NET ZERO NORTH WEST

SIEMENS

ECONOMIC INVESTMENT PROSPECTUS

Funded by

NET ZERO NORTH WEST

Greater Manchester Local Enterprise Partnership

Liverpool City Region Local Enterprise Partnership

Cheshire and Warrington 87 Local Enterprise Partnership

FOREWORD - JOIN US FOR THE NORTH WEST'S DECARBONISATION JOURNEY

Decarbonising the economy in the North West is critical to the success of the UK achieving its net zero target. We were the cradle of the first industrial revolution and must now be the powerhouse of the fourth digital and sustainable industrial revolution. The North West has the ingenuity, the skills and the passion to deliver on this vital transformation at the scale and speed needed to succeed. This is not a technology challenge but a policy one and it's time now for Government, National and local, to make good on their policies to lead on decarbonisation.

Carl Ennis, Chairman, Net Zero North West and CEO, Siemens GB & Ireland

If we get serious now about the climate crisis, it will also help us tackle the post-pandemic jobs crisis. There are tens of thousands of good green jobs just waiting to be created across the North West – in retrofitting our buildings, modernising our energy systems, and decarbonising our transport. Now is absolutely the time to make that happen. We are outlining our vision to achieve a net zero North West by at least 2040, 10 years ahead of the national target. Benchmarks like these not only give us something to aim at – they also demand meaningful commitments and urgent action. Together, we hope to build a movement to make the North West the country's leading force in the zero-carbon economy. We are all already working together and developing detailed energy and environment plans for our places which can meet our collective ambitions. We want to show the world that the North West of England is ready once again to lead an industrial revolution – this time a green one.

Andy Burnham, Mayor of Greater Manchester

Our region can lead the way via business-led collaborations such as Net Zero North West in developing new technologies and investible projects and exporting that expertise both nationally and internationally. This will provide key employment and skills opportunities in the wake of COVID-19, creating a sustainable and inclusive economic recovery by retaining and growing UK manufacturing.

We know that the climate crisis does not respect local boundaries, nor does business and economic opportunity. If we are to achieve our ambitions, we need to take a collaborative approach that builds on all the skills and expertise available to us, and the North West is a leading example of this type of collaboration beginning to deliver real change.

Steve Rotherham, Metro Mayor for Liverpool City Region

Securing an inclusive and sustainable economic recovery is at the heart of the long term vision for Cheshire and Warrington. Action, innovation and leadership by industry, supported by government and the wider public sector, is going to be key in decarbonising our economy and maximising the local benefits and wider economic opportunities of this. This region has a strong and proud track record of collaborative working and we intend to build on these powerful partnerships to ensure we are the catalyst for sustainable growth.

Clare Hayward MBE DL, Chair of the Cheshire and Warrington Local Enterprise Partnership

This prospectus sets out an exciting vision for the North West's role in delivering both net zero and economic growth by working with government, investors, public and third sector partners alongside our communities. The North West is uniquely placed to contribute to this agenda given our knowledge, expertise and global leading businesses. Cumbria LEP is committed to delivering this ambition by supporting new clean energy generation based on our nuclear, offshore and manufacturing expertise and by helping our existing businesses to rapidly decarbonise. Cumbria LEP and our partners very much look forward to delivering our collective North West ambition.

Lord Inglewood, Chair of the Cumbria Local Enterprise Partnership

This is an exciting time for the North West, and Lancashire in particular. Our energy and low carbon sector is diverse, with strengths in key industries which present a credible and compelling offer. However, when combined with our strong manufacturing and engineering heritage, our technological expertise and significant innovation asset base, as a county this translates into a formidable, unique low carbon ecosystem with huge potential and unrivalled capabilities to contribute to the Government's Net Zero and levelling-up ambitions. This means that Lancashire is uniquely well placed to not just drive decarbonisation at home but also to develop, manufacture and export low carbon technologies globally.

Sarah Kemp, Chief Executive of the Lancashire Local Enterprise Partnership

OUR CALL TO ACTION

This Economic Investment Prospectus has been developed to showcase the investment opportunities presented by the North West of England's drive to achieve net zero emissions by 2040 across the region's industries, communities and built-environment. The significant decarbonisation effort required cannot be overstated, but Net Zero North West shows this can be achieved by working to 3 objectives. These will grow our regional economies in a coordinated fashion - delivering a decarbonised industrial cluster with security in clean energy and hydrogen to build sustainable income streams and create jobs.

Delivering clean growth is at the heart of the UK Government's Industrial Strategy and 'Build Back Better: our plan for growth', which is why this Economic Investment Prospectus shows our first step is to secure value in the region by developing and integrating our industries to provide immediate, credible returns from capital and social investment in the North West.

The North West of England is ideally placed to lead, demonstrate, harness and share the benefits that will come from decarbonisation. We are situated in one of the most productive regions of the UK: we have a highly-skilled and diverse workforce; significant capacity for the continued expansion of renewable energy; the structures to deliver world-leading energy innovation; and are supported by a network of highly capable public, private, research and training sector partners keen to pursue bolder and more sophisticated decarbonisation developments.

This Prospectus showcases 18 investment cases across the North West to deliver real impact at the right price, whilst protecting our environment. The Net Zero North West partnership have brought together the stakeholders, challenges and opportunities from across the whole geography to develop the detailed case for economic investment. We present supporting exemplar projects that evidence the scalability required for the investments, and provide the platform to deliver the UK's first net zero region and industrial cluster by 2040.

The investment required, jobs secured / created, greenhouse gas emission reductions and the economic benefit to the North West are developed through analysis and expert insight, which are referenced in the report Annex. The investment numbers are extrapolated from the financial performance of the exemplar projects presented or from project feasibility reports in the UK. The number of jobs secured / created reflect an extrapolation from the exemplars and referenced publicly-available sources. Gross Value Add (GVA) is calculated from the number of jobs utilising UK Government statistics for current GVA performance of the region.

As next steps, Net Zero North West will endorse and commend this Economic Investment Prospectus to the UK Government and Investors to attract the necessary resources and input to our region, which we will then support. We will also widely publicise and propagate this document across the UK and Internationally to stimulate interest and investment from both our public sector colleagues and also large-scale private-sector finance, which might include pension funds, infrastructure investors and international finance institutions.

A final key activity will be to work with all investors, as well as our public, private, research and training sector partners to realise the shared objectives presented within this document to achieve our decarbonisation targets. This will secure our future, extend our competitiveness as a region and help to level up our economy, with our industrial cluster as the cornerstone.

Acknowledgement

We would like to thank Siemens plc for assisting us in producing this Economic Investment Prospectus. Headquartered in Manchester, they have brought an innovative perspective to the work that will benefit all regional stakeholders in the years to come. Employing more than 8,700 people in the UK and Ireland, Siemens has repeatedly worked at the heart of innovative collaborations such as these, underpinned with environmental aims.

EXECUTIVE SUMMARY - THE BIG NUMBERS

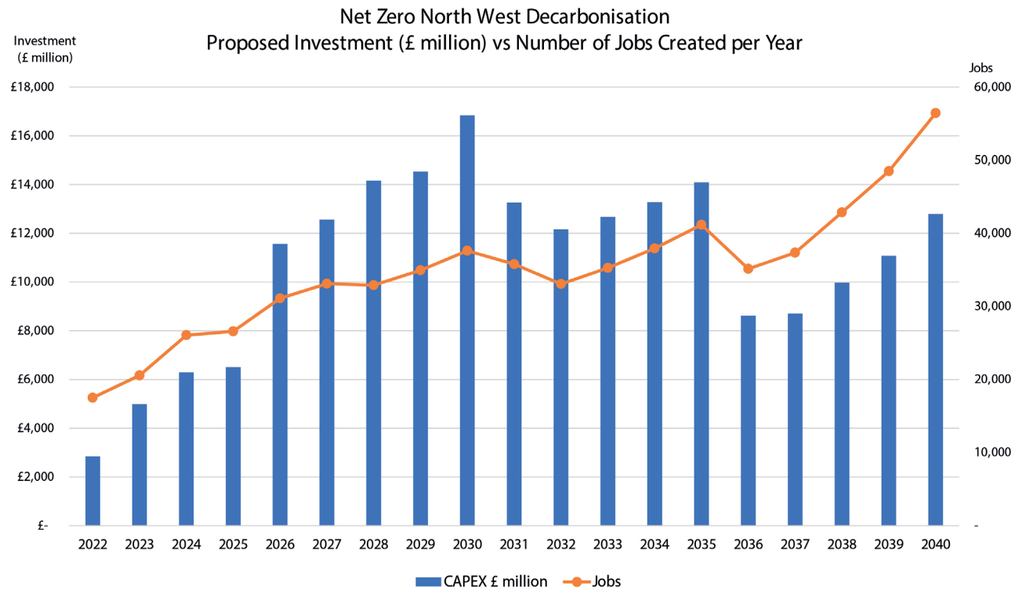
The North West of England is the pre-eminent region for sustainable investment because together we will deliver and achieve:

38.5 $MtCO_2e$ emissions reduction to meet the North West's decarbonisation net zero goal by 2040...

through £206.9 billion of planned spending...

which will help develop a total workforce with over 660,000 secured or created jobs (with a half-million in our industrial cluster)...

and grow our economy by £285 billion GVA to become self-reliant and protect our combined commitments to a clean economy.



This Economic Investment Prospectus demonstrates 18 key investment opportunities with exemplar projects that:

1. have already been successfully delivered so investors can have assurance of proven returns from extension and scale-up across the North West; or
2. are "shovel ready" for deployment, providing confidence to investors that the investment is secure and will make returns in the short-term; or
3. require more engaged investment with an eye to sustainable development and the long-term picture.

Investment in the North West of England will be secure because:

- capital protection is enhanced via our integration of activities with the public sector to underpin industrial growth, to provide exceptional performance which will bring greater returns than the sum of the parts;
- this Investment Prospectus shows a diverse range of opportunities that together pump-prime transformation in the region while ameliorating risk in future sustainable investments; and
- the circular, self-sustaining economy will secure value in the region and returns for investors, rather than the old linear model where end-of-life destroys value.

Working with the North West of England provides greater returns through:

- Larger ambition for sustainable transformation that is proven, coordinated and scaled-up across the region;
- Demonstrable success in securing inward investment and developing innovative financing models; and
- A combined, holistic view of development and investments that includes embedding skills, training provision and social benefits.

The Net Zero North West partnership and key regional stakeholders will unlock and de-risk multiple subsequent projects at scale-up, exhibiting clear investibility and replicability. This comes from a multitude of existing regional capabilities including:

- a world-beating industrial cluster, balancing tradition and innovation, delivering £239 billion GVA from an £180.8 billion inward investment that creates or secures 538,810 jobs;
- extensive renewables and nuclear capabilities;
- a committed public sector working closely with our communities and commercial entities;
- first-mover advantage in building out the region's key industrial strengths into innovative business models for clean energy and hydrogen, as evidenced by the HyNet project; and
- continuous drive to grow the skills and economy to serve society with clean and sustainable solutions.

Please join us to help meet our three objectives for transitioning our region through the 18 investment cases presented in this Prospectus. These will provide the large-scale critical mass required to successfully transition the North West as the UK's first decarbonised region and industrial cluster by 2040.

EMISSIONS REDUCTION
38.5 $MtCO_2e$

INWARD INVESTMENT
£206.9 BILLION

660,000 JOBS SECURED OR CREATED

GROW OUR ECONOMY WITH £285 BILLION GVA

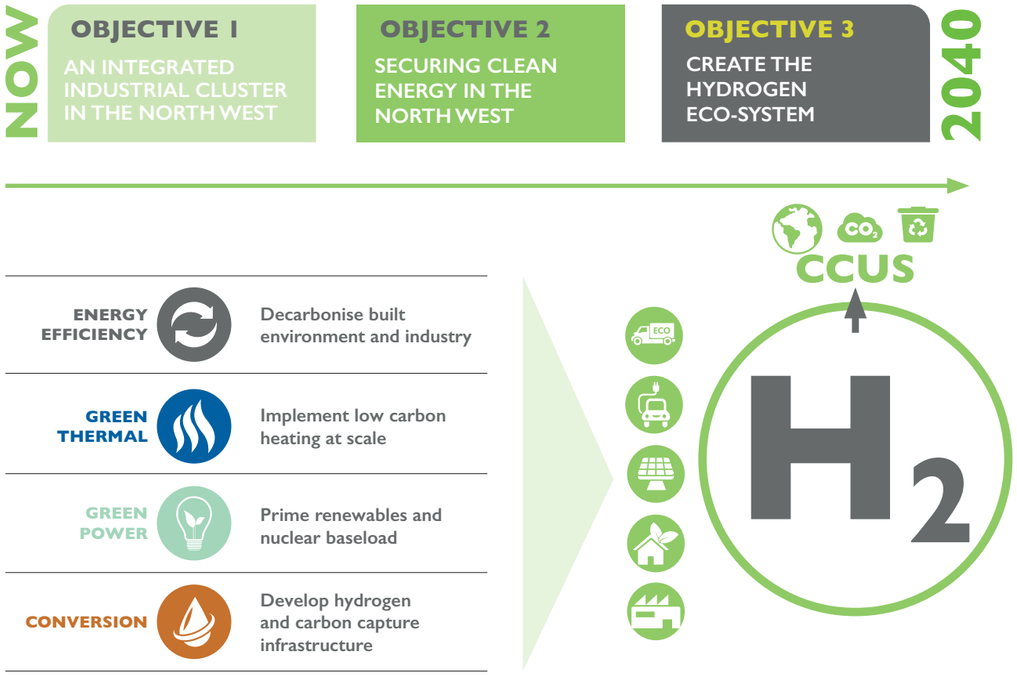
WHY INVEST IN DECARBONISING THE NORTH WEST?

The North West of England produces approximately thirty-eight mega-tonnes of carbon dioxide (38.5 $MtCO_2e$), the same as the Republic of Ireland. With a £185 billion GVA, we are economically the largest region outside of the South East of England, yet we produce over 20% more industrial emissions. This reflects our region's highly positive economic contribution to the UK, which comes with a high environmental cost. Net Zero North West shows how we will decarbonise by 2040 through growing our regional economies in a coordinated fashion - delivering a decarbonised industrial cluster underpinned by energy security and a regional hydrogen economy that has sustainable income streams and an engaged workforce.

NORTH WEST: LOCAL ENTERPRISE PARTNERSHIP REGIONS

The UK Government in June 2019 enshrined a commitment to net zero emissions by 2050 into law, and in April 2021 the obligation to be at 78% reduction by 2035. These ground-breaking actions make Britain the first major economy to legislate an end-date for the nation's contribution to global warming, a world-leading position as from COP 26 in Glasgow. Considering this national backdrop, the Net Zero North West partnership and key regional stakeholders are working extensively to build our economy sustainably. In order to tackle climate change, this Investment Prospectus details the actions we will take to shoulder our commitments, and the investment required to succeed.

OUR APPROACH TO DECARBONISATION



This Economic Investment Prospectus is seeking investment combined with regional and national government action to build a world-leading, self-sustaining coordinated decarbonised industrial cluster for the North West built upon:

- a highly skilled, motivated workforce;
- a responsive and delivery-focused public sector; and
- enabled by an innovative transport infrastructure and multi-vector energy system upon which our industry can drive forward regional economic growth.

As a broad partnership and stakeholder organisation, Net Zero North West is working to a target of full (net zero) decarbonisation for the region by 2040.

This will be achieved through the delivery of 3 key objectives:

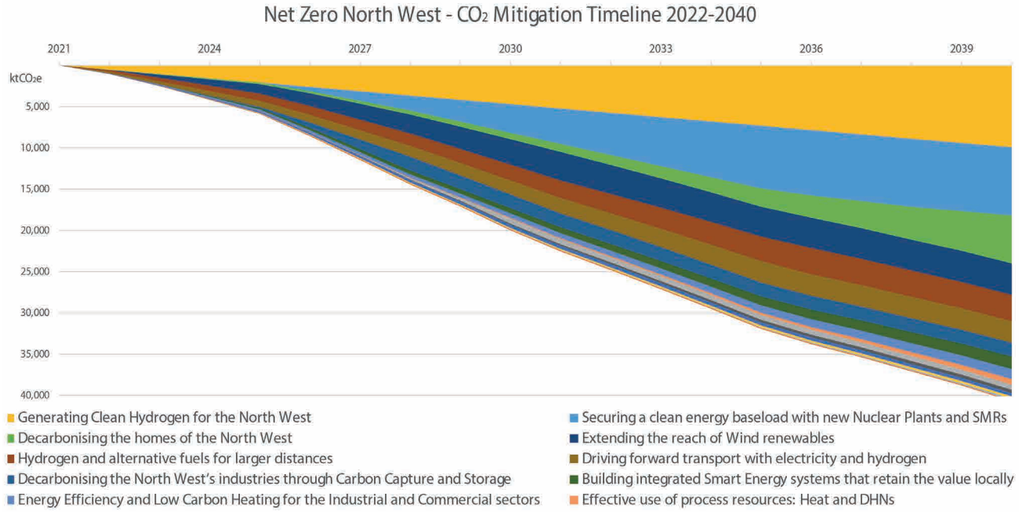
- #1 - delivery of a fully-integrated decarbonised industrial cluster driving a sustainable economy;
- #2 - securing clean energy as a platform for all decarbonisation activities across the North West;
- #3 - creating the eco-system and market for hydrogen as the fundamental change to the society and communities of the region.

The development of a hydrogen infrastructure and market in the North West and our neighbours in North Wales, through the HyNet project, is a vitally important keystone in the decarbonisation of both our region and the country. This is because hydrogen is a clean alternative to gas for our vehicles, heating, industry and energy supply, and it can be utilised in a lot of our existing gas infrastructure. By accelerating our region towards low carbon electricity and green hydrogen supply from renewable sources, it will transform our society as a driver of economic change.

This will particularly be seen in the job market, with Green New Deal UK suggesting this could lead to a net gain in the nation's jobs of almost 240,000 over two years, creating over 1.2 million green jobs, and more than 2.7 million jobs over ten years .

The area's response to climate change is so far a positive one: the North West has achieved significant reductions in energy-related greenhouse gas emissions over the last fifteen years, tracking the national trajectory with a reduction in our emissions by 36 percent. However, despite this success, achieving our 2040 target of net zero will not be easy as much of the 'low hanging fruit' has already been picked. The cluster of industries, public bodies, communities and businesses in the North West will have to implement major interventions to our energy ecosystem over the coming years to stay on course.

It is therefore essential to consider the carbon emissions in terms of a fundamental change to our electrical, heat and transport requirements, powering a modal shift to establish and secure an integrated industrial cluster, clean energy environment and fundamentally powering towards the Hydrogen Economy. To this end, we are offering 18 investment cases for the whole North West region that will secure our position as the powerhouse of the fourth digital and sustainable industrial revolution based on low carbon technologies, addressing our carbon emission gap as shown:



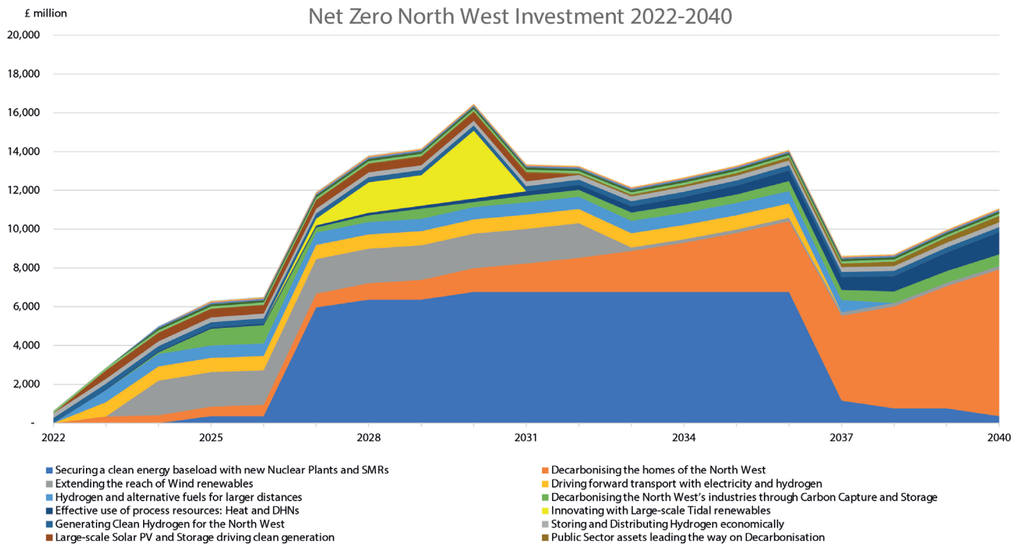
To meet net zero by 2040 requires an investment level of £206.9 billion, to create a newly skilled workforce of 663,890 within the region, with an annual average requirement of over 34,940 workers from 2022 to 2040 providing societal benefit of £285 billion GVA.

This will be a major lever to the levelling-up agenda, attracting significant commercial activities to the region and growing and securing new low carbon industries which will then be able to extend their reach globally from a strong base.

How to invest in the North West

The eighteen investment opportunities presented offer secure value and returns for investment, based on existing exemplar projects. We demonstrate how to unlock and de-risk multiple subsequent projects as scale-up for investibility and replicability. The investments will build a critical mass of revenues, skills and experience that will enable the North West to become the UK's first decarbonised cluster, and deliver quantified economic benefits to the region.

The investments are collated from key stakeholders in the North West and North East Wales over a series of workshops and interviews to ensure the region is fully and holistically covered. The focus is to deliver returns and real impact by delivering a decarbonised industrial cluster, underpinned with security in clean energy and hydrogen to build sustainable income streams and create or secure jobs. A summary of the investments is presented over the page.



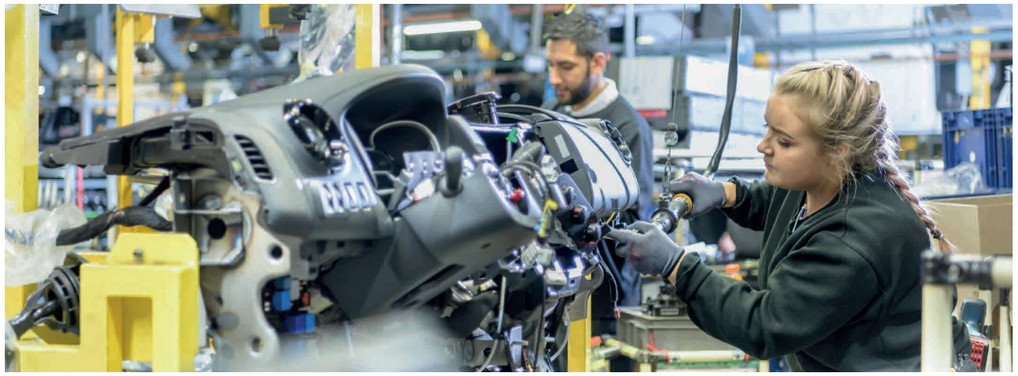
Investment	CAPEX £ million	Jobs secured / created	Carbon saved in $ktCO_2e$
1 - Decarbonising the North West's industries through Carbon Capture and Storage	£8,621	1,450	3,880
2 - Energy Efficiency and Low Carbon Heating for the Industrial and Commercial sectors	£1,433	19,270	2,836
3 - Developing the Supply Chain with Process Efficiency and Consulting	£60	10,000	250
4 - Building integrated Smart Energy systems that retain the value locally	£835	78,569	3,437
5 - Priming green industry and workforce: Low Carbon Academies and Clean Energy Manufacturing	£2,218	2,310	-
6 - Decarbonising the homes of the North West	£52,738	204,550	13,327
7 - Public Sector assets leading the way on Decarbonisation	£2,284	26,119	396
8 - Effective use of process resources: Heat and DHNs	£7,995	53,300	1,526
9 - Taking heat from the ground beneath our feet	£1,980	16,500	702
10 - Community renewable energy schemes	£510	1,250	149
11 - Innovating with Large-scale Tidal renewables	£7,000	5,000	1,415
12 - Securing a clean energy baseload with new Nuclear Plants and SMRs	£70,172	64,000	18,864
13 - Extending the reach of Wind renewables	£17,612	50,549	8,735
14 - Large-scale Solar PV and Storage driving clean generation	£3,873	7,747	902
15 - Generating Clean Hydrogen for the North West	£5,000	5,177	22,716
16 - Driving forward transport with electricity and hydrogen	£10,325	82,031	5,934
17 - Hydrogen and alternative fuels for larger distances	£9,562	21,344	7,234
18 - Storing and Distributing Hydrogen economically	£4,724	14,724	-

OBJECTIVE 1

DELIVERING AN INTEGRATED INDUSTRIAL CLUSTER IN THE NORTH WEST

Objective 1: DELIVERING AN INTEGRATED INDUSTRIAL CLUSTER IN THE NORTH WEST

Within the North West, there is a wide diversity of industries including petrochemicals and alternative fuels production; chemical manufacture and storage; glass manufacture; pharmaceuticals; and food processing and manufacture. As one of just six energy-intensive industrial clusters in the UK, we make an important contribution to the country's economy. But this comes at a regional cost of 14 $MTCO_2e$, more than any individual cluster; our Ellesmere Port complex alone consuming some 5% of the UK's energy makes this a key national priority.



The North West's industrial cluster will deliver:

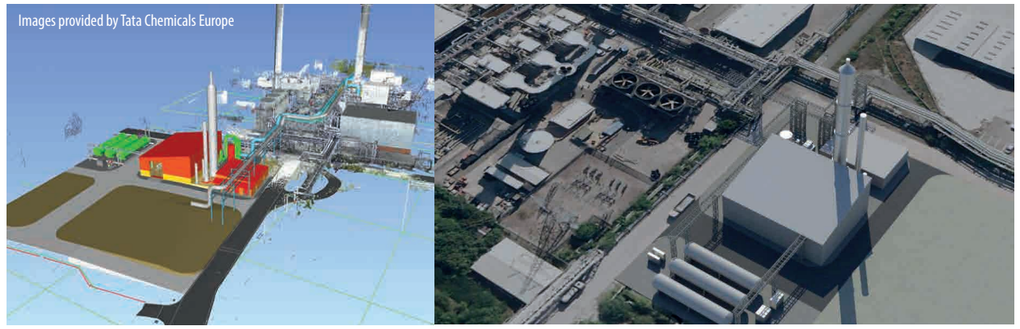
- **£239 billion GVA from £180.8 billion of inward investment**
- **based on creating and securing an industrial workforce of 538,810 within the region**

Over a century ago, economist Arthur Marshall devised the concept of the "industrial district" to explain how bringing jobs and businesses together in specific locations can help improve the productivity of work. The advantages he foresaw are manifest in the North West's industries working in close proximity, such as an ability to attract and retain talented people, integration of processes, building more efficient supply chains, and utilising by-products or waste materials between organisations. Thus, our peak economic output is greater than that of core cities such as Birmingham, Leeds and Sheffield, with productivity records of output per head of around 118% and £3,100 more than the UK average.

With investment, our clustering in the North West presents an enormous opportunity to conduct Research and Development (R&D) on new technologies such as Hydrogen, Carbon Capture Utilisation and Storage, and heat networks. Underpinned by a secure, clean energy supply, our region's unique characteristics enable us to deliver economic decarbonisation, and lead the World in exports of services and skills, to assist others to do so as well.

The delivery of the Net Zero North West three objectives will position our industrial cluster to capitalise on the nation's growth plans. The UK's strategic trading, manufacturing and regional narratives are changing under the actioning of the Industrial Strategy and the Industrial Decarbonisation and Energy Efficiency Action Plans to 2050. There is a firm focus by central government in regional industrial and decarbonisation opportunities for a renewed strategic engagement leading to growth and increased wealth for the nation.

We are uniquely placed to become an exemplar of a leading hydrogen-powered, integrated low carbon manufacturing region. Our North West universities lead in the stimulation of low carbon technological innovation and we have the regional advanced manufacturing capability to drive the development of UK green technologies from conception to commercialisation, providing the ecosystem to accelerate the manufacturing of developing innovations and reap the benefits of an escalating global net zero export market.



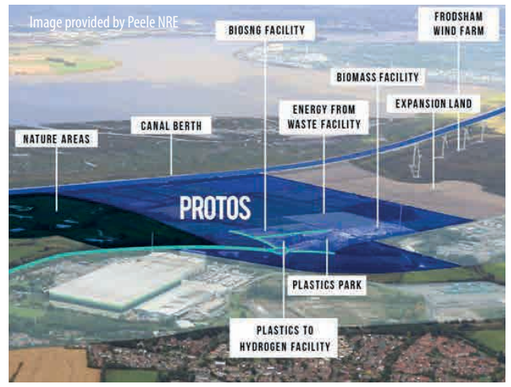
Investment 1 Decarbonising the North West's industries through Carbon Capture and Storage

The UK Climate Change Commission (CCC), along with many other organisations, has identified the vital importance of Carbon Capture and Storage (CCS) as well as Utilisation (CCUS) for climate mitigation. Analysis by the UK Government of net-zero future scenarios shows that a minimum of 75 to 175 megatonnes of CO_2 is required to be captured and stored. Our region's heavy industry processes such as petrochemicals, chemical and glass manufacture emit large quantities of CO_2 and therefore the application of CCS technologies is important to deeply decarbonise these energy intensive industries. The Government has invested over £130 million in the last ten years for Research and Development, and innovation support to develop CCUS in the UK. In 2018 the CCUS Innovation Programme provided £24 million towards CCUS feasibility studies, industrial research, experimental development projects and infrastructure projects.

The North West can today demonstrate a range of potential CCUS technologies. These range from advanced mechanical scrubbing, chemical absorber solutions to biological "living" filtering systems. These will be extended across our diverse industrial cluster, as well as exporting of the systems, services and skills to develop carbon capture for others as well.

Exemplar: CCS - Tata Chemicals Europe

The Tata Chemicals Europe (TCE) plant at Winnington, Cheshire is the first large-scale carbon capture project of its kind in the UK. The TCE plant represents a world first in capturing and purifying carbon dioxide from its 96 MWe gas-fired combined heat and power (CHP) generation plant. The emissions are used as a key raw material in the manufacture of high purity sodium bicarbonate. Fully operational from summer 2021, this saves an estimated 40,000 tCO_2e pa. It cost £18 million to develop and was supported to the tune of 25% by BEIS.



Exemplar: Protos Negative Emissions Technologies and Alternative Fuels

Protos is an energy and resource hub located near Ellesmere Port over 134 acres of land. Developed by Peel NRE, Protos could unlock over 3,000 new jobs and £700 million levered investment in the local area in projects such as:

- A 26 MW operational biomass facility capable of powering 40,000 homes
- A 49 MW energy from waste facility currently in construction
- A First-Of-A-Kind hydrogen from plastics facility providing 2 tonnes of clean fuel for HGVs and buses daily, whilst eliminating end-of-life plastics from our ecosystem.
- A Bio-Substitute Natural Gas plant (BioSNG) to supply low-carbon gas for up-to 1000 low carbon HGVs and buses each year.
- A carbon transport infrastructure project, connecting CO_2 emitting facilities at Protos to the HyNet CO_2 regional network.

Collectively the projects under Protos enable the abatement of over 8.6 million tonnes of CO_2 by 2050, with potential for an additional 10 million tonnes of CO_2 by 2050 if expansion plans are fully realised (Scope 1 emissions only). These savings are the equivalent of removing emissions from the entire industrial sector of Cheshire West and Chester for over 5 years (using 2019 levels).

Negative Emissions Technologies result in the net removal of CO_2 from the atmosphere, predominantly by using Bioenergy with Carbon Capture and Storage (BECCS) which combines biomass power generation, waste-based industrial processes and carbon sequestration. Hydrogen and BioSNG technologies on the other hand provide clean or low-carbon fuel for transport markets to displace diesel or petrol use.

Scale-up Opportunity for the North West

Project Approach	Delivering 100 CCUS systems in the North West from 2025, across power generation, hydrogen production and industry.
Investment Required	£8,621 million
Investor Profile	• UK Government / Local Government grant funding scheme and Enterprise Zoning • Public / Private partnership to provide carbon and hydrogen offtaker markets • Private investment backing the project developers • Small- or Medium-Enterprises (SMEs) and large businesses as supply chain extension / diversification to deliver the technology • R&D investment to drive savings for the technologies
Carbon Saved	3,880 $ktCO_2e$ pa
Secured / Created Jobs	1,450
Next Step	UK Government apportionment of funding to be accelerated and shared between CCS / CCUS projects

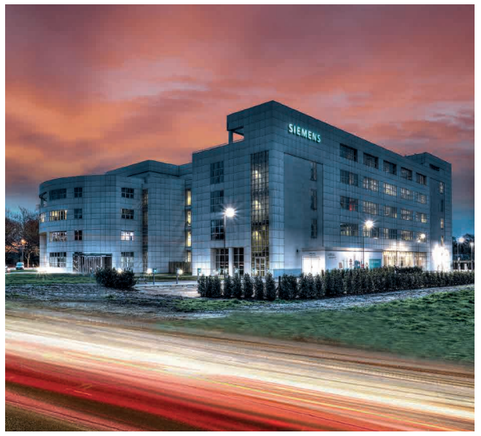
Other North West Initiatives:

- Holmen Iggesund biomass scheme in Workington (www.iggesund.com/sustainability/raw-material/fossil-free-energy)

Image provided by Holmen Iggesund

Investment 2 Energy Efficiency and Low Carbon Heating for the Industrial and Commercial sectors

Decarbonisation of the North West's Industrial and Commercial sector will require the reduction and management of 14 $MtCO_2e$ emissions per annum. A number of key organisations have already committed to and are undertaking appropriate measures; this includes Siemens, who have pledged to be net zero in their International operations by 2030. For the Siemens plc headquarters in Manchester, this means a reduction of 596 tCO_2e in part achieved through energy saving measures which reduce the site's utility bills by over £113k every year; these cost reductions have been ploughed into further decarbonisation measures creating a virtuous circle. Payback by three of the measures being undertaken is under 4 years, and will reduce emissions by 24% alone.



Scale-up Opportunity for the North West

Project Approach	Over 100,000 commercial and industrial buildings of the North West will be addressed to achieve a reduction in demand of 26% by applying ISO 50001 as follows: 1. Energy efficiency retrofit 2. Installation of or replacement with Low Carbon Heating
Investment Required	£1,433 million
Payback Period	2 – 10 years per installation
Investor Profile	• UK Government / Local Government grant funding scheme implemented • Public / Private partnership with public funds mechanism e.g. Green Deal • SME and Large-Business extension / diversification to deliver the scale-up, including 'Benefits Sharing' or even 'Energy / Decarbonisation as-a-Service' models • Entity will procure the interventions
Carbon Saved	2,836 $ktCO_2e$ pa
Secured / Created Jobs	19,270
Next Step	Leadership on firm sectoral targets and support for new technologies

Investment 3 Developing the Supply Chain with Process Efficiency and Consulting

The North West small- and medium enterprises (SMEs) and "ESOS" Certified business community will need to move to a decarbonised state by 2040. This requires a modal shift in terms of their efficiency of processes and commercial activities. Change will be facilitated by the application of improved, sustainable technology measures. This can be achieved by focusing effort and people resource on 'Value Added' activities. In particular there are two approaches:

- businesses who wish to implement energy efficiency measures as hardware or operational services to show an energy reduction and measurable carbon emission reduction, and;
- businesses who are in the Low Carbon / Environmental supply chain who wish to develop a specific product or service that achieves energy efficiency gains and carbon reductions.

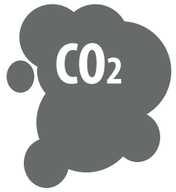
Exemplar: ENWORKS program

ENWORKS was set up in 2001 as the direct result of research by the Environment Agency into the provision of environmental support to businesses across North West England. A cross-sector, independent partnership of business leaders, influencers and policy-makers was formed, to define a new approach to delivering environmental business support in the North West.

ENWORKS has become an internationally recognised, award-winning and leading authority on environmental business issues, helping thousands of businesses to make the transition to a low-carbon economy. ENWORKS has helped businesses to convert environmental pressures into competitive advantages by improving their resource efficiency and, in doing so, saving millions of pounds each year. This is achieved through a combination of practical advice, awareness-raising activities, tailored on-site support, plus training, all focused on creating cultural change throughout the entire business workforce.

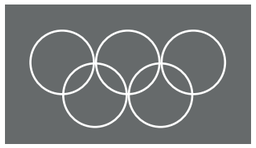
The Enworks program has achieved:

£316 million
Cost savings achieved in business by ignoring environmental performance



1.3 million
Tonnes of carbon dioxide equivalent CO_2 saved - like driving a Hummer from Manchester to the moon nearly 8,000 times

30.6 million
Tonnes of solid, liquid and gaseous materials saved - enough to build nealry 12,000 Blackpool Towers



14.9 million
Cubic metres of water saved - enough to fill over 5,91 Olympic sized swimming pools

8,314
Jobs created or safeguarded

£371 million
Sales increased or safeguarded

1.1 million
Tonnes of waste diverted from landfill - the weight of over 5,846 Blue Whales

13,594
Businesses advised, including over 5,500 assisted with intensive resource efficiency support; 3,716 individuals have been helped with environmental training and skills development

ENWORKS is part of the GC Business Growth Hub (www.green-growth.org.uk), which has helped thousands of businesses across Greater Manchester to grow, develop and reach their full potential. The current programme of support is part-funded by the European Regional Development Fund (ERDF).

CHAMBER LOW CARBON
HELPING BUSINESSES GO GREEN

European Union
European Regional Development Fund

Exemplar: Chamber Low Carbon, Lancashire

Chamber Low Carbon (CLC) is a £7 million program running over 6 years, across the whole of Lancashire and part funded by the European Regional Development Funding. The scope of CLC's activities is to work across Lancashire with 1275 SMEs to help them reduce their CO_2 emissions and plan their path to net zero, including providing a Lancashire low carbon grant. CLC is currently working with 150 firms through in-depth consultancy support for those developing new low carbon technologies to help with viability assessment of their technologies, identify market opportunities, customers, research & development partners and commercialisation funding streams and prepare them for RedCAT support (see Investment 5).

Scale-up Opportunity for the North West

Project Approach	Driving sustainable innovation with 5,000 North West businesses by: • expert consultancy to find efficiency savings in process • refocusing businesses for Clean Energy and Hydrogen Typically aiming to achieve 50 tCO_2e per business, this will build supply chain transition to meet the Net Zero North West objectives
Investment Required	£60 million
Payback Period	2 – 10 years per installation
Investor Profile	• UK Government / Local Government grant funding scheme implemented • Public / Private partnership with public funds mechanism such as the LEP support programme • SME and Large-Business extension / diversification to deliver the scale-up, including 'Benefits Sharing' or even 'Energy / Decarbonisation as-a-Service' models • Entity will procure the interventions
Carbon Saved	250 $ktCO_2e$ pa
Secured / Created Jobs	10,000
Next Step	Establish new Public-Private Partnership funding scheme for SMEs

Investment 4 Building integrated Smart Energy systems that retain the value locally

Cheshire energy hub

The North West industrial cluster needs smart, flexible energy infrastructure as a key component in the decarbonisation of our industries. These use multiple energy vectors that include power, heat, cooling, hydrogen and transport. By unlocking these from their one-dimensional silos to be shared and to interact between multiple parties will enable significantly greater coordination and integration that could achieve a self-sustaining decarbonised cluster for the North West. This can be achieved through the deployment of intelligent systems to unlock and integrate disparate technologies through digitalisation. The capability to measure, control and coordinate across different vectors will be fundamental to unlocking the business cases that will scale-up to meet the decarbonisation trajectories required in the North West region.

The benefits for our cluster of industries, communities and businesses integrated into such local, independent, multi-vector networks could make an important contribution to maintaining energy supply security in the future. In the face of Climate Change, this will help us to fill demand gaps created by storms, flooding or blackouts.

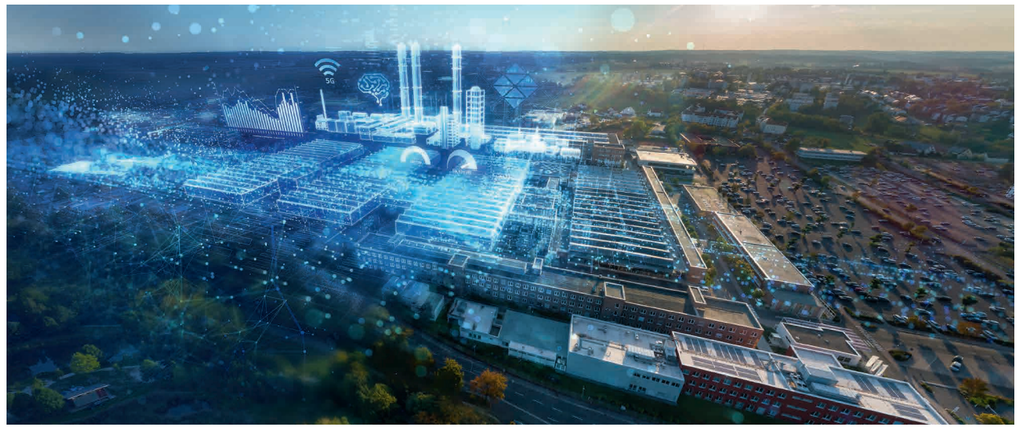
Exemplar: Invest Net Zero Cheshire

This project was awarded £700k of government funding to define a local low-carbon smart energy system for the Energy Innovation District – an area surrounding the industrial heartland of Ellesmere Port in Cheshire – which could deliver cheaper and cleaner energy for power, heating and transport. The project will set out a 10-year roadmap for a cost-effective transition to net-zero, creating a model that could be applied nationally and exported internationally. The Industrial cluster consumes around 5% of the UK's energy and the region is the fourth largest CO_2 emitter in the UK, hence significant effort and investment is required to decarbonise and reach net-zero emissions. The only way to do this is to consider this system holistically and build out an industry-led joined-up approach. This will unlock a supply of secure, low-carbon and low-cost energy to build supply chain and global investment opportunities. Specific issues that will be addressed include:

- The provision of an electrical micro-grid that connects electricity generating assets directly to large industrial users to provide secure, low carbon and lower cost electricity;
- Developing heat networks to support local communities and business;
- Promote hydrogen, along with carbon capture and storage, as a means of decarbonising the gas network;
- Providing a network of charging and hydrogen refuelling stations to encourage the uptake of electric vehicles (EVs);
- Utilising a hierarchical, decentralised control system with a layer of individual local controllers in smaller geographical areas with the ability to talk with neighbouring local area controllers; this provides greater control of the assets in manageable portions;
- A novel Market Platform to facilitate energy trading within the Energy Innovation District area and out of the area by balancing energy supply and demand operated by the trading platform operator. This would encourage participation of low carbon energy resources into the market and maximise local energy asset use for the benefit of the local community and industrial users; and
- To stimulate the deployment of innovative energy technology and to develop a skilled workforce through work with the University of Chester, local colleges and the Cheshire Energy Hub Graduate Programme.

Invest Net Zero Cheshire statistics

Carbon Saved	350 $ktCO_2e$ by 2030 through avoided electricity grid emissions
Secured / Created Jobs	8,000
CAPEX / Investment	£85 million
Payback Period	15 years



Scale-up Opportunity for the North West

Project Approach	Delivering 50 Smart Microgrids across the North West to integrate multiple energy vector sources of generation, storage and demand
Investment Required	£835 million
Payback Period	15 years
Investor Profile	• UK / Local Government grant funding scheme, Enterprise Zoning and Regulatory change for carbon / energy trading • Public / Private partnership to provide appropriate market elements • Private investment backing the project developers • SMEs and large businesses as supply chain extension / diversification to deliver the technology • R&D investment to drive savings for the technologies
Carbon Saved	3,437 $ktCO_2e$ pa
Secured / Created Jobs	78,569
Next Step	Completion of funding for large-scale demonstrator that can stimulate the necessary Market and Regulatory changes

Other North West Initiatives:

- MRC Low Carbon Demonstrator (www.amrc.co.uk/facilities/amrc-north-west)

Investment 5 Priming green industry and workforce: Low Carbon Academies and Clean Energy Manufacturing

This Economic Investment Prospectus offers a significant number of large-scale projects, for which the North West's industries, businesses and supply chain will require over 34,900 workers every year from 2022 - 2040. This bulk amount of upskilling and training will directly support and facilitate the diversification of the existing workforce into the solar PV, hybrid boiler, DHN and retrofit programmes, which are also aimed at the Domestic and Commercial built environment. Such a skills demand will be met from a region-wide coordinated syllabus college system labelled as the 'Low Carbon Academy'.

The 'Low Carbon Academy' mission will be to address the competence and personnel gaps in the North West by offering hands-on training and facilitating collaboration and sharing of best practice. The 'Low Carbon Academy' could be setup as a fully independent organisation based on a collaborative model involving partnerships with local colleges, universities, public institutions, energy operators, investors, and the wider supply chain.

In parallel, there will need to be a significant increase in the capacity of the North West's manufacturing sector to provide clean energy products and services. Support will be required to ramp-up activity to meet the new demand, with a further key potential being the insourcing of industrial activity to the region to streamline the green supply chain.

Exemplar: Lancashire's Low Carbon Skills Academy and Manufacturing Supply Chain / Cluster Accelerator

The Low Carbon Skills Academy is being developed as part of a wider program of low carbon technology business & skills support by a consortium led by East Lancashire Chamber of Commerce (CoC). This includes Councils in the Priority 1 areas of Pendle, Rossendale, Burnley, as well as Blackburn with Darwen, Nelson & Colne College Group, Blackburn College and Burnley College. It is supported by and integrated with significant employers including the Advanced Manufacturing Research Centre (AMRC) North West, Electricity North West, the Environment Agency, the LEP and charity NCN. Focusing on progressing Lancashire's position as a major centre for the design innovation and manufacture of low carbon technologies, this will upskill our local workforce to be able to innovate, develop, build, install and utilise such products and services.

Completing the low carbon technology development ecosystem of support is the Manufacturing Supply Chain / Cluster Accelerator, again developed with a wide range of public, educational and private / industry partners. This is built out on a hub-and-spoke model and will enable the building of full scale test beds for the manufacturing supply chains of new low carbon and decarbonisation technology innovations. These will optimise industrial production before rolling out into the component manufacturers and co-located local manufacturing centres.

Exemplar: RedCAT, the Lancashire Centre for Alternative Technologies

Pump-primed by £1.5 million investment from UK Government's Getting Building Fund, RedCAT is an initiative developed and led by East Lancashire CoC. It was conceived in December 2019 in partnership with regional and national bodies such as AMRC NW, the Environment Agency and innovation leaders in the low carbon field. RedCAT provides a pathway of financial and R&D support to accelerate the commercialisation of low carbon technologies.

Scale-up Opportunity for the North West

There are some 77 Colleges and Universities across the North West who can be part of a 'Low Carbon Academy' partnership and form the platform for 'Clean Energy Manufacturing' acceleration, with research and development in conjunction with the region's supply chain. The 'Low Carbon Academy' training courses would be designed along two broad categories:

- **Higher education subjects** focusing on the theoretical aspects of implementing the smart energy infrastructure that underpins decarbonisation. Important consideration is given to matters such as political, strategic, legal, financial, commercial, technical, leadership and communication themes. This would contribute to Regulated Qualifications Framework (RQF) levels 5 - 8.
- **Vocational training** at RQF levels 1 - 4 addressing the practical activities related to design, installation, operations and maintenance of systems.

By developing the 'Clean Energy Manufacturing' accelerator in parallel, this will upskill existing employees for decarbonisation, provide the necessary career pathways to attract a new workforce and expand the local industry supply chain and marketplace capacity.

Project Approach	Development of the 'Low Carbon Academy' partnership and acceleration of 'Clean Energy Manufacturing' through a network of the North West's 77 Colleges and Universities.
Investment Required	£2,218 million
Investor Profile	• UK Government / Local Government grant funding scheme, Public / Private partnership to provide appropriate market elements • Private investment backing the schemes' developers • SMEs and large businesses as supply chain extension / diversification to deliver the technology • R&D investment to drive savings for the technologies
Secured / Created Jobs	2,310 training and accelerator roles (supporting 277,200 trainees over 18 years)
Next Step	Leverage the activities of LEPs and CoCs to break down the barriers for significantly increased skills training; extension of funding for the 'Low Carbon Academy' initiative and the 'Clean Energy Manufacturing' accelerator.

Other North West Initiatives:

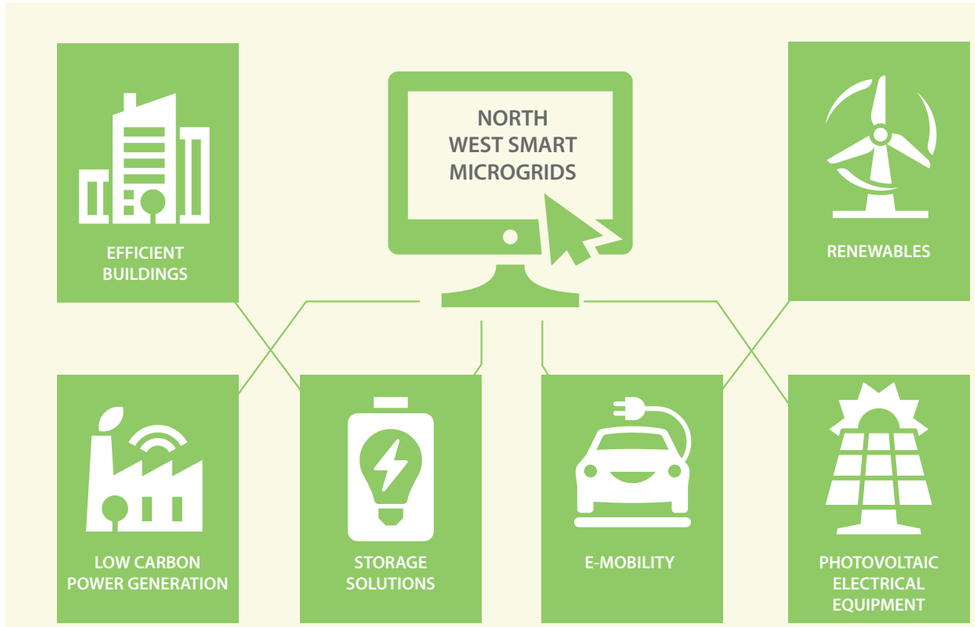
- Energy House and Smart Meter Lab, Salford (www.salford.ac.uk/our-facilities/energy-house-labs)
- National Graphene and Henry Royce Institutes, Manchester (www.graphene.manchester.ac.uk)
- Energy Innovation Agency (www.greatermanchester-ca.gov.uk/news/new-university-led-energy-agency-to-turn-greater-manchester-green)

OBJECTIVE 2

SECURING CLEAN ENERGY IN THE NORTH WEST

Objective 2: SECURING CLEAN ENERGY IN THE NORTH WEST

To support the large-scale aspirations of decarbonising North West England, we need investment so that our heat and power is cleanly generated and economically delivered. This will be coordinated through a market framework in which suppliers and consumers are appropriately financially served. The key component facilitating this development is our energy system, which needs to provide decarbonised power. We will complement this by locally generating our own energy for consumption. Storage technologies are a key driver to manage the increasing uncertainty and intermittency in such a system. To deliver our Clean Energy objective, we will showcase and scale-up new methods to secure our Energy Supply and keep the cost appropriate to maintain the competitiveness of our region.



The North West region's immediate opportunity is to decentralise our energy, using Smart systems and Microgrids to regionalise our supply and demand, with the opportunity to build revenues through reducing system constraints and improving flexibility on the national grid. There is even the opportunity to become a net exporter of clean energy, once our regional requirements have been met. The recent rapid penetration of energy storage systems on the UK's energy networks has shown how systems can be built in isolation, co-located with renewable generation or even on an industrial estate to smooth peaks in local demand. Integrating smart technologies like this can address capacity constraints and also provide valuable revenue streams to investors.

Transforming the consumption of energy in our domestic and industrial built-environment to deliver energy efficiency opportunities is a 'win-win' for households, businesses and the economy. It reduces carbon emissions, lowers energy bills and also retains wealth in the local area. The UK energy efficiency sector already turns over £20.3 billion, employs 144,000 people and sells exports worth over £1 billion; and British businesses could save more than £6 billion by 2030 through investment in cost-effective energy efficiency technologies in buildings and industrial processes . And there are key Social Benefits to be attained including taking people out of fuel poverty, improving health outcomes and ultimately retaining the economic value of energy in our region by reducing gross consumption.

Our region is blessed with ample renewable resources such as onshore and offshore wind, solar, geotechnical sources and potentially even tidal. Due to current planning restrictions onshore wind and tidal power schemes are difficult to deliver, but solar is commercially viable even without Feed-In-Tariff subsidies. By utilising space on our industries, commercial, public sector and domestic buildings and land more effectively, the North West will significantly increase the production of electricity for our own needs. Also, by making it easier for public bodies and communities to invest, it's possible to ensure that the economic value of the energy produced is retained in the local area. With new technology like battery storage becoming cheaper it is possible to circumvent the technical constraints on the distribution networks that have held the region back.

We are seeking investment support to capitalise on these clean energy opportunities to support the first at-scale heat and power networks, underpinned with commensurate growth of the supply chain and businesses. In succeeding with this objective, we will secure and create 429,015 jobs in the North West of England.

Investment 6 Decarbonising the homes of the North West

The decarbonisation of our North West homes is crucial to be able to meet the overarching aim for the North West region to be net zero by 2040. This requires an integrated approach to answer the trilemma of how energy is used in the home – to provide power for the modern lifestyle, heat for a healthy environment and to embed this into a highly energy efficient structure.

Our primary focus of improving energy efficiency is a 'win-win' for households and the region, as it then reduces the demands for heat and electrical energy supply from generating sources. This then leads to a range of key benefits: it increases energy security, lowers energy bills and reduces carbon emissions.

We will deliver a program of:

- Energy efficiency upgrades and retrofit of insulation and double/triple glazing to a typical house to promote an average EPC shift from the level of D to A/B by 2040.
- Enable the transition away from Natural Gas for heating, hot water and cooking – to facilitate the move into decarbonised heating systems such as heat pumps, hybrid heating with green gases and district heating.
- Drive home-based generation with roof-based solar PV systems linked into in-house battery storage and thermal units controlled with Smart systems to ensure integration into localised micro grid networks.

These approaches shall be followed in an integrated way, as it is pointless undertaking a 'heat transition' to a property without first making the building fabric as efficient as possible. To deliver this ambitious program will provide huge diversification opportunities for the localised North West business community, create tens of thousands of long-term jobs with associated training support needs, and so create significant economic benefit measured as an increase in GVA.

Exemplar: Homes as Energy Systems, Greater Manchester

The Homes as Energy Systems (HaES) ERDF funded project, led by local regeneration company Procure Plus, is a £13.8 million project looking at turning homes from passive energy loads to active energy contributors to the electrical networks through better heating systems and innovative energy solutions that improve people's wellbeing (www.procure-plus.com/haes-homes-as-energy-systems). Bringing together two regional social housing providers, Stockport Homes Group and Northwards Housing (and their respective local authorities), the University of Salford and local digital energy solutions business Upside Energy, HaES is installing renewable energy technologies and other energy efficiency measures in over 750 public and privately owned properties in Greater Manchester.

As well as installing measures, HaES is trialling how the technologies being installed can add further value. Monitoring data helps overcome concerns of efficiency and running costs whilst also helping landlords develop strategies to help tenants to use these systems most efficiently. The project is also exploring the role of 'aggregated' heat pumps and batteries in delivering enhanced carbon and bill savings and even revenue opportunities for landlords, tenants and even private homeowners, helping to build the financial business case for deployment at scale of low and zero carbon technologies. The project has already delivered unexpected value by identifying challenges in engaging with District Network Operators (DNOs) and local planning policies as well as accelerating deployment of heat pump manufacturers 'advanced remote control' technologies. Lessons being learned, coupled with proactive engagement with wider project stakeholders, have already had an impact on 'successor' schemes such as the Arrowfield Zero Carbon Estate project led by Southway Housing Trust. Although challenges encountered have frustrated HaES, through their identification and subsequent actions to overcome them, the ground is being prepared for others to not have to face these issues.

Scale-up Opportunity for the North West

Project Approach	3.4 million North West homes will be addressed by 2040 as: 1. Energy efficiency retrofit of 95% homes 2. Installation of Low Carbon Heating in 95% homes 3. Renewable Generation / Storage fitted to 50% homes
Investment Required	£52,738 million
Payback Period	8 years per installation based on 2020 energy price
Investor Profile	• UK / Local Government underpin the scheme • Public / Private partnership with public funds mechanism e.g. Green Deal • SME and Large-Business extension / diversification to deliver the scale-up • Householder will contribute to the scheme for their house
Carbon Saved	13,327 $ktCO_2e$ pa
Secured / Created Jobs	204,550 jobs are secured or created through to 2040 to undertake the works and within the necessary supply chain, as well as the opportunity for insourcing manufacturing of key components of delivery
Next Step	UK Government engagement with Local Authorities to develop way forward for large-scale programme stimulus

Investment 7 Public Sector assets leading the way on Decarbonisation

Local Authorities across the North West hold large land and building assets that require the application of emission reduction measures and offer an opportunity for on-site generation. There is considerable opportunity for the decarbonisation of the Public Estate to play its part in the overarching aim for our region to be net zero by 2040. The decarbonisation of the Public Estate requires an integrated approach that meets the varying vectors that differing buildings types have as emission points – such as the energy usage differential between a police station vs a school vs a leisure centre.

Exemplar: Greater Manchester's Public Sector Decarbonisation Scheme

Manchester City Council has secured more than £19 million of government funding to retrofit 11 council owned buildings to make them more energy efficient. This money from the Public Sector Decarbonisation Scheme (PSDS) represents the largest council allocation among £78.2 million awarded to Greater Manchester, as part of a joint bid coordinated by Greater Manchester Combined Authority. The 11 schemes will collectively save an estimated 2,000 tonnes of carbon emissions a year, around 40% of the target saving for council owned buildings by 2025, as well as saving thousands of pounds on the buildings' running costs.

Scale-up Opportunity for the North West

Project Approach	The Public Sector estate of the 39 local government districts across our region will be fully decarbonised through energy efficiency and low carbon measures
Investment Required	£2,284 million
Investor Profile	• Local Government undertaking the scheme e.g. PSDS or SALIX • Public / Private partnership with public funds mechanism e.g. Green Deal • Novel asset ownership or 'Sustainability-as-a-service' model
Carbon Saved	396 $ktCO_2e$ pa
Secured / Created Jobs	26,119
Next Step	UK Government engagement with Local Authorities to develop wayforward for funding and demonstrating social benefits

Investment 8 Effective use of process resources: Heat and DHNs

Heating is responsible for approximately 37% of the total UK carbon emissions when the 14% contribution of the industrial processes is considered. The Government has a target for around 20 per cent of 'heat' to be generated and supplied in network infrastructure by 2050.

According to the Association for Decentralised Energy, the heat networks in the North West have the highest heat density compared to the other UK regions. These and future networks can be expanded and interconnected into industrial sites who will have tradeable waste heat.

The UK has a number of existing large heat networks but these form less than 2% of the country's heat supply, even when combined with a few smaller, localised inner-city developments. Thus, to support the required transition to heat networks, the UK government established a series of initiatives including the investment by BEIS of £320 million in England and Wales up-to March 2022 through the HNDU & HNIP programmes, designed to accelerate the growth of the market for initial feasibility studies accessible by Local Authorities.

There are already a number of District Heat Network (DHN) projects underway in our region with such funding. The proposed Oldham DHN will take ground heat from flooded coal mines to create an environmentally friendly power source for the town centre. A synergistic development between industry and business parks also exists, with the deployment in Alderley Park, Cheshire of a lower temperature 'ambient loop' heat network which provides reduced heat loss levels and increases the efficiency and resilience of heat delivery due to integration of multiple low carbon heat sources.

Such agglomeration of demand on a network infrastructure means the heat generation source can be recyclable or renewable non-fossil fuels such as hydrogen, biomass, waste heat from local industrial process, energy from waste (EFW), renewable electricity and also decarbonised natural gas by CCS. Centralising the boiler systems at key nodes in the North West is more efficient than individual systems, due to smarter operating conditions across a range of buildings and homes rather than just one building. Further, opportunities for local partnership would then exist to support localised generation and network distribution – in build, operation, maintenance and billing services, anchoring strong local economic benefits with an upskilled workforce.

Exemplar: Alderley Park Ambient Loop

The previous heat system serving Alderley Park has been changed to a fifth-generation ambient loop network. According to Buro Happold, this highly innovative system is equipped with reversible heat pumps that exchange heat with the network when needed, applying intelligent technology that greatly reduces energy transportation losses. This is the system of its kind in the UK and will save 74% of carbon emissions – equivalent to 350,000 tonnes of CO_2 – over a 40-year period.

Key Data: Alderley Park Ambient Loop

Carbon Saved	295 tCO_2e per year based on 6.1 MW Energy Centre and 16 MW of WSHPs
Projected Jobs	54
Project Cost	£12 million

Image provided by Viridor / INOVYN

Exemplar: Greater Manchester waste management

Non-recyclable waste generated by Greater Manchester's households is not destined for landfill disposal. Instead, the UK's largest energy from waste (EFW) facility processes the refuse to play a significant role in reducing carbon impacts from a manufacturing process at INOVYN. The combined heat and power plant, developed in partnership by Viridor, INOVYN and Greater Manchester Combined Authority (GMCA), receives non-recyclable waste into mechanical treatment facilities where it is shredded and then transported by train to the Energy Recovery facility in Runcorn. There, it is offloaded into a waste bunker and fed into a furnace for combustion. The heat and steam produced drives turbines to produce electricity, so this and the steam are used at the adjacent INOVYN chemical manufacturing site. This reduces the companies use of fossil fuel resources, and the use of rail transport significantly reduces the need for lorry journeys from Greater Manchester to Runcorn.

Scale-up Opportunity for the North West

Project Approach	Development of over 530 heat systems across the North West
Investment Required	£7,995 million
Investor Profile	• DHN Utilities to build, own and operate the heat network assets • Private investment backing the project developers • SMEs and large businesses as supply chain extension / diversification to deliver the scale-up
Carbon Saved	1,526 $ktCO_2e$
Secured / Created Jobs	53,300
Next Step	Policy support by Government to create heat market

Investment 9 Taking heat from the ground beneath our feet

When aligned with the government's ten-point plan for a green industrial revolution, the warm water in abandoned coal mines is seen as a viable new form of sustainable energy with the potential to play a vital role in making homes and public buildings greener, warmer and more energy efficient and aligned to the Government target of 20% of Heat to be supplied in Networks by 2050.

Analysis by the Coal Authority details that one quarter of the UK's population live above abandoned coal mine systems. The mines which are now flooded are warmed by natural geothermal processes and will be developed as a source of low carbon energy to heat homes and businesses. There is great potential to utilise heat from the extensive Cumbria and Lancashire coalfields into localised community heat networks. Further, the Ince Marshes of Cheshire will be the site of one of two UK Geoenergy Observatories, to focus on improved understanding of the subsurface environment across a 12 km^2 area, down to 1,200 metres below ground. This knowledge can be applied to the North West and beyond for a range of ground energy technologies that will kick-start a new renewable industry in our region, create employment, tackle climate change and attract investment to our coalfield communities previously disadvantaged by mine closures.

Scale-up Opportunity for the North West

The application of mine water heat from 'closed' coalfields in our region will provide 10% of the Domestic and Public space heat load by 2040 through DHNs. The Coal Authority shows a typical 'closed' coalfield scheme to be able to provide 75 Gigawatt hours (GWh) that can power the equivalent of 6,750 homes and give a 7,500 tonnes reduction in CO_2 emissions. Such a scheme posited for Crewe could support 200 full-time employees (FTEs) and provide £10 million GVA in construction; annual operation and maintenance benefits would support a further 16 FTEs and £0.9 million GVA.

Scale-up Opportunity for the North West

Project Approach	Mine water heat from 'closed' coalfields in the North West will provide 10% of the Domestic and Public space heat load by 2040 into 165 District Heat Networks (DHNs)
Investment Required	£1,980 million
Investor Profile	• Local Government undertaking the scheme e.g. PSDS or SALIX • Public / Private partnership with public funds mechanism e.g. Green Deal • Novel asset ownership or 'Sustainability-as-a-service' model • Initial Government seed funding then into third party private equity likely through Utilities and Power companies
Carbon Saved	702 ktCO_2e pa
Secured / Created Jobs	16,500
Next Step	Clear investigation of the underground potential under the remit of HNDU / HNIP

Investment 10 Community renewable energy schemes

The community energy sector in the North West is very significant, with projects addressing solar PV on the roofs of schools and community buildings, biomass DHNs in remote communities, small-scale hydro and innovative new approaches to engaging citizens in energy masterplanning for their neighbourhoods, by working in partnership with Local Authorities. There is a huge potential to grow the low carbon supply chain economy in the North West through investments in community renewables. In 2019, the UK's community energy sector installed 15.4 MW of new electricity generation, taking the community-owned capacity in the UK to 264.9 MW and generated £4.6 million in local benefit. With excellent renewable resources across our region, we can capitalise on these opportunities, supporting the growth of businesses and develop our environment in new and innovative ways. By utilising space on building roofs and unusable land more effectively, our communities could produce a significant proportion of their own electricity needs. Also, by making it easier for public bodies and communities to invest, this will ensure social benefit and the economic value of the energy produced is retained in the local area. With new technology like battery storage becoming cheaper, it is possible to circumvent the technical constraints on the distribution networks that have previously held the regional development back. The community energy sector has a key role to play in delivering our ambitious net zero carbon targets.

Exemplar: Burneside Community Energy (BCE), Cumbria

The 994 kW of solar projects on the roofs of the James Cropper plc local paper mill are owned by the local community. BCE have also gifted 'the installation of 29.5 kWh of solar panels' onto the roof of a local school, the projects costing a combined £767 thousand. As a Community benefit company, BCE are expecting to be able to distribute in the region of £150 thousand into community projects within Burneside village. The project is currently generating 543 MWh, increasing to 795 MWh of renewable electricity per annum to power the major local employer with renewable electricity. It is reducing CO_2 emissions by over 8,500 tonnes over the 20 years of the project, securing jobs in the local economy and providing a positive, sustainable legacy for future generations in Burneside.

Exemplar: Go Neutral Greater Manchester

The Greater Manchester Combined Authority is leading the development of a pipeline of low carbon development and nature recovery opportunities on land, car park and building assets across Greater Manchester. Initially portfolios of public sector owned assets will be brought forward via a procurement framework and expressions of interest invited from the market. Local need and priorities will define the solutions and delivery models being sought. An inclusive approach and proposition will be encouraged that plays to the strengths of all market players and supports integrated smart energy solutions that will decarbonise Greater Manchester's electricity grid and transportation systems and build in flexibility to provide us with a more resilient energy system.

Scale-up Opportunity for North West

Project Approach	Development of 1000 community renewable schemes across the North West with 300 MW of overall capacity and an estimated 2 TWh of electrical supply with battery or other storage technologies
Investment Required	£510 million
Investor Profile	• Local Government undertaking the scheme e.g. PSDS or SALIX • Public / Private partnership with public funds mechanism e.g. Green Deal, Rural Community Energy Fund • Novel asset ownership or 'Sustainability-as-a-service' model • Initially Government seed funding then into community-owned company schemes
Carbon Saved	149 $ktCO_2e$ pa
Secured / Created Jobs	1,250
Next Step	Extension of funding regimes such as Rural Community Energy Fund (RCEF)

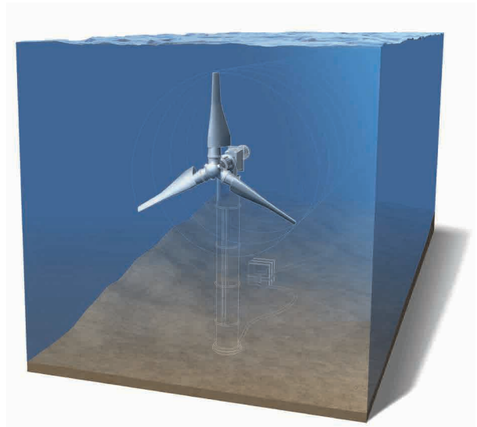
Other North West Initiatives:

- Clean Energy Greater Manchester https://es.catapult.org.uk/impact/projects/ucegm/
- Knutsford and Cheshire Energy Company

Investment 11 Innovating with Large-scale Tidal renewables

Tidal and wave energy are amongst the most innovative options in the race towards decarbonisation. The Government estimates that tidal and wave energy when considered together could potentially meet up to 20 per cent of the UK's current electricity needs, requiring an estimated install capacity of between 30 – 50 GW.

The Mersey Tidal Power project is one such way that we will meet the North West's energy demand by 2040. The Mersey has the second-highest tidal range in the UK, with water from the high tides being released through turbines as the tide falls, generating power. The project will take a decade to put into operation but, once it is up and running, it will be able to provide energy for 100 years - in principle, supplying all the energy needs for the Liverpool city region as it is today.



Delivering Mersey Tidal Barrage

Project Approach	Develop the Mersey coastal and offshore lagoon to provide up-to 5 TWh electricity annually from tidal energy with potential output between 1 - 5 GW. A tidal range project close-coupled to the urban and industrial demand of a port city can complement the offshore wind capacity and industrial decarbonisation agenda.
Investment Required	estimated £7,000 million The project is currently in Stage 3 feasibility development, with a view to moving into Phase 4 Consenting and FEED in 2022, with construction start forecast for 2025/6 and operation in the 2030s
Investor Profile	• Part of Liverpool City Region Devolution Agreement with UK Government • Initial funding from Liverpool City Region • FEED funding through BEIS • SMEs and large businesses as supply chain extension / diversification to deliver • Green Investment potential within CfD or RAB renewable funding regime • Keystone financing from Green Investment Bank, etc. • Private investment backing the project developers • Seed-funding from UK Government / Local Authorities • Large Infrastructure provider to construct, own and operate / maintains
Carbon Saved	1,415 $ktCO_2e$ pa
Created Jobs	5,000
Next Step	First-mover demonstration of viable tidal project

Other North West Initiatives:

- Duddon Estuary project

Previous studies have suggested Duddon Estuary has the potential to generate around 100 MW of energy and cut 17 miles off the journey between Millom and Barrow. Britain's Energy Coast view this as a project that would support the development of new nuclear reactors at Sellafield (because of the road link). A tidal barrage generating 280 GWh per year is considered technically feasible at a cost of between £650 million and £750 million, but progress would be subject to many commercial and environmental considerations, and including a transport link would add approximately £140 million to the cost.

- Solway Energy Gateway

The Solway Energy Gateway is a sustainable, renewable energy project to create an "electric bridge" across the Solway Firth. It will harness tidal energy to generate green electricity, whilst creating a new pedestrian and cycle route between England and Scotland, a tourist attraction and a multi-use asset for the benefit of local communities. It will have a generation capacity of about 100 MW with a consistent output of about 22 MW or 192 GWh, enough to power about 60,000 homes.

Investment 12 Securing a clean energy baseload with new Nuclear Plants and SMRs

The North West of England and North Wales has a strong and long history in the nuclear sector and is set to build on this heritage through the sectoral growth aims of the North West Nuclear Arc (NWNA):

50%
OF UK SITES FOR LARGE NUCLEAR NEW BUILD

£90m
UK GOVERNMENT R&D SPEND

70%
OF UK SITES **AMR** AND **SMR**

44%
OF UNIVERSITY RESEARCHERS IN UK

2 SITES FOR LARGE NEW NUCLEAR PLANTS & 5 SMR/AMR COULD DELIVER

8.1GW
NEW CLEAN ENERGY

£5.9BN
AT PEAK CONSTRUCTION

£125BN
IN **UK SMR** EXPORTS

60,000 NEW JOBS AT PEAK CONSTRUCTION
2,600 LONG TERM JOBS
2,100 APPRENTICES

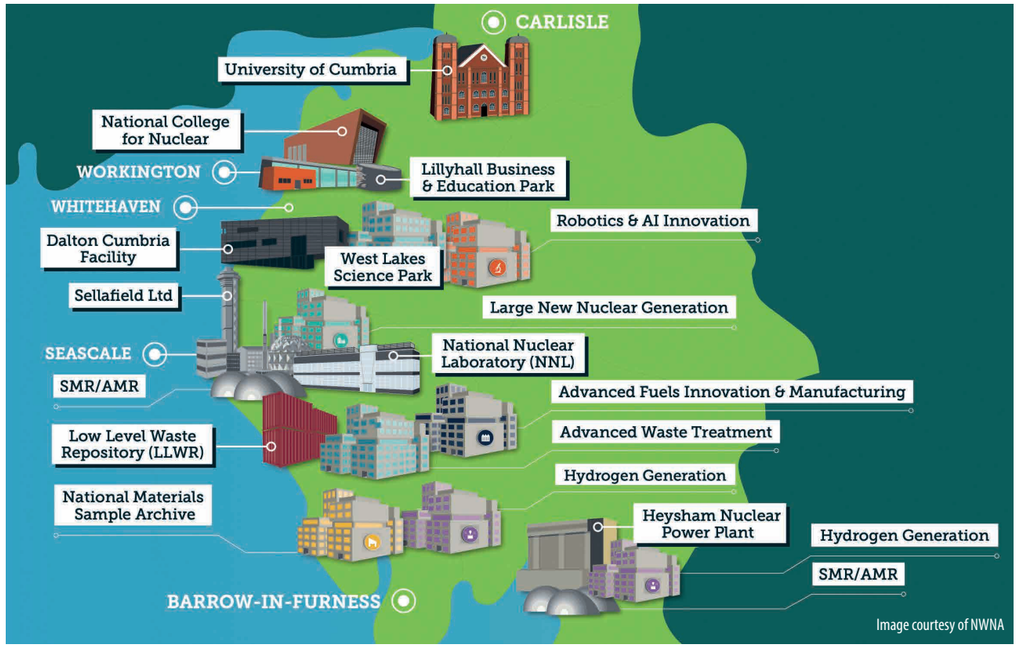


Image courtesy of NWNA

The NWNA is a nuclear sector cluster incorporating all the facilities and capabilities across the whole nuclear lifecycle from fuels to energy production, management of waste and decommissioning. NWNA is unique in the UK and widely recognised as a world class, self-contained, end-to-end nuclear system all within a very compact geography. The NWNA vision is a nuclear cluster that provides sustainable, clean energy to the regions of the UK and supports high value local jobs, livelihoods and business growth in some of its most disadvantaged places. This can be achieved through a range of new nuclear power stations and supporting facilities that build on Decommissioning expertise.

Large scale nuclear facilities such as the UK European Pressurised Reactor (UK EPR) are being considered at locations such as Moorside near Sellafield, where economies of scale and learning from Hinkley Point and the proposed Sizewell C development could provide a wayforward for financing. This initiative would form part of a wider clean energy and decarbonisation hub in the region.

Further building on the shared nuclear power heritage of the North West of England and North Wales is the take-up of the Small Module Reactor (SMR) system being developed by Rolls-Royce. Prospective build sites at Wylfa and Trawsfynydd, as well as in Cumbria and Lancashire, are already being considered.

Rolls-Royce announced in early 2021 it will soon complete the feasibility stage in the development of its UK SMR system and in May will focus on securing investment for the first SMRs to be deployed by 2030. This could support 40,000 jobs in the next 20 years and add £100 billion to the UK economy in 2030 - 2050. Rolls-Royce see one SMR system as being able to power a city the size of Manchester, but could also be developed for location close to other local centres around Carlisle, Preston, Lancaster and Liverpool. SMRs also offer the opportunity for the significant energy requirements to produce off-grid green hydrogen. UK SMR would offer significant manufacturing opportunities for the North West with anticipated growth in deployment into wider UK and worldwide, particularly considering our aspiration to be a world-leader in low carbon technologies manufacturing capability.

Exemplar: Springfields Clean Energy Technology Park

In 2020, the Springfields site launched the UK's Clean Energy Technology Park to further support the UK's net zero ambitions. The Clean Energy Technology Park provides a collaborative hub for demonstrating and accelerating the commercialisation of a broad range of nuclear-related technologies. Westinghouse is inviting technology providers to join this collaborative hub with access to world-class people and facilities to advance developments in game changing technologies within power generation.

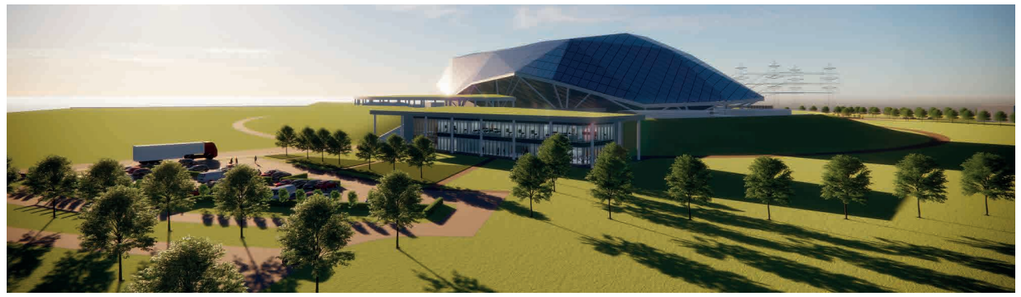
The Clean Energy Technology Park is focused on securing a long, sustainable future for the Springfields site – Shaping Tomorrow's Future, by focusing around three areas:

- Fuel Manufacturing Centre of Excellence
- A leading facility for Nuclear Materials Management
- A collaborative innovation hub for Advanced Nuclear Technologies

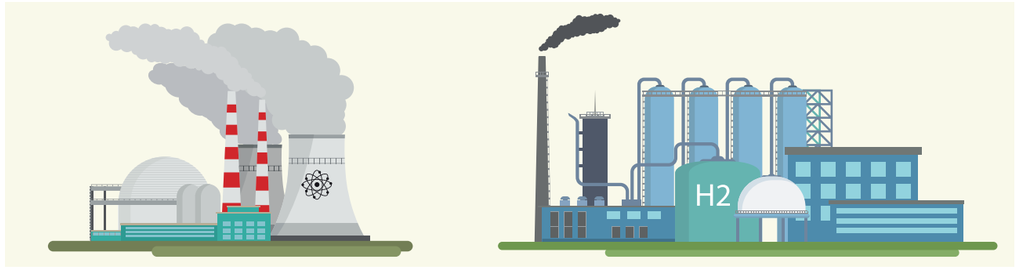
More than 7,000 Terawatt hours (TWh) of safe, clean and reliable electricity has been generated from fuel manufactured at Springfields, which has included fuel for Magnox Reactors, Advanced Gas-cooled Reactors (AGR) and Pressurised Water Reactors (PWR). This is enough energy to supply the UK's electricity demand for more than 20 years. More than 30% of the employees at Springfields were trained on-site in the Apprentice Training Centre, which has been at the heart of the local community for more than 70 years – training approximately 2,000 apprentices in total.

Scale-up Opportunity for North West

Development of the nuclear power supply chain, extension of reprocessing capacity to become the UK hub and generation capacity for the North West includes 2 large plants (one in North Wales) and 5 SMR builds. The NWNA views 2030 onwards for multi-site deployment to complete.



Project Approach	Building of 2 large 3.35 GW nuclear stations, 5 SMRs at 450 MW each and significant extension of reprocessing activities in the region
Investment Required	£70,172 million
Investor Profile	• Keystone financing from Green Investment Bank, etc. • Private investment backing the project developers • SMEs and large businesses as supply chain extension / diversification to deliver • Seed-funding from UK Government / Local Authorities • Large Infrastructure provider to construct, own and operate / maintain • UK Government Regulated Asset Base model
Carbon Saved	18,864 $ktCO_2e$ pa
Created Jobs	64,000
Next Step	Completion of funding dialogues to signal national commitment to a nuclear future



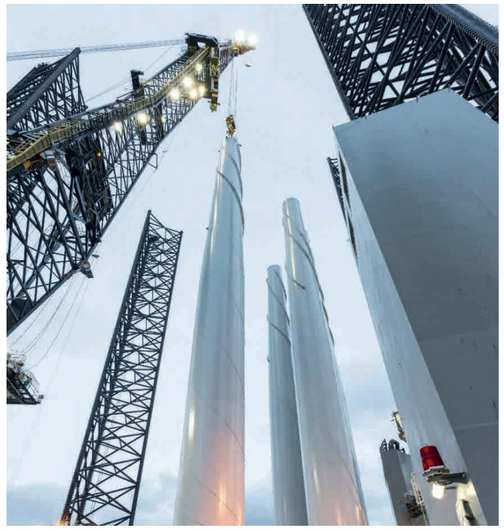
Special Focus: Using Nuclear to produce Hydrogen

Nuclear power has the capability to produce green hydrogen at scale and could deliver today. Broadly speaking, nuclear hydrogen production can split into low and high temperature methods. At low temperatures, water electrolysis is used, which benefits from the large amounts of low carbon electricity which nuclear power reliably generates.

A benefit of nuclear power is that it is a thermal generating technology which means that it is also able to produce abundant, high quality heat alongside electricity. This opens the door to a number of high temperature production methods. Steam electrolysis makes use of this ability by combining heat and electricity with solid-oxide separation membranes to improve the efficiency of hydrogen production. Looking to the middle of the century, a future generation of very-high temperature reactors would support thermochemical hydrogen production – using nuclear heat to boost hydrogen production even further.

The National Nuclear Laboratory have a programme to develop such advanced reactor systems from their base in the North West, with laboratories at Sellafield and a Design/Engineering Office in Warrington. Nuclear heat could also support hybrid hydrogen production methods to allow a transition from blue to green hydrogen production, whereby nuclear heat could be provided to traditional steam methane reforming plants. This would reduce the carbon emissions from this process as methane would be used exclusively as a chemical feedstock and not also as a source of heat. In this way natural gas usage could be reduced 25%, with the heat input being replaced from a zero-carbon nuclear source. Similarly nuclear heat could support bio-alcohol steam reforming and biomass gasification routes.

Investment 13 Extending the reach of Wind renewables



The UK's wind sector has huge growth potential: it remains one of the UK's largest infrastructure investments with an estimated turnover of EUR 8.8 billion and over 24 GW capacity installed. The UK Government's "Ten Point Plan" reinforced previous commitments to increase offshore wind to 40 GW by 2030, including at least 1 GW of innovative floating technologies. The UK's Sector Deal is targeting UK content in offshore wind to increase to 60% by 2030 and expectation of a fivefold increase in exports to £2.6 billion pa. In terms of onshore wind, it is estimated that the current operational capacity of 13.6 GW in the UK could grow to 30 GW by 2030.

Onshore wind in the North West has a current capacity of approximately 3.2 MW. ENW estimates that transition to net zero would require over 500 MW additional capacity by 2040. However, contemporaneous planning constraints around new onshore wind farms might render these aspirations

challenging. Scale-up activities should include the securing and maintaining of the North West region as a key national hub for wind farm construction and supply chain, such as the Cammell Laird shipyard in Merseyside, which delivered 160 turbines to Gwynt Y Mor. There is also significant relevant delivery experience in the region, for instance Siemens plc is now headquartered in Greater Manchester. The picture is completed with Orsted building an operations and maintenance team out of Barrow from their construction of the 11th operational offshore windfarm in the UK, the Walney Extension.

Sustainable growth can be achieved through building-upon existing capabilities, competencies and infrastructure to ensure the Renewables ecosystem becomes more efficient and can work independently of national and international influence. Further, programmes such as the Engineering Construction Industry Training Board's (ECITB) 'Connected Competence' scheme will facilitate the efficient transfer and upskilling of employees and capabilities from our region's traditional manufacturing sectors and businesses to emerging renewables and low carbon.

Scale-up Opportunity for the North West

Project Approach	The Crown Estate Round 4 build out in the North West of 3.5 GW offshore. Gaining commitment of a further 3.5 GW under Round 5 to be secured. Continued expansion of onshore wind to deliver 1 GW of new wind capacity onshore.
Investment Required	£17,612 million
Investor Profile	• Keystone financing from Green Investment Bank, etc. • Private investment backing the project developers • SMEs and large businesses as supply chain extension / diversification to deliver • Seed-funding from UK Government / Local Authorities • Large Infrastructure provider to construct, own and operate / maintain
Carbon Saved	8,735 $ktCO_2e$ pa
Secured / Created Jobs	50,549
Next Step	Review of planning and regulatory constraints to ensure wind renewables and storage can continue on trajectory

Other North West Initiatives:

- Cumbria offshore wind development
- VolkerInfra - North West based cable systems design and installation specialist helping the UK to extend the reach of Wind renewables (www.volkerinfra.co.uk)

Investment 14 Large-scale Solar PV and Storage driving clean generation

Solar PV energy is a commercially viable option, even without subsidies, which utilises space effectively and paves the way towards decarbonisation. When combined with battery storage systems, mitigates the inherited intermittency problems of this technology and leads to revenue streams. Warrington Borough Council has been an unlikely pioneer in renewables investment, now holding a portfolio of plant around the UK that will generate millions of pounds in profits every year and generate an operating surplus of over a hundred million pounds over 30 years to invest back into the town's essential services. Warrington's recent takeover of a 34.7 MW solar farm at York uses 30 MWh of battery storage and sophisticated technologies to maximise revenues and help balance the grid. For the Council, it will help secure the region's energy supply, provide local control over energy prices and contribute to reducing fuel poverty. As scale-up for the North West of England, Electricity North West's 2020 Future Energy Scenarios estimate that to transition to net zero carbon by 2050, over 1,000 MW of PV capacity would be required before 2040.

Exemplar: Bentley factory, Crewe

The roof-mounted and car port PV installation at Bentley's factory in Crewe was the first automotive plant utilising renewable fuels and green electricity to meet all in-house operations demands. The system provides:

- Solar Car Port PV: 2.7 MW
- Roof top PV: 5 MW
- Total: 7.7 MW - 30,815 Panels
- 6,100 MWh per year

Scale-up Opportunity for the North West

Project Approach	Fitting-out 31 industrial parks and over 5,900 public sector asset sites across the North West renewable generation and storage
Investment Required	£3,873 million
Investor Profile	• Keystone financing from Green Investment Bank, etc. • Private investment backing the project developers • SMEs and large businesses as supply chain extension / diversification • Seed-funding from UK Government / Local Authorities • Large Infrastructure provider to construct, own and operate / maintain • Joint approach between Commercial / Industrial and Public Sector land asset holders
Carbon Saved	902 $ktCO_2e$ pa
Secured / Created Jobs	7,747
Next Step	Regulatory and market changes to facilitate local supply and consumption of renewable energy

Other North West Initiatives:

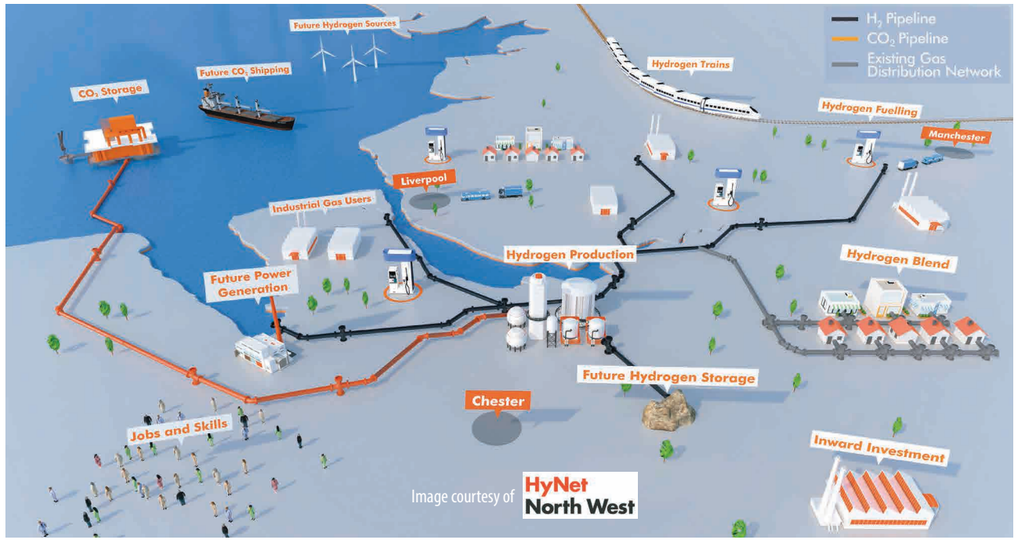
- Carlisle Kingsmoor Business Park Solar Farm, Cumbria
- CRYObattery - by Carlton Power and Highview Power, Greater Manchester (see www.highviewpower.com/news_announcement/highview-power-breaks-ground-on-250mwh-cryobattery-long-duration-energy-storage-facility)

OBJECTIVE 3

CREATE THE ECO-SYSTEM AND MARKET FOR HYDROGEN IN THE NORTH WEST

Objective 3: CREATE THE ECO-SYSTEM AND MARKET FOR HYDROGEN IN THE NORTH WEST

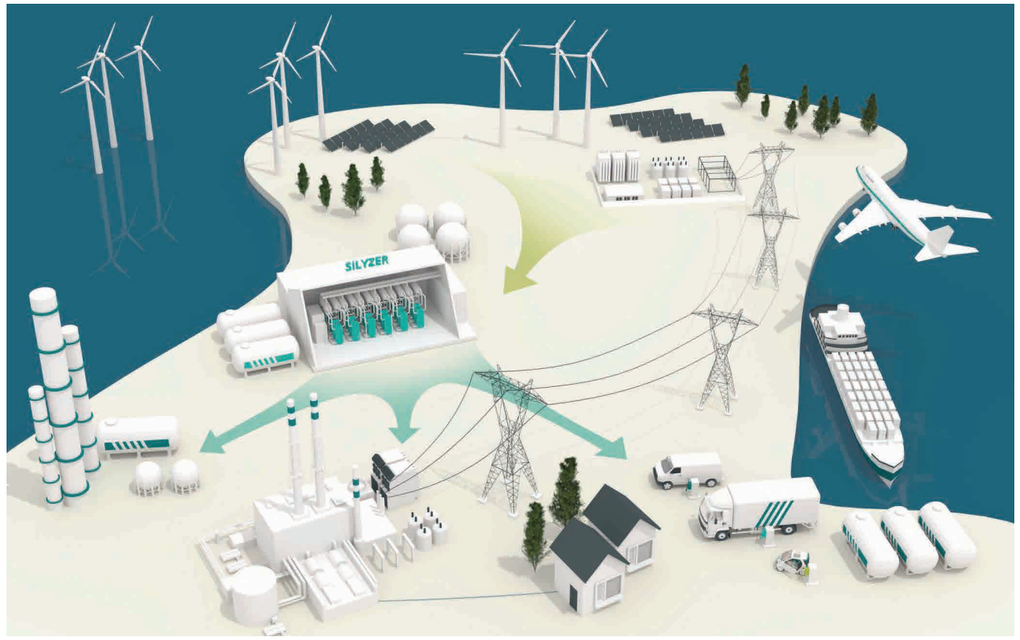
Securing clean electricity in the North West will not be enough to meet the energy demand of our industry, transport and domestic sectors: we need a new form of energy which can be produced and transported cleanly. Our region has all the infrastructure required for the production of hydrogen, including security of supply. Indeed, the industry cluster of the North West is already producing and utilising hydrogen in their processes, and we will transition these to Green Hydrogen to decarbonise their activities. Building out the first UK network of hydrogen generation, storage and distribution completes our 3 Objectives for achieving net zero in the North West by 2040.



Net Zero North West is working with a number of key partners and stakeholders across the North West of England and North Wales to deliver the first low carbon hydrogen economy. This will help to reduce emissions, protect and create jobs, and position the UK the global leader in clean energy innovation. We are already testing and demonstrating the opportunities, for instance in our HyDeploy, HyNet and HySecure programs. This final Economic Investment objective will see us build a Green Hydrogen network that will produce, store and distribute hydrogen. Together with carbon capture and storage (CCS), these technologies have the potential to reduce CO_2 emissions by 10 million tonnes every year by 2030 – the equivalent of taking four million cars off the road. By working with our industry cluster and utilising our large-scale clean energy resources such as renewable and nuclear, we will create world's first Hydrogen Economy and associated supply chain cluster in the region. The skills and technology developed will be shared round the world, bringing a many-fold return on the investment.

Hydrogen could be used in many novel ways across our region - distributed via the gas grid to be a source of heating (and cooking) for our homes and businesses. As already undertaken in Merseyside and Greater Manchester, hydrogen shall also be used in small and large-scale transport, from individual vehicles to fleets and public transportation. Our activities already show that hydrogen offers great potential and can replace fossil fuels in our industrial processes. Two unique opportunities stem from this: we will be able to use surplus energy resources in the North West to support the nation, and we can use our unique geology to store energy through hydrogen. Further, our region's ports, rail links, pipe networks and road freight infrastructure (with capacity for any further necessary expansion) are also ready for transporting hydrogen or ammonia. Our proposed development of a hydrogen distribution network, combined with CCS, will secure first-mover advantage and complete the decarbonisation of our region.

Investment 15 Generating Clean Hydrogen for the North West



The decarbonisation of the North West region will require a modal change to our utilisation of electrical power, space heating and industries, for which hydrogen can form the pivotal role as a fuel that burns cleanly. Worldwide, 95% of hydrogen is produced from fossil fuels by steam reforming of natural gas, partial oxidation of methane and coal gasification. Cleaner methods of hydrogen production include biomass gasification and the electrolysis of water. Particularly, the latter can come from any source of electricity, such as nuclear, solar and wind: this is termed Green Hydrogen, as it is significantly more sustainable and contributes to decarbonisation. This is the keystone of our Objective to transition to a hydrogen eco-system and market.

Our industrial cluster already produces and consumes hydrogen in many of the essential chemical manufacturing processes. As of 2019, approximately 70 million tonnes of hydrogen are produced annually worldwide for various important uses across society such as oil refining, and in the production of ammonia and methanol.

For the North West, some 42 TWh of hydrogen is viewed as being required by 2040 for use in our buildings, transport, and industry. This will essentially be a replacement of natural gas and, along with electricity, make a significant contribution to the transition from our fossil fuel dependency for transport.

Exemplar: HyNet North West

HyNet North West is a unique opportunity to move in the UK towards clean technological and economic growth. The project aims to produce hydrogen from natural gas while utilising CCS technology to increase emissions savings. The wider investment opportunities presented within this Prospectus for regional renewable energy projects, could also be encouraged through this connection to hydrogen infrastructure.

Besides the carbon savings and the investment opportunities that HyNet brings to the North West, it renders the area as the centre of upskilling for the employees as over 80% of the construction and over 60% of the design and engineering will be resourced from the area. Expertise and skills around Hydrogen generation and distribution will then firmly place our region on the map as the export centre for hydrogen eco-system and market knowledge in the UK.

HyNet Project Data

Carbon Saved	1,000 $ktCO_2e$
Projected Jobs	5,000
CAPEX / Investment	£900 million
Societal Benefit	£17 billion GVA
Finance Approach / Investor Profile	• Government funding • Private sector contribution by converting industrial sites from natural gas to hydrogen

Scale-up Opportunity for the North West

For our decarbonisation pathway, hydrogen will be generated in two ways:

Green Hydrogen - the electrolysis of water using electricity from renewable sources. North West generation vectors will use off-peak electrical power from wind, solar and tidal, as well as low demand period nuclear or SMR.

Blue Hydrogen - utilising fossil fuels for chemical cracking or steam reforming, but where the CO_2 component is captured by CCS systems.

Further, the utilisation of CO_2 in chemical and food production gives synergistic parallel processing opportunities.

Project Approach	Generation of hydrogen from 500 electrolyser units across North West of England
Investment Required	£5,000 million
Investor Profile	Initially, Government seed funding then into third party private equity likely through Utilities and Power companies. Financial support required for cross-skilling into the supply chain SMEs and businesses supported by training from Clean Energy Academies
Carbon Saved	22,716 $ktCO_2e$ pa
Created Jobs	5,177
Next Step	Recognising that blue and green hydrogen are different types of investment, coordinated parallel efforts are required to stimulate and balance offtaker demand

Other North West Initiatives:

- Morecambe Bay gas fields
- Trafford Low Carbon Energy Park (https://energycentral.com/c/cp/greater-manchester%E2%80%99s-first-low-carbon-hydrogen-hub)

Investment 16 Driving forward transport with electricity and hydrogen

Transport is a significant contributor of emissions in the North West, generating 13,648 $ktCO_2e$ which is over a third of our region's carbon budget to mitigate by 2040. When considering emissions, there's a tendency to focus on the main arterial routes like motorways. However, a lot of our communities are rural in nature which means that a significant amount of transport emissions are from vehicles using minor roads, a fact that alerts us to future energy infrastructure challenges given the intended rapid growth of electric vehicles.

While the UK has dramatically cut its greenhouse gases from power generation, the emissions from transport have seen little change over the last 25 years. Recent Government policy to phase out the sales of new petrol and diesel vehicles by 2030 means the electric and hydrogen powered vehicle revolution is imminent. Research by the North West Hydrogen Alliance (NWHA) in 2019 showed that 69% of people believe it is important for every UK household to move away from fossil-fuelled cars.

Public transport is the source of between 12 to 18 percent of household emissions (the spread is between poor and rich households); by way of comparison, International aviation contributes between 3 to 26 percent on the same basis. Low emission buses now represent 13 percent of all buses in the UK, but the government wants to go well beyond this to achieve significant uptake of ultra-low and zero emission buses, such as the use of hydrogen fuel for a fleet in Liverpool.

But it's not just passenger transport that is evolving. Road haulage is also poised for change in order to address the many pollution problems that are associated with it. According to the government, heavy goods vehicles (HGVs) only account for five percent of miles covered in the UK, but they produce around 20 percent of the total nitrogen oxide emissions. There's no hiding the fact they play a major role in our economy: 89 percent of all goods transported by land in the UK and 98 percent of all food, agricultural products, consumer products and machinery in the UK are transported by road freight. In our urban areas, there have been serious concerns raised about the potential health impacts of slow-moving HGVs, which can exacerbate congestion problems and endanger cyclists, pedestrians or other drivers.

Scale-up Opportunity for the North West

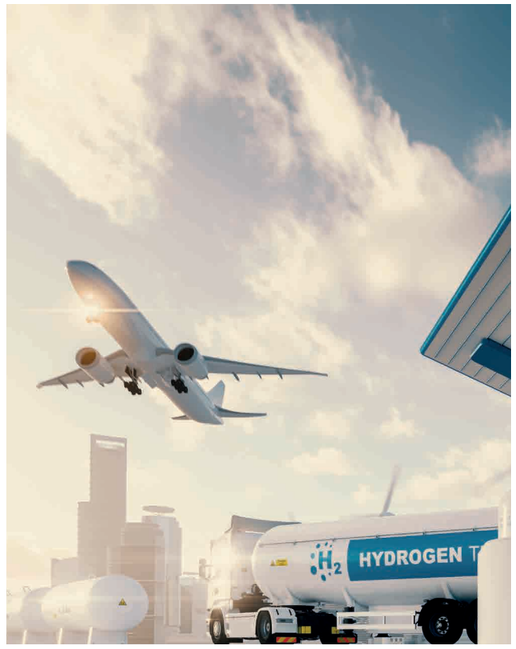
Project Approach	Rollout of Electric Vehicle (EV) charging to continue and paving the way for hydrogen transport fuelling: 325,000 individual charging points and 500 bulk charging centres with hydrogen filling stations to be installed across the North West by 2040
Investment Required	£10,325 million
Investor Profile	• Private sector led by present transport fuelling incumbents to keep market share through development of infrastructure ownership and maintenance • Local Government supported schemes • Public / Private partnership with public funds mechanism
Carbon Saved	5,934 ktCO_2e pa
Created Jobs	82,031
Next Step	UK policy to support creation of hydrogen and EV market

Investment 17 Hydrogen and alternative fuels for larger distances

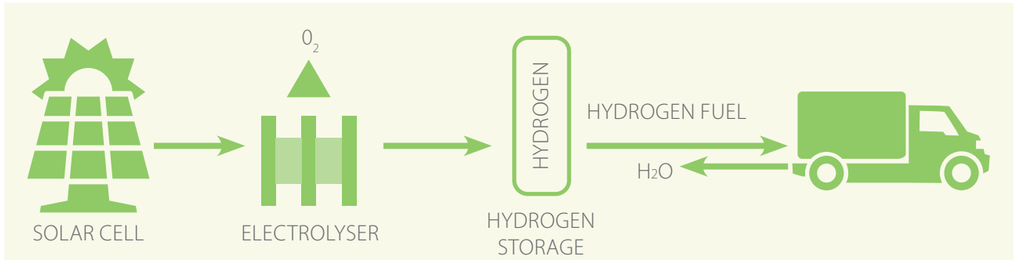
Decarbonisation of the transport sector is pivotal towards a net zero carbon future. Electrification of the vehicle fleet is essential and examined in detail in most UK future scenarios documents. However low/zero carbon fuels are expected to also play an important role, including fuelling LGVs and HGVs.

Green Hydrogen can be a zero-carbon fuel, while Bio-CNG (compressed natural gas) can result in CO_2e emissions reduction of up-to 84%, and up to 40% cost saving compared to a diesel vehicle. A recent study revealed that: "even if the gas was not from renewable sources, derived instead completely from fossil fuel, the 'well-to-wheel' emission saving from CNG dispensed from the high-pressure system would still be as high as 15 per cent".

In the North West steps have already been taken towards unlocking utilisation of these cleaner fuels. Examples are Cadent's Leyland CNG fuelling station in Lancashire and Project Vanguard in Middlewich, Cheshire. The former uses gas that is certified as 100% renewable, while the latter is a pilot project to consider the storage of Green Hydrogen and its refuelling for vehicles.



Exemplar: Project Vanguard



In order to produce green hydrogen which will supply the refuelling station, a large solar PV array is utilised to fuel the Project Vanguard electrolyser. Initially three hydrogen-run vehicles – two refuse trucks and a vehicle - will be supplied by the station with commercial operational date of 2021.

Scale-up Opportunity for the North West

Project Approach	For the North West we will install over 1,900 charging stations for use by waste HGVs to serve as a transition point from diesel fuelling through CNG to hydrogen
Investment Required	£9,562 million
Investor Profile	• Government leads by converting public vehicle fleets such as waste vehicles/public transport to hydrogen or CNG vehicles • Local Government supported schemes • Public / Private partnership with public funds mechanism
Carbon Saved	7,234 ktCO_2e pa
Created Jobs	21,344
Next Step	UK policy to support creation of hydrogen and CNG market

Investment 18 Storing and Distributing Hydrogen economically

Utilisation of hydrogen is a leading factor towards the UK's net zero carbon target. Hydrogen deployment in a large scale for both industrial and domestic use via the existing gas grid means that a large capacity of hydrogen storage is essential. This is because a hydrogen distribution network will not benefit from the diversity of sources in the same way as our current natural gas network is, so it will not be so readily available. Therefore, vast stored quantities of hydrogen will be required to ensure security of supply in order to avoid supply shortages and intermittency.

Geologically, Cheshire is one of the few places in the UK where underground gas storage in salt caverns has been delivered, paving the way for potential hydrogen storage. Offshore facilities in the East Irish Sea can also store CO_2 produced from hydrogen reforming. All of these factors are brought together to develop a utility-scale hydrogen distribution network to provide hydrogen to key nodes across the North West, such as city heat and transport hubs, and our industrial cluster. Every activity within this Investment Prospectus moves our region towards securing first-mover advantage and complete our decarbonisation pathway by 2040.

Exemplar: Project HySecure

In Stublach, Cheshire this pilot project is examining grid scale hydrogen storage in salt caverns. It is estimated that the facility will be able to store over 1,000 tonnes of hydrogen with corresponding costs around £10 per kg of stored hydrogen.

It is implementing the latest safety standards and processes to examine the feasibility of large-scale, low-cost hydrogen compared to surface storage. It will support various projects across the North West such as the use of stored hydrogen in buses in Liverpool and Manchester.

Technical information:

- 300,000-350,000 m^3 cavern volume
- Hydrogen capacity: up-to 1,850 tonnes
- 50 GWh energy storage capacity
- Injection and withdrawal at 40 tonnes/day
- Full capacity from 2025

Project Approach	Complete the first development worldwide of a hydrogen utility distribution infrastructure and storage capability in the North West 1) Build of Hydrogen network to reach strategic centre nodes requires 350 miles of pipework 2) Repurpose existing geological storage capability for 10% reserve of the North West's projected annualised hydrogen consumption
Investment Required	£4,724 million
Investor Profile	Government-led infrastructure and private-sector network owners
Created Jobs	14,724
Next Step	Security of supply and infrastructure in place for hydrogen distribution to demand nodes

CONCLUSION

This Economic Investment Prospectus has offered a series of key investment cases building on region-wide exemplar projects with demonstrable returns to achieve Net Zero carbon emissions by 2040 for the North West region and industrial cluster with:

- delivery of a fully-integrated decarbonised industrial cluster driving a sustainable economy of the North West as a demonstrable powerhouse of the fourth industrial revolution to make a significant contribution to the UK's target to reach net zero carbon emissions by 2050;
- creating a smart, digitally enabled, low carbon energy system as a platform for all decarbonisation activities across the North West enabling towns, cities and regional industry to diversify from the current traditional technology sectors into modern high technology and low carbon manufacturing by 2040;
- create the eco-system and market for the hydrogen economy as the fundamental change to the society and communities of the region with an enhanced environment and better quality of life for North West residents; and
- develop the next generation workforce for a sustainable development in the region.

This Prospectus has tried to inform and guide the reader how the region will positively respond to the energy transition in the coming 20-year period by highlighting the net zero carbon ambitions, exemplifying our traditional manufacturing strengths, our capacity for innovation and quantifying the full range of economic development opportunities. Further, the assessment has focused on some of the key technologies relevant to the green generation with wind, solar, tidal and hydrogen (across generation, storage and supply). Multiple green energy generation vectors have been addressed, including EV-infrastructure and transport, smart networks, heat; as well as the new technology markets of SMR and CCUS, which are viewed as potential gamechangers in the North West Net Zero ambition. We have also identified the support required from Government & others to enable this transition, including polices, regulation and investment.

Executing the roadmap provided in this Prospectus will enable the North West of England to secure and provide greater returns on the suggested investments because our activities are fully integrated across industry, business, the public sector, transport and our communities. The range of opportunities are diverse, together pump-priming transformation in the region while ameliorating risk in future sustainable investments. Altogether, the development of a self-sustaining economy built on our North West industrial cluster will secure value in the region and returns for investors. Our ambition for the necessary sustainable transformation is proven from the coordinated scale-up opportunities presented. This builds on our demonstrable success in securing inward investment and developing innovative financing models, built-on embedding skills, training provision and social benefits in our developments.

The next steps will include establishing an appropriate governance structure, for which Net Zero North West will act as an overarching umbrella organisation to represent and communicate the request for investment with a unified voice. This discussion should seek to influence Government strategy and policy on the key issues facing our region, showing how targeted development of our industrial cluster will provide the greatest benefit for UK plc. We will pursue increased funding and policy support for renewable and clean energy security and energy efficiency. Within this framework, industry in the region will be enabled and encouraged to collaborate more effectively, have a stronger voice in Government and more effectively take advantage of the opportunities provided by national and international initiatives.

EMISSIONS REDUCTION
38.5 $MtCO_2e$

INWARD INVESTMENT
£206.9 BILLION

660,000 JOBS SECURED OR CREATED

GROW OUR ECONOMY WITH £285 BILLION GVA

SUMMARY DATA BY LOCAL ENTERPRISE PARTNERSHIP

	NZNW Objective	Develop Industrial Cluster	Secure Clean Energy	Create a Hydrogen Economy
Cumbria	Carbon $ktCO_2e$	461	2,038	1,590
	CAPEX £ million	£1,397	£17,419	£3,142
	Jobs	7,635	29,351	8,434
Cheshire and Warrington	Carbon $ktCO_2e$	855	3,784	2,951
	CAPEX £ million	£2,593	£32,333	£5,832
	Jobs	14,246	54,764	15,736
Greater Manchester	Carbon $ktCO_2e$	1,337	5,913	4,611
	CAPEX £ million	£4,052	£50,526	£9,114
	Jobs	43,044	165,471	47,548
Lancashire	Carbon $ktCO_2e$	910	4,025	3,138
	CAPEX £ million	£2,758	£34,390	£6,203
	Jobs	22,930	88,149	25,329
Liverpool City Region	Carbon $ktCO_2e$	780	3,452	2,692
	CAPEX £ million	£2,366	£29,497	£5,321
	Jobs	23,744	91,279	26,229
North West	Carbon $ktCO_2e$	4,343	19,212	14,982
	CAPEX £ million	£13,166	£164,164	£29,612
	Jobs	111,599	429,015	123,276

Note: the figures presented are based on UK Government data for NUTS2 regions which have Halton incorporated into Cheshire.

GLOSSARY

BECCS - Bioenergy with Carbon Capture and Storage

BEIS - Department for Business, Energy and Industrial Strategy

CCUS - Carbon Capture, Utilisation and Storage

CfD - Contracts for Difference

CHP - Combined Heat and Power plant

CNG - compressed natural gas

CO2 - carbon dioxide

CO_2e - carbon dioxide equivalent

CoC - Chamber of Commerce

DfT - Department for Transport

DHN - District Heat Network

DNO - Distribution Network Operator

EFW - Energy from Waste

EPC - Energy Performance Certificate

ERDF - European Regional Development Fund

ESCo - Energy Services Company

EV - electric vehicles, whether fully electric powered (instead of diesel, petrol or gas) or a hybrid combination

FTE - Full-time Employee

Greenhouse gases - a gas that is detrimental to the Earth's environment in contributing to the greenhouse effect by absorbing infrared radiation, e.g. carbon dioxide and chlorofluorocarbons

GVA - Gross Value Add, an economic metric

HNDU - Heat Network Delivery Unit

kW / MW / GW / TW - kilowatt, megawatt, gigawatt and terawatt are scaled units of power

kWh / MWh / GWh / TWh - kilowatt-hour, megawatt-hour, gigawatt-hour and terawatt-hour are scaled units of energy consumption

LA - Local Authority

LED lighting - light-emitting diodes, a lighting technology now widely adopted due to its significant energy saving capabilities compared to traditional incandescent bulbs

LEP - Local Enterprise Partnership

LGV / HGV - large / heavy goods vehicle

Micro-grid - a collection of different types of generation technologies and consumers, all connected together across a small geographical area (typically community)

Mtoe - million tonnes of oil equivalent, a measure of consumption of energy on a national scale

NWNA - North West Nuclear Alliance

PV - photovoltaic generation or more typically known as solar panels

R&D - Research and Development

RAB - Regulated Asset Base model

RQF - the Regulated Qualifications Framework for Northern Ireland and England

SME - Small or Medium Enterprise

SMR - nuclear Small Modular Reactors

SNG / BioSNG - Synthetic Natural Gas; BioSNG is the production from plant-based materials

ULEV - Ultra-Low Emission Vehicle

WSHP - Water-Source Heat Pump

ANNEX: REFERENCES AND ASSUMPTIONS

Investment	References
1 - Decarbonising the North West's industries through Carbon Capture and Storage	Information provided by Tata Chemicals Europe was used to scale up to 23 natural gas fired systems across North West England identified from the UK Government's National Atmospheric Emissions Inventory large point sources emissions dataset and extrapolated to 100 CCUS systems for industrial process decarbonisation from 2025 onwards.
2 - Energy Efficiency and Low Carbon Heating for the Industrial and Commercial sectors	UK Government's Valuation Office Agency (VOA) Primary Description and Special Category (SCat) Code was used to categorise building types in North West England to which a range of case study data was applied to extrapolate by sector, with projects commencing from the present day.
3 - Developing the Supply Chain with Process Efficiency and Consulting	ENWORKS model was used as the basis of targeting 5,000 North West England businesses with a £12,000 grant each to achieve an average 50 tCO_2e savings and securing / creating 2 FTEs on average per intervention, commencing from the present day.
4 - Building integrated Smart Energy systems that retain the value locally	31 industrial business park sites across North West England were identified with potential for application of microgrid technologies from present day, with scope for a future 20 sites to be developed. Jobs secured / created were extrapolated from figures provided by Invest Net Zero Cheshire and "Job creation from a Sustainable Transition for Sheffield City Region" (May 2018).
5 - Priming green industry and workforce: Low Carbon Academies and Clean Energy Manufacturing	Training developed at market cost of £8,000 per individual for 40% of the required number of secured / created jobs across North West England, with the training partnership and accelerator developed from present day.
6 - Decarbonising the homes of the North West	Greater Manchester Parity home retrofit dataset was extrapolated for North West England using ONS UK housing dataset with an assumed 9 FTE equivalents required on-site for the interventions at each property, with works commencing from the present day.
7 - Public Sector assets leading the way on Decarbonisation	Greater Manchester Public Sector Decarbonisation Scheme (PSDS) funding and utility savings achieved through SALIX funding were extrapolated across North West England on a per capita basis, with interventions commencing from the present day.
8 - Effective use of process resources: Heat and DHNs	Data from existing UK heat network implementations was interpolated to meet the UK Government target of 20% of space heat load to be met by District Heat Networks, based on rollout of schemes from the present day.
9 - Taking heat from the ground beneath our feet	Data from UK Coal Authority for 2.5MWth systems in North West coalfield assets, interpolated to be part of the solution to meet UK Government target of 20% of space heat load to be met by District Heat Networks, based on rollout of schemes from the present day.
10 - Community renewable energy schemes	Data utilised from Community Energy England and "Job creation from a Sustainable Transition for Sheffield City Region" (May 2018) to extrapolate for schemes being implemented from the present day.
11 - Innovating with Large-scale Tidal renewables	Data for Mersey Tidal Barrage utilised with development commencing from 2027.

Investment	References
12 - Securing a clean energy baseload with new Nuclear Plants and SMRs	Information from the North West Nuclear Arc and National Audit Office was utilised for scheme development from 2026.
13 - Extending the reach of Wind renewables	https://guidetoanoffshorewindfarm.com Offshore Wind Catapult and RenewableUK datasets "Future renewable energy costs: onshore wind", BVG Associates (2014).
14 - Large-scale Solar PV and Storage driving clean generation	31 industrial business park sites across North West England were identified with potential for application of large-scale renewable technologies from the present day. Detailed analysis of potential schemes on public-sector land holdings in Wigan were extrapolated to the 39 Local Authorities of North West England, for development from the present day. Jobs secured / created were extrapolated from figures provided by Bentley and "Job creation from a Sustainable Transition for Sheffield City Region" (May 2018).
15 - Generating Clean Hydrogen for the North West	The North West region's energy usage from natural gas was extrapolated to 41.5TWh in 2040 based on data from Cadent and National Grid. It was assumed this would be replaced by hydrogen generation from electrolysers, with data from ITM Power utilised on the basis of schemes developing from 2022.
16 - Driving forward transport with electricity and hydrogen	Vehicle charging requirement was based on meeting mileage profiles interpolated for North West England from Department for Transport VEHO0105 dataset and 2018 emissions dataset from National Atmospheric Emissions Inventory. Investment figures assumed £1000 install cost for standard chargers and £10M CAPEX for bulk charging centres, with schemes developing from 2022.
17 - Hydrogen and alternative fuels for larger distances	Vehicle charging requirement was based on meeting mileage profiles interpolated for North West England from Department for Transport VEHO0105 dataset and 2018 emissions dataset from National Atmospheric Emissions Inventory, with schemes developing from 2022.
18 - Storing and Distributing Hydrogen economically	Information provided for the HySecure project was extrapolated on the basis of a core hydrogen network of 350 miles in North West England at an estimated cost of £10M per mile. Jobs secured / created were based on unit numbers for the network construction of 100 FTEs and operation of 5 zones by 250 FTEs; for storage system construction of 50 FTEs and operation 12 FTEs, with schemes developing from the present day.

Notes:

1. *Phasing of investments recognises present day resource and project availability, with 20% proportional ramp-up through investment and job creation as applicable.*
2. *Decarbonisation figures are typically presented using DUKES emissions factors for 2018 on the basis of mitigation against electricity and / or gas consumption.*
3. *Where the sources for jobs created and / or retained are not directly referenced, numbers were developed through expert interview. FTEs working directly on the intervention or scheme were assumed to work for 252 days per annum and require direct office and administrative support, as well as an associated supply chain for materials, services, etc. which is reflected in the presented job numbers.*
4. *GVA was calculated on a per-capita basis using Office for National Statistics data for the region from the presented job figures.*

NET ZERO NORTH WEST

https://netzeronw.co.uk/

Including world leading manufacturers, our partnership brings together companies, regional leaders and a network of academic experts. 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.

Net Zero North West unites industry, providing a strong voice and holistic vision for industrial de-carbonisation in the North West. The partners are committed to working together to deliver change that is not only essential in supporting the energy intensive industries that make this region thrive, but critical in reaching the UK's net zero targets.

The region has a long history of collaboration with business, regional leaders and academia working together to share knowledge and best practice. We are supported by senior members of the City Regions, Local Enterprise Partnerships, academia and regional industry bodies.

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