable power:

- **Open Cycle Hydrogen Turbine (OCHT):** A traditional gas turbine, very similar to existing GTs designed for natural gas, though with a specially designed fuel delivery and combustion system for hydrogen
- **Combined Cycle Hydrogen Turbine (CCHT):** Largely the same technology as a GT but fitted with a heat recovery system that drives a secondary steam turbine, improving power output and fuel efficiency.
- **Reciprocating Engine:** Similar to combustion engines found in vehicles, hydrogen is combusted in a series of small chambers to drive pistons, turning a crankshaft to create electricity.
- **Combined Heat and Power (CHP):** Any form of hydrogen combustion generator (mostly reciprocating engines) that recycles waste heat by exporting it for external use such as in heat networks.
- **Hydrogen Fuel Cell:** Very similar to electrolysers, but the reverse of this process in which hydrogen and oxygen are combined, releasing electrical energy and creating water as a by-product.

Several commercial grid-scale projects are already under operation and in construction using fuel cell technology, operating on 100% hydrogen. With numerous fuel cell suppliers offering multi megawatt systems, projects have been able to take final investment decisions.

Demonstrations have already proven the feasibility of both blended and 100% hydrogen power generation, including the HYFLEXPOWER project, a power-to-hydrogen-to-power demonstration by Siemens Energy where a gas turbine with Dry Low Emissions (DLE) technology was fuelled with 100% green hydrogen. The DLE technology allows 100% hydrogen to be combusted for zero CO_2 emissions as well as maintaining low levels of other emissions species such as NO_x and CO to legislated levels.

A follow up project HyCoFlex builds on HYFLEXPOWER to extend operation to industrial heat production and explore ways of scaling up and commercialisation, ready for when a reliable low carbon hydrogen supply is available. International OEMs are working on 100% hydrogen firing versions of their large scale CCGTs, with targets for commercial availability by 2030, with some smaller frames available earlier. Collaborations such as those between Siemens Energy and SSE[6] are helping accelerate this technology development.

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Case Study

The potential H2P fleet to support Clean Power 2030 and beyond

Aldbrough Hydrogen Pathfinder (SSE Thermal, Equinor)

Located at SSE Thermal and Equinor's Aldbrough Gas Storage site, Aldbrough Hydrogen Pathfinder (AHP) is an important building block in the development of a hydrogen economy in the Humber. Comprising a 35MWe electrolyser, a converted salt storage cavern and a 50MW OCGT running on up to 100% hydrogen, it will export power back to the grid in times of low renewable capacity and showcase how hydrogen can provide security of supply and power the UK to net zero.

Pathfinder will support the evidence base for wider deployment of flexible hydrogen power, and the required interactions between production and storage, as an enabler of at-scale hydrogen offtake and a key provider of home-grown, secure, dispatchable power. In addition, Pathfinder will unlock critical hydrogen storage capacity, which will be key to balancing production and offtake as the hydrogen economy develops and regional hydrogen networks are established. The project is significantly advanced, with FEED completed and a planning application recently submitted.

Brigg Energy Park (HiiROC / Centrica)

HiiROC and Centrica have formed a partnership to conduct a hydrogen to power demonstration at Centrica's Brigg peaking plant in Lincolnshire. The trial will mix hydrogen produced through HiiROC's patented Thermal Plasma Electrolysis (TPE) process with natural gas at the peaking plant, which is designed to meet energy demand during peak times. With a fully integrated whole system infrastructure the long term vision would be to move towards a 100 per cent hydrogen to power solution.

HyPower (HDF Energy)

HyPower is a multi-MW fuel cell power plant harnessing the potential of low-carbon hydrogen to generate clean electricity. Integrated with HyNet's hydrogen transport and storage infrastructure, the HyPower project will utilise HDF Energy's fuel cell system to deliver 40MW of emissions-free power. The fuel cell system is modular, high efficiency, using mature technology, and replicable at sites with access to reliable hydrogen.

Project Arrington (ESB)

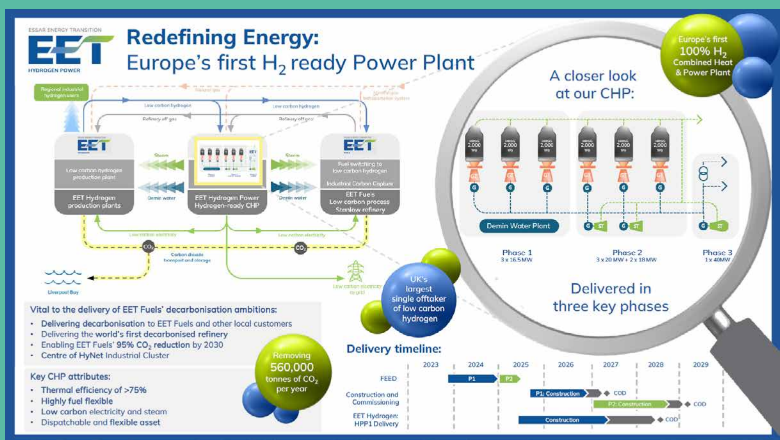
Carrington is an 884MW power station that employs Combined Cycle Gas Turbine (CCGT) technology to generate enough electricity to power over one million homes and business. Owned and operated by Ireland's state-owned Electricity Supply Board (ESB), Carrington began commercial operation in 2016 and is one of the most efficient of its kind in the UK.

It is strategically located near the Track-1 HyNet industrial cluster, ensuring a reliable hydrogen supply for the power station. Utilising advanced Ansaldo GT26 Gas Turbine Technology, initial feasibility studies indicate that the project can initially achieve up to 45% hydrogen blend giving a significant carbon reduction across the two units which could be achieved in line with HyNet Phase 2. Further phases of the project will be developed to technically assess the feasibility of higher blends and further carbon reduction.

The GT26 gas turbine fleet represents nearly 9.5GW of installed CCGT capacity in the UK. The implementation of hydrogen blending at Carrington could significantly contribute to the decarbonisation of dispatchable power in the UK through hydrogen, as a first of a kind proof of conversion of an existing turbine in the UK.

EET Hydrogen Power (EET)

Essar Energy Transition (EET) is developing Europe's first hydrogen-ready combined heat and power plant (CHP) to be built at its Stanlow refinery, with the aim of completing construction of the first phase in 2027. The H2P project will support EET Fuels' ambition to deliver the world's first decarbonised refinery, and will also provide low carbon power to other industrial users in the region to support their decarbonisation targets. EET Hydrogen Power will be developed over three phases to reach a capacity of 150 MW of power, with the hydrogen replacing hydrocarbons delivering a reduction of 560,000 tonnes of carbon dioxide per annum. The CHP plant has a high thermal efficiency and can be operated as a flexible, dispatchable asset.



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The wider benefits of H2P

H2P enables the deployment of renewable energy

As previously described, the increasing penetration of renewable electricity in the generation mix creates the potential for large and/or long gaps between supply and demand when the sun is not shining and the wind stops blowing. However, deployment rates can continue to accelerate, knowing that the excess generation can be used to produce electrolytic hydrogen which can be stored for long durations, and run through H2P plants to provide the firm and flexible supply required to manage the gaps that can't be met by other technologies.

Hydrogen provides a pathway to decarbonise the role currently fulfilled by unabated gas (and diesel) and maintain energy security

The Decarbonisation Readiness policy consulted on by the previous Government cemented H2P plants alongside Gas CCS as one of the two main avenues for the decarbonisation of unabated gas power generation. Hydrogen gas turbines are very similar to conventional natural gas turbines in terms of engineering and design. Where other factors such as space and equipment compatibility allow, projects can be developed and designed now so as to achieve low-impact retrofit, and extend the lifetime of existing generation. Ensuring that any new-build unabated gas turbine capacity is hydrogen-ready will be important to facilitate hydrogen's introduction into the market by reducing the lead times required to convert to low carbon, reducing the risk of potential capacity cliff-edges which could undermine UK power system security of supply.

Hydrogen power will be the most cost-effective low carbon option for certain applications

Hydrogen power could play a variety of roles in a clean power system. When considering large scale power generation, it is likely that hydrogen will be the lowest cost, low carbon, dispatchable option for low load factor operation. This is due to the structure of costs, particularly the lower upfront capital costs when compared to gas CCS. Analysis for government suggests that in 2035, in an unsubsidised scenario, H2P will be lower cost than gas CCS at load factors of up to 5-20%. The range here depends on the price of hydrogen and whether the power plant is an OCHT or CCHT[7]. It is likely that gas CCS will be more cost effective at higher load factor operation, however the decarbonisation investment decisions for individual power plants may depend on other factors such as access to infrastructure and space constraints.

Hydrogen technology provides wider cost savings to the electricity grid

The integration of hydrogen into the energy system provides an opportunity to reduce the burden of electricity grid investment, and play a vital role in balancing the system. As noted in both the Offshore Wind Champion's and Hydrogen Champion's respective reports[8,9], integrated infrastructure planning across electricity and hydrogen transmission alone could provide energy system savings of up to £38 billion by 2050.

> **"As part of our Sixth Carbon Budget advice, we recommended that new gas plants be made properly CCS - and/or hydrogen-ready as soon as possible and by 2025 at the latest."**
>
> Climate Change Committee

H2P provides a large source of hydrogen offtake

Owing to the technology synergies between hydrogen and natural gas power generation and the pioneering development work by UK power generators, with adequate vision and support from Government the UK could have a strong fleet of H2P assets by 2030 to support its mission for a clean power system.

The volumes of hydrogen required for H2P are significant, with the UK Hydrogen Strategy showing that H2P could require 10-30TWh of hydrogen by 2035. With clear and effective government support for H2P, this could bolster the wider hydrogen economy significantly by providing anchor demand and, with it, revenue certainty for low carbon hydrogen production, transport, and storage developers. Hydrogen-ready assets also provide certainty that large-scale offtake can step up as soon as the production, transport and storage infrastructure is ready.

H2P will help UK industrial clusters to decarbonise

Before 2030, whilst national and regional hydrogen networks are under development, large-scale hydrogen projects will largely concentrate around industrial clusters where infrastructure synergies are greatest, and supply and demand can be co-located to drive down cost. The Cluster Sequencing program is already providing a financial framework for carbon capture enabled hydrogen production projects to come forward and produce low-carbon hydrogen at scale before 2030. With UK industrial clusters already home to a significant portion of the UK's thermal power generation fleet, and with ready access to subsidised low carbon hydrogen, H2P projects located in or near to industrial clusters are likely to form the majority of the UK's early H2P capacity. Moreover, H2P can play a role in supporting adjacent industry in decarbonising, either by improving local access to low carbon hydrogen supply and infrastructure, or by supplying low carbon electricity through direct wire connections or local power networks.

Delivering jobs and economic growth

H2P supply chains have a lot of commonalities with their natural gas counterparts. Many of the companies involved in designing, manufacturing, operating, and maintaining gas turbines will continue to do so as global demand for high-efficiency unabated gas turbines, CCS-abated gas turbines, and hydrogen gas turbines continue for the next few decades. Furthermore, those companies already operating fuel cell assets abroad could deploy H2P in UK as soon as a business model is available, bringing jobs and economic growth before 2030. The HUK Economic Impact Assessment indicated that H2P could support more than 5,000 jobs and contribute more than £2bn in GVA to the UK economy by 2030.

GeoPura HPU

GeoPura is leading the shift to sustainable energy by delivering zero-emission power solutions through its innovative Hydrogen Power Unit (HPU) technology. By harnessing green hydrogen, GeoPura generates clean, reliable electricity with water as the only byproduct, displacing traditional fossil fuels and improving air quality wherever power is needed. From festivals and construction sites to live TV broadcasts, GeoPura's HPUs are already in action across diverse sectors, providing emission-free power and supporting the UK's transition to net-zero.

GeoPura produces, stores, and transports green hydrogen from its UK-based facilities, ensuring power is available even in areas with insufficient grid infrastructure. In collaboration with Siemens Energy, GeoPura is scaling up production, with plans to deploy over 3,600 HPUs by 2033, collectively displacing over ten million tonnes of CO_2 emissions throughout their operational life.

GeoPura's technology is trusted by industry leaders like the BBC, Balfour Beatty, and HS2, who are already benefiting from its sustainable power solutions. Recent high-profile deployments include the DP World Golf Tour broadcast, EV charging for the MOD, and powering the shutdown of a Uniper power station, exemplifying GeoPura's impact on today's energy landscape.


EKFB


Cottam Power Station


Balfour Beatty A63


Westmorland Services


Cottam Power Station


Balfour Beatty A63


Latitude Festival


MOD - RAF Leeming


2023 BMW PGA Championship

Siemens Energy, Lincoln

Hydrogen UK member, Siemens Energy, is building on 175 years of engineering innovation in the UK to bring innovative technology to the energy market to enable gas turbines to run on hydrogen. Siemens Energy Lincoln introduced its first gas turbine in 1952 and from its manufacturing and service centre in Lincoln develops, markets and supports world leading gas turbines and services. The company employs over 1000 people and supports a local and UK-wide supply chain valued at over £86m annually. The company sells most products to export and provides services for a fleet of around 3,000 gas turbines globally generating significant export revenues. Siemens Energy Lincoln supports the strength of a diverse workforce and works.

Barriers to the deployment of H2P

Lack of adequate hydrogen storage volumes

The success of H2P is highly dependent on the development/availability of cross-chain transport and storage infrastructure. H2P technologies consume quantities of hydrogen that currently far outstrip real-time production capacities.

Large scale infrastructure projects such as geological storage have much longer lead times than the construction of any individual H2P asset. Therefore, should Government wish for H2P to play a role in the 2030 UK energy mix and beyond, strategic decisions must be made before the end of 2025 pertaining to the T&S infrastructure necessary to facilitate this, else H2P assets risk becoming delayed, stranded, cancelled, or forced to run as unabated gas generation, locking in carbon for longer due to a lack of access to low carbon hydrogen fuel.

HUK encourages Government to accelerate its timelines and ambitions on the development of hydrogen networks and storage whilst removing H2P development barriers. Furthermore, the availability of other enabling infrastructure elements has been highlighted as an ongoing concern to power developers including physical connections, access rights, and contract frameworks; these elements should be streamlined and finalised as soon as possible to provide greater investor confidence and promote timely FIDs.

Uncertainty over business models

Hydrogen storage for power generation requires very specific large-scale and highly flexible geological stores. Large-scale hydrogen stores, such as salt caverns, have high capital costs and long lead times, posing prohibitive market barriers to developers who do not have access to support mechanisms, such as the Hydrogen Storage Business Model (HSBM). Given the scale of these projects, hydrogen producers and qualifying offtakers such as H2P are unlikely to develop, own or operate the hydrogen storage facilities.

Hydrogen producers can receive support for small-scale hydrogen transport and storage under the Hydrogen Production Business Model, however it is not expected that small-scale storage will be suitable for large scale hydrogen power generation given the high cost of pressurised vessel

"Progress will also need to be initiated on a range of hydrogen production and geological storage solutions, so that where possible these can be operational by 2030 or as soon afterwards as possible" [10]

National Energy Policy Centre

storage (relative to amount of hydrogen stored), scale and flexibility requirements (injection and withdrawal rates).

Clear alignment and understanding of the interaction of the various business models and incentives will attract investment and streamline the development of hydrogen infrastructure. This will ensure that production, distribution and off-take are developed in a co-ordinated manner, optimising the hydrogen value chain.

Cross-chain nascency risks

Cross-chain hydrogen infrastructure consists of all the enabling infrastructure upstream of the point of use. This consists of hydrogen production, networks, and storage first and foremost. However, this also extends to carbon capture networks and storage that will play a key role in producing a significant volume of the low carbon hydrogen required before 2030, and the electricity networks that will link to electrolytic hydrogen projects and H2P generation. Much of this required infrastructure is new to the UK energy system, with some hydrogen technologies requiring novel and innovative solutions that are still in the process of being proven at scale. Therefore, the risk of delays or unplanned unavailability of nascent cross-chain infrastructure is considerable, and this risk has the potential to scare off project developers and investors without proper mitigation from government, or will result in very high risk premiums being priced into early financing and hurdle rates.

No clear route to market

The capacity market is the UK's primary mechanism for securing adequate firm power capacity to ensure security of supply. It provides annual payments to capacity providers that are awarded contracts in the CM auctions per kW of de-rated capacity they are able to supply.

The CM still requires certain updates to be fully compatible with H2P. As primarily a security of supply mechanism, the CM has very harsh penalties for unavailability, such as large fines or even early termination of contracts. As such, power developers are unlikely to take positive FIDs on FOAK H2P assets due to excessive risks to investment.

In order to bring forward sufficient volumes of H2P before 2030, it may also be appropriate for DESNZ to consider allowing new-build and retrofitting low carbon capacity to bid into the CM as unabated plant up to the date that they can access adequate hydrogen supply. In its current form, the policy has the potential to disincentivise decarbonisation-ready generation from bidding into the CM as it may preclude them from accessing a H2P business model in the future once they are able to make the switch. This could have unintended consequences on security of supply, delay transitions to low carbon power, and increase overall cost to the consumer. As such, HUK would welcome the exploration of further measures to better incentivise low-impact, retrofit-ready power projects in the CM that can make the switch to low carbon power generation with minimal bearing on security of supply.

The DPA-style mechanism proposed in the H2P business model would provide an alternative route to market, addressing many of the risks noted above that would prevent developers from accessing the CM. However, until the business model is finalised, with committed allocation rounds and funding, there remains no clear route to market for H2P assets.

Delays to Decarbonisation Readiness, originally intended to come into force in 2024 but now scheduled for 2028, risks delaying investment decisions in new hydrogen-ready gas capacity as there is currently no legislative framework for them to obtain planning permission.

Concerns over strategic oversight

Given the long lead times associated with large scale infrastructure projects, it is vital that DESNZ makes the strategic decisions on hydrogen T&S infrastructure required not only for H2P but also other hydrogen users before NESO takes over strategic planning responsibilities for hydrogen in 2026. The Strategy and Policy Statement for Energy Policy[11] gives Government a mandate to ensure that infrastructure is ready ahead of need. This oversight could be critical not only for the deployment of physical infrastructure, but also the development of liquid, bankable hydrogen trading markets.

The power system is highly complex and the ability to decarbonise it by 2030 is contingent on effective and timely decisions made using a holistic, whole-system approach. For a clean power system to be achieved by 2030, and be resilient and secure beyond 2030, strategic oversight from a central body is required so that networks, storage, and H2P can progress in tandem and thus be unlocked in a timely manner. The current timelines and remits for the Strategic Spatial Energy Plan (SSEP) and Centralised Strategic Network Plan (CSNP), due to be delivered by NESO, do not currently include hydrogen nor do they align with the lead times noted earlier for salt cavern storage to be able to be operational at or near to 2030.

HUK therefore encourages Government to:

- Expedite the SSEP covering the whole energy system (electricity, gas, CCUS and hydrogen) to ensure that enabling hydrogen transport and storage infrastructure required for H2P assets in the early 2030s is considered within the first Centralised Strategic Network Plan; and

- Commit to making the strategic decisions on hydrogen transport and storage infrastructure, required in 2025 before the National Energy Systems Operator (NESO) takes on the responsibility for hydrogen in 2026, to ensure that enabling hydrogen transport and storage infrastructure is ready for H2P assets to access by 2030.

Recommendations

Set an ambitious target for H2P deployment by 2030 and beyond

HUK encourages Government to set targets for the deployment of H2P up to 2030 and beyond to give markets clear and positive investment signals, with a clear distinction made between new build and retrofitted capacity. This could not only serve as a benchmark for deployment of H2P, encouraging new plant to come forward, but could also give further certainty to the wider hydrogen economy, particularly those looking to invest in hydrogen production and associated critical enabling infrastructure such as networks and storage. The CCC has modelled a clean power system in 2035 and recommended a range of 12-20GW of low carbon dispatchable generation, with the majority provided by hydrogen.

Formalise the hydrogen to power business model

The hydrogen to power business model should become the primary means of de-risking and bringing forward sufficient volumes of first of a kind H2P capacity for a clean power system in 2030 and beyond. Given the lead times of large-scale H2P projects and enabling geological storage, the details of this should be confirmed in the first half of 2025 to provide adequate time for projects to be approved, developed, and commissioned before 2030. This will help to inform the roll-out of a fleet of hydrogen-to-power stations as these early projects provide valuable insights and reduce risks for subsequent developments. HUK supports the preferred option of a DPA-style mechanism with variable dispatch incentive to overcome the risks faced by FOAK projects.

Align deployment of adequate hydrogen storage to enable H2P

Alongside formalising the required capacity of H2P, it will be necessary to ensure that sufficient hydrogen transport and storage infrastructure is available to facilitate this build-out. The timelines, allocation structure, and volume requirements of the HSBM and HTBM should align with those of the power sector. The interaction between these policies must be mapped and clearly communicated with industry as soon as possible to ensure efficient investment and capacity delivery before 2030. Furthermore, a strategic plan setting out the expected location of hydrogen infrastructure must be published by the end of 2025 to provide confidence to H2P project developers that the enabling infrastructure will be ready in time for deployment as close to 2030 as possible.

Create viable and enduring market entry pathways for H2P capacity

A viable and enduring market framework must be put in place as soon as possible to provide sufficient confidence in the long-term business case for H2P. Committed and frequent allocation timelines, supported by capacity targets and funding, will support the business case for a variety of H2P technologies and scales. This can also help to encourage hydrogen-ready capacity to come forward through the capacity market in the short-term that can later switch to hydrogen through low-impact managed exits and retrofits as soon as infrastructure allows.

The findings of this report also build on the recommendations set out in previous HUK reports, including:

- A clear plan for hydrogen supply to be ready in time for testing and operation
    - A 50MW gas turbine could require more than four tonnes of hydrogen, equivalent to nine tube trailers (500kg), to run for one hour at full load. An equivalent fuel cell power plant requires less hydrogen per MW, due to its higher efficiency, and can be tested modularly.
- A pipeline of H2P projects in the UK, sufficient to attract OEMs
- A central hydrogen supply chain support and funding body to help OEMs access hydrogen supplies for testing and scale up manufacturing capability.

References

[1] NIC (2023), Second National Infrastructure Assessment, Available **here**

[2] Royal Academy of Engineering (2024), Rapid Decarbonisation of the GB Electricity System, Available **here**

[3] CCC (2023), Delivering a reliable decarbonised power system, Available **here**

[4] Labour Party (2024), Change. Labour Party Manifesto 2024, Available **here**

[5] Siemens Energy (2024), Available **here**

[6] SSE Thermal (2024), Available **here**

[7] DESNZ (2023), The Need for Government Intervention to Support Hydrogen to Power, Available **here**

[8] DESNZ (2023), Independent report of the Offshore Wind Champion – Seizing our Opportunities, Available **here**

[9] DESNZ (2023), Hydrogen Champion Report, Available **here**

[10] Royal Academy of Engineering (2024), Rapid Decarbonisation of the GB Electricity System, Available **here**

[11] DESNZ (2024), Strategy and policy statement for energy policy in Great Britain, Available **here**