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HUMBER INDUSTRIAL CLUSTER PLAN

TOGETHER IT IS POSSIBLE

Executive Summary: Our plan for a Net Zero Humber Industrial Cluster by 2040

Download the complete Cluster Plan and associated reports:





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THE HUMBER REGION IS TURNING THE TIDE IN FAVOUR OF CLEAN, GREEN GROWTH. STEEPED IN INDUSTRIAL HISTORY IT HAS BEEN ON THE FRONT LINE OF INDUSTRIAL REVOLUTIONS SINCE THE 1700's.

Our region has unparalleled natural assets, including unique CO₂ and hydrogen storage solutions, coupled with extensive port facilities, renewable power generation and investment-ready land serviced by extensive supply chains and the engineering skills needed to drive our ambition. We are poised to become a global leader for industrial decarbonisation.

The Humber Industrial Cluster Plan, funded by the UK Research and Innovation Industrial Decarbonisation Challenge Fund, is the result of a two-year collaborative journey of wide-ranging research, in-depth analysis, scenario modelling and extensive consultation. Our Plan demonstrates how the Humber can become the first Industrial Cluster to achieve net zero by 2040, and then go beyond to become strongly carbon negative, removing more carbon from the atmosphere than it produces.

Our industries have already invested significantly in plans and feasibility studies. Through working together – Industry, Government, Stakeholders, and Communities - we will build a Humber region that remains attractive to inward investors and provides freedom, choice and opportunity for employment and economic growth. A region that is sustainable, resilient, and inclusive.

Our comprehensive and dynamic plan sets out the next steps.

The Humber Industrial Cluster Plan (HICP) is one of six projects receiving funding from UKRI's Industrial Decarbonisation Challenge to create a regional blueprint towards decarbonising the region. In many ways, the HICP has the greatest challenge, as the Humber is the UK's largest carbon emitting industrial cluster; as such it is essential that we decarbonise the Humber to meet our national net zero targets.

Working in partnership over the last two years, the HICP has built on the rich heritage and natural assets of the region to develop an ambitious plan to achieve low carbon status by 2030, and support the UK's ambition of the world's first net zero industrial cluster by 2040. The Cluster Plan highlights key contributions towards skills development, supply chain, inwards investment, workforce planning and socioeconomic impacts for the cluster, alongside technical recommendations supporting the roll out of carbon capture and storage, and low carbon hydrogen deployment. The mandates outlined in this report are an impressive set of recommendations, essential for the region to decarbonise and achieve its future potential for local businesses and people, as we transition to a low carbon economy.

The achievements of the HICP will create a lasting legacy, enabling the cluster to achieve its world scale industrial decarbonisation plans, and the net zero future that will be key to regional and national success.



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When the iconic Humber Bridge opened in June 1981, it did more than just set records for its size. It connected the region, uniting both communities and industries, and allowing the Humber to become what it is today: a thriving industrial hub that contributes more than £18 billion to the UK economy and supports some 360,000 jobs. Climate change is the defining challenge of our time, compelling us to decarbonise our economy, develop energy resilience and invest in new low carbon technologies.

Decarbonising the Humber, the largest industrial cluster emitting more CO₂ than any other region in the UK, is essential to achieve net zero. The Humber Energy Board (HEB) brings together the public and private sectors in the region on both banks of the estuary to help deliver this ambition.

The HEB is hugely supportive of the Humber Industrial Cluster Plan, which has been central to setting the agenda for the direction and purpose of the Board as well as helping to determine the opportunities created by decarbonisation and challenges the region must overcome. The Cluster Plan has been developed from a vast amount of industry led studies, data and modelling; it has engaged a broad audience and created a single conversation on decarbonisation as well as helping to define the economic and environmental benefits that will deliver a sustainable future in the Humber for generations to come.

Through this decarbonisation journey, the Humber has an unrivalled opportunity to level up the country and can set a world leading example in how to decarbonise an industrial powerhouse. The Cluster Plan highlights a number of nationally critical energy and decarbonisation projects including carbon capture and storage (CCS), low carbon hydrogen production, bio energy with carbon capture and storage (BECCS) as well as the delivery of pipelines to take captured carbon dioxide away for permanent storage under the North Sea and bring hydrogen to existing industry to promote low carbon fuel switching.

The Humber has delivered for the UK before, leading the clean energy transition through its thriving offshore wind sector, stepping up to deliver world-class skills, manufacturing facilities and supply chains. Today, business stands ready to make the Humber the world's leading net zero industrial cluster.

The Cluster Plan creates a
'Greenprint' for a sustainable future;
now is the time to deliver.

OUR OPPORTUNITY

The Humber Industrial Cluster has the potential to reduce more industrial emissions than any other region in the UK.

And having pledged significant investment our cluster is uniquely positioned to deploy world-class decarbonisation projects. As the UK's Energy Estuary, the Humber region benefits from access to large scale CO₂ and hydrogen storage sites, along with abundant energy generation such as wind, solar and biomass. Deployment of our internationally recognised projects will put the UK on course to exceed deep decarbonisation targets as early as 2030.

Building on our proud industrial heritage and existing strengths in stakeholder collaboration, the Humber Industrial Cluster is set to become the UK's 'Super Hub' for carbon capture & storage (CCS), low carbon hydrogen production and storage, and greenhouse gas removal (GGR).

The Humber Industrial Cluster is ready to become the world's first net zero industrial cluster by 2040.

Together it is Possible

The Humber is the largest industrial decarbonisation opportunity in the UK

OUR PLAN

The Humber Industrial Cluster Plan has completed over 24 months of detailed analysis, which validates the ambition of the region's decarbonisation projects, cementing our unique position as leaders in the UK's Industrial Decarbonisation Challenge.

We have modelled different technologies, and uptake rates based on a range of external and legislative drivers. Our findings show that:

- We can significantly decarbonise as early as 2030, reaching net zero by 2040. Our core modelled scenarios fully support the region's decarbonisation projects in addition to providing welcome space to decarbonise other sectors.
- Carbon capture and storage (CCS), and low carbon hydrogen production and storage, provides the backbone to our decarbonisation strategy. In combination with resource efficiency and electrification, we can deeply decarbonise our industrial cluster by 2030.
- Greenhouse gas removal technologies (GGR), will place our region on a pathway to net-negative emissions as early as 2030, and are vital for our cluster to reach net zero emissions by 2040.

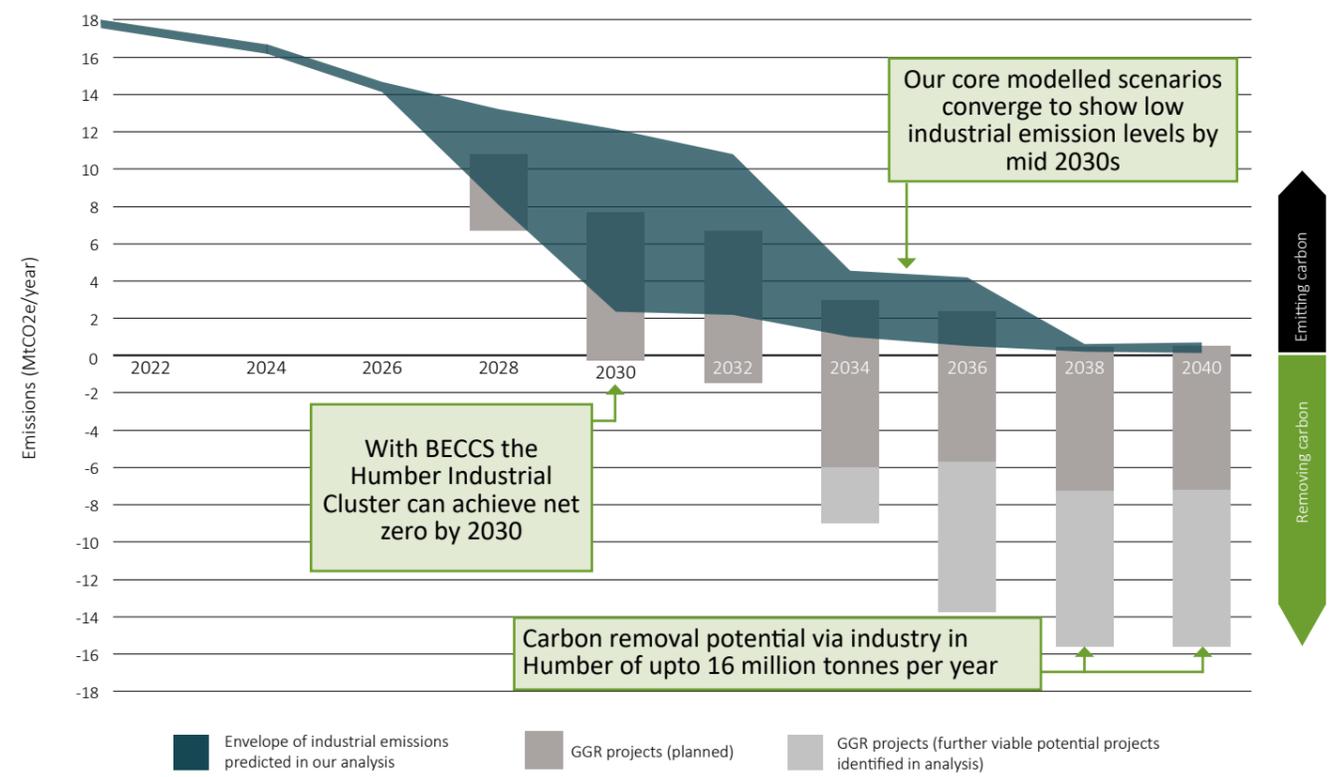


Maintaining coordinated action across the cluster is key to harnessing the benefits that our plan will provide for the region. We are strongly positioned, and possess the resources, drive, scale, and capability to deliver.

Download the Humber 2030 Vision Map



Significant emissions reductions and net zero are achievable in the Humber Industrial Cluster



OUR MANDATES FOR ACTION



Mandate 1: To implement Carbon Capture and Storage and Greenhouse Gas Removal technologies at pace and scale

Our modelling shows that carbon capture and storage (CCS) is the most important industrial decarbonisation option for our region, abating to up to 55% of industrial emissions by 2040 which is equivalent to 8 MtCO₂e per year.

CCS is an umbrella term for a suite of technologies, some more advanced than others, which includes separating out CO₂ from a waste gas stream. This technology will play a significant role in the decarbonisation of Ironmaking, Refining, and Combined Heat and Power sectors. As a high capital investment choice, CCS is favoured for heavy industrial processes offering economies of scale. It is also the only viable abatement option for emissions from many industrial processes.

The Humber cluster can significantly deploy CCS before 2030 if favourable policies are in place. The sheer scale of the Humber Cluster makes for a highly attractive CCS proposition. This has been recognised by both the UK Government and industry. Our internationally recognised CCS projects, such as Humber Zero and Zero Carbon Humber, plan to collectively remove at least 8 Mt CO₂e per year by 2030 – exceeding the national CCS target of 6 MtCO₂e from industrial emissions per year by 2030.

CCS is also critical for generating negative emissions through greenhouse gas removal (GGR) technologies such as bio energy with carbon capture and storage (BECCS), without which, attaining net zero is not possible. GGR is currently planned for biogenic emissions at Drax with an annual capture rate of 8 MtCO₂e per year by 2030, exceeding the national target of 5 MtCO₂e per year. By 2030 the Humber will provide a significant contribution to the government's overarching target of capturing 20-30 MtCO₂e per year.

The Humber Industrial Cluster uniquely benefits from being near vast offshore CO₂ stores, with estimated storage equivalent to hundreds of years at 20 MtCO₂e per year, supporting key transport and storage projects that are already in motion: East Coast Cluster (comprising Humber Low Carbon Pipelines Project and the Northern Endurance Partnership), and Viking CSS. To further strengthen Humber's position as the UK's 'CCS Super Hub', the region is capable of future expansion of transport and storage, enabling imports from the wider UK and European markets through our pipelines and ports.

5-8 MtCO₂e/year

Abated by carbon capture and storage by 2040

133%

Proportion of national 2030 CCS target for industrial emissions met by planned Humber projects

160%

Proportion of national 2030 GGR target achieved by planned Drax BECCS

35%-
56%

by 2040

Cluster emissions abated using CCS

Mandate 2: To implement low carbon hydrogen at scale

Low carbon hydrogen can be produced in several ways most typically either from methane with CCS abatement or from electrolysis of water. Low carbon hydrogen is one of the decarbonisation options with the highest impact for the cluster, particularly vital for the Chemicals, Combined Heat and Power and Refining sectors.

Hydrogen fuel switching across our region will be the optimal way of abating up to 21% of emissions by 2040, equivalent to 3.0 MtCO₂e per year. These findings support SSE Thermal and Equinor's feasibility planning for the switch of Triton Power to hydrogen, and the potential to switch the 3rd combined cycle gas turbine at VPI Immingham to hydrogen fuel.

Hydrogen fuel switching is a particularly attractive option for smaller point source emissions where carbon capture may be less economically viable.

Our analysis shows that our Cluster's current hydrogen production plans exceed the regional industrial demand, creating an opportunity for surplus hydrogen to be utilised in other sectors such as transport and heating, establishing the Humber as the true 'Hydrogen Super Hub' in the UK. The Humber Cluster is very well suited to making CCS enabled hydrogen from natural gas and electrolytic hydrogen from renewable electricity.

There are well-established plans to produce low carbon hydrogen in the Humber, totalling 5.2 GW by 2030, which represents over half of the national 2030 hydrogen production target of 10GW.

A major new hydrogen pipeline across the region is in the advanced stages of planning, which will connect producers and end users, enabling supply to future hydrogen off-takers. The underground salt caverns at Aldbrough will provide an initial capacity of at least 320 GWh by 2028, while offshore storage would be available via the UK's largest natural gas storage facility at Rough, which will be repurposed to create 10 TWh of hydrogen storage.

11%-
21%

by 2040

Cluster emissions abated using hydrogen

1.6-3 MtCO₂e /year

Abated by hydrogen fuel switching

52%

Proportion of national 2030 hydrogen production target met by planned Humber projects

50%

The Centrica Rough facility can provide 50% of the UK's hydrogen storage requirements by 2050



Mandate 3:
To adopt all optimal electrification measures



14%-
30%

by 2040

Cluster emissions abated through electrification

Electrification is a vital decarbonisation option abating up to 30% of the cluster emissions by 2040, which is equivalent to circa 5 MtCO₂e per year. It is a particularly attractive option for Ironmaking, Refining and Chemicals sectors. The use of electrification in our model is dominated by the early installation of an electric arc furnace (EAF) at British Steel Scunthorpe in the late 2020's. This represents the only site capable of adopting large-scale electrification across all modelled scenarios. This would position the UK as a green Steelmaking economy, protecting jobs, utilising the abundant low carbon electricity produced offshore, and allowing increased reprocessing of steel scrap that is currently exported.

Electrification will play a key role in decarbonising small and remote sites that will not have ready access to CCS infrastructure or hydrogen. A distinct advantage of the electrification option is that industries do not have to wait for the pipeline infrastructure, enabling adoption and emission reduction from 2025 in some sectors.

The viability of electrification is very sensitive to the price of electricity. Government support, or alternative market incentives will be needed to enable the rapid decarbonisation electrification offers.

Mandate 4:
To prioritise efficiency and circular economy measures

11%-
13%

by 2040

Cluster emissions abated through efficiencies

Driving industrial emissions to their lowest possible level will require a continual focus on Resource Efficiency and Energy Efficiency (REEE) across all our industries. Our analysis, based on national trends and the specific industries in our region, predicts that this could lower the cluster's emissions by up to 13%, saving over 1 MtCO₂e per year. By rigorously maximising all opportunities for REEE these measures will be cost effective, able to be implemented quickly and should not require access to region-wide infrastructure.

Whilst REEE measures can be implemented in individual industries and at individual sites, collaboration can enable transformative changes. The industrial partnerships formed in the Humber focussed on net zero will enable this. Together we can find opportunities such as waste heat supplying district heating systems, wastewater being recycled to reduce water stress, and waste streams from our integrated works and chemicals parks becoming feedstocks for neighbours.

AN OPTIMISED AND COSTED PLAN

Our analysis supporting this Plan focussed on finding the lowest cost solutions to decarbonise the energy intensive industrial sectors represented in our cluster. We carefully considered which technologies could be adopted for each process at each site, the regional infrastructure required to enable this, and the associated site and system-wide costs. The capital cost of this transition in our modelled scenarios is forecast to be between £7bn and £10bn.

The total cost to industry is also influenced by the additional fuel costs associated with each abatement option. This could result in total costs to industry between now and 2040 of £20bn to £34bn, and average costs of abatement of between £120 and £210 £/tCO₂. Timely and well-defined business models are needed to unlock the cluster's potential to

decarbonise. It is clear that by supporting the Humber industries to lead on industrial decarbonisation, we will provide the best national-scale value and impact. The technologies and knowledge developed through this bold transition can then be applied in the harder to decarbonise industrial clusters through CO₂ import and supply of low carbon hydrogen.

The Humber is very attractive to UK and foreign investors due to its existing infrastructure and the expanding low carbon opportunities. Decarbonising our industry will further enhance this- as a track 1 cluster we are already leading. The region's investment in decarbonisation will create up to 70,000 new jobs nationally, and over 20,000 in the Humber. It will support new low carbon enterprise through collaborative innovation opportunities, and growth in supply chain businesses through a clearly mapped programme of works.

Through providing investor confidence and continued investment, the Humber's unique contribution to the national economy will continue to grow.

Securing access to water for green technologies

Our water study highlighted the importance of effective management of water supply and demand to avoid water availability becoming a constraint in the Humber region. Electrolytic hydrogen is likely to develop the highest water demand in the Humber, with increased water use predicted for other low carbon hydrogen production, carbon capture and storage technologies.

The study investigated the risks and found that industries are likely to need to adopt a more circular approach, optimise processes and find synergies within the Humber cluster to promote efficient transfer of water around the region. We are working closely with water suppliers and the Environment Agency to ensure long term strategies for water supply are in place.



Mandate 5:
To generate social value through the industrial transition

Our region benefits from a thriving industrial community, with generations of family members contributing to the manufacturing outputs from some of the UK's largest businesses.

Our region delivers highly skilled and in turn highly paid jobs, including those necessary to enable industrial decarbonisation. Through our consultations with members of the local community and key stakeholders, we identified that people are protective and proud of where they live, and the region's heritage. Alongside a strong sense of identity and place, they told us that they want to be involved with the transition from the start, not only for themselves, but to safeguard their children's futures too.

Our Plan carefully considers and recommends that a strong community input is critical to generating buy-in, and that communication efforts need to be reframed to emphasise long term public participation. Young people need to be educated on future opportunities and considered in future consultations.



Mandate 6:
To further develop Humber skills and supply chains

As a region we are fortunate that many decarbonisation projects have already begun their public consultations. Our recommendations will enable them to refine their processes to further support visibility of opportunities, strengthen our economy, increase resilience and reduce inequality.

With ambitious timelines for the creation of a net zero cluster, the coming decade will see a period of intensive activity and high demand for the goods, services and skills needed to drive decarbonisation.

As the Humber's decarbonisation projects move into their development and construction phases, there will be a large increase in the parts and materials and engineering construction skills needed from the cluster's manufacturing, engineering and contractor supply chains.

Supply Chain & Skills

The Humber's engineering and industrial supply chains have grown to support our vast industrial base and continue to respond to the need for a range of services both on and off-shore. By acting now, we can ensure that local supply chains will be able to further grow their capabilities and capacities to meet future demands.

Through early supply chain engagement activities, we have communicated the breadth of requirements for parts and materials to develop the first phase of decarbonisation projects in the region. We have

£7-10bn

Capital Investment

22,800

Jobs created in the Humber region

enhanced workforce planning, recruitment and school engagement activities, alongside expanded action to meet equality, diversity and inclusion targets in our future workforce. Successful, strong supply chains will ensure that regional and national economies maximise the benefits from the anticipated investment, and that our suite of decarbonisation projects can be completed on time and on budget.

Our Plan identifies the steps that need to be taken to ensure local supply chains, skills and education providers play their full role in the creation of the UK's first net zero industrial cluster by 2040. Our region is poised to develop the technologies, skills and experience in the Humber which can be exported to other clusters and regions.



Mandate 7:

To drive investment and collaboration to deliver the net zero Humber of tomorrow

Our Plan sets out how the Humber can rapidly achieve net zero through implementation of our mandates. Our research, analysis, and consultation proves that it is viable, robust, optimised, and can be implemented at speed. Our Deployment Projects, along with additional net zero projects that are being developed in the cluster, align with our Plan. Each will contribute meaningfully to deep decarbonisation of the cluster. These projects urgently require the appropriate policy and economic frameworks to be established, and decarbonisation technologies to continue to be developed, to allow the planned and necessary rapid decarbonisation.

The Humber is uniquely positioned to go beyond net zero, with the potential to enable transformational levels of greenhouse gas removals. Decarbonising the Humber industrial cluster will be catalytic, enabling wider industrial decarbonisation and is core to the UK's overall pathway to net zero. Now is the time to start decarbonising the UK's vital energy intensive industries, through developing and implementing projects where they can be done most efficiently- in the Humber.

Our Mandates for action

1

To implement Carbon Capture and Storage and Greenhouse Gas Removal technologies at pace and scale

2

To implement low carbon hydrogen at scale

3

To adopt all optimal electrification measures

4

To prioritise efficiency and circular economy measures

5

To generate social value through the industrial transition

6

To further develop Humber skills and supply chains

7

To drive investment and collaboration to deliver the net zero Humber of tomorrow

Our Plan to reduce emissions is exemplary, both nationally and globally.

Our region has unique access to renewable energy and CO₂ and hydrogen storage.

Our rich industrial heritage equips the region with the skills and capability to lead.

Our industries are primed and ready to invest in this transformation.

Our Plan builds on this momentum, showing how to accelerate delivery.

**We invite you to join us on this journey.
Together it is possible.**

