THE ROLE OF HYDROGEN INFRASTRUCTURE IN THE FUTURE ENERGY SYSTEM

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North West Hydrogen Alliance

EXECUTIVE SUMMARY

The UK has committed to achieving net zero by 2050[1], an ambitious goal that requires reducing net greenhouse gases across all sectors. Low-carbon hydrogen will be crucial in meeting this target, particularly in decarbonising hard-to-abate sectors like industry, aviation, heavy transport and flexible power generation. Additionally, the UK Government has set an ambitious goal to decarbonise the power sector by 2030[2] , and hydrogen will be pivotal in providing long duration energy storage and flexible power supply to help achieve this target.

For hydrogen to scale effectively, production, infrastructure, and demand must develop together.

Significant progress has been made in creating the necessary policy frameworks required to unlock production, such as the Hydrogen Production Business Model (HBPM)[3] and the Low Carbon Hydrogen Standard (LCHS)[4] . The UK has also set a target of achieving 10 GW of hydrogen production capacity target by 2030[5] , a critical step toward meeting the 2050 goal, where hydrogen is expected to supply 20-35%[6] of future energy demand. Additionally, the UK government has supported the growing demand for hydrogen, driven by developers' efforts, through the Industrial Fuel Switching programme which aims to demonstrate practical applications of hydrogen.

However, the development of Hydrogen Transport and Storage Business models (HTBM[7] and HSBM[8]) to link production and demand have not progressed at a pace aligned to their long lead times. The first allocation rounds are still pending and expected to launch in Q3 2024, with successful projects anticipated to become operational between2028 and 2032. It is crucial that the Government prioritises unlocking investment in these key infrastructure assets, sets out capacity targets and makes funding commitments to ensure the successful scaling of hydrogen.

The North West is a global leader in developing hydrogen solutions and hosts the UK's largest and most advanced projects. The region also demonstrates significant hydrogen demand, as evidenced by the numerous ongoing fuel switching demonstrations that have attracted interest from multiple off takers, as well as the ambition of airports in Manchester and Liverpool to secure a hydrogen pipeline for its airline partners. Investing in infrastructure is key for expanding hydrogen use beyond individual projects and catalysing the next phase of growth in the region. Scaling hydrogen in the North West has the potential to generate significant economic benefits including the creation of 11,500 jobs and delivering £3.4bn in GVA by 2030[9] .

To support the achievement of these economic benefits, the North West Hydrogen Alliance recommends that the Government:

- Reach final investment decision on the initial phase of HyNet
- Select HPP2 in the HyNet Track-1 Expansion process
- Launch the first allocation rounds of the Hydrogen Transport and Storage Business Models by Q3 2024 and award contracts by Q4 2025
- Support the HSE to develop the safety case for hydrogen in networks
- Develop a strategic vision for development of transport and storage infrastructure geographically
- Provide DEVEX funding for HyNet pipeline to support necessary works
- Provide clarity on decisions regarding the national hydrogen pipeline network, including the timeline for phasing of connection points
- Progress Project Union

THE ROLE OF HYDROGEN IN THE ENERGY SYSTEM

Hydrogen will play a crucial role in the UK's transition to net zero by 2050, offering a viable solution for decarbonising hard-to-abate sectors including industry, heavy transport and power. The UK's hydrogen strategy estimates that by 2050 hydrogen could account for 20-35% of the UK's final energy demand[10], a substantial increase from current levels.

As such, the UK Government has recently been focusing on hydrogen production, establishing funding mechanisms to boost domestic production. Furthermore, through the Industrial Fuel Switching programme, the UK government has supported the growing demand for hydrogen, driven by developers' efforts, with the aim of demonstrating practical applications of hydrogen.

As these mechanisms begin to support hydrogen production and demand projects, focus must now shift to the development of essential infrastructure for hydrogen transportation and storage, while expanding the number and diversity of users.

THE ROLE OF HYDROGEN NETWORKS IN THE ENERGY SYSTEM

Natural gas networks are an integral part of the UK energy system. Our 284,000 km natural gas network transports 900 TWh of energy every year with 99.9% reliability (1 unplanned interruption every 140 years[11]) and cost-effectively. The same potential exists for hydrogen networks, through either the construction of new pipelines or the repurposing of current pipelines[12]. These hydrogen pipelines could play a vital role in linking both ends of the value chain – from efficient, industrial cluster-bound producers to diverse and distributed end users and storage facilities. The gas industry is currently undertaking the Iron Mains Risk Reduction Programme (IMRRP)[13], a £28bn project aimed at replacing the low-pressure gas distribution network with 'hydrogen ready' pipelines. This programme is scheduled for completion by 2032 and had reached 75% completion as of 2022. Repurposing this existing asset is a cost-effective solution (approximately 5.5 times cheaper than onshore electrical transmission[14]) for transporting energy and enabling hydrogen's role in decarbonisation and energy security.

The benefits of hydrogen networks include:

1. ENABLING A BROADER RANGE OF OFFTAKERS

Hydrogen networks allow large scale hydrogen production at centralised facilities, which can then be distributed across regions to multiple offtakers such as industrial users, transportation hubs and businesses. This improves accessibility, eliminates the need for each offtaker to have dedicated hydrogen production facilities and encourages more businesses to adopt hydrogen for their energy needs. Crucially, well connected networks create the infrastructure for a broader range of potential offtakers including smaller industries and new markets by lowering barriers to hydrogen access and increasing economic feasibility through more efficient distribution of larger volumes. In essence, hydrogen networks enable the production of hydrogen at optimal and cost-effective locations whilst facilitating its distribution and utilisation in areas with the greatest demand.

2. DERISKING PRODUCTION OF HYDROGEN

A network infrastructure will drastically derisk hydrogen production assets becoming stranded, expanding the range of potential end users, thereby increasing investment security. This is particularly crucial for first mover hydrogen projects. By guaranteeing an offtaker for hydrogen production through a reliable transport network, the infrastructure becomes more attractive to investors. This, in turn, drives development across the entire hydrogen value chain, from production to end-users. Additionally, a network that supports hydrogen blending mitigates risks associated with hydrogen production. For instance, if hydrogen production becomes operational before an offtaker can accept the hydrogen, the surplus hydrogen can be blended into the gas network, acting as a buffer mechanism. Hydrogen blending percentages would likely remain low (<20% by volume), reducing as offtake comes on line. This enables hydrogen production to commence earlier, reducing investment risk and enhancing the investability of hydrogen projects by lowering production costs before large scale storage becomes available.

3. LINKING OPTIMUM PRODUCTION AND STORAGE LOCATIONS

A developed network system would allow geographic flexibility of production and storage locations, by establishing a vital connection between the economically efficient, yet geographically bound, hydrogen producers (e.g. industrial clusters and offshore wind electrolytic production) and large scale storage facilities (depleted fields and salt caverns). In essence, hydrogen networks allow for hydrogen to be produced where it is cheapest and used where the demand is greatest.

4. IMPROVES ENERGY RESILIENCE AND SECURITY

Hydrogen networks will significantly contribute to enhancing the UK's energy resilience and security. They will address current energy constraints by managing short-term demand and supply fluctuations and 'future proofing' the system against increasing demand through expanded connections between producers and storage facilities. Developing these links will facilitate rapid recovery during energy disruptions, enabling better balance of supply and demand across regions. An example of networks balancing supply and demand is linepacking, a method where gas is stored in pipelines and subsequently released as demand increases throughout the day. Currently, natural gas networks utilise linepacking, and hydrogen can be similarly stored in large scale gas transmission and distribution networks using this technique. While linepacking can address short duration hydrogen discharge for managing short term supply-demand fluctuations, it is not a solution for bulk, long term storage. The latter is critical for significantly reducing reliance on external factors and foreign countries thereby enhancing overall energy security.

THE ROLE OF STORAGE IN THE ENERGY SYSTEM

Storage infrastructure is a critical component of the hydrogen value chain, complementing network infrastructure by accommodating demand side variations whilst maximising the utilisation of CCUS-enabled hydrogen production capacity at baseload for capital efficiency, and balancing the intermittent nature of renewable electricity production. Developing long duration energy storage facilities is integral to the UK's energy system, offering flexible energy generation that can address a range of challenges including the following[15]:

1. ENABLING DECARBONISATION OF THE ELECTRICITY SYSTEM DURING PEAK DEMAND

The UK's annual energy demands exhibit seasonal fluctuations ranging from 0.4 TWh in summer to 3.5 TWh in winter[16], driven by heating for homes, which presents a challenge for intermittent renewable energy production to consistently deliver these demands. Hydrogen storage can support the UK energy system by matching production with demand whilst facilitating decarbonisation of the electricity system. By storing surplus electricity during periods of excess generation, hydrogen storage provides flexible energy generation during times of high demand and low renewable energy output. An example is the use of combined cycle gas turbines (CCGT) which enhance energy resilience by utilising stored hydrogen as a fuel to regenerate electricity during peak demand periods. To achieve the UK's 2030 target of 10 GW for hydrogen power and Labour's mission for zero carbon electricity by 2030, significant advancements in hydrogen storage technology are required.

2. ENABLING MORE EFFICIENT PRODUCTION

The future energy mix will include both dispatchable and baseload sources, with hydrogen playing a key role in fulfilling both functions. Storage enables producers to generate hydrogen continuously, even during periods of low demand, by storing excess hydrogen. For CCUS-enabled hydrogen, this allows for steady, baseload production even when demand varies. In the case of renewable hydrogen, where energy sources are intermittent, production can occur independently of immediate demand. This decoupling of production from consumption leads to more efficient use of production facilities allowing them to operate at optimal capacity without need for ramping down production or frequent shutdowns.

3. ENERGY SYSTEM RESILIENCE

The UK's limited gas storage capacity has exposed the nation to gas price volatility. The geopolitical consequences of Russia's invasion of Ukraine highlighted the UK's vulnerability to gas price volatility and subsequent inflated energy bills for consumers. While most European countries maintain gas storage capacities equivalent to an average of 20%[17] of their annual gas consumption, the UK maintains only 2%[18]. It is claimed that in the two years following Russia's invasion of Ukraine, UK investment in gas storage facilities may have saved UK energy bill payers at least £1.7bn[19]. Leveraging a resilient hydrogen transport and storage system, where energy is moved and stored efficiently, enables interseasonal storage, which is vital for home heating and enhances the UK's resilience to global events. Additionally, given the limited number of hydrogen production facilities currently available, storage plays a key role in ensuring fuel stability and supports the case for industries to transition to low carbon alternatives.

4. AVOIDING CURTAILMENT OF RENEWABLES DURING HIGH PRODUCTION

Throughout the year, periods of excess electricity production often lead to costly waste, with curtailment costs reaching £920m in 2023[20]. Hydrogen storage offers a solution to this challenge by capturing surplus electricity as hydrogen, which may reduce curtailment costs and help maximise the use of available renewable energy sources. The latter is a better alternative to the costly and lengthy expansion of the existing national grid. Developing hydrogen storage facilities will support the rapid deployment of renewables, such as offshore wind and solar, helping to achieve the target of 50 GW offshore wind and 70 GW solar by 2035[21], and concurrently reduce national grid constraints.

5. ALLOWING OFFTAKER FLEXIBILITY AND UPTAKE

A consistent supply of hydrogen allows offtakers to access fuel as needed even without production occurring. This ensures hydrogen is available on demand, enabling offtakers to meet their specific requirements while maintaining operational continuity.

STORAGETECHNOLOGIES

Hydrogen's high energy density by weight, compared to other fuel alternatives makes it a promising energy vector. However, its extremely low volumetric energy density poses storage challenges. For long duration energy storage, large scale hydrogen storage presents an efficient and cost effective approach. Several options for hydrogen storage facilities are currently available, with an overview on their development status, scale and associated cost outlined below[22]:

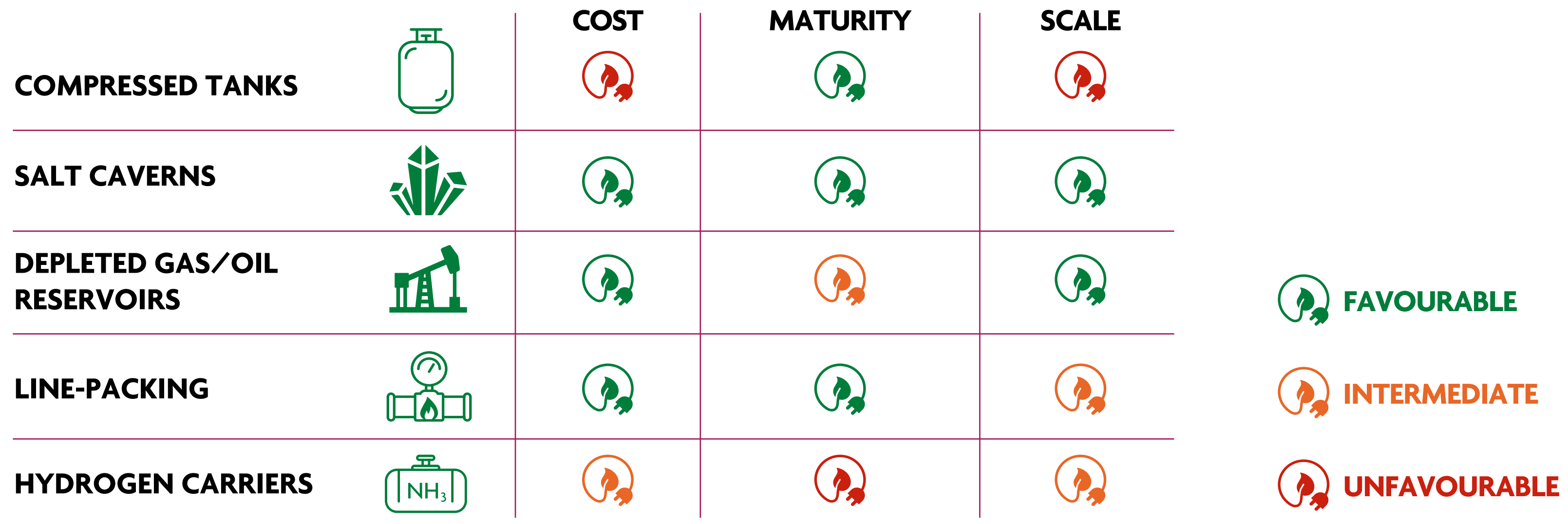

Figure 1: Schematic illustration of different hydrogen storage technologies

SHORT-TERM, SMALL-SCALE STORAGE IN COMPRESSED GAS TANKS

In the absence of large-scale storage, the first hydrogen projects for instance, dispersed hydrogen refuelling stations utilise small-scale pressurised tanks and vessels that store hydrogen onsite. While this is a manageable solution for small scale projects to provide a buffer, there are technical and economic limits to this approach, meaning that large scale storage will be required as the hydrogen economy scales and applications such as power generation begin to come online. Additionally, low public acceptance of hydrogen surface storage may affect the continued use of small scale compressed gas tanks.

SALT CAVERNS

A more cost-effective method for storing large volumes of hydrogen, approximately 100 times cheaper per unit of energy stored than lithium-ion batteries[23] is through the use of salt caverns. Storing hydrogen in salt caverns is a mature and well understood process having been used by the chemical industry in Teeside for hydrogen storage since the 1970s. These leak-proof caverns operate at lower pressure than cylinders, resulting in reduced costs and increased efficiency. Salt caverns also have minimal visual impact which is an advantage both environmentally and publicly. However, caverns are geographically constrained and vary in capacity, presenting limitations in their use

DEPLETED GAS RESERVOIRS

Depleted gas fields are the most suitable option for offshore large-scale hydrogen storage due to their sufficient size and proven effectiveness. The existing infrastructure, including pipelines linking storage sites to processing facilities is particularly attractive to investors and helps to reduce capital costs. Converting these depleted gas fields is more cost-effective than constructing new salt caverns. However, a potential concern is that depleted gas fields may be less inert than salt caverns, posing some risk of geochemical and microbial reactions. Ongoing investigations aim to address this and currently suggest there is no significant risk[24 25] . Additionally, the higher cushion gas requirement for gas fields may increase capital cost. Despite these challenges, repurposing depleted gas fields is anticipated to be the most cost-effective option for large scale offshore hydrogen storage.

LINEPACKING

Linepacking is a technique that allows the temporary storage of excess hydrogen in pipelines at increased pressure. When demand rises, pipeline pressure is lowered to release stored hydrogen to offtakers[26]. Due to already existing pipeline infrastructure, linepacking is an economical way to store hydrogen. However, as a temporary storage medium to enable operational flexibility, linepacking typically stores small volumes compared to dedicated options such as salt caverns or compressed tanks. Therefore, it is most suitable for short term rather than medium-to-long term needs.

HYDROGEN CARRIERS

Liquid organic hydrogen carriers (LOHC) are a storage technology in which hydrogen is chemically bound to a stable organic liquid carrier[27]. This technology is being investigated due to its compatibility with existing fuel infrastructure. Another similar storage technology and hydrogen carrier is ammonia[28]. Storing hydrogen within ammonia is a more promising option because of its natural high energy density by volume (compared to hydrogen and lithium-ion batteries) and the fact that it does not require cryogenic storage. The high hydrogen content, zero carbon nature, and ease of liquefaction of ammonia makes this a cost-effective storage solution. Additionally, ammonia has mature supply chains further enhancing its feasibility as a storage option. Hydrogen carriers are important for international shipping but have limited use for domestic storage.

STORAGEREQUIREMENTS

In the short-term, small-scale storage assets, such as compressed cylinders, are anticipated to dominate the market, meeting immediate demand. However, as the industry progresses toward more ambitious targets, the need for large scale storage will become critical.

According to high level analysis conducted by Hydrogen UK, an estimated 3.4 TWh of large-scale storage capacity will need to be operational by 2030, increasing to 9.8 TWh by 2035[29], in order to support the UK's net zero 2050 goals and ensure sufficient hydrogen storage for decarbonisation.

A study conducted by the Royal Society modelled the scale of hydrogen storage required to support Great Britain's future electricity demand, which the National Grid's ESO Future Energy Scenarios projects to be at least 850 TWh/year by 2050[30], considering peak winter demand. For a supply of 760 TWh/year, met exclusively by wind and solar, The Royal Society's study estimates that up to 100 TWh[31] of hydrogen storage would be required. These projections highlight the substantial scale of storage needed in the coming decade to meet government targets and emphasise the critical role hydrogen will play in the nation's energy transition.

To reinforce this, the National Infrastructure Commission's five-yearly National Infrastructure Assessment[32] recommends that the Government target establishing at least 8 TWh operational large scale hydrogen storage by 2035 to manage periods of peak demand and low renewable energy output.

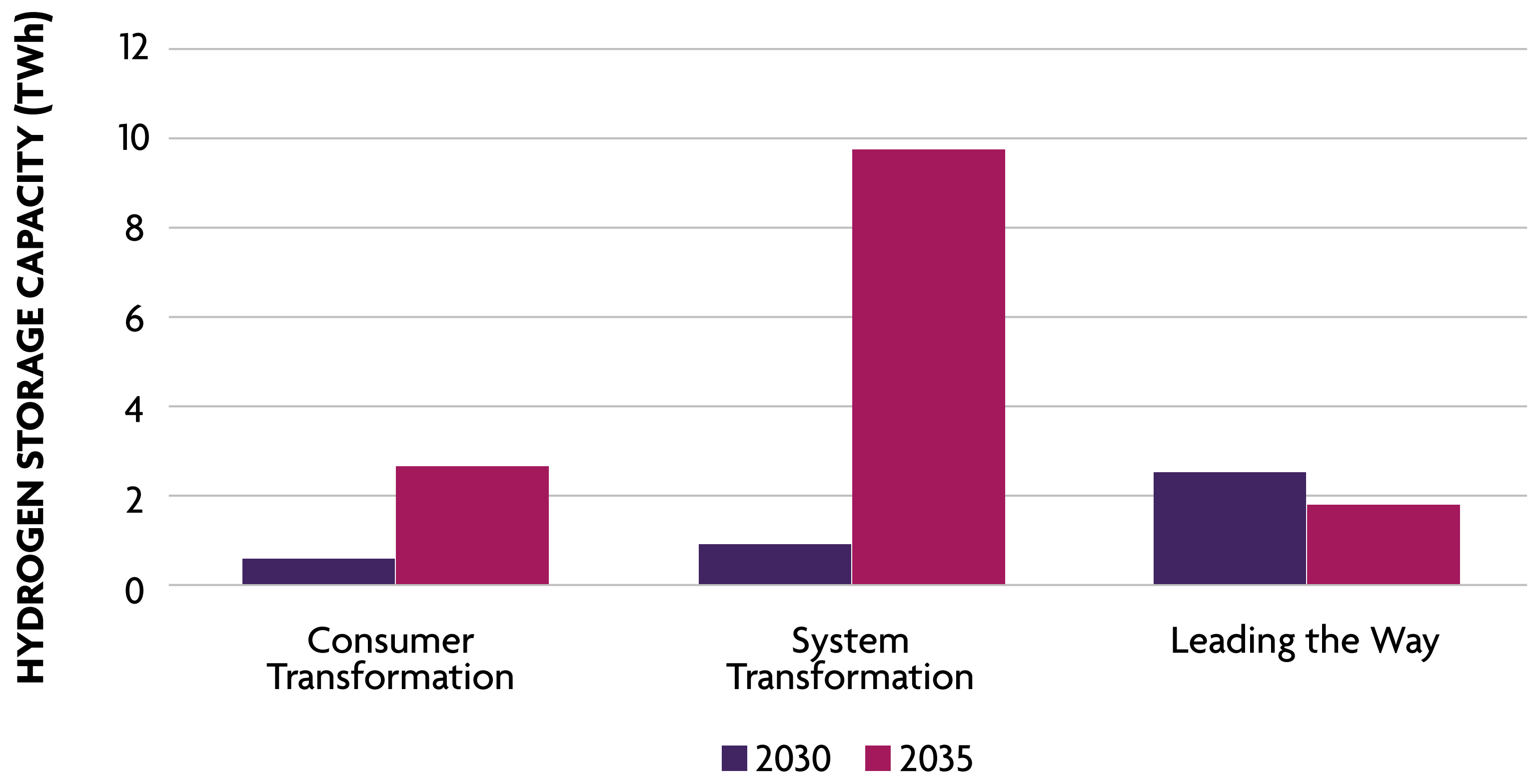

Figure 2: Projected Hydrogen Storage Requirements Based on NGESO Future Energy Scenarios

The UK benefits from favourable geographical storage conditions, with access to salt caverns and gas fields in onshore regions such as Wessex and Cheshire as well as offshore regions like the Eastern Irish Sea and North Sea[33]. Coupled with the nation's experience in underground gas storage, salt caverns and gas fields present significant opportunities for large-scale hydrogen storage development. Advancing these assets will play a key role in achieving hydrogen storage on the scale of tens to hundreds of TWh by 2050.

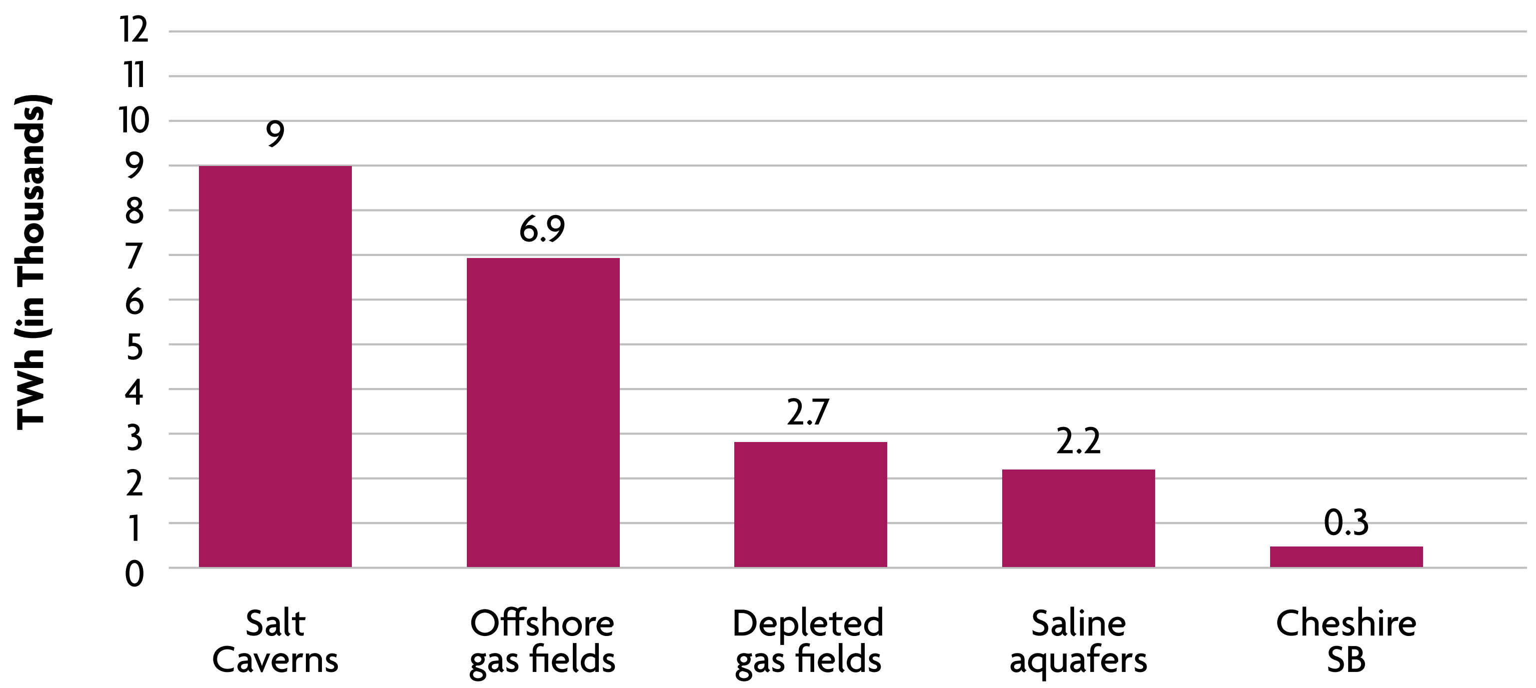

Figure 3: Estimated Hydrogen Storage Capacity in the UK by Technology

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WHOLE SYSTEMS APPROACH

To date, hydrogen transport and storage have been considered as relatively separate technologies. However, it is increasingly evident that their integration is where the true benefits and critical importance of hydrogen infrastructure emerge. The synergy between these two technologies points out the necessity of adopting a whole systems approach to decarbonisation. This integrated perspective is key for advancing the pathway to net zero, with combined transport and storage solutions enhancing the overall effectiveness and efficiency of hydrogen infrastructure.

In a broader context, adopting a whole systems approach is essential to ensure that hydrogen transport and storage developments are strategically integrated into the UK's energy system. Recognising this need, the UK Government announced in 2023 the new role of the now National Energy Systems Operator (NESO), formerly the Future Systems Operator (FSO) to assume responsibility from Government for the strategic planning of hydrogen transport and storage infrastructure. NESO's mandate will encompass critical roles in managing and developing both electricity and gas networks. By taking a holistic view of the energy system, NESO will assess how hydrogen production, transport, storage and use in power will influence the operation of electricity and natural gas networks. For instance, in gas networks, NESO will consider potential opportunities to repurpose natural gas infrastructure which may help achieve substantial cost savings compared to constructing new hydrogen pipelines[34]. The design to assign NESO the responsibility of hydrogen transport and storage infrastructure planning is a positive step, leveraging its expertise as the primary planner for electricity and gas systems. NESO is well positioned to support the integration of hydrogen into the broader energy landscape. However, with NESO not expected to formerly assume responsibility for hydrogen transport and storage planning until 2026 and given the current lack of clarity surrounding its specific role in this area, its impact remains limited at present.

A whole systems approach ensures the coordinated development of the hydrogen value chain, from production, storage, transport and demand while facilitating its seamless integration into the existing energy system. Establishing comprehensive planning and strategy frameworks is crucial, and accelerating the development and implementation of these frameworks is considered a priority.

CASE STUDY: PROJECT UNION

Project Union, led by National Gas Transmission is a 'no regrets' initiative designed to establish a backbone of hydrogen transmission pipelines across the UK. The project aims to strengthen the hydrogen value chain by linking hydrogen production, storage and demand throughout the country. This will be achieved by repurposing up to 2000km of the existing national transmission system (25% of the UK's current methane transmission network) to transport hydrogen and create a resilient network[35]. The project is due for completion in the early 2030s and is projected to directly contribute approximately £300m annual Gross Value Added (GVA)* and support around 3,100 jobs at peak construction[36]. Repurposing existing pipelines is highly cost effective, up to 5 times more so than building new pipelines[37], and minimises environmental impact whilst establishing a first of its kind, reliable and expansive hydrogen network. The phased repurposing of existing high pressure gas networks, along with some new developments, will occur nationwide, with key links in the North West (namely Merseyside) – ensuring the North West remains integrated into the broader hydrogen market. The rollout model for repurposing these networks follows an initial feasibility study, pre-FEED, FEED, and then construction with key decision points that account for policy evolution. Project Union is currently in the pre-FEED stage, beginning to plan the phasing[38]. Developing this network will contribute to achieving net zero and decarbonising hard to abate industries by reducing the costs of supplying low carbon hydrogen and supporting the broader transition toward a hydrogen economy.

Project Union will build on the findings of FutureGrid, an OFGEM SIF funded project, also led by National Gas Transmission. FutureGrid, which recently concluded its phase one trials, was a demonstrator project conducted by the main delivery partner DNV, to assess the viability of transporting 2%, 5%, 20% and 100% blends of hydrogen[39] through decommissioned assets. The phase one test conducted at DNV GL Spadeadam, confirmed that the National Transmission System (NTS) can safely and reliably transport a 5% hydrogen blend[40] with no significant differences compared to natural gas. The project also identified areas for improvement in future testing phases and reinforced the feasibility of rolling out a repurposed hydrogen network nationwide.

*Based on 2021 prices

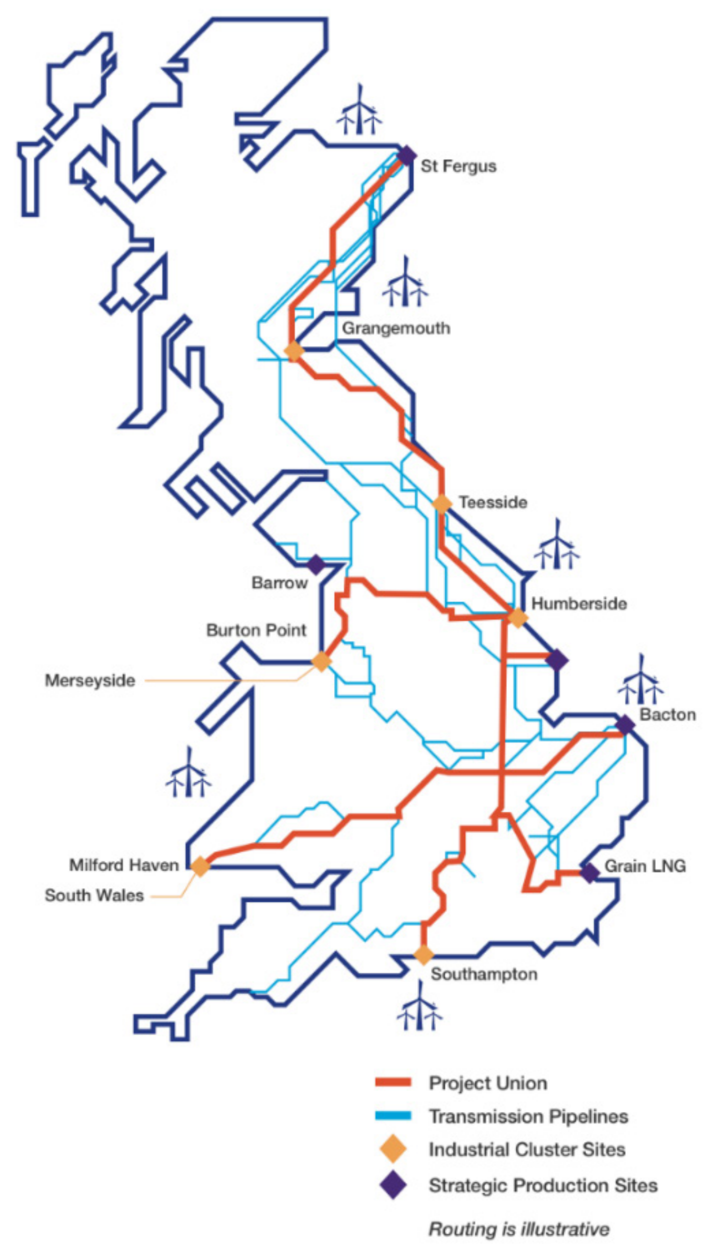


Figure 4: Schematic of Project Union pipeline

Figure 5: Illustration of Hynet cluster

CASE STUDY: HYNET

HyNet, the most advanced Track-1 Carbon Capture, Utilisation and Storage (CCUS) cluster in the UK, is projected to reduce CO2 emissions by 4.5-10 Mt/year[42] and generate 1.35 GW of CCUS-enabled hydrogen by 2030[43, 44, 45]. Located in and around Liverpool, Chester and Manchester, HyNet is poised to become the epicentre of the hydrogen market in the North West. The initial focus has been on hydrogen production at the Stanlow Manufacturing Complex, where the low carbon Hydrogen Production Plant 1 (HPP1), led by Essar Energy Transition, aims to produce 350 MW of blue hydrogen by 2027. This is to be followed by a 1000 MW HPP2 by 2028[46], and a further two plants, whilst effectively capturing 97% of CO_2[47].

While hydrogen production is a critical component of the value chain, the development of transport and storage infrastructure is equally essential to prevent market constraints and realise the full benefits of the network.

To this end, Cadent's HyNet North West hydrogen pipeline will be the UK's first large scale 100% hydrogen pipeline network, linking production sites, storage facilities, and end users via new infrastructure. The pipeline is planned to span 125 km by 2028 with future plans extending it to 270 km[48]. This network will provide a reliable hydrogen supply to industries, transport, domestic consumers, and flexible power generation, promoting cost-effective decarbonisation across multiple sectors and regions. In parallel, HyNet is advancing hydrogen storage capabilities. In Cheshire, INOVYN, via the HyKeuper project plans to repurpose salt caverns connected to the distribution network enabling up to 1.3 TWh of hydrogen storage[49]. The HyNet cluster is projected to generate an estimated 6,000 new jobs and deliver a GVA of £31bn for the UK with £17bn benefitting the North West[50].

THE NORTH WEST

INDUSTRY IN THE NORTH WEST

The North West of England is a key industrial region, known for a concentration of energy intensive heavy industrial sites, a robust technical skills base, manufacturing expertise, and strong research and academic institutions. Renowned as a hub for major companies in the industrial and energy sectors, the region hosts a number of heavy emitters. With the mandate of net zero approaching, the North West faces considerable challenge in decarbonising its industries. However, this also presents a significant opportunity, particularly in the context of hydrogen, to lead the transition towards a low-carbon economy.

NORTH WEST AND HYDROGEN

The North West's capabilities position it well for hydrogen development. With its existing industrial clusters to favourable geological features, the region is poised for the full development of the hydrogen value chain. The North West Hydrogen Alliance's Economic Impact Assessment (EIA) estimates that the North West's hydrogen sector could generate up to 37,000 full time employment years and deliver a cumulative GVA of about £3.4bn by 2030[41].

To realise this economic potential, substantial investment is required in the regional hydrogen economy. Investment and planning must focus on transport and storage infrastructure to support and complement the anticipated large scale hydrogen production in the region, through initiatives such as the HyNet project. The potential for producing and using the region's own hydrogen demonstrates the promising prospects of a thriving regional hydrogen economy, with further benefits that include:

- Providing valuable insights and lessons for other regions,
- Attracting additional investment,
- Enhancing local decarbonisation efforts,
- Stimulating support from local consumers.

These benefits are dependent upon the development of regional transport and infrastructure. Given the long lead times associated with infrastructure projects, it is crucial that development begins promptly to mitigate the risk of temporal misalignment with the North West's flagship hydrogen value chain project, HyNet.

ROLE OF INFRASTRUCTURE IN THE NORTH WEST

It is clear that the North West will require both large-scale hydrogen storage and transport infrastructure to meet future demands. Figure 6 illustrates this and shows the projected hydrogen storage needs to enable the expected demand in the North West. This is based on a demand side study carried out for NWHA which estimates high level storage requirements based annual demand. This approach uses the ratio between demand and storage from National Grid's Future Energy Scenarios 2023. While true storage requirements will depend on production and demand profiles, this approach gives an appropriate high-level estimate. In all three scenarios, modelled by Gemserv, there is increased demand over time which emphasises the region's growing responsibility in facilitating hydrogen's expanding role within the energy market.

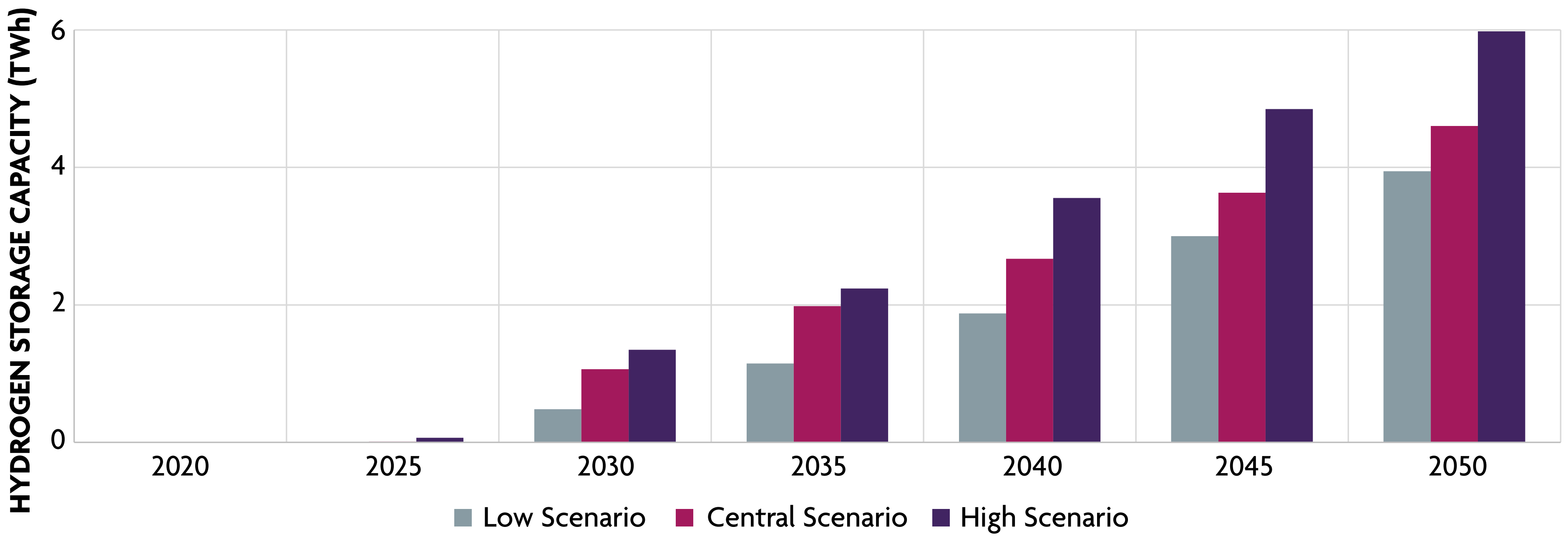
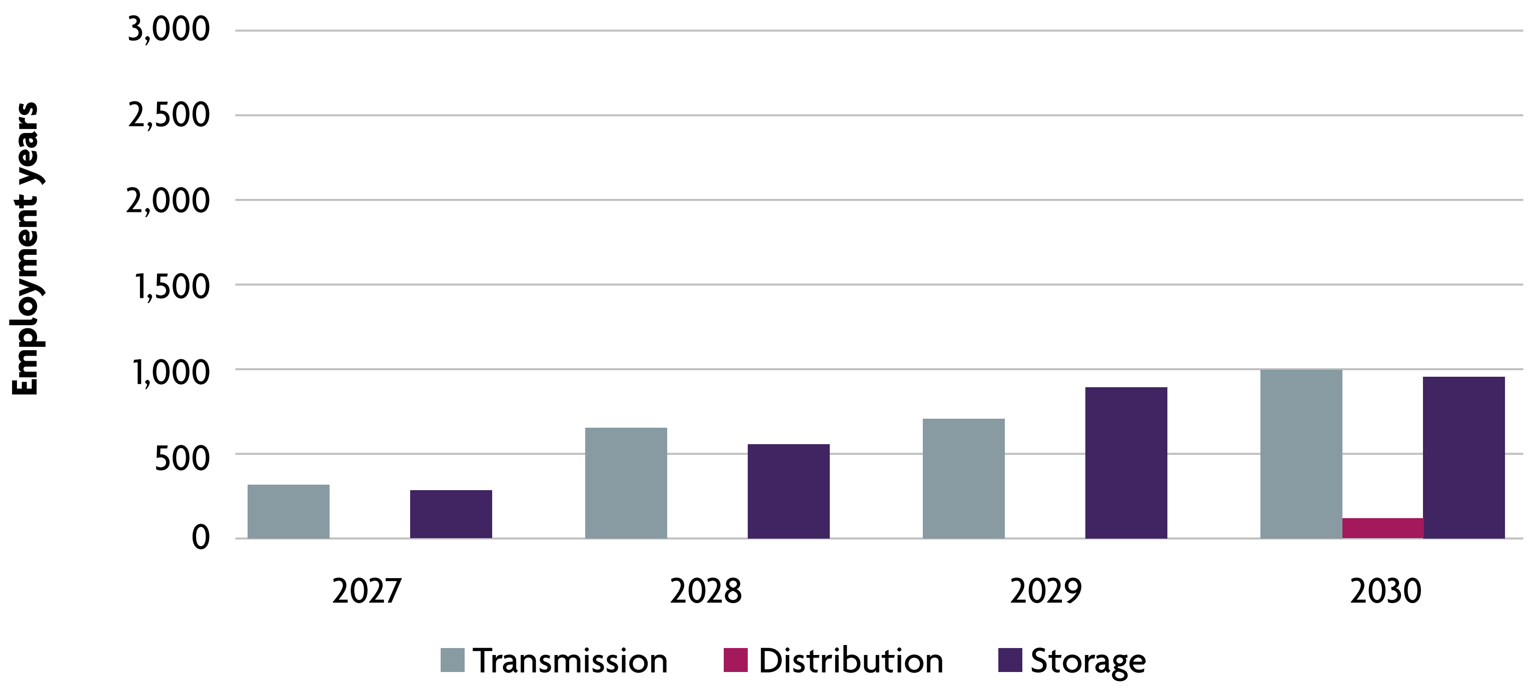


Figure 6: Hydrogen storage necessary to meet demand

The graph above outlines the required hydrogen storage to match future demand, yet it does not capture the potential growth of the storage sector. In contrast the graphs below illustrate the projected economic and employment benefits within the North West's transport and storage sector, extending through 2030.

Figures 7a and 7b illustrate the job creation potential within the North West's hydrogen transport and storage sector, highlighting both direct and total (direct and indirect) employment opportunities. The North West is projected to generate a cumulative total of 11,320 employment years by 2030. Figures 8a and 8b present the direct and total (direct and indirect) annual GVA generated by these sectors demonstrating consistent growth and projecting a cumulative total annual GVA of £890m by 2030. Together, these four graphs highlight the immediate, consistent, and promising returns that investment in the North West's transport and storage infrastructure can deliver, emphasising the critical role this infrastructure will play not only in the region's hydrogen market but also in its broader economic landscape.

ANNUAL DIRECT JOB CREATION IN HYDROGEN TRANSPORT & STORAGE



TOTAL ANNUAL JOB CREATION IN HYDROGEN TRANSPORT & STORAGE

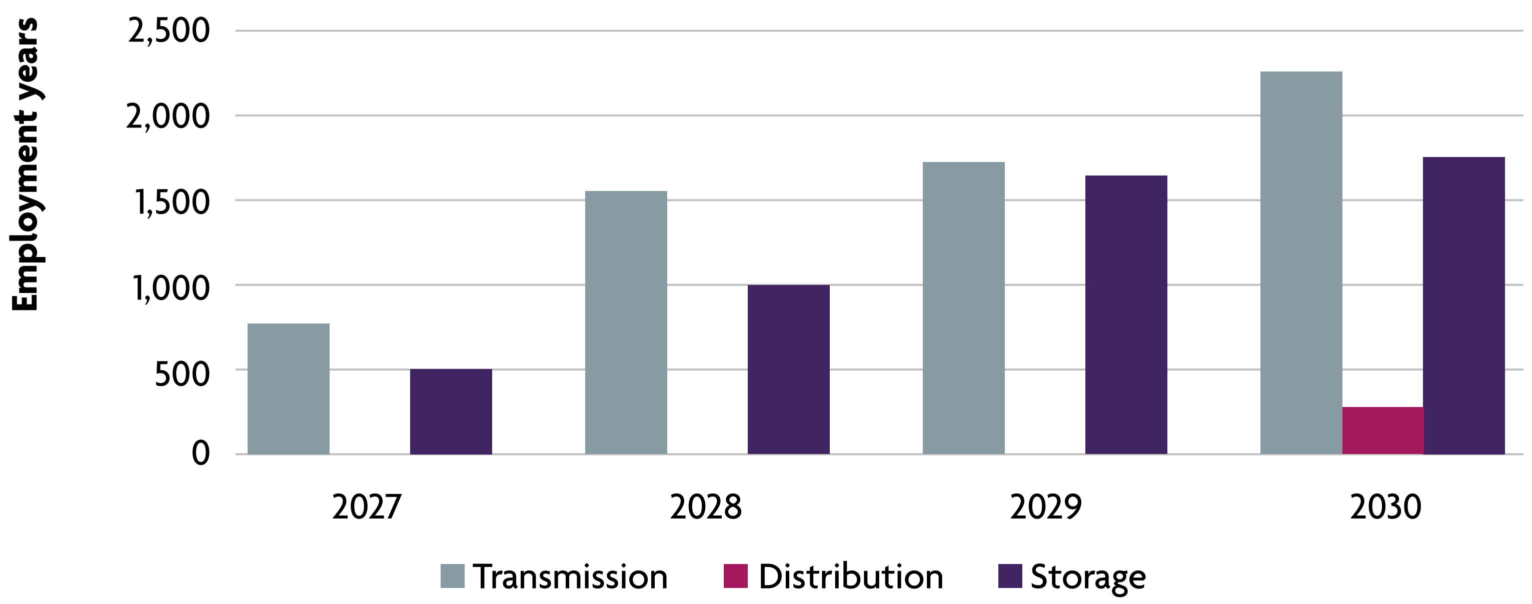
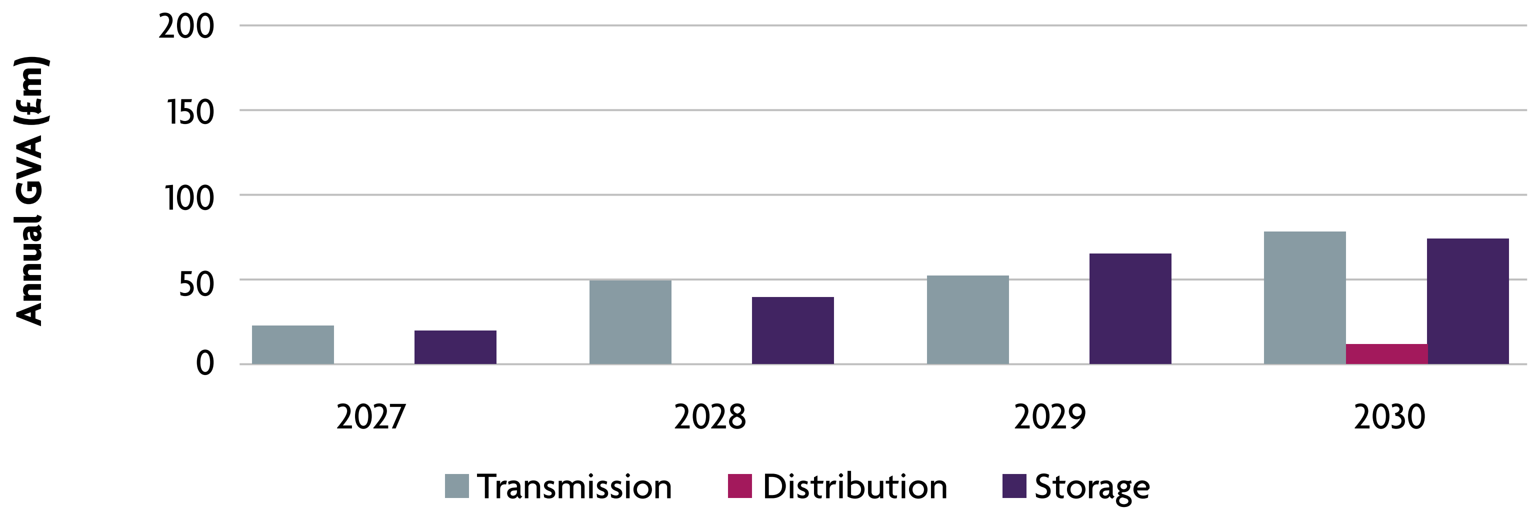


Figure 7a and 7b: Annual direct and total job creation hydrogen transport and storage in the North West from 2027 to 2030

ANNUAL DIRECT JOB CREATION IN HYDROGEN TRANSPORT & STORAGE



TOTAL ANNUAL JOB CREATION IN HYDROGEN TRANSPORT & STORAGE

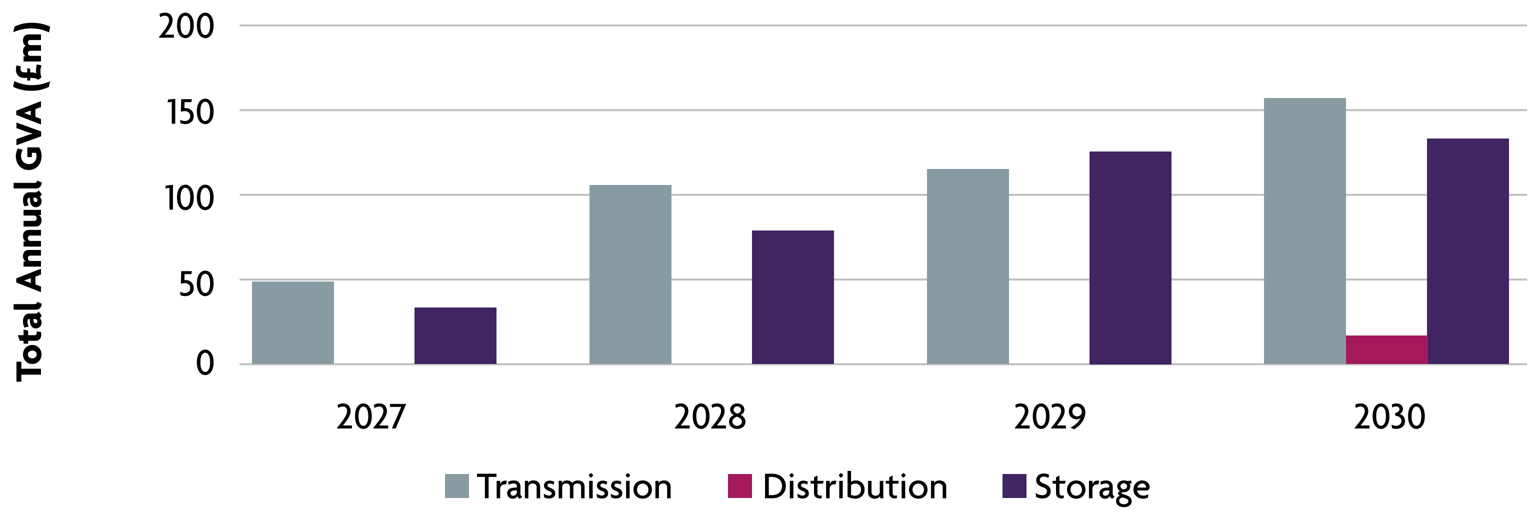


Figure 8a and 8b: Annual direct and total GVA generated in hydrogen transport and storage in the North West from 2027 to 2030

The analysis presented above highlights the importance of transport and storage infrastructure in the North West by demonstrating the significant job creation and annual GVA that can result from strategic investment in this sector. In recognition of this, the National Infrastructure Commission's five-yearly National Infrastructure Assessment[51] recommends the development of a national hydrogen network to connect and decarbonise major industrial centres across Britain while enhancing energy security. The North West is uniquely positioned to play a pivotal role in the national transition to hydrogen. While the current transport and storage infrastructure in the region is underdeveloped, the analysis shows that it represents a highly attractive investment opportunity, promising significant economic growth and a strong return on investment.

HYDROGEN TRANSPORT AND STORAGE BUSINESS MODELS

The UK Government set out the Hydrogen Transport and Storage (T&S) Business Models to unlock growth and stimulate investment into the hydrogen infrastructure sector. While progress with the Hydrogen Production Business Model is critical, production, network and storage projects need to be developed in tandem to maximise the whole-system and economic benefits of low carbon hydrogen and enhance energy security and resilience.

The Hydrogen Transport and Storage business models are key to remove the investment barriers of high capital costs, long leads, demand uncertainty and, in certain cases, monopoly. The Government has committed to designing a Regulated Asset Base (RAB) business model, allowing pipeline operators to earn regulated returns on their investment. The first allocation round, anticipated to be launched in 2024, would support regional, within-cluster large-scale pipeline infrastructures. To avoid prohibitively high network charges, this business model is anticipated to be supplemented with an external subsidy mechanism for early-stage users.

The Hydrogen Storage Business Model would have a different approach, setting a minimum revenue floor for storage users with a potential mechanism that gives the subsidy provider some of the "upside" demand risk. While no hydrogen capacity target has been specified for the first allocation round, the Government signalled to support up to two storage facilities, each with a minimum working gas capacity of 50 GWh. Network and storage projects supported under the first allocation round will need to be either operational or in construction by 2030, with winning projects scheduled to be announced by the end of 2025. As most infrastructure projects have long lead times, it is critical that the Government continues to implement the timeline set out in the Hydrogen Transport and Storage Networks Pathway paper and opens the application window in Q3 2024. Any delay with the T&S business models could result in market inefficiencies and increase the overall cost of meeting net zero.

RECOMMENDATIONS

Having established the critical need for transport and storage infrastructure, immediate action is required to advance development. As this is a national priority, the North West is well positioned to make significant contributions. The region's favourable geographical features, existing industrial infrastructure, skilled workforce and readiness for development offer a strong foundation to meet future network and storage aims objectives. However, the transport network and storage infrastructures are currently lagging in the hydrogen market, making continued government support essential to ensure balanced development across the sector. To sustain the momentum of hydrogen economy growth with the necessary urgency, the North West Hydrogen Alliance recommends the following steps be taken:

1. REACH FINAL INVESTMENT DECISION ON THE INITIAL PHASE OF HYNET

Reaching the final investment decision for HyNet's initial phase will initiate the construction of CO_2 transport and storage infrastructure, essential for facilitating CCUS-enabled hydrogen production. This milestone will also boost investor and project developer confidence, paving the way for future projects to move forward.

2. SELECT HPP2 IN THE HYNET TRACK-1 EXPANSION PROCESS

The selection of the 1000 MW HPP2 in the Track-1 Expansion process will enable large scale hydrogen production and its supply to multiple offtakers via the hydrogen network.

3. ACCELERATION OF DELIVERY OF THE TRANSPORT AND STORAGE BUSINESS MODEL

A. OPEN THE FIRST ALLOCATION ROUNDS

Establishing the transport and storage business model represents a significant advancement; however the pace of progress is insufficient. Accelerating the delivery of this business model is crucial to ensure comprehensive development across the entire value chain and prevent the limitation of hydrogen's potential for decarbonising hard to abate end users, hence keeping the 2050 net zero target within reach. Given the long lead times associated with infrastructure development, it is essential to accelerate the delivery of the business model by opening the first allocation rounds. This will mitigate the risks of delays and ensure timely infrastructure connections, thus securing the success of hydrogen initiatives nationally and in the North West. Launching the first allocation rounds will not only support economic development and job creation but also stimulate growth within the hydrogen market.

4. EXPEDITE PLANNING AND PERMISSION TO HELP REACH TARGETS

A. SUPPORT THE HSE TO DEVELOP THE SAFETY CASE FOR HYDROGEN IN NETWORKS

Disparate demand for hydrogen is projected to rise, and without balanced development across the entire value chain constraints on the hydrogen network will increase. To achieve set targets and mitigate future constraints, enhanced planning and permitting is critical to ensure that new projects commence promptly. Given the lengthy lead times and high capital costs associated with infrastructure development, it is crucial to expedite planning, permitting and safety checks to accelerate project completion. Effective planning should encompass decisions regarding pipeline locations, storage technology, and storage sites. It is vital for ensuring that infrastructure deployment proceeds efficiently and without delay, thus warranting government attention. Part of this planning includes obtaining approval from the Health and Safety Executive (HSE), to validate the safety of hydrogen use in pipelines. We recommend that the Government collaborate with the HSE to expedite the approval process for hydrogen usage in existing pipelines, allowing progress in both the hydrogen network infrastructure and the wider value chain.

5. SET A PLANNED TIMELINE AND INFRASTRUCTURE FOR PROJECT UNION AND HYNET NETWORK

A. DEVELOP STRATEGIC VISION FOR DEVELOPMENT OF INFRASTRUCTURE GEOGRAPHICALLY

B. PROVIDE DEVEX FUNDING TO SUPPORT NECESSARY WORKS

A key component of planning will be the focus on the flagship projects of Project Union and the HyNet network. Providing clarity and certainty by setting a detailed timeline for the development of this infrastructure helps investor confidence and enhances accountability for both investors and the Government. This drives progress, ensuring more projects are approved, which in turn advances the hydrogen market. This planning phase will involve the determination of pipeline routes, including HyNet's 350km pipeline[54] and Project Unions 2000 km pipeline[55] as well as the location and technology choice for storage facilities. Comprehensive planning will outline optimal use of financial subsidies and DEVEX funding, laying the groundwork for successful project initiation. A strategic approach to planning will facilitate the creation of a reliable and resilient hydrogen value chain, supporting the development of a leading regional hydrogen economy.

6. PROVIDE CLARITY ON DECISIONS REGARDING THE NATIONAL HYDROGEN PIPELINE NETWORK

The North West Hydrogen Alliance recommends the Government commit to establishing a 100% national hydrogen pipeline with a specified target date, including the timeline for phasing of connection points. Such commitment to a core network will increase investor confidence and unlock the development of additional hydrogen projects across the value chain. It will also enhance accountability for progress, ensure that forward steps are taken, and prevent delays in achieving stated goals.

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INDUSTRY IN THE NORTH WEST

The North West of England is a key industrial region, known for a concentration of energy intensive heavy industrial sites, a robust technical skills base, manufacturing expertise, and strong research and academic institutions. Renowned as a hub for major companies in the industrial and energy sectors, the region hosts a number of heavy emitters. With the mandate of net zero approaching, the North West faces considerable challenge in decarbonising its industries. However, this also presents a significant opportunity, particularly in the context of hydrogen, to lead the transition towards a low-carbon economy.

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