NET ZERO NORTH WEST

UK Research and Innovation

NORTH WEST CLUSTER PLAN
INTERIM FINDINGS

April 2022

1. INTRODUCTION

The North West boasts the largest concentration of advanced manufacturing and chemical production in the UK and is home to a concentration of energy intensive users. Industrial consumers in the region emit nearly 17 million tonnes of carbon emission per year, of which the largest industries in the Cluster account for over 6 million tonnes.

As part of the government's Industrial Decarbonisation Challenge, the Cluster has received UK Research and Innovation (UKRI) funding to prepare a plan for decarbonising our region's industry and business.

The Net Zero North West Cluster Plan will create a deliverable investment, technology and infrastructure blueprint for the North West's net zero transition and low carbon recovery post-COVID-19. It will recommend the technologies, infrastructure changes and investment necessary to transition the North West, working with North Wales, to net zero carbon by 2040.

The Cluster Plan is supported by Innovate UK and will inform UKRI and Government's preparation of a national industrial cluster plan strategy, industrial decarbonisation strategy and other policy areas. The Cluster Plan aims to act as a roadmap to explain how the North West can lead in:

- Establishing a low-carbon industrial cluster by 2030, by deploying anchor investment projects including HyNet North West's ('HyNet') hydrogen and carbon capture utilisation and storage (CCUS) infrastructure
- Establishing a net zero carbon industrial cluster by 2040, underpinned by multi-vectored industrial decarbonisation solutions

The Cluster Plan is being developed by a consortium of organisations that are seeking to address the technical and economic questions raised by the imperative to remove carbon from industrial processes. Alongside public, private and academic institutions, the NZNW consortium includes representation from energy intensive industrial consumers based in the North West that recognise the necessity to decarbonise.

Preparation of the Cluster Plan began in January 2021. This Interim Report summarises the progress made in the first year, and the findings of detailed research into options for decarbonising industry via the use of energy networks, dispatchable power generation, CCUS (direct capture of CO_2) and via CCUS enabled and electrolytic hydrogen. The full reports are available at **www.netzeronw.co.uk/net-zero-nw-cluster-plan/**

NET ZERO NORTH WEST

The Net Zero North West Cluster Plan is sponsored by Net Zero North West.

Net Zero North West (NZNW) is an industry-led cluster organisation acting as a public and private sector investment accelerator for industrial decarbonisation and clean growth projects in the North West. We unite business, regional leaders and academia, and are committed to delivering a co-ordinated net zero vision for the region. It covers the traditional industrial powerhouses of the Liverpool and Manchester City Regions, as well as Cheshire and Warrington, working closely with partners in Lancashire, Cumbria and North Wales.

The NZNW Economic Investment Prospectus showcases the North West as the UK's leading region for green and sustainable investment. Setting out a £206bn investment case for a pipeline of long-term and shovel ready green investment projects, the prospectus demonstrates how the North West can lead the green industrial revolution and create the UK's first net zero region by 2040.

THE ROAD TO NET ZERO

Government published its Net Zero Strategy in Autumn 2021, in the run up to the International COP26 conference in Glasgow. The strategy includes a range of policies related to power supply, industry, fuels and innovation.

The Net Zero Strategy provides a policy framework until 2035 by which point UK emissions are to be reduced by 68% on way to Net Zero by 2050, as enshrined in the UK Climate Act. The Cluster Plan can help meet the ambition of national policy. The Net Zero Strategy designated the 'Merseyside Cluster' as a potential 'SuperPlace' which will be transformed over the next decade.

The Industrial Clusters Mission, supported by UKRI, seeks to deliver Net Zero Industrial Clusters by 2040. The Mission will support the development of strategic assets in a number of Industrial Clusters. Government has provided a number of other funds to support businesses to begin the process of decarbonisation now, including the Industrial Energy Transformation Fund, Industrial Fuel Switching Competition and Industrial Hydrogen Accelerator.

The North West is the leading region which already has all the elements required to deliver a low carbon industrial cluster by 2030 – including renewables, hydrogen, CCUS, nuclear and smart grids. With an unrivalled range of projects, the Cluster offers a multi vector energy system that can drive clean growth.

HyNet represents an anchor project for decarbonising industry in the North West. HyNet is an integrated hydrogen and CCUS infrastructure project, which will deploy a hydrogen pipeline network and provide a catalyst for other sources of hydrogen generation. The project has received funding of £33M from UKRI under the IDC 'Deployment' programme (which has been 'matched' by £39M of consortium partner funding), and has also been selected by BEIS as a priority 'Track 1' (Phase 1) project in its 'Cluster Sequencing' process. A final investment decision (FID) on the project is expected in 2023 with the first phase to begin operation by the end of 2025.

DEVELOPING THE INVESTMENT CASE

To date, the Cluster Plan has focussed on determining a credible decarbonisation roadmap for industry in the North West. This report synthesis the findings of this research, highlighting how the major projects that have been proposed, or are in development, will be essential to achieving the aim. Continued investment in zero carbon energy generation and fuel switching for industry will also be necessary, as will investment in supporting energy network infrastructure, both at grid scale and localised.

In the second year of the Cluster Plan, an Investment Case will be developed to support the delivery of this roadmap and build upon the NZNW Economic Prospectus published in 2021. This Investment Case will aggregate a portfolio of current projects and quantify the potential for further investment. An assessment of the skills requirements and supply chain impacts of the plan will be developed.

2. POWER SECTOR DECARBONISATION

GRID SCALE LOW CARBON DISPATCHABLE POWER, UNIPER, APRIL 2022

The report undertaken by Uniper explores and evaluates the potential role of low carbon dispatchable power generation in the transition to a Net Zero future.

It investigates the technical and commercial aspects of the technologies considered feasible to deliver at scale (>300MW) dispatchable power generation onto the National Transmission System in 2030 and further into the future.

Published future energy scenarios have been reviewed and compared to help inform a view of the future requirements for dispatchable power in the UK, with these being related back to the North West context, providing indication of possible future potential within the Cluster.

The technical, commercial and strategic considerations have been aligned to provide quantification of the possible demand such technologies could place upon a hydrogen network, with this data being incorporated into the demand modelling developed by EQUANS in their research.

KEY OUTPUTS

It has been shown that in order to reach Net Zero in the UK by 2050, significant changes must be implemented in the electricity sector on a national level. Evidence stated in each of the four future energy models consulted, shows that much of this required decarbonisation is likely to be achieved via greater penetration of renewables. However, in order to maintain security of supply, low carbon dispatchable power is shown to be required throughout the forecast period to 2050.

Current technology forecasts suggest Hydrogen Turbines and Natural Gas Turbines with carbon capture to be the most likely technologies to provide a significant portion of the required low carbon dispatchable power. The exact mix, capacity and generation, however, is open to significant variation across future predictions. Other developing technologies, such as the Allam cycle or large scale fuel cells, have also been shown to have future potential as their technology readiness improves.

Based on the proposals, made as part of HyNet and other projects, for considerable hydrogen production, infrastructure and storage and carbon dioxide infrastructure and storage, there is significant opportunity for deployment of dispatchable low carbon power generation in the North West region.

Some considerable challenges must, however, be overcome before deployment of such assets can be considered as 'bankable' projects:

- Greater certainty around future energy outlooks to further inform the possible role of dispatchable power
- Proof of technological capability at scale is required for both Hydrogen Gas Turbines and Natural Gas Turbines with carbon capture;
- Suitable business models and regulatory frameworks are required to ensure investor confidence; and
- Suitable and sufficient infrastructure developments, providing capacity and flexibility, will be required on hydrogen, carbon dioxide and power networks.

2040 ENERGY SCENARIOS NORTH WEST OF ENGLAND, LOCAL ENERGY NORTH WEST HUB, APRIL 2022

Nationally Significant Infrastructure Projects that will support grid decarbonisation are based in the North West of England, the Irish Sea and in neighbouring regions where they might feed into localised production of hydrogen.

Work has taken place in parallel to the Industrial Cluster research to develop 2040 energy scenarios for the North West of England.

Mapping work undertaken by the Local Energy North West Hub has reviewed the major generation projects that may come forward. These include:

- **OFFSHORE WIND**
  Up to 65.5 TWh to be generated in the Irish sea. Not all of which will be landed onshore in the North West.
- **TIDAL POWER**
  Up to 3.0 TWh of tidal energy from the Mersey Power project.
- **NUCLEAR**
  Up to 56.8 TWh of nuclear energy from new Small Modular Reactor (SMR) and Advanced Modular Reactor (AMR) schemes.
- **RENEWABLES**
  Up to 3.0 TWh of renewable energy from solar and onshore wind.
- **HYDROGEN**
  Up to 69 TWh of hydrogen from CCUS and electrolytic sources.

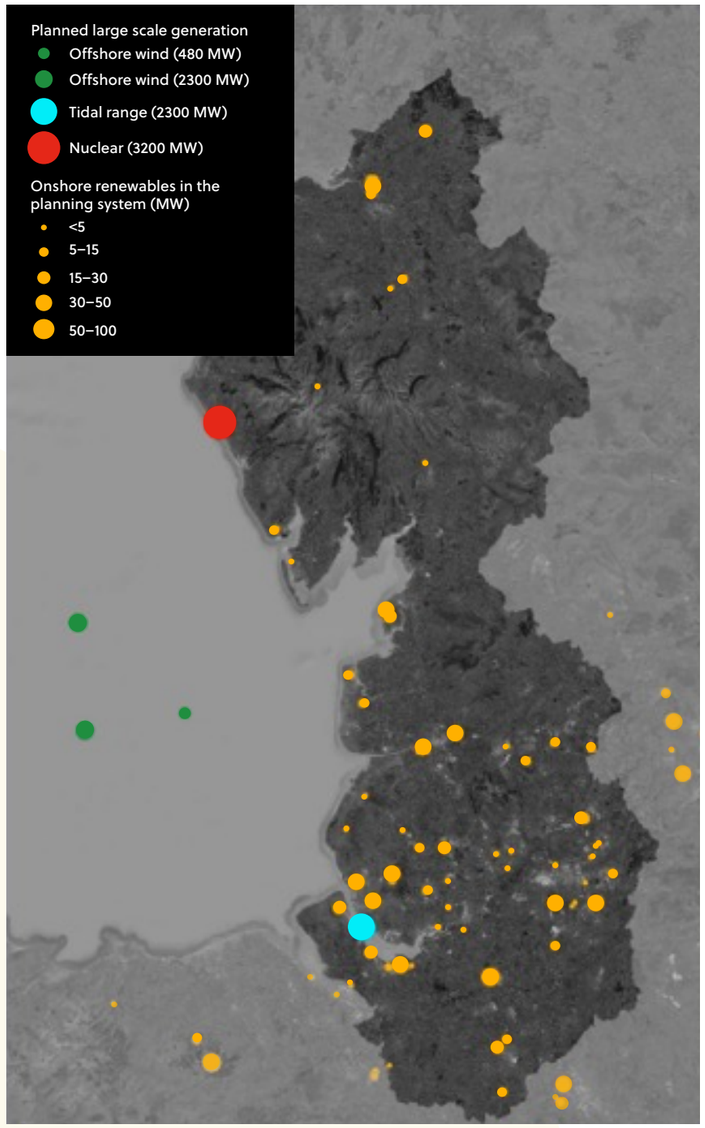

FIGURE 1: Planned additional generation in the North West Region.

POWER SUPPLY CONSIDERATIONS

Decarbonisation of industry in the North West will have significant implications for the power grid both at the transmission level and distribution network level. There is anticipated to be a need for significant new generation, to reinforce the network substantially to enable new developments to come forward and for industry to electrify some processes.

There is also the opportunity to reduce the demand on the grid through efficiencies on the demand side.

As part of the next phase of work, consortium partner SP Energy Networks (SPEN) will publish a report on the implications of the Cluster Plan on their Manweb distribution network, which includes the North Wales, Cheshire and Warrington and Liverpool City Region Areas.

3. INDUSTRIAL CONSUMERS

INDUSTRIAL CONSUMERS, EQUANS, APRIL 2022

Alongside the decarbonisation of the power sector, on-site interventions will be required to decarbonise industrial consumers in the North West. This analysis was completed by EQUANS and the Local Energy North West Hub with 3.7Mt of carbon savings identified.

The report undertaken by EQUANS considers current practical initiatives for decarbonisation delivery and provides an assessment of future technologies across 27 industrial sectors including 160 manufacturing sites. It incorporates four common technology themes across the sectors: **Energy Efficiency, Low Carbon Technologies, Renewable Generation** and **Hydrogen**. This analysis does not include the power generation sector. The approach to decarbonising this sector is covered in Section 2.

Sectoral decarbonisation roadmaps were created for key sectors in the North West. The first step in developing this was to benchmark current consumption through evaluating a range of data sources to derive the most effective results. The data sets that were evaluated include **European Union Emissions Trading System (ETS), UK National Atmospheric Emissions Inventory (NAEI), Energy Saving Opportunity Scheme (ESOS), Energy survey reports and The Green House Gas (GHG) inventory.**

EVALUATE OPTIONS FOR CARBON REDUCTION

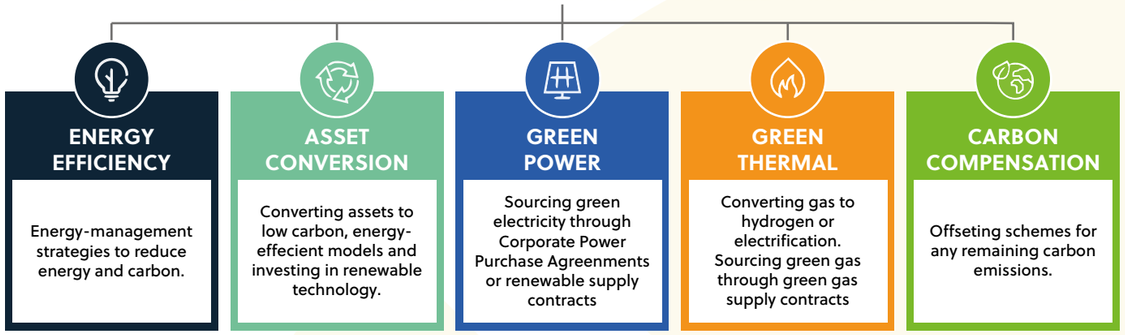

FIGURE 2: Categorisation of carbon reduction measures.

The next step in developing the roadmaps was to evaluate decarbonisation initiatives through energy efficiency. In its simplest form energy efficiency is the measure of how much energy is required when performing an action. Strategies that enable organisations to use less energy are one of the easiest, lowest-investment, and often simplest approaches to lowering carbon emissions, however these are sometimes overlooked for larger transformations that come with corresponding risks. The identified energy efficiency measures were included in each of the sectoral roadmaps.

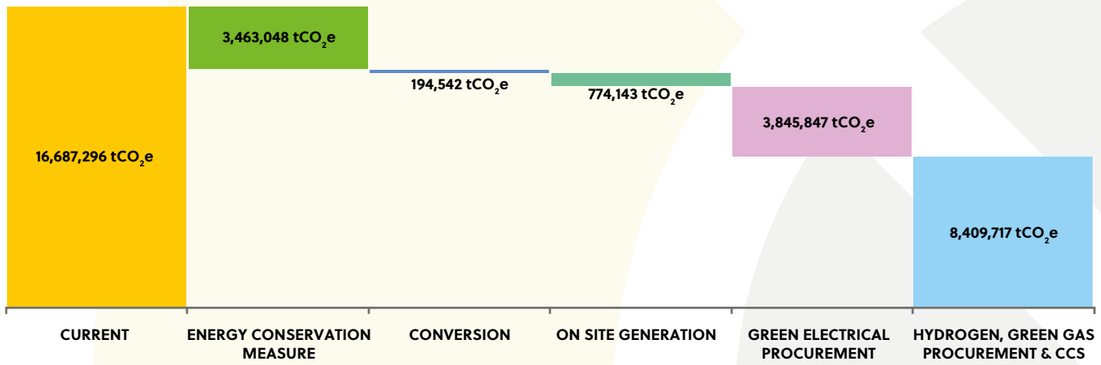

FIGURE 3: North West Industrial Consumers Roadmap

The decarbonisation of site processes and heat was achieved by a range of different technologies such as the use of hydrogen as an alternative fuel (expected to be available to some parts of the North West from 2025), combined heat & power (CHP) plants, heat pumps (HP) and electrification (which assumes electricity is procured from renewable sources). The identified heat decarbonisation strategies were included in each of the sectoral roadmaps.

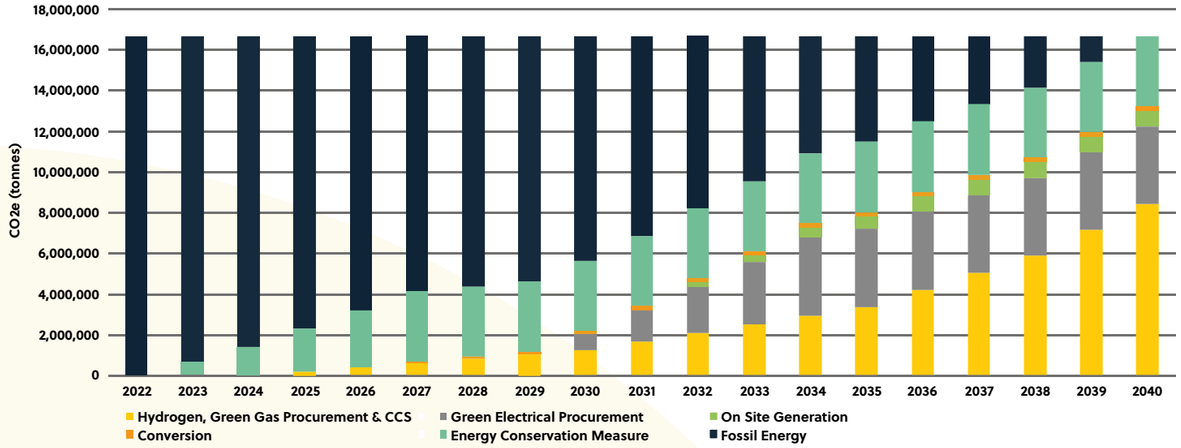

FIGURE 4: North West Industrial Consumers Action Plan Priorities.

Using the aforementioned approach, a North West Net Zero Road Map was developed which is shown in Figure 3. Energy efficiency, procurement of green power and green hydrogen are key measures in delivering substantial carbon savings and are applicable to each sector in the North West.

The action plan to achieve net zero prioritised availability of new technology and ease of implementation, as well as alternative fuels such as hydrogen, shown in Figure 4.

A highly attractive overall payback of 3.7 years for the energy efficiency and on-site generation measures was estimated for the Cluster, which fits within the payback requirements/criteria of all the industrial sectors.

The EQUANS Industrial Consumers report details roadmaps for the major industrial sectors in the North West Cluster and will be used to inform the decarbonisation impact assessment of the electricity distribution network, upskilling in local education, skills requirements and in the development of the investment case for the North West.

2040 ENERGY SCENARIOS NORTH WEST OF ENGLAND, LOCAL ENERGY NORTH WEST HUB, FEBRUARY 2022.

The Local Energy North West Hub has supported research into industrial consumers by providing GIS information for key industrial sites. Ongoing work by the energy hub is identifying sources of data to support local area energy masterplanning for industrial decarbonisation.

4. HYNET & CCUS ENABLED HYDROGEN

HYNET – THE ROAD TO NET ZERO, PROGRESSIVE ENERGY & CADENT, APRIL 2022

This section has particular importance due to its focus on the hydrogen and CCUS infrastructure being developed by the HyNet North West ('HyNet') Project. The analysis here demonstrates how HyNet will be deployed over several phases and expanded to decarbonise both industry and all wider sectors of the North West economy.

DEPLOYMENT AND EXPANSION OF CCUS INFRASTRUCTURE

CO_2 transport and storage infrastructure underpins both the direct capture of CO_2 from industry and the production of low carbon hydrogen by HyNet. Initially direct capture of CO_2 will come from three core HyNet partners and then be expanded in the late 2020s and 2030s to a wider range of industry sites. This will include Energy from Waste (EfW) and biomass facilities combusting biogenic fuels (so-called Bioenergy Carbon Capture and Storage or 'BECCS'), thus offering the opportunity of 'negative' emissions to the Cluster. This is such that the total potential CO_2 captured directly from industry has been modelled as 3.5Mtpa in 2030, rising to 4.9Mtpa in 2040.

Initially focused on using up to 200Mtpa of CO_2 storage in the Liverpool Bay oil and gas fields, as the requirement increases further in the 2030s, further storage capacity in gas fields in Morecambe Bay is likely to be required. The Morecambe North and Morecambe South fields potentially have combined capacity for in excess of 1Bn tonnes of CO_2, which would represent 100 years storage at 10Mtpa or 50 years storage should CO_2 capture across the HyNet project increase to 20Mtpa.

DEPLOYMENT AND EXPANSION OF THE HYDROGEN NETWORK

An initial phase of network deployment is planned from 2025-27, which will deploy around 90km of pipeline to connect major gas users in Liverpool City Region, Cheshire and Greater Manchester. A further 350km of pipeline will connect sites in Liverpool, South Lancashire, North Wales and further into Manchester by 2030. During the 2030s, the hydrogen network may be extended beyond the North West into the West Midlands and further into North Wales, also potentially supplying 100% hydrogen to homes.

DEPLOYMENT AND EXPANSION OF HYDROGEN PRODUCTION

The vast majority of hydrogen production prior to 2030 will come from the Stanlow Hydrogen Production Hub. Vertex Hydrogen (a joint venture company between Progressive Energy and Essar Oil UK) was launched in January 2022 and will deploy production capacity at Stanlow in phases, starting with an initial 3TWhpa in 2025, increasing to 30TWhpa by 2030.

As the HyNet project expands beyond 2030, new CCUS-enabled low carbon hydrogen capacity will be developed away from Stanlow, potentially at Morecambe, with increasing amounts of electrolytic hydrogen also supplying into the HyNet network.

DEPLOYMENT AND EXPANSION OF HYDROGEN STORAGE

The Cheshire salt basin represents an ideal location for the development of significant geological hydrogen storage infrastructure. Salt caverns in the basin have been used to store natural gas for decades and so it is very well characterised. As HyNet expands outwards in the 2030s, there are further locations at which hydrogen might be stored underground, including the onshore Lancashire Salt Basin and offshore in the East Irish Sea, either in salt caverns or in depleted oil and gas reservoirs. Consequently, availability of underground storage capacity does not function as a constraint to wider deployment of hydrogen as an energy vector.

GROWTH IN HYDROGEN DEMAND

Our model suggests that in 2030, industrial demand might range from 12TWhpa to 20TWhpa and come from a range of sub-sectors. Combined with hydrogen demand from flexible power generation, buildings and vehicles, total hydrogen demand in 2030 is modelled to be 22-29TWhpa, which results in avoided CO_2 emissions of 4.1-5.5Mtpa. In 2040, as HyNet expands geographically, industry demand could grow to 17-24TWhpa, whilst significant growth across wider sectors of the economy could result in total hydrogen demand of 56-74TWhpa.

EMISSIONS AVOIDED BY HYNET

In 2030, total avoided emissions modelled for HyNet across all sectors of the economy range from 6.9-8.1MtCO_2 pa. This level of abatement increases to 16.3MtCO_2 pa to 17.4MtCO_2 pa in 2040. In relation to industry specifically, avoided emissions modelled for 2030 range from 5.1-6.4MtCO_2 pa rising to 7.3-8.4MtCO_2 pa in 2040. In the context of current total direct emissions from industry in the North West of around 10MtCO_2 pa, this represents a critical contribution to decarbonisation of the region.

THE OPPORTUNITY

The 30TWhpa of hydrogen which may be produced by HyNet in 2030 is equivalent to around 4GW of continuous peak output. HyNet, therefore, has the potential to deliver around 80% of the Government's 5GW target for 2030, which was published in the National Hydrogen Strategy in 2021.

HyNet will also enable the North West to make a material contribution to meeting the UK's 5th Carbon Budget. Given the need to reduce emissions by 56MtCO_2 pa between the UK's 4th (2023-2027) and 5th (2028-2032) Budgets, the potential 8MtCO_2 pa of abatement delivered by HyNet in 2030 equates to around 16% of this improvement.

Ultimately, deployment of hydrogen, CCUS and BECCS in the North West is subject to the Government putting in place a set of long-term business models for hydrogen and CCUS against which upfront investment from the private sector can be justified. The progress on these business models is mixed, with significant work still to do in many areas to enable timely investment.

Measures, such as industrial energy efficiency, onsite renewables and electrification will also need to be deployed to help the region meet Net Zero in 2040. These areas are explored in wider studies undertaken as part of the North West Cluster Plan.

5. ELECTROLYTIC HYDROGEN FOR NORTH WEST INDUSTRY

ELECTROLYTIC HYDROGEN RECOMMENDATIONS, EQUANS, APRIL 2022

The analysis in EQUANS' Industrial Consumers report suggests that 8.4 $MtCO_2$ /a of industrial emissions could remain after energy efficiency and electrification projects have been deployed. For the North West Industrial Cluster to reach net zero, these emissions must be abated and low carbon hydrogen is recognised to be a credible and scalable solution. This scalability is embodied by the HyNet project which has the potential to decarbonise swathes of industry by supplying consumers with CCUS enabled hydrogen via a dedicated hydrogen network. However, with its residual emissions, CCUS enabled hydrogen is often regarded as a transition fuel and an enabler of a future electrolytic hydrogen economy (i.e. zero carbon hydrogen produced through the electrolysis of water). Despite this long-term vision, there is currently a gap in the literature around what a future electrolytic hydrogen economy for the region would entail. EQUANS' Electrolytic Hydrogen Recommendations report aims to fill that knowledge gap by analysing the viability of electrolytic hydrogen production in North West England and North East Wales.

To achieve this, a comprehensive technoeconomic modelling exercise was undertaken whereby a multi-nodal, multi-vector optimisation tool was configured to design a regional hydrogen production system capable of producing, distributing, and supplying electrolytic hydrogen at the lowest overall cost. The modelling was repeated for eight alternative future energy scenarios and iterated on an hourly basis to examine the complex relationship between intermittent renewable generation and hydrogen demand. To account for decentralised consumers, renewable development constraints and HyNet infrastructure, the region was disaggregated into 13 analytical nodes. This enabled analysis to be conducted at an inter-scenario and intra-scenario level to explore how systemic considerations (e.g. national policy) or geographic considerations (e.g. development constraints) would affect the levelised cost of hydrogen (LCOH) production. This allowed the regional scalability of electrolytic hydrogen projects to be assessed and the key variables that affected the LCOH to be analysed.

In the majority of cases, electrolytic hydrogen was seen to be more expensive than CCUS enabled hydrogen and its scalability was driven by the systemic considerations. Depending on the scenario modelled, the installed electrolyser capacity ranged from tens of megawatts to 7.5GW highlighting the uncertainty associated with modelling future energy scenarios. However, the lower hydrogen demand scenarios are not expected to be net zero compliant, and thus gigawatts of electrolytic hydrogen capacity, alongside CCUS enabled hydrogen, could be required for the North West Industrial Cluster to reach net zero by 2040.

The intra-scenario analysis indicated that large scale electrolytic hydrogen grid injection projects and decentralised embedded green hydrogen for industry were the two primary project archetypes for the region. Numerous variables impacted the economic viability of these projects and the LCOH varied from £1.96/kg to £10.36/kg depending on the design. Given this wide variability, the factors that affected the LCOH were grouped into three characteristics of success that stakeholders should be cognisant of when developing projects.

1. **THE ELECTRICITY SOURCE**
   Directly connecting electrolysers to onshore wind, offshore wind and SMRs demonstrated the greatest potential for LCOH reduction. Grid electricity was costly and embedded projects benefitted from utilising multiple generation technologies behind the meter.

2. **THE DECOUPLING OF DEMAND**
   Grid injection projects were inherently cheaper than embedded solutions as the hydrogen demand peaks could be met by centralised storage and CCUS enabled hydrogen. Adding on-site storage or gas grid blending to embedded projects was shown to reduce their LCOH.

3. **COORDINATION IS CRUCIAL**
   Aggregating decentralised consumers and developing electrolytic projects alongside other decarbonisation solutions led to cost reductions. Close collaboration with regional and national energy stakeholders will be necessary to ensure projects are practicable.

Finally, given the current market failures, government support will be vital to unlock the societal benefits that electrolytic hydrogen can bring. Subsidies must be flexible and accessible, empowering all consumers to embrace the zero carbon transition: protecting local jobs and ensuring the longevity of British industry.

ELECTRICITY SOURCE	POSITIVES	NEGATIVES
Onshore wind	+ LCOE + Load factor & profile	– Capacity
Solar PV	+ LCOE + Capacity	– Load factor & profile
Offshore wind	+ LCOE + Load factor & profile	– Location
Tidal power	+ Capacity + Load factor & profile	– LCOE
Small modular reactor	+ Load factor & profile + LCOE	– Location (short/ medium term)

FIGURE 5: The positives and negatives for different electricity sources for electrolytic hydrogen production.

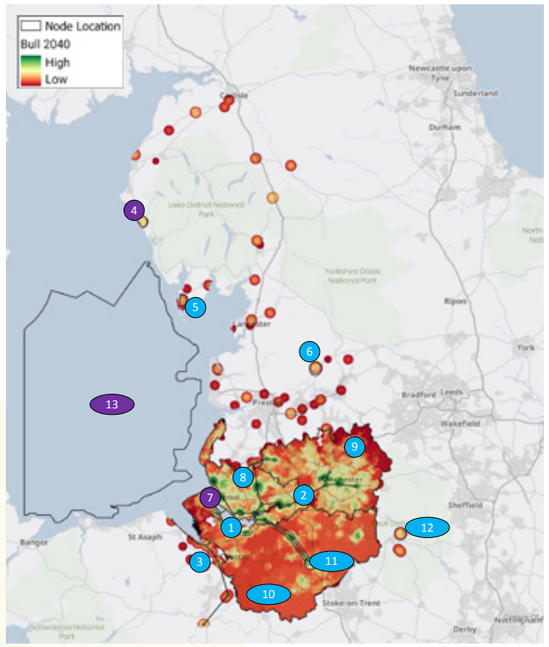

FIGURE 6: A map showing the 13 analytical nodes and the location and quantum of the hydrogen demand for one of the future energy scenarios.

BREAKDOWN OF THE GREEN LCOH FOR EACH NODE (BULL 2040)

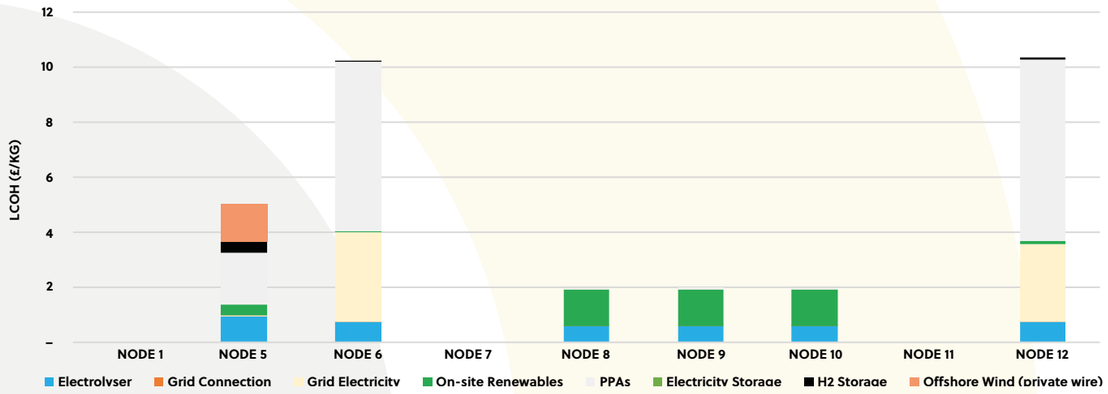

FIGURE 7: A graph showing the breakdown of the LCOH for each node in the No Target Mix decentralised high hydrogen 2040 scenario.

6. CONCLUSION

At the end of year one of the NZNW Cluster Plan research, the following findings are provisional and will be refined through the development of the Cluster Plan Investment Case.

An emissions baseline for Industry in the North West has been agreed by the Cluster partners and is evidenced here. This baseline of current emissions (based on 2019 data) can be reduced to zero through a series of step changes that will combine to deliver the necessary savings.

Carbon emissions associated with total industrial production in the North West are 16.7 million tonnes per annum. Industrial emissions for the purposes of this study are those associated with energy intensive industry, foundation industries, manufacturing and other activities that are captured by the EU Energy Trading Scheme.

This figure also includes the emissions associated with very large emitters and power generation, which are not always included in sub-regional statistics. Direct (Scope 1) carbon emissions are associated with the use of fossil fuels in industrial process and commercial activities. They are associated with the burning of natural gas, petrol and fuels that are hard to decarbonise and which are the focus of this research. Also considered within this baseline are emissions associated with these industries' use of grid electricity (Scope 2).

Based on the information presented in Sections 2-5, the Cluster partners have developed two scenarios for emissions reduction in 2040. A 'higher hydrogen' scenario in which the production of hydrogen is maximised to supply industry and other sectors and a 'lower hydrogen' scenario which will be used for comparison within the Cluster Plan investment case in year two. Under these two scenarios, the following emissions savings have been modelled:

- Decarbonisation of Grid Electricity could deliver savings of 4.6 million tonnes of CO_2e. Electrification of Scope 1 processes could deliver savings of 0.2 million tonnes of CO_2e. Energy efficiency could deliver savings of 1.9 million tonnes of CO_2e (Scope 1) and 1.6 million tonnes of CO_2e (Scope 2).
- Production of electrolytic hydrogen from regionally based renewable generation capacity if supplied to industry could deliver savings of:
  - 1.2 million tonnes of CO_2e under the higher hydrogen scenario; and
  - 0.7 million tonnes of CO_2e under the lower hydrogen scenario
- CCUS and BECCS could deliver savings of 4 million tonnes of CO_2e.
- CCUS enabled hydrogen could deliver savings of:
  - 3.2 million tonnes of CO_2e under the higher hydrogen scenario; and
  - 1.8 million tonnes of CO_2e under the lower hydrogen scenario

Figure 8 shows that under the higher hydrogen scenario, if all measures are implemented as per the model, there is a plausible route to industry meeting net zero by 2040. However, under the lower hydrogen scenario shown in Figure 9, whereby lower volumes of hydrogen are produced and networked to industrial sites, there remains around 1Mtpa/ annum of CO_2 emissions from industry in the region.

This analysis demonstrates that Government needs to at least match the ambition of 5GW of hydrogen production stated in its own National Hydrogen Strategy. It must therefore support greater levels of the deployment of hydrogen than the current 1.5GW combined total to which it has committed for the UK as a whole for both the CCUS-enabled and electrolytic production as part of the Hydrogen Business Model Processes.

NEXT STEPS FOR THE CLUSTER PLAN

- In year 2 of the NZNW Cluster Plan an investment case will be developed built on the foundation of the year one research.
- A final report will update findings and be informed by further work to understand skills and supply chain.
- The research undertaken to date will contribute to the development of a national strategy for cluster decarbonisation supported by Innovate UK
- Net Zero North West will continue to engage with government and industry in the region to make the case for industrial decarbonisation.

HIGHER HYDROGEN SCENARIO

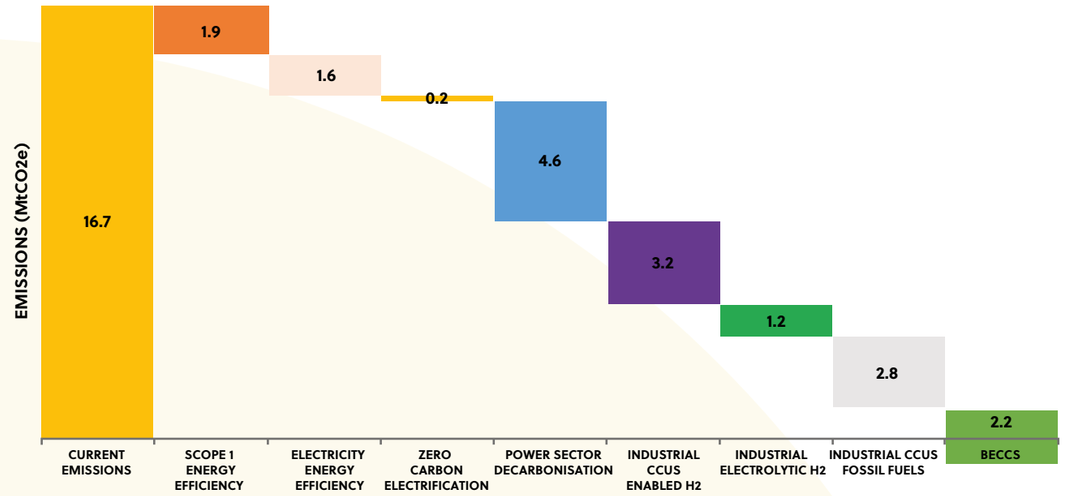

FIGURE 8: Higher Hydrogen Scenario.

LOWER HYDROGEN SCENARIO

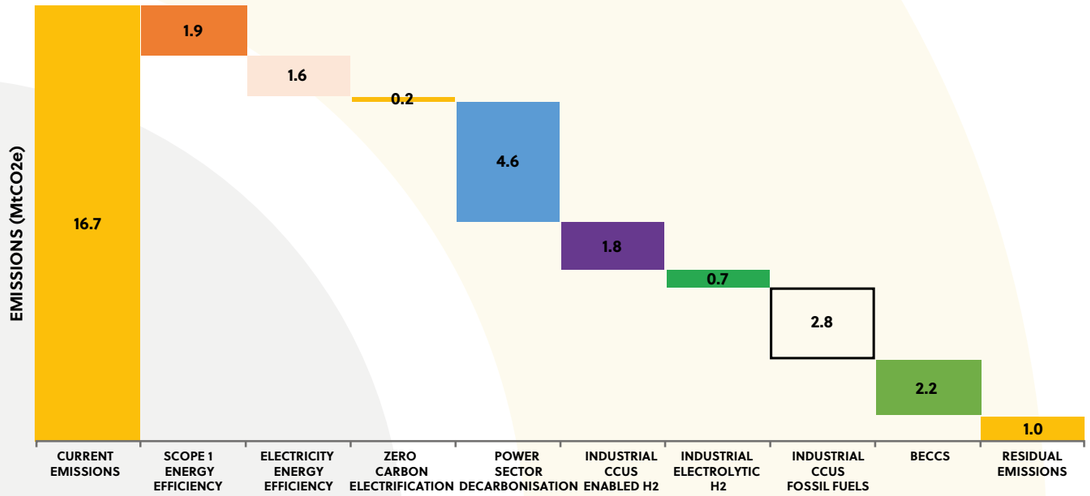

Figure 9 Lower Hydrogen Scenario.

7. PARTNERS

FUNDING

Launched in April 2018, UKRI is a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS).

It brings together the seven disciplinary research councils, Research England, which is responsible for supporting research and knowledge exchange at higher education institutions in England, and the UK's innovation agency, Innovate UK.

CONSORTIUM PARTNERS – MANAGEMENT & ENGAGEMENT

NET ZERO NORTH WEST

Net Zero North West is an industry-led cluster acting as a public and private sector investment accelerator for industrial decarbonisation and clean growth projects in the North West. We unite business, regional leaders and academia, and are committed to delivering a co-ordinated net zero vision for the region.

PEEL NRE

Peel NRE, part of Peel L&P, is at the heart of the nation's activity around clean growth and the circular economy – helping the UK achieve net zero by 2050 and supporting regions in their actions to achieve climate emergency targets. We reuse, repurpose and re-energise natural resources to develop and maintain vital infrastructure across the UK and are experts in renewable energies, district heating, waste to value, water management, materials management and electric vehicle charging. Our Protos Cheshire energy and resource hub leads the way in low carbon energy and waste management.

NORTH WEST BUSINESS LEADERSHIP TEAM

Brings together leaders of national and international businesses with substantial commitments and interests in the North West of England.

CHESHIRE AND WARRINGTON LEP

The Local Enterprise Partnership leads the growth of the Cheshire and Warrington economy through a powerful partnership between the private, public, and voluntary sectors. Its ambition is to make Cheshire and Warrington the UK's healthiest, most sustainable, inclusive and growing economy, working in collaboration with local government, businesses, educational institutes and other public, private and community sector organisations.

UNIVERSITY OF CHESTER

A home to academic researchers at Thornton Science Park who have been closely involved with past work on industrial decarbonisation and development of a hydrogen economy. The team is experienced in academic research.

LIVERPOOL CITY REGION LOCAL ENTERPRISE PARTNERSHIP

A delivery body branded as Growth Platform hosts the Local Energy North West Hub. The Liverpool City Region Growth Company is a partner organisation of the LCR Combined Authority and LCR Local Enterprise Partnership.

CONSORTIUM PARTNERS – RESEARCH

EQUANS

EQUANS is the world leader in multi-technical services aiming to combine its competence to serve the 3 major transitions which are key for the next decades: Energy, Digital and Industry Transition. We are rooted in exceptional history, gifted with unique competences and talents including specialist energy related capabilities: smart buildings, green mobility, district & embedded energy and decentralised renewables.

UNIPER

Uniper is an international energy company with around 12,000 employees in more than 40 countries. The company plans to make its power generation CO_2 -neutral in Europe by 2035. As a pioneer in the field of hydrogen, Uniper has set itself the target of operating worldwide along the entire value chain in the future and implementing projects that will make hydrogen the mainstay of the future energy supply.

PROGRESSIVE ENERGY LTD

An independent UK clean energy company focusing on project development. Progressive is a co-founder of the HyNet North West project and also a joint owner of Vertex Hydrogen, which will supply low carbon hydrogen to customers using the HyNet hydrogen network.

CADENT

Gas distribution network Cadent distributes gas to over 11million customers across our 4 networks. Committed to positioning our network as central to reach net zero.

SP ENERGY NETWORKS

SP Energy Networks own and operate the electricity transmission and distribution network in the south of Scotland and the distribution network in Cheshire, Merseyside and North Wales.

NET ZERO NORTH WEST

For further information visit: **www.netzeronw.co.uk**

Or email us at: **info@netzeronw.co.uk**