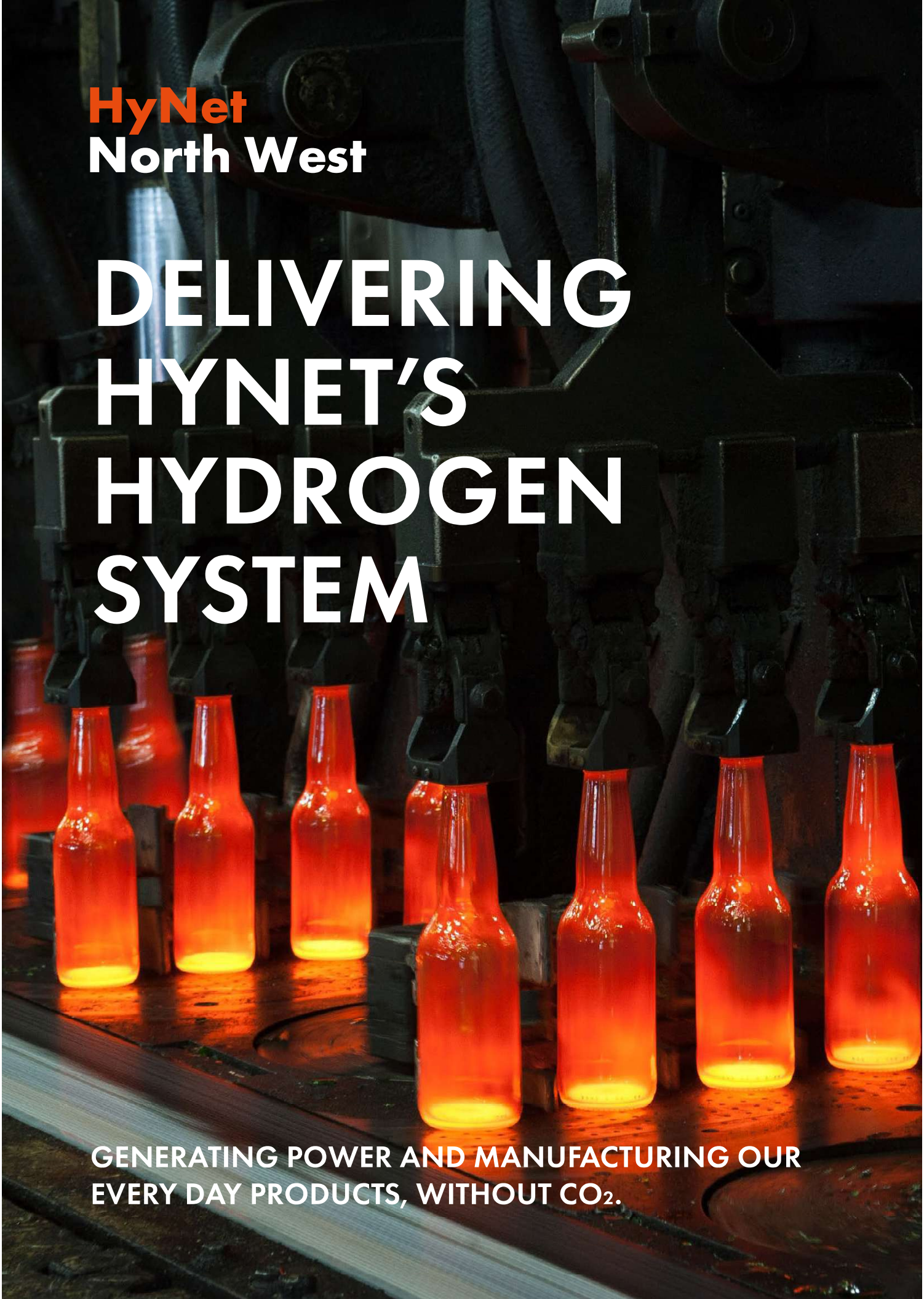


HyNet
North West

DELIVERING HYNET'S HYDROGEN SYSTEM

GENERATING POWER AND MANUFACTURING OUR EVERY DAY PRODUCTS, WITHOUT CO_2.

HYNET HEADLINES

The North West is home to some of the UK's most important industries, producing everyday essentials and products that underpin the economy, such as glass, cement, chemicals, aluminium, paper and chemicals.

Industrial Transition
Collectively, we need to reduce the carbon emissions of these processes, while retaining jobs and economic output. Many of these industries cannot transition easily to electricity, so we need to look at other solutions. Low carbon hydrogen is an essential part of this industrial transition, and, more broadly, the UK's future energy system.

Deliverable by 2030
The key building blocks of HyNet's hydrogen system, including production, distribution and storage are well-advanced and deliverable by 2030. HyNet will provide over £5b of private sector investment, and create up to 16,000 jobs.

Low Carbon Power
HyNet provides the backbone for low carbon dispatchable power across the region – by storing hydrogen, a low carbon fuel, and converting our power stations to use it, electricity can be generated when the wind doesn't blow and the sun doesn't shine.

Government Support
Building on the Government's support for HyNet's carbon capture and storage infrastructure, confirmed by the Prime Minister in October 2024, industry stands ready to deliver HyNet's hydrogen system.

World-leading Project
We are proud to be the companies behind this world-leading project and are working closely with Government to make it a reality.

EXECUTIVE SUMMARY

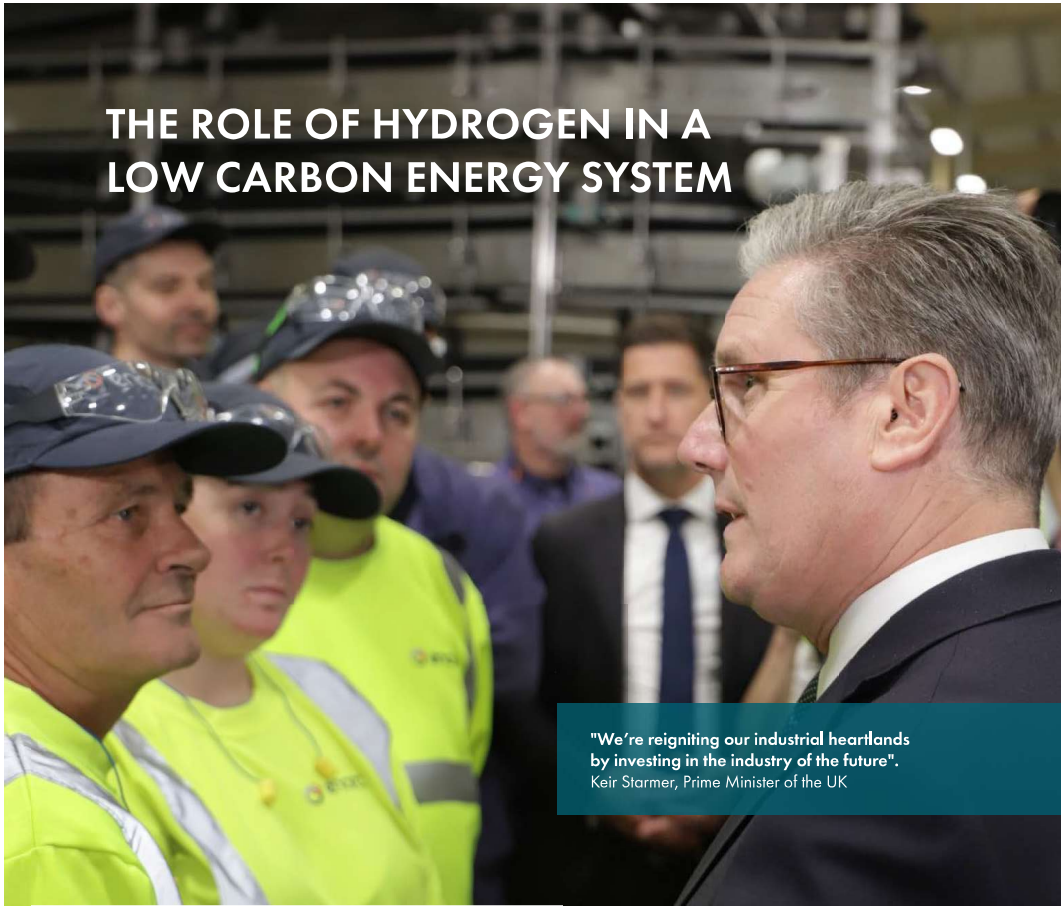
HyNet is a world leading carbon capture and storage (CCS) and low carbon hydrogen infrastructure project located in the North West of England and North Wales.

Funding approval for the first CCS phase of the project was announced by the Prime Minister, Sir Keir Starmer, in October 2024 and it is expected to enter construction by the end of the year.

HyNet's hydrogen infrastructure is of equal importance in driving decarbonisation and the economic benefits of a low carbon manufacturing sector. The project is in an advanced stage of development with detailed designs complete for hydrogen production, pipelines and storage, and, with the right interventions, can be operational by 2030. However, an acceleration of the policy framework is needed to make this a reality. HyNet's hydrogen infrastructure will deliver:

- Significant emissions reductions through the decarbonisation of industry, preserving and creating manufacturing jobs;
- Significant contribution to the Labour Government's Clean Power 2030 mission through the provision of large scale, low cost, hydrogen storage to support low carbon power generation; and
- Job retention and growth across the manufacturing sector in the North West as companies transition to the low carbon economy, and the attraction of inward investment in new enterprises looking to use the HyNet infrastructure.

We now urgently seek increased momentum in Government's allocation process for project selection, and a commitment to progress project consents and permits on an accelerated basis. With this facilitation from Government, industry stands ready to deliver this essential piece of energy infrastructure.



THE ROLE OF HYDROGEN IN A LOW CARBON ENERGY SYSTEM

"We're reigniting our industrial heartlands by investing in the industry of the future".
Keir Starmer, Prime Minister of the UK

To achieve the UK's climate targets, a wholesale change to the ways in which our energy is produced, transported, stored and used is required. The energy transition will touch all aspects of society and will require significant political will, coupled with genuine commitment to project delivery and financing.

In the UK, many of the key enablers are in place. The net zero target is enshrined in law, the independent Climate Change Committee (CCC) sets periodic carbon budgets and measures progress, and there is broad cross-party political support for the transition.

The UK continues to be one of the most successful countries in the world in reducing the carbon intensity of power generation.

This has been enabled by a transition from coal to a world-leading roll-out of large-scale renewables, particularly offshore wind. To enable deeper decarbonisation requires further renewables, combined with measures to deliver energy resilience and security when the wind isn't blowing or the sun isn't shining.

Alongside renewable electricity, hydrogen is seen to be essential to the provision of energy for industry and power generation. The ability to store hydrogen for long durations enables it to support the energy transition by providing resilience and energy security that is a low carbon equivalent to the role that natural gas plays today.

The UK continues to be one of the most successful countries in the world in reducing the carbon intensity of power generation.

ENABLING CLEAN POWER 2030

Government has set the target of achieving a Clean Power system by 2030. This will require a rapid expansion of renewables roll-out, enhancements to electricity transmission and distribution systems and a step-change increase in demand side response. For energy resilience, there will also be the need for low carbon dispatchable power fuelled by hydrogen or natural gas with carbon capture.

There are a range of estimates of the scale of dispatchable thermal power required to meet the needs of a Clean Power system, depending on the scale of renewables and demand side response available.

The CCC's 2023 report[1] suggested a central case of 17GW, mirrored by a similar figure in Afry's report for OEUK[2]. This scale of deployment would be achievable through new-build thermal generation projects across the leading CCS and hydrogen clusters, using a combination of both natural gas with carbon capture and hydrogen-fired technologies. These industrial clusters represent the most advanced locations for carbon capture and hydrogen production in the UK. The current progress across these clusters will need to be accelerated to meet the 2030 timeframe. The level of ambition, however, is similar to that required across renewable generation.

There are widespread benefits in developing a hydrogen economy in the North West, namely:

Maximising energy efficiency

By producing hydrogen on a 24/7 basis using CCS-enabled hydrogen production technology ('blue hydrogen') and then storing it until it is required, the capital efficiency of the hydrogen production plant is optimised. Unlike natural gas with CCS plants, it also maximises utilisation of capacity constrained CO_2 infrastructure, allowing greater decarbonisation of other sectors.

Full-chain hydrogen system

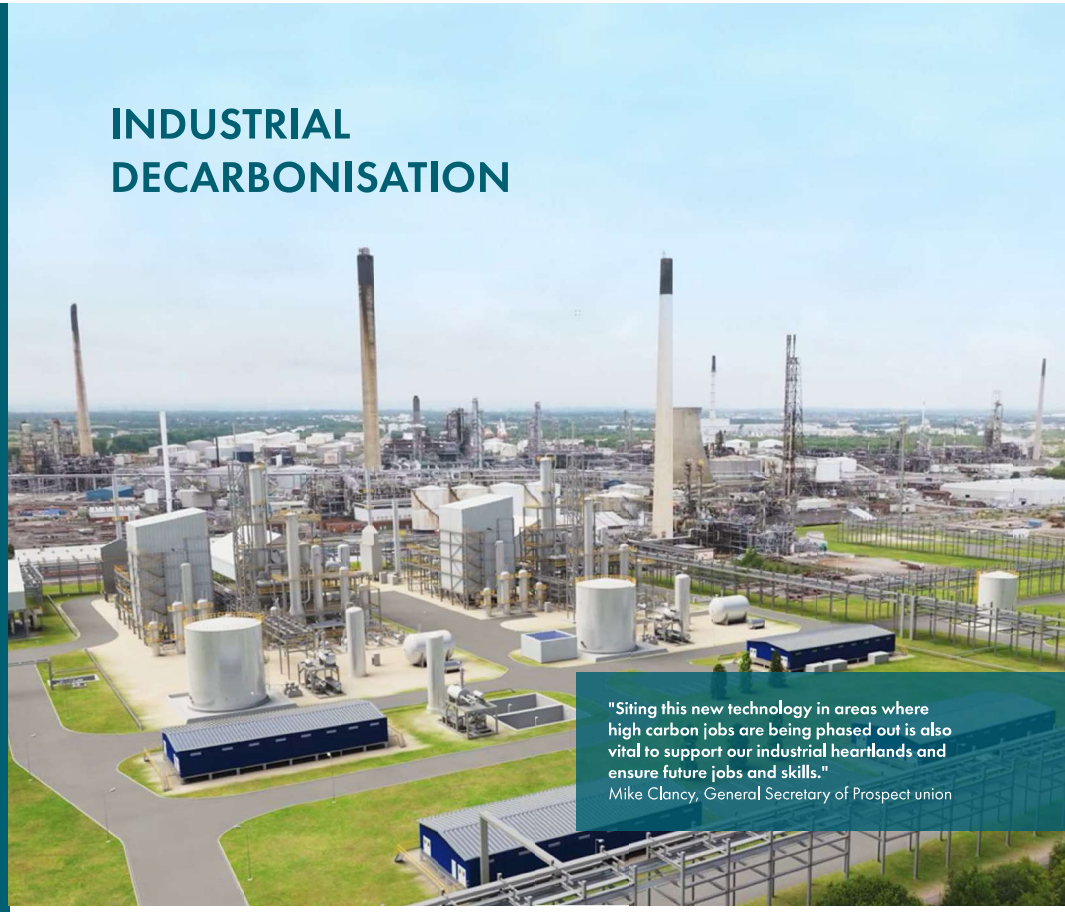
Developing a full-chain hydrogen system, currently anchored on CCS-enabled hydrogen supply, allows the transition to electrolytic hydrogen ('green hydrogen') over time, ensuring no fossil fuel lock-in beyond the initial CCS-enabled hydrogen production plants (which capture 97+% of carbon emissions and meet the UK's Low Carbon Hydrogen Standard).

Salt cavern storage

Energy storage of hydrogen in the UK's pre-existing salt-caverns is technologically proven, easy to deploy at scale and leverages UK experience of building and operating natural gas storage. It delivers at very high power, and costs orders of magnitude less than forms of electricity storage, such as batteries or pumped hydro. This has been widely recognised by studies by the Royal Society[3] and the Royal Academy of Engineering[4]. This means that industry and power stations can both access hydrogen with the flexibility to meet their needs.

Why not just use renewable electricity?
Hydrogen is well suited for dispatchable power generation due to the ease and relatively low cost of storage when compared to electricity; it can meet demand when renewables are insufficient. It is also essential for the decarbonisation of heavy industry in high temperature direct firing applications, and the most cost effective option for many other industrial processes (steam generation, heating) due to the relatively minor modifications required to allow boilers and furnaces to run on hydrogen.

INDUSTRIAL DECARBONISATION



"Siting this new technology in areas where high carbon jobs are being phased out is also vital to support our industrial heartlands and ensure future jobs and skills."
Mike Clancy, General Secretary of Prospect union

Establishing a hydrogen ecosystem to enable low carbon flexible power generation also supports the decarbonisation of hard to abate industrials.

Across our industrial clusters, there are energy-intensive industrial plants for whom electrification is either technically challenging (and therefore uneconomic) or undeliverable.

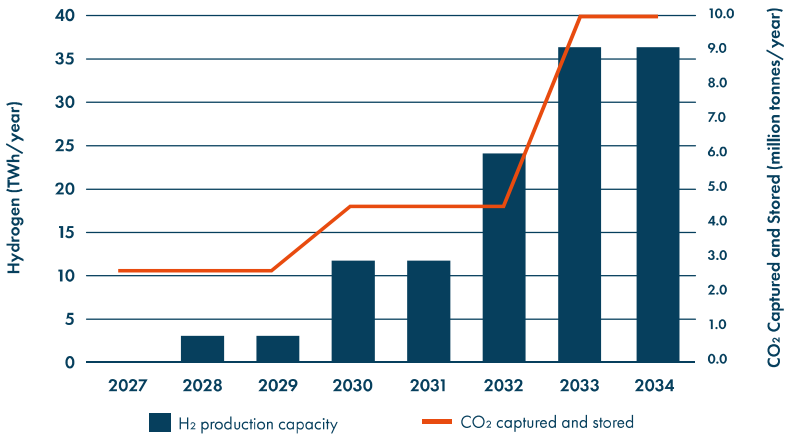
For these reasons, a supply of low carbon hydrogen is highly attractive, with minimal disruption to existing production processes and with availability in line with their corporate decarbonisation targets and timescales.

Types of industry that would look to convert existing manufacturing processes to hydrogen include chemicals, ceramics, glass, steel, food production and oil refining. Hydrogen firing trials across a number of these sectors have successfully been carried out in recent years.

1 Delivering a reliable decarbonised power system, CCC (March 2023) https://www.theccc.org.uk/publication/delivering-a-reliable-decarbonised-power-system/
2 Feasibility analysis for achieving a net zero power grid in Great Britain by 2030, Afry (on behalf of OEUK), July 2024 https://oeuk.org.uk/product/analysis-for-achieving-a-net-zero-power-grid-by-2030/
3 https://royalsociety.org/news-resources/projects/low-carbon-energy-programme/large-scale-electricity-storage/
4 https://nepc.raeng.org.uk/enabling-a-decarbonised-electricity-sys

HYNET OVERVIEW

The most advanced low carbon cluster in the world?



The North West of the UK is home to over 300,000 manufacturing jobs producing glass, cement, aluminium, chemicals, paper, automotive components and food and drink. HyNet has been conceived to allow this industrial sector to transition to a low carbon economy, retaining and growing jobs, skills and economic output. HyNet's strategy is one of incremental growth, with the potential to capture up to 10 million tonnes of CO_2 per year and a steady build out of up to 30 TWh per year of low carbon hydrogen production and distribution to meet the demands of industrial users and flexible power generation.

The components of HyNet (carbon capture and storage, hydrogen production, a hydrogen distribution network and hydrogen storage) are each underpinned by a different business model in varying stages of development.

HyNet's CCS elements are advancing first which provides the infrastructure backbone to decarbonise all the major industrial CO_2 emitters in the region. Government has issued its notice of intent to award an economic licence, which is the formal commencement of the Final Investment Decision process, and, in October 2024, the Prime Minister, Chancellor and Secretary of State visited HyNet to confirm that the funding package had been agreed and the first stage of the project would proceed into construction.

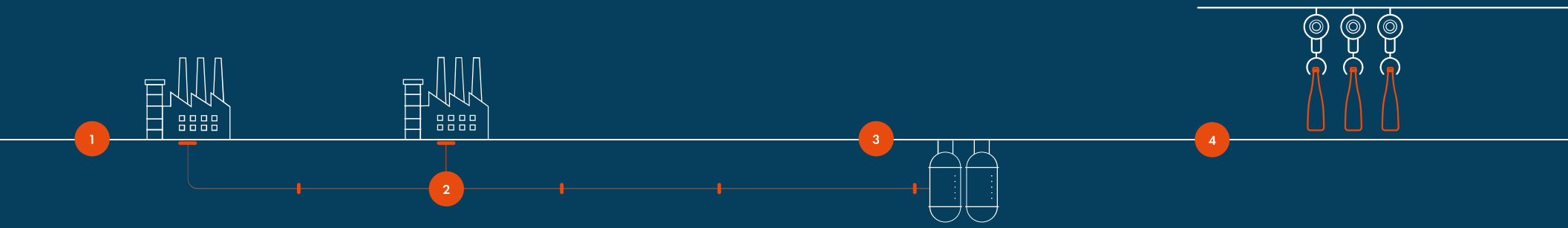
To enable the wider hydrogen infrastructure supporting Clean Power 2030, the remainder of the business models need to be progressed in parallel and at pace. These include the Track 1 Expansion process to deliver the second hydrogen production plant, and the Hydrogen Transport and Hydrogen Storage Business Models (HTBM and HSBM).

The development of these models and the allocation process for hydrogen transport and storage infrastructure was announced in December 2023, and these now need to be rapidly progressed to enable the programme to deliver the 2030 ambition.

HyNet is a well-defined, well-engineered advanced infrastructure project that has been developed very successfully in conjunction with the emerging institutional framework for CCS and low carbon hydrogen. It is now at the point that, by accelerating the execution of the next phases of hydrogen infrastructure deployment, it can make a meaningful contribution to the Clean Power 2030 mission.

READY TO BUILD

The anatomy of HyNet's hydrogen system



Hydrogen production

At an early stage of HyNet's project development, an offtake assessment concluded that there was ca. 4GW$_{th}$ (30 TWh/yr) of low carbon hydrogen demand in the region, comprising industrial fuel switching, industrial power generation (baseload Combined Heat and Power), flexible power generation and blending into the gas distribution network. This demand profile has largely remained consistent throughout the development period.

Of this total capacity, the first two hydrogen production plants (HPP), with capacities of 350MW and 1000MW respectively, are at advanced stages of development as follows:

- HPP1 (350MW – Johnson Matthey ATR technology): Front End Engineering Design (FEED) completed by Kent, full planning permission granted, environmental permit granted, Track 1 application successful, commercial terms agreed with Government, Engineering, Procurement & Construction (EPC) contract finalised and ready to execute, financing in progress.
- HPP2 (1000MW – KBR SMR technology): FEED completed by KBR, outline planning permission granted, Track 1 Expansion application under evaluation by DESNZ.

In addition, a number of electrolytic hydrogen projects have been announced in the region, some of which are in the Hydrogen Allocation Round processes. These will be able to utilise HyNet's infrastructure and enable a robust, future-proofed and fully integrated hydrogen system supplying power generation and industrial users across the region. Critically, HyNet will enable an accelerated ramp-up in 'green' hydrogen production by providing the transport and storage infrastructure to connect directly to users and minimising offtaker risk.

Hydrogen transport

The hydrogen transport system, developed by Cadent, comprises three phases of new-build development:

Phase 1
Less than 5km of pipeline to supply Encirc (glass bottle factory) from the first hydrogen production plant (HPP1), to be developed as a private pipeline and partially funded through a Low Carbon Hydrogen Agreement. The engineering design is complete.

Phase 2
Approximately 125km of large diameter, high pressure pipeline (design pressure of 70 bar) to connect hydrogen production plants at Stanlow with major industrial and power generation users and to act as a transmission scale regional backbone, capable of interconnecting with Project Union in the future. This will be funded under the Hydrogen Transport Business Model (HTBM) if successful in the competitive process. The Front End Engineering Design (FEED) is complete and two phases of public consultations have taken place. The final stage of targeted consultation ongoing ahead of Development Consent Order submission.

Phase 3
Approximately 150km of smaller diameter, lower pressure pipelines to connect industrial users across a wider regional footprint, including North Wales, the Wirral, Lancashire and further users across Greater Manchester and Liverpool City Region. The feasibility study is complete and pre-FEED in preparation. This will bid into future Hydrogen Transport Business Model allocation rounds.

Hydrogen storage

The HyKeuper hydrogen storage system, developed by INEOS Inovyn and Storengy, comprises 19 new-build salt cavern stores, to be constructed in the vicinity of existing operational natural gas stores.

The FEED engineering was completed and a DCO granted for the Keuper natural gas storage facility in 2017, but the facility wasn't constructed. The project was repurposed for hydrogen (and renamed HyKeuper), commencing in 2021 as part of the broader HyNet programme. Following completion of a further FEED for the hydrogen gas processing facility, a non-material DCO change application was submitted to DESNZ for determination. The Secretary of State determined that the change was material and a new DCO application is now in preparation.

The storage will be developed under the Hydrogen Storage Business Model.

Why blue and green hydrogen?
HyNet's system envisions blue (CCS-enabled) and green (electrolytic) hydrogen as vital to the energy transition. Blue hydrogen allows for the scalability of hydrogen supply and unlocks key transport and storage infrastructure in the short term, paving the way for green hydrogen production to then flourish once the technology becomes scalable.

Use

The HyNet hydrogen partners (EET Hydrogen, Progressive Energy, Cadent, INEOS and Storengy) have worked closely with hydrogen customers ('offtakers') to determine the characteristics of their hydrogen demand profile, including location, volume, average and peak mass flow rates and start dates. A customer database has been developed by Cadent, and numerous Memorandums of Understanding and Heads of Terms have been executed between EET Hydrogen and users to develop a full view of supply, demand and storage requirements.

In parallel, several industrial fuel switching trials have been undertaken at representative sites across the region to demonstrate the ability to fuel switch to hydrogen. These include Pilkington Glass, Unilever and Kellogg's. Novelis, an aluminium recycling company, will undertake their trial in late 2024. In addition to the physical trials, feasibility studies have been conducted for conversion of a number of other hydrogen offtakers.

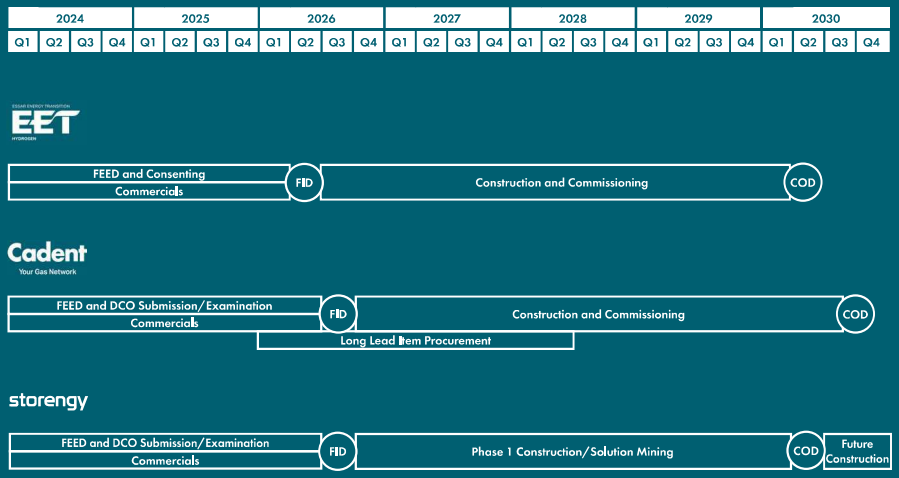
There are two existing power stations in the region with plans to re-purpose their assets for hydrogen-firing, ESB's Carrington (885MW) and Intergen's Rocksavage (800MW). Both sites have development pathways which enable a level of hydrogen blending ahead of full conversion to hydrogen. In addition, new power stations are at early stage of development in the region, seeking to utilise HyNet's infrastructure to enable low carbon dispatchable power.

AN INTEGRATED DELIVERY PROGRAMME

The HyNet hydrogen system is deliverable by the end of 2030, subject to the enablers set out in the following section.

Large energy infrastructure projects follow similar development pathways – the period prior to the Final Investment Decision (FID) is known as the development phase, and usually comprises feasibility, pre-FEED (Front End Engineering), FEED and Consenting. FEED is now broadly complete across all elements of the system and the projects are substantially risk-reduced.

The HyNet hydrogen system partners are now working to complete consenting and to align, where possible, Final Investment Decision (FID) and Commercial Operational Dates (COD). There are multiple critical paths through this process, including the selection of HPP2 in the Track 1 Expansion process and subsequent FID process, the consenting of the hydrogen pipeline system and early enablement of detailed design and procurement, and the consenting of the hydrogen store. However, despite this complexity of scheduling, we are confident that, with the right determination from industry, Government and regulators, the 2030 date can be achieved.



Will it work?
Industrial trials have been underway for several years, successfully demonstrating that hydrogen can be used as an alternative to natural gas without negatively impacting safety, the environment or product quality. The components of the HyNet hydrogen system have been developed collaboratively to ensure that it works cohesively as a 'full chain' system of production, distribution, storage and use.

KEY ENABLERS

To leverage the benefit of this large-scale project, the production, storage and pipeline infrastructure need to be delivered together, despite having different construction timescales and investment models. It is therefore important that Government approaches the delivery of this infrastructure in a coordinated way. Once the core infrastructure is in place, other users (both hydrogen producers and offtakers), can connect in a timeframe that suits them.

The underlying business models have been developed separately rather than together and this creates challenges in terms of the timing of investment decisions.

Who is paying for it?
The hydrogen producer will receive a subsidy to cover the incremental production cost of low carbon hydrogen production above an achieved sales price (with natural gas price setting a floor); the Energy Act 2023 indicates that this subsidy will be funded by UK gas shippers. As the both the sales price of low carbon hydrogen and the price of natural gas increases, this subsidy diminishes until the hydrogen economy becomes self-sustaining.

To progress this whole scheme to meet the 2030 target, there are a number of interventions required that would add pace and certainty:

Allocation Processes:

- Confirmation that HPP2 has been successful in the Track 1 expansion allocation process.
- Acceleration of the Hydrogen Transport and Hydrogen Storage allocation processes. There are limited geographies across the UK where projects such as this can be deployed – where projects have been developed they should be selected and move forward rapidly.

Planning:

- Progression of both HyKeuper and HyNet Hydrogen Pipeline DCOs through the fast-track determination process.

Regulation and Market Framework:

- Confirmation that hydrogen transport development expenditure will be recoverable in the Regulated Asset Base (RAB) business model.
- Commitment from DESNZ and Ofgem to work with HyNet partners to construct a fit for purpose market framework to include network code, system operation and balancing functions.

HyNet is made up of a group of organisations which have come together to build the infrastructure which will:

lock away carbon dioxide emitted by industry

provide locally-produced low carbon hydrogen which industry can switch to as an alternative to fossil fuels

www.hynet.co.uk

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Front cover image courtesy of Encirc Glass