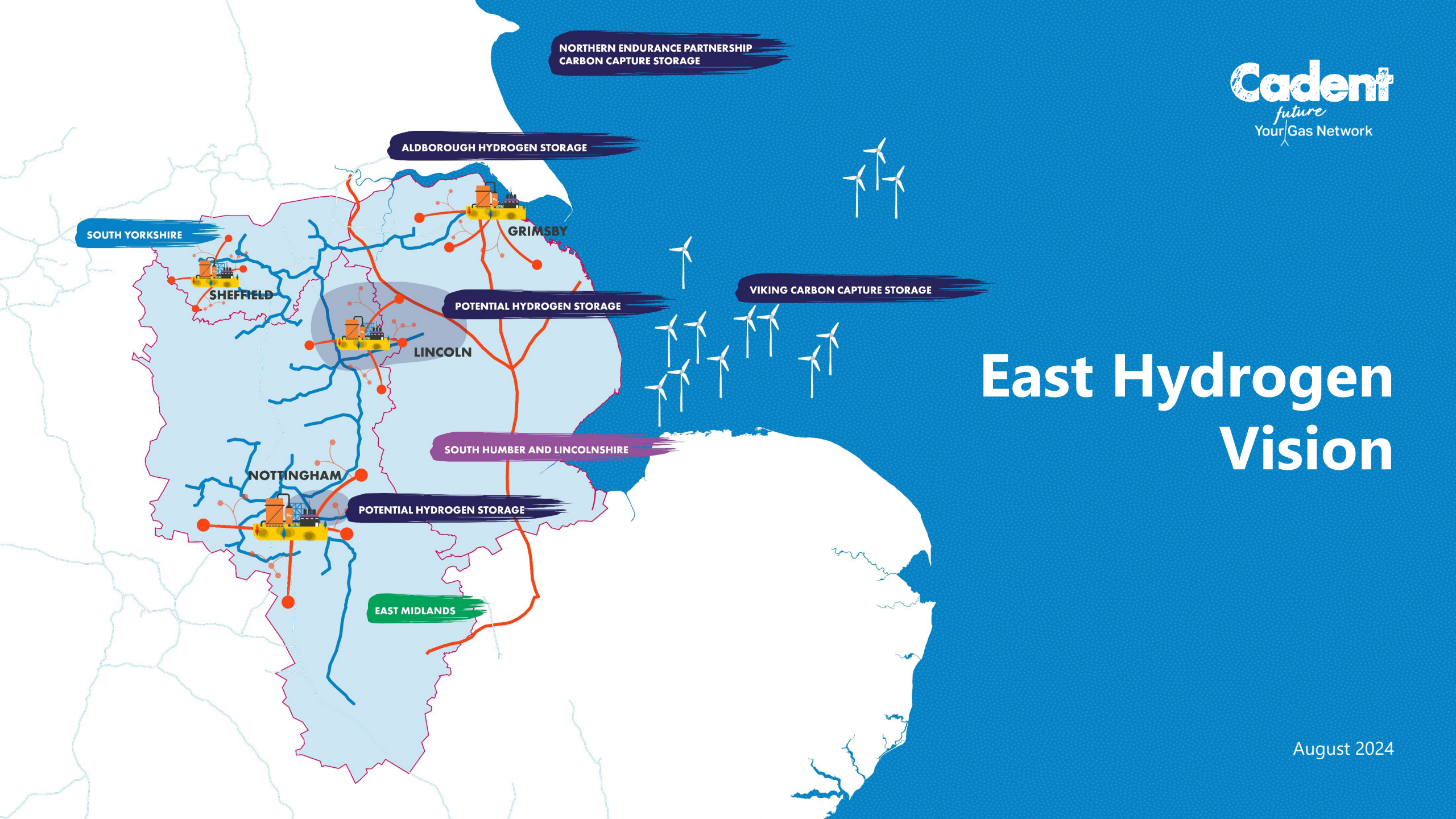


Cadent future
Your Gas Network

East Hydrogen Vision

August 2024

1.0
Executive Summary

Executive Summary

Hydrogen development in the East could decarbonise power, industry and transport whilst protecting existing jobs and creating new opportunities

This Vision demonstrates how hydrogen demand in the East can grow to almost 65TWh, by 2050 and avoid 9.6Mt of carbon dioxide emissions per year, equivalent to taking 5.7 million cars off the road. The development of new hydrogen production hubs and infrastructure in the region can decarbonise key sectors including power generation, industry and transport. The transition will also create high value jobs and see the region play a pivotal role in delivering the UK's ambition to be Net Zero by 2050.

For this study, the East region comprises of three distinct sub-regions: South Humber and Lincolnshire, the East Midlands, and South Yorkshire. We have used data-driven modelling to formulate a Vision for the hydrogen economy across the region and sub-regions.

Our model projects that the East will require nearly 65TWh of low carbon hydrogen per annum by 2050. This production is equivalent to approximately 8.7GW of hydrogen production capacity.

More than 17 hydrogen production projects are already in development in the region with a total capacity of 3.9GW. The hydrogen demand identified in this report presents an opportunity to attract a further 4.8GW hydrogen production capacity by 2050, requiring new production projects to be developed.

Beyond production, the region is also expected to benefit from new hydrogen transport and storage infrastructure. This includes the key pipelines of East Coast Hydrogen and hydrogen storage at Aldbrough and Rough.

The development of a hydrogen economy will stimulate economic growth in the region, creating **high-quality jobs across the ecosystem**. Our analysis demonstrates that, during the construction phase over 8,000 jobs could be created across the supply chain between 2025 and 2050, with peak activity from 2025 to 2035. Operational jobs in the hydrogen industry are forecast to reach 32,500 by 2050. Our modelling indicates that the deployment of hydrogen in the East creates an additional £3.44bn of GVA per annum (in today's prices) by 2050.

Collaboration is key to support the development of the hydrogen economy in the East. The East Coast Hydrogen and East Midlands Hydrogen consortia are already leading progress in this space.

This Vision seeks to engage stakeholders across the region, to unlock the benefits brought about through the deployment of hydrogen as a part of delivering their own Net Zero strategies. It highlights the distinctive advantages in the region, provides clarity on how the region's hydrogen economy could develop and shows the economic benefits gained.

by 2050

POTENTIAL TO PRODUCE NEARLY

65TWh

of Low Carbon Hydrogen

SAVING

9.6Mt

of CO_2 / Year

CREATING AN ADDITIONAL

£3.4bn

in GVA per annum

CREATING ALMOST

11,000

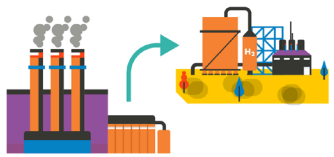
direct jobs

*Direct jobs in hydrogen production and transportation as well as industries that directly supply goods or services e.g., water or feedstock energy for hydrogen production

SAVING
9.6Mt
of CO_2 / Year

POTENTIAL TO PRODUCE NEARLY
65TWh
of Low Carbon Hydrogen
BY 2050

2025
0.1TWh

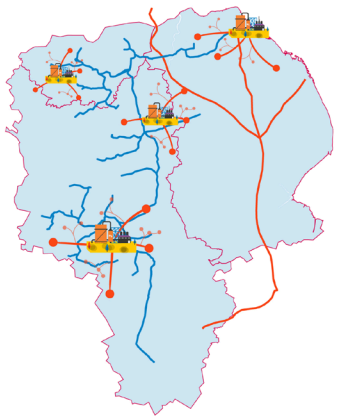


The region's first low carbon hydrogen production facility goes into operation at HyMarnham

2030
7TWh

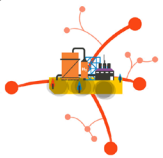
Carbon Capture and Storage facilities come online (Northern Endurance Partnership and Viking)

2035
24TWh



Regional hydrogen demand has reached 24TWh each year

2040
37TWh



Construction of the East Coast Hydrogen pipeline has been completed

2050
65TWh

The East has achieved Net Zero, utilising 65TWh of hydrogen a year

CREATING ALMOST
11,000
direct jobs

CREATING AN ADDITIONAL
£3.4bn
in GVA per annum

Cadent
future
Your Gas Network

2.0
The East: A region ready to embrace the hydrogen opportunity

*Modelled energy demand includes Oil and Gas derived energy in industry, power, commercial, transport and domestic sectors. This excludes low carbon sources, coal derived and off grid energy demand.

The East

Encompassing three sub-regions each with their own hydrogen opportunity

The East has a strong industrial heritage and is expected to play an important role in delivering the UK's Net Zero goals. Of the modelled sectors, today, the region contributes 13% of the UK's carbon dioxide emissions*. Hydrogen will help to decarbonise the region, preserve jobs, and open new opportunities.

The East is made up of the three sub-regions **South Humber and Lincolnshire, South Yorkshire and the East Midlands.** Each sub-region has its own characteristics which are described on the following three pages.

Our modelling suggests that future hydrogen demand in the East will be driven by the decarbonisation of power, industry and transport. The region's **industrial legacy** began at Crawford Mill, Derby, the world's first factory and by the 1960s, coal-fired power stations along the River Trent were supplying a quarter of the UK's **power demand**. This earned the region the moniker "Megawatt Valley". Today, 18.4TWh of natural gas in the region is used by industrial and commercial customers:

- Large-scale power generation e.g. Staythorpe.
- Lime and cement e.g. Singleton Birch and Hanson.
- Iron and steel e.g. British Steel.
- Oil Refining e.g. Phillips 66 Ltd Humber Refinery.
- Mineral industries, such as glass and ceramics e.g. Ardagh Glass and Forterra.

The East has direct connection across the UK and to the rest of the world through its **transport links.** Regional shipping ports, including Immingham and Grimsby, handle 50 million tonnes of cargo annually, whilst East Midlands and other smaller Airports serve over four million passengers per year[1,2]. The East's road network, including the M1, accommodates goods vehicles traffic, the southern part of the region is also situated in the UK's Logistics 'golden triangle,' which is within a four-hour drive of 90% of the population[3].

In addition to these key demand sectors the region also has characteristics that will support the development of a future hydrogen economy:

- The East's geology provides access to both offshore carbon storage, which will enable blue hydrogen production and hydrogen storage potential.
- Existing renewable electricity supply in the region will be strengthened by new offshore wind projects, supporting green hydrogen production.
- Legacy powerlines and an abundance of water along what was formally the 'Megawatt Valley' lending themselves to green hydrogen production.

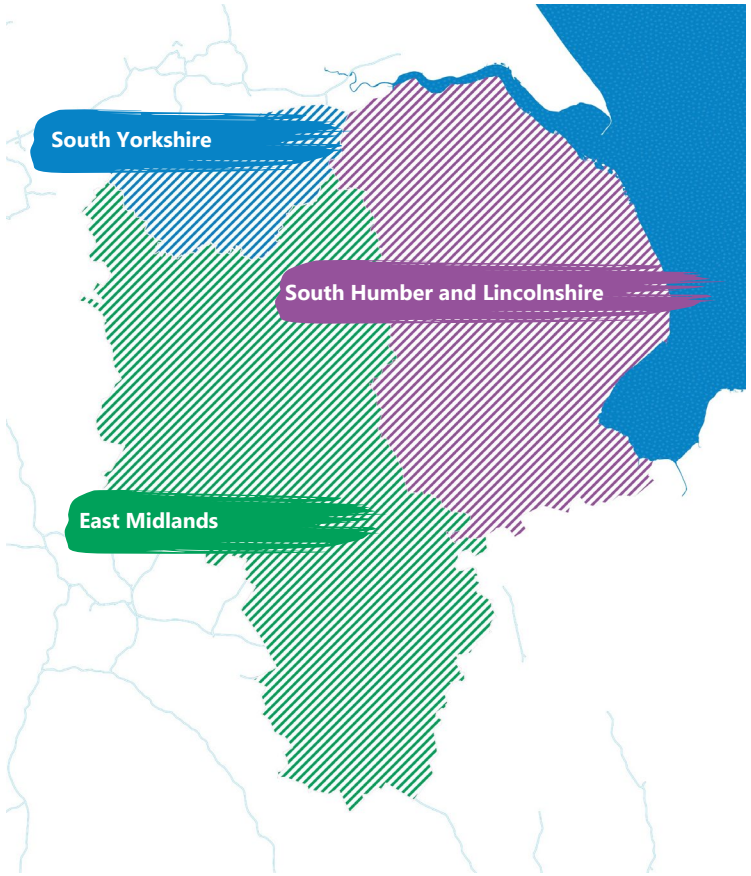


Figure 1: Sub-regions within the East Hydrogen Vision

*Modelled energy demand includes Oil and Gas derived energy in industry, power, commercial, transport and domestic sectors. This excludes low carbon sources, coal derived and off grid energy demand.

South Humber and Lincolnshire

Kickstarting the hydrogen economy

The South Humber and Lincolnshire region is well positioned for hydrogen and is already advancing the opportunity. It has access to 80% of the UK's licensed offshore carbon dioxide storage capacity, 35% of the operating offshore wind capacity and creates almost 40% of the UK Government's industrial cluster emissions[4, 5].

South Humber forms part of the Humber Industrial Cluster, the UK's largest emitting industrial cluster and Lincolnshire is predominantly rural, with a large coastline along the North Sea.

South Humber and Lincolnshire are a vital part of the UK's energy landscape generating over 25% of the UK's renewable electricity today[6]. The coast provides access to 4GW of offshore wind, with developments such as Outer Dowsing, set to add an additional 1.5GW. The region also generates renewable electricity from its 317MW of solar farms, and biogas with 1TWh produced annually within the region[7].

Immingham port, England's largest port per tonnage, is in the region. With the shipping industry currently developing sustainable marine fuel, there is an opportunity for South Humber and Lincolnshire to be at the forefront of maritime decarbonisation.

Across South Humber and Lincolnshire, regional and local authorities have introduced plans to achieve Net Zero.

Additionally, the region is preparing for the transition by upskilling local people. Lincolnshire County Council for example, have allocated funding from 2026 for training in green jobs[6].

The region's **hydrogen journey has already begun**. Multiple projects span the production, storage, transportation and demand supply chain. **East Coast Hydrogen**, extending across the region, will transport hydrogen through new and re-purposed Cadent and National Gas Transmission Pipelines, connecting the East with the North East in collaboration with Northern Gas Networks. There is also the potential to expand to other hydrogen programmes in the future, including neighbouring Hydrogen Valley in the Midlands and HyNet in the North West.

The South Humber and Lincolnshire region has the following advantages which lend themselves to developing a hydrogen economy:

- Access to **Carbon Capture and Storage (CCS) infrastructure** such as Viking with the ability store 10 million tonnes of carbon dioxide per year.
- Access to **renewable energy** including onshore solar and offshore wind.
- Densely clustered industrial and power generation companies readying themselves to transition to hydrogen.
- Action taken to **train and re-skill workers** for growing demand from the green and hydrogen sectors.

Figure 2a.

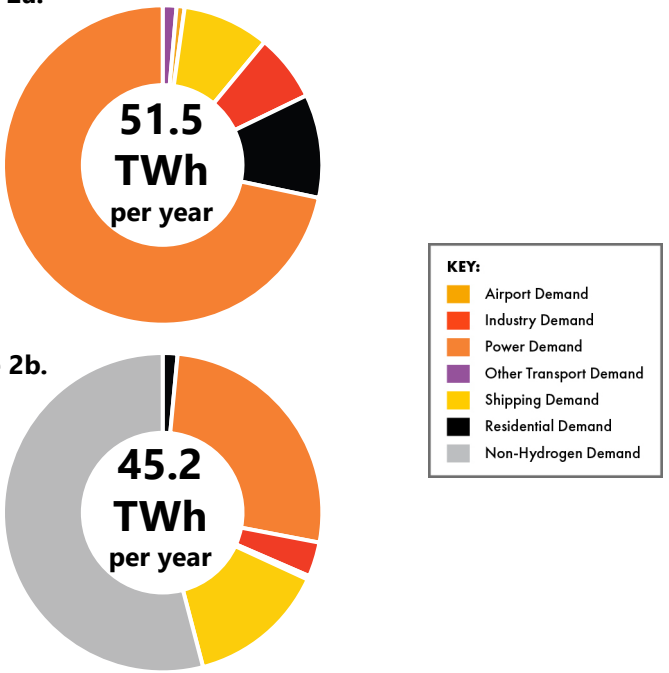


Figure 2b.

Modelled Energy Demands in South Humber and Lincolnshire

Figure 2a. Distribution of current energy demand between modelled sectors based on today's predominantly fossil fuel based economy.

Figure 2b. 2050 modelling of the sectoral distribution of hydrogen (coloured) and non-hydrogen (grey) energy demand.

*Modelled energy demand includes Oil and Gas derived energy in industry, power, commercial, transport and domestic sectors. This excludes low carbon sources, coal derived and off grid energy demand.

South Yorkshire

Establishing the hydrogen supply chain

South Yorkshire is home to key parts of the hydrogen supply chain as well as difficult to decarbonise industries, such as steel and glass. Collaboration will enable the continued growth of the hydrogen sector.

South Yorkshire is well connected with the rest of Yorkshire as well as the North East. Its inland landscape is predominantly an **urban area with an industrial heritage**. In energy terms the landscape is difficult to decarbonise creating an opportunity for hydrogen to play a key role. The South Yorkshire Mayoral Combined Authority area gets most of its energy from fossil fuels, only 11% coming from renewables[8]. Wind contributes 250GWh of electricity to the area, and the other major low carbon sources are produced from Biomass and waste e.g. Blackburn Meadows Power Station and Veolia Energy from Waste (EfW) Plant. Transport, industry and commercial sectors account for a third of the region's energy demand.

Both public and private sector stakeholders, have set out **ambitious Net Zero targets** for the region. Sheffield City Region published their 'Establishing a Regional Hydrogen Economy' report in 2019[9]. As part of this, the South Yorkshire Hydrogen Network was formed.

Cadent's East Coast Hydrogen pipeline connects Immingham to Rotherham initially and extends in a later phase. It will supply steel manufacturers, glass companies, flexible power generators, and potentially hospitals and the university.

Today, **the regional hydrogen economy revolves around its role in the supply chain**. South Yorkshire is home to several companies providing key elements for hydrogen production projects including CPH2, ITM Power, Lhyfe and Chesterfield Special Cylinders.

ITM Power, a market leading hydrogen electrolyser manufacturer based in South Yorkshire, have plans for a "Gigafactory" in Tinsley. Part of these plans are for a **National Hydrogen Research Innovation and Skills Centre** to undertake research into using low carbon sources of energy, and teach the skills required to build the hydrogen economy.

South Yorkshire has the following traits which can be built upon to enable a hydrogen economy:

- **Track record for innovation** e.g. home to the country's first hydrogen mini-grid in Rotherham.
- Significant supply chain elements manufactured in-region including electrolysers at ITM power and CPH2.
- The beginnings of **collaboration initiatives e.g. South Yorkshire Hydrogen Network.**
- Planned hydrogen pipeline from East Coast Hydrogen.
- Difficult to decarbonise energy demand well suited for hydrogen deployment e.g. Forgemaster's steelworks.

Figure 3a.

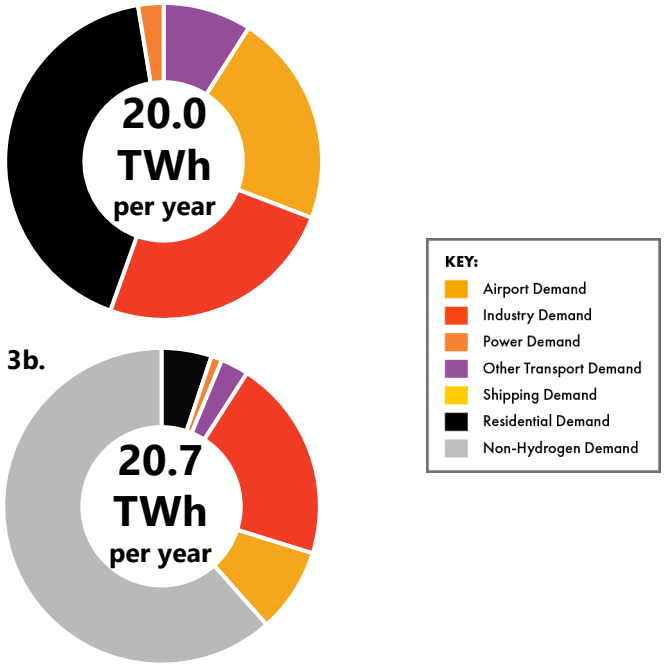


Figure 3b.

Modelled Energy Demands in South Yorkshire

Figure 3a. Distribution of current energy demand between modelled sectors based on today's predominantly fossil fuel based economy.

Figure 3b. 2050 modelling of the sectoral distribution of hydrogen (coloured) and non-hydrogen (grey) energy demand.

*Modelled energy demand includes Oil and Gas derived energy in industry, power, commercial, transport and domestic sectors. This excludes low carbon sources, coal derived and off grid energy demand.

East Midlands

Collectively developing the hydrogen economy

The East Midlands is starting to pursue the hydrogen opportunity. The region's stakeholders are taking a collective approach with initiatives such as East Midlands Hydrogen.

The East Midlands has a **diverse landscape with farmlands, the UK's oldest National Park and urban areas**. It is well connected to the South of England and West Midlands. In the 1980s, the River Trent Valley was home to numerous coal-fired power stations which produced electricity in the region and saw it nicknamed the Megawatt Valley. The stations are now being phased out in favour of lower carbon natural gas power stations and renewable energy production.

Over 50% of the modelled current energy demand* in the East Midlands sub-region is from aviation demands and electrical power generation. 32% of the modelled energy demand is associated to power generation and East Midlands Airport accounts for 20% of the region's identified energy demand.

Collaboration is well established within the region, local authorities are supportive of hydrogen and following discussions with producers and potential offtakers as part of East Midlands Hydrogen, Cadent are developing hydrogen pipelines for the region. This section of East Coast Hydrogen enables hydrogen to get to those who need it and demonstrates the need for collaboration in developing a hydrogen ecosystem.

The Megawatt Valley has the opportunity to become a hydrogen production powerhouse. The legacy high voltage transmission lines and water from the River Trent could unlock significant green hydrogen production opportunities. Chinook Hydrogen and Ratcliffe-on-Soar projects are already in development targeting 50MW and 500MW of hydrogen production, respectively. Additionally, supported through Government Hydrogen Allocation Round 1 (HAR1) funding, HyMarnham will produce 9.3MW of hydrogen.

The East Midlands is ready to take hold of the opportunity with the following key assets in development:

- East Midlands Hydrogen encouraging cross sector **collaboration.**
- **More than 650MW** of planned hydrogen production facilities in the region.
- Planned hydrogen transportation infrastructure, **Cadent hydrogen pipelines** will serve Nottinghamshire, Derbyshire and Leicestershire as part of the **East Coast Hydrogen** network. Future expansion will connect to South Yorkshire and Northamptonshire.
- **Initiatives such as EMStor** developing inland underground hydrogen storage options.

Figure 4a.

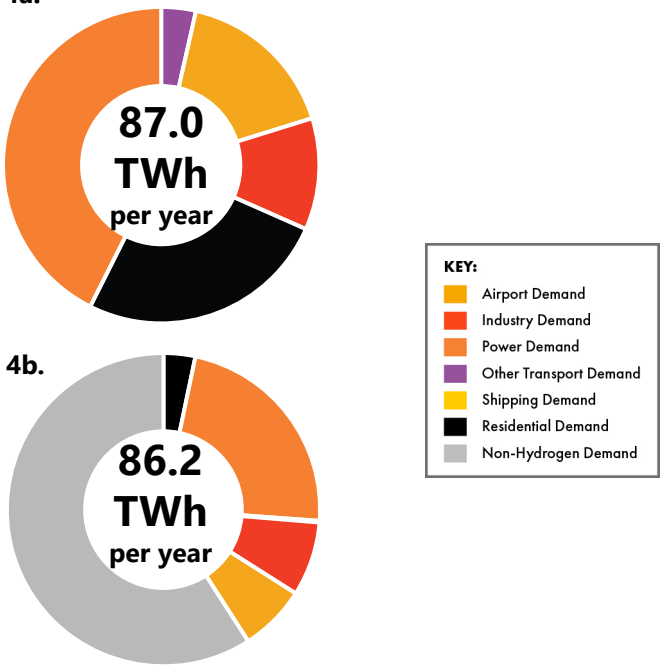


Figure 4b.

Modelled Energy Demands in East Midlands

Figure 4a. Distribution of current energy demand between modelled sectors based on today's predominantly fossil fuel based economy.

Figure 4b. 2050 modelling of the sectoral distribution of hydrogen (coloured) and non-hydrogen (grey) energy demand.

3.0
The Vision

*Via connection to North Humber bank

The Opportunity

65TWh of hydrogen is required in the region by 2050 to displace natural gas and aid decarbonisation

Regionally, **more than 17 hydrogen production projects are in development** totalling 3.9GW and new ones are being announced as developer's plans mature. Our modelling shows there is potential demand to attract a further 4.6GW of low carbon hydrogen production by 2050.

The East Coast Hydrogen pipeline supports cost-effective hydrogen transport around the region and will facilitate its export to other regions of the UK. **Hydrogen storage** near Aldbrough (0.32TWh) and Rough (3.3TWh) will provide resilience and flexibility for hydrogen users. Additionally, the EMStor project has identified possible inland hydrogen storage and are assessing the potential for hydrogen storage in depleted oil fields.

Regional hydrogen demand, from industry, power and transport supports this opportunity; our modelling shows **65TWh of regional cross-sector hydrogen demand by 2050.**

South Humber and Lincolnshire	South Yorkshire	East Midlands
Humber H_2ub (840MW) Immingham Green Energy Terminal (300MW) And other projects in development.	Blackburn Meadows (24MW) H_2 Mini Grid (0.1MW)	HyMarnham (100MW) Bilsthorpe (1.25MW) Ratcliffe-on-Soar (0.5GW) Chinook (50MW)
Strategic collaboration through East Coast Hydrogen, Humber Industrial Cluster Plan.	HyDESS trialling hydrogen for steel manufacture. Advanced Manufacturing Research Centre (AMRC) ITM Power and CPH2	Strategic collaboration through East Midlands Hydrogen
Aldbrough* (0.32TWh) Rough* (3.3TWh) East Coast Hydrogen		EMStor East Coast Hydrogen

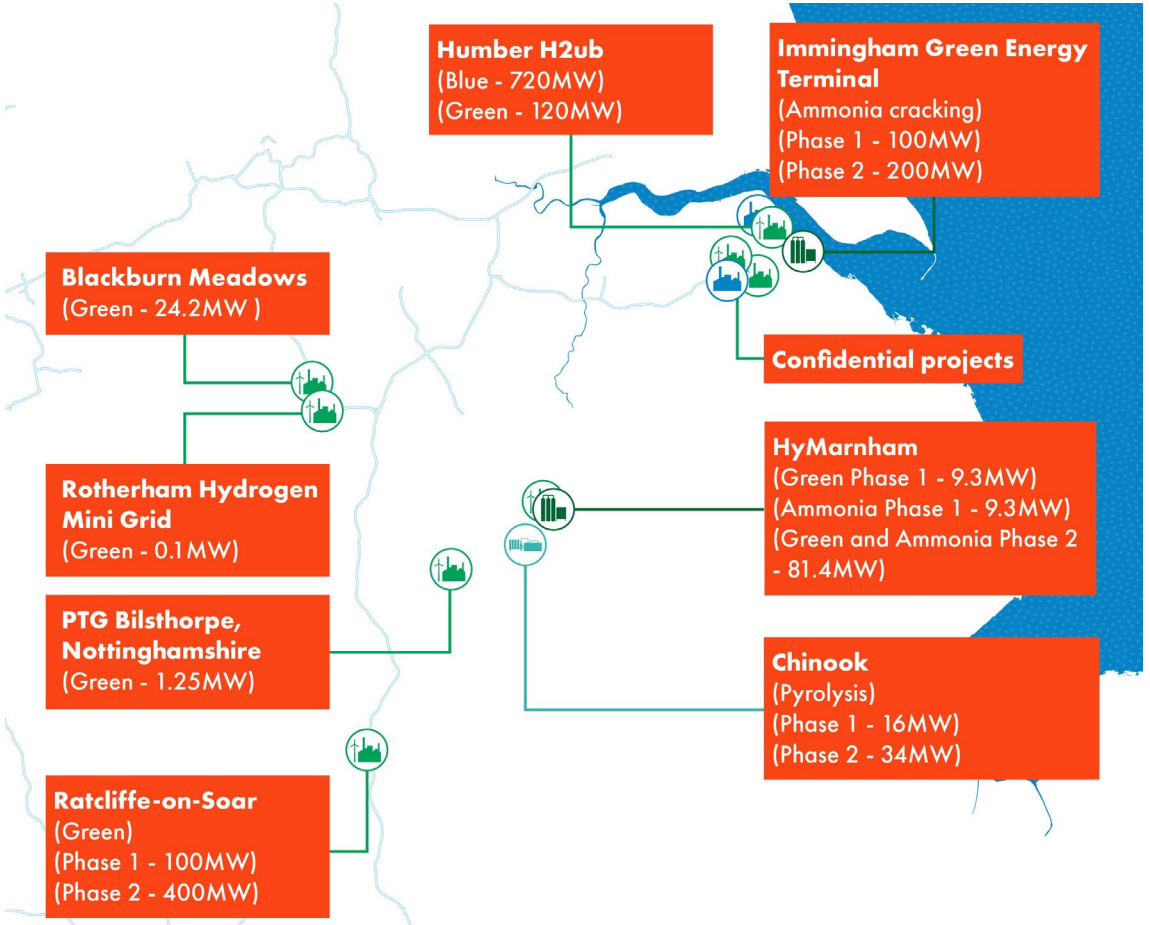


Figure 5: Planned hydrogen production across the East

Our Approach

A robust model to calculate hydrogen supply and demand per annum by 2050

We have taken a data backed approach using both top-down and bottom-up analysis to model the development of hydrogen supply, demand and infrastructure in the East over the next 25 years.

The modelling methodology has been developed around the alignment of results from **top-down and bottom-up** analysis. This ensures we are using the latest targets, literature, and opinions, as well as local deployment requirements.

Our **top-down** approach uses sector-based assumptions and profiles to model how current energy demand transitions over time into projected future hydrogen demand. Our modelling considers that hydrogen is one of many decarbonisation strategies and that significant electrification will be required in the region. The Leading the Way Future Energy Scenario 2023 (FES) was used as a base case to determine these sector-based transition proportions and profiles to hydrogen. The FES assumptions were then localised for the East; accounting for its features that lend themselves to hydrogen transition, as outlined in Section 2.0.

The **bottom-up** approach leverages local knowledge and technical constraints collected from literature and stakeholder engagement. The methodology identifies hydrogen demand by comparing the estimated size of a site's hydrogen demand with its distance from planned hydrogen infrastructure.

The hydrogen demand used in the bottom-up process is the current energy demand converted to future hydrogen demand by using the following assumptions:

- growth
- efficiency gains
- the amount of hydrogen required compared to incumbent fuels in the sites processes
- the degree of choice a site has on the future fuel used

Bottom-up parameters were adjusted following investigation of the results and comparison with the top-down approach. Then iterations continue until reasonable alignment of the methodologies occurs.

The model assumes that hydrogen production beyond current planned projects, follows demand utilising Government support.

The outputs of this model are the geospatial development of hydrogen supply, distribution, and demand over time.

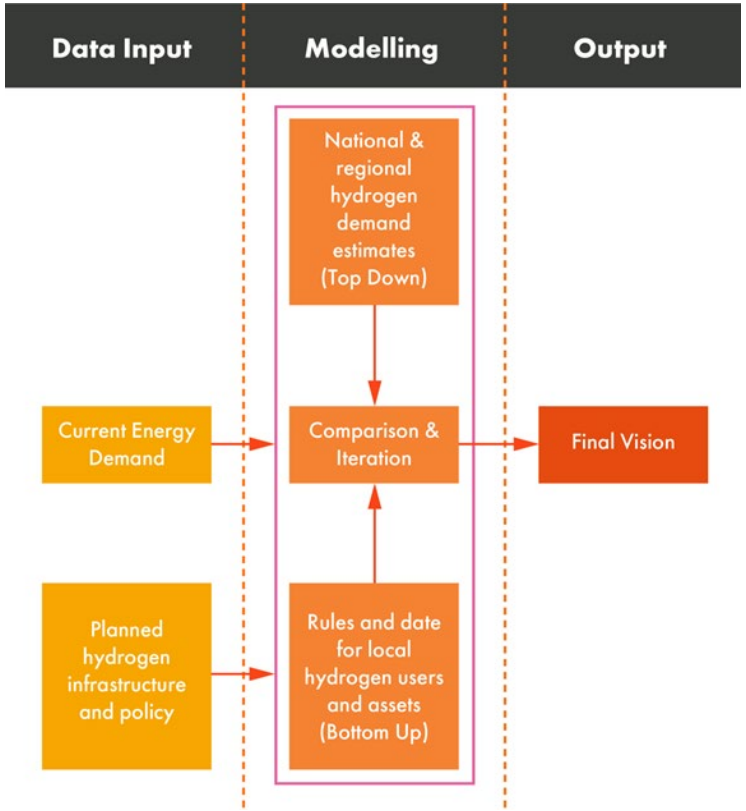


Figure 6: Top-down and bottom-up approaches used within the hydrogen development model

Assumptions

The real-world context driving these insights

The Vision is data driven, drawing on over 20 data sets for current energy demand and approximately 50 assumptions to bring real life context. This section provides a summary of the assumptions used.

The model utilises data from a wide range of sources including Cadent's and National Gas's gas consumption figures[10]. **Data assumptions** include those made to generate a regional picture of current energy demand, e.g. energy demand associated with shipping can be distributed between ports using freight volumes.

A set of assumptions were used to illustrate the **hydrogen production infrastructure** that will be online by 2050, including how biomethane sites may contribute to the future production capacity for hydrogen.

To regionalise the percentages provided in the FES Leading the Way scenario for the different sectors switching to hydrogen, justification categories were designed. The categories were used to adjust the sector-specific percentages in the **top-down** methodology. For example, sectors that already demonstrate using hydrogen within the region would convert at higher percentages than those demonstrated within the UK, internationally, or not at all.

In the **bottom-up** analysis, assumptions were made to convert current energy demand to future hydrogen demand and connect them to hydrogen infrastructure. These include growth, process efficiency and site's control over choice of fuel.

Finally, assumptions on the **political landscape** have been made, including:

- The Government ambition to achieve 10GW (or more) of low carbon hydrogen production capacity by 2030 is met.
- A Government decision on hydrogen for heat in 2026 is supportive of converting a limited portion of the gas network to 100% hydrogen. The volume of hydrogen required to meet this demand is linked to the FES Leading the Way scenario. This leads Government to setting a new target for hydrogen production and adapting business model support accordingly.
- Government policy will continue to support hydrogen production, beyond the Hydrogen Allocation Round (HAR) remit, with business model support until the market is established. Support is also provided to the gas network as part of the Hydrogen Transport and Storage Business Models. The UK Emission Trading Scheme (ETS) is strengthened, and the proposed Carbon Border Adjustment Mechanism (CBAM) is well designed.
- Government continues to support hydrogen blending as an off-taker of last resort.

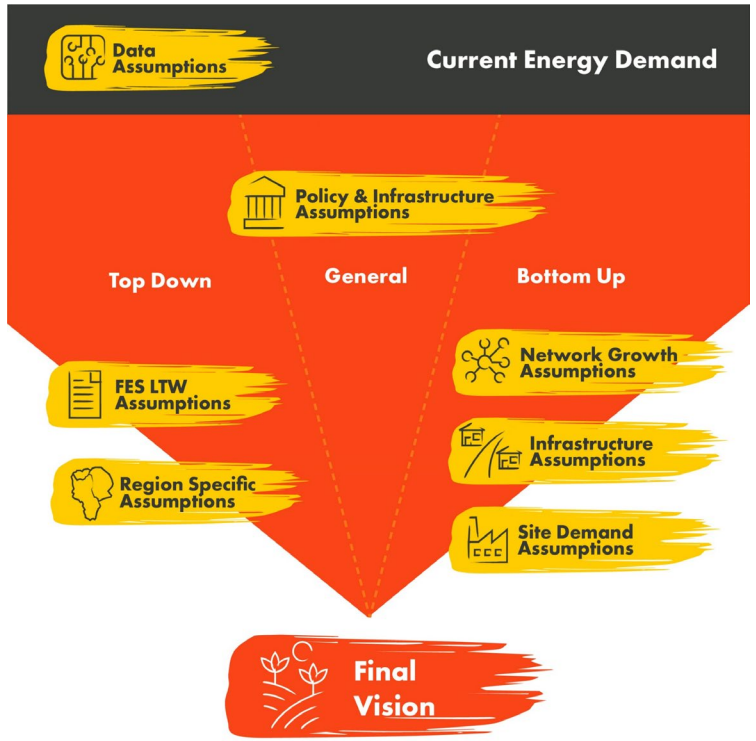


Figure 7: Summary of the model assumptions

By 2025

The first low carbon hydrogen molecules are produced in the region

Across the East work is underway to develop the hydrogen opportunity.

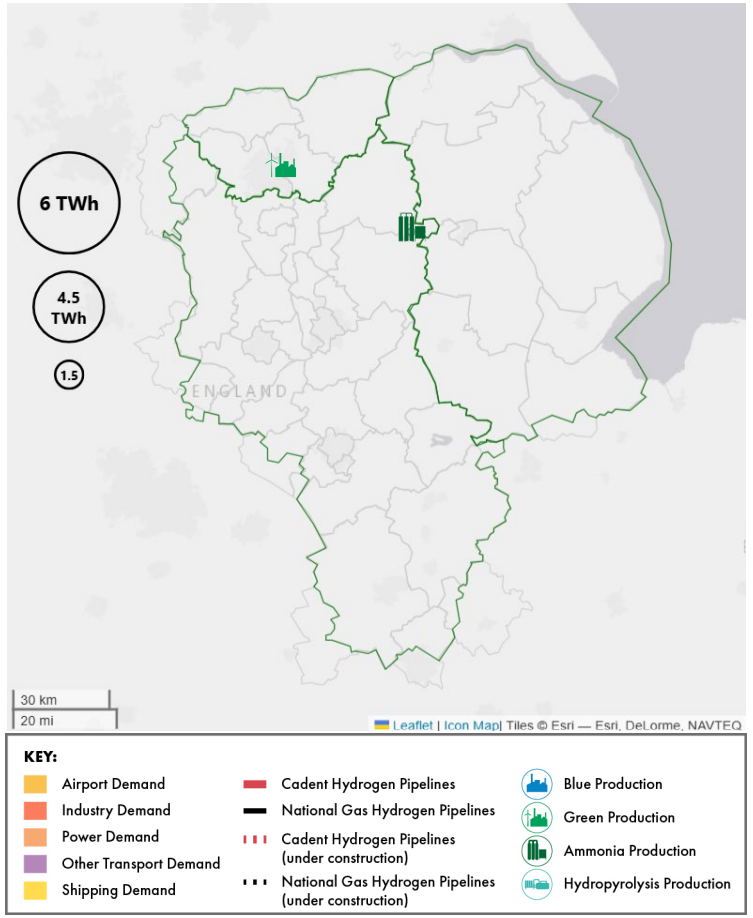
Production: The first hydrogen production sites are in final development or construction, with HyMarnham in operation.

Demand: Pre-agreed offtakers begin to take hydrogen, many blending hydrogen into natural gas processes. Government support under Hydrogen Allocation Round 2 (HAR2) sees up to 875MW of contracts allocated in 2025 across the UK. Hydrogen Allocation Round 3 (HAR3) is launched, bringing additional opportunity for new production projects in the East. HyDESS has completed Front End Engineering Design (FEED) furthering the case for utilising hydrogen in the steel industry.

Transport and storage: EMStor enters Strategic Innovation Fund Alpha Phase, looking to develop a depleted oil field hydrogen storage trial. The design of new and re-purposed hydrogen pipelines by Cadent and National Gas Transmission is underway through the East Coast Hydrogen collaboration, driving confidence to invest across the wider value chain.

Potential offtakers, producers and transporters are coming together across the region to identify how they can work together and build momentum in the transition to Net Zero. This collaboration is providing security and confidence, encouraging organisations to make the switch to hydrogen.

Figure 8: Operational hydrogen production across the East



Growth of hydrogen production and demand

Developments

- Hydrogen production sites are supplying hydrogen to the first offtakers
- New projects receive support under HAR2
- HAR3 launched in 2025, allocates 750MW of low carbon hydrogen production
- East Coast Hydrogen is at Front End Engineering Design stage
- National target of 2GW of hydrogen production in construction or operation is met
- Construction companies begin to reskill and recruit, preparing for an increase of hydrogen production sites.

By 2025

The first low carbon hydrogen molecules are produced in the region

South Humber and Lincolnshire

Positive advances have been seen in South Humber and Lincolnshire with hydrogen production facilities such as Immingham Green Energy Terminal and Humber H2ub under development, preparing for construction. Industry are preparing for the transition to using hydrogen fuel.

Construction begins on the Viking CCS project targeting 2028/2029 operation. Running from Immingham to Theddlethorpe and into the North Sea, Viking brings potential for blue hydrogen to the region.

South Yorkshire

Collaboration between industry, producers and key stakeholders in the region builds consensus and momentum. E.g. Hydrogen for the Decarbonisation of Sheffield Steel (HyDESS) is demonstrating the potential for hydrogen in the steel industry.

Production sites such as Blackburn Meadows are in development, encouraging potential users of hydrogen in South Yorkshire to make the switch and decarbonise. With increasing demand in the hydrogen supply chain, manufacturing industries across South Yorkshire are ramping up production to support hydrogen developments across the UK.

East Midlands

Hydrogen starts to hit the market with construction underway for Chinook Hydrogen Phase 1 and HyMarnham planned to be operational. Uniper's Ratcliffe Project is continuing to develop, mobilising to produce hydrogen on a mass scale.

Regional pipelines and storage facilities are in development through East Midlands Hydrogen. Development of the Cadent regional hydrogen network is working to ensure difficult to decarbonise industry have the option to switch to hydrogen.

Killingholme power station

Liberty Steel Rotherham site

Forterra brick factory

By 2030

Hydrogen production expands across the region decarbonising industry and power

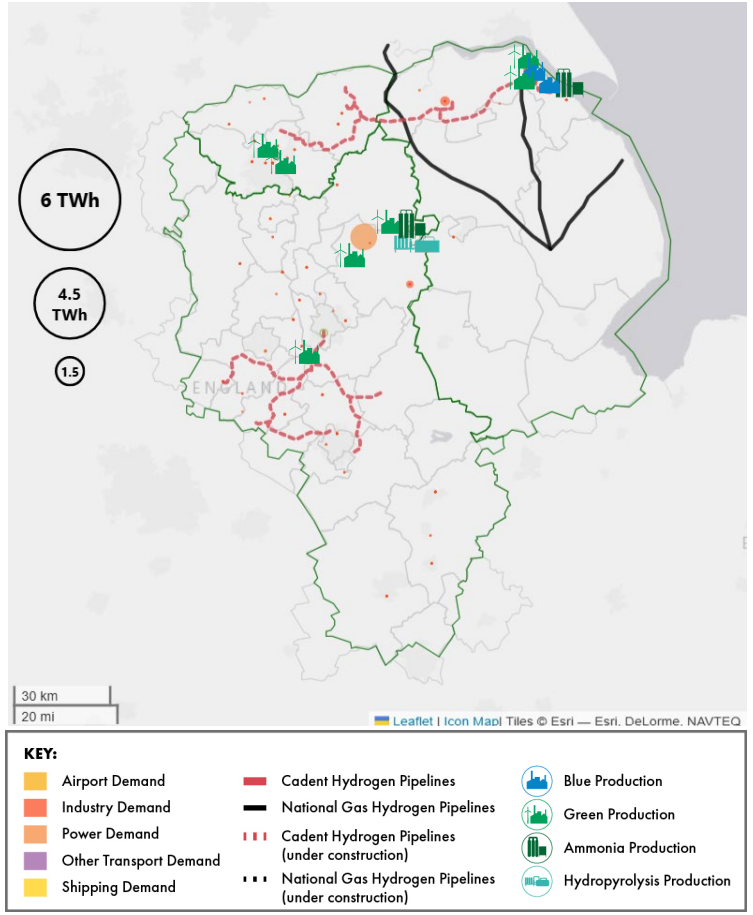
The first production sites and early adopters have been operational for several years encouraging industry in the East to decarbonise, increasing hydrogen demand.

Production: Offshore wind farms in the North Sea enable green hydrogen production with planned production sites in development to keep up with rising hydrogen demand. Through Hydrogen Allocation Rounds, the Track 1 expansion and Track 2 processes, low carbon hydrogen production has reached a capacity of 3.4GW. Carbon Capture and Storage facilities such as Northern Endurance Partnership, and Viking allow blue hydrogen production to come online by the end of 2030. The East has contributed 32% of the Government's 10GW low carbon hydrogen production target.

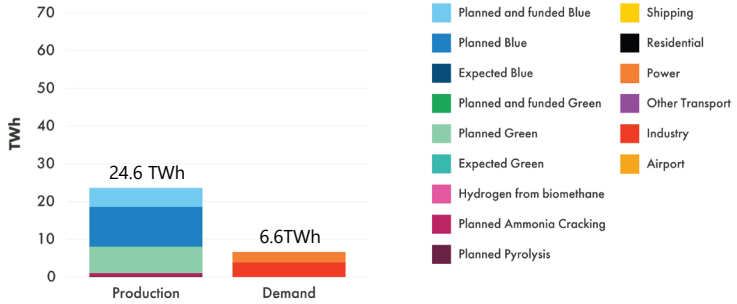
Demand: 21% of regional industrial gas demand has switched to hydrogen. Collaboration in and between the regions has allowed producers to supply industries that require hydrogen, establishing transport and storage infrastructure where required, accelerating the transition to reach Net Zero.

Transport and storage: East Coast Hydrogen pipelines are under development. Re-purposed National Gas pipelines are carrying hydrogen to customers in the region, and new build Cadent and National Gas hydrogen pipelines are under construction in the South Humber and South Nottinghamshire area. Cadent's EMStor Project has commissioned a demonstrator of storage of hydrogen in a depleted oil field.

Figure 9: Developing hydrogen production and infrastructure



Growth of hydrogen production and demand



Developments

- 10GW low carbon hydrogen production in the UK is met
- 2026 hydrogen for heat decision brings clarity to the role of hydrogen for domestic heat
- Government implements a 10% SAF mandate on aviation fuel, driving use of low carbon hydrogen as a feedstock in SAF production
- East Coast Hydrogen Pipelines have been re-purposed in the South Humber, and new build pipelines are under construction there and in Nottinghamshire
- Biomethane production reaches 6% of gas demand
- Rough and Aldbrough storage caverns are operational
- Construction of infrastructure supports local jobs.

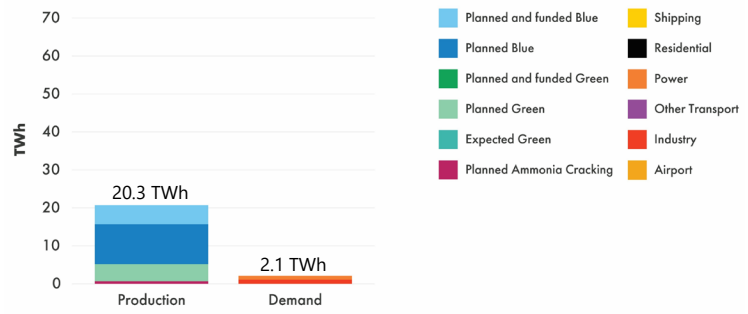
By 2030

Hydrogen production expands across the region decarbonising industry and power

South Humber and Lincolnshire

Much of the East's hydrogen production is being generated in South Humber and Lincolnshire. Production projects, such as Humber H_2ub, are bringing total capacity of 2.8GW of hydrogen to the region, supported by operational Carbon Capture and Storage (e.g. Northern Endurance Partnership). Industries in the region have responded by starting to transition to hydrogen, accounting for 1TWh of hydrogen demand.

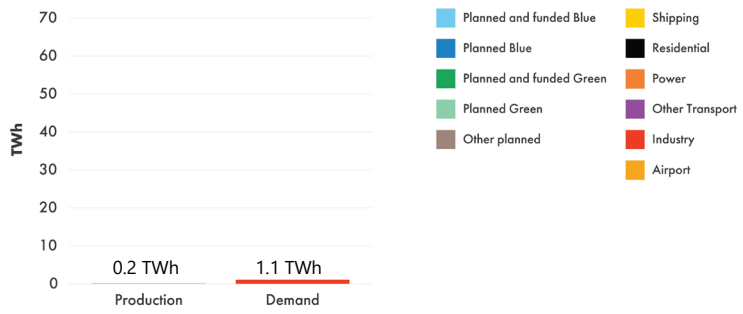
Initial phases of pipeline re-purposing by National Gas have been completed, laying the foundations for connecting the South Humber to the North East.



South Yorkshire

Many industries in the region are working with local authorities and producers to transition to hydrogen by blending hydrogen into natural gas processes, resulting in 1TWh of demand in South Yorkshire. Currently there is only 24.2MW of production capacity planned, creating an opportunity for additional regional projects to be developed.

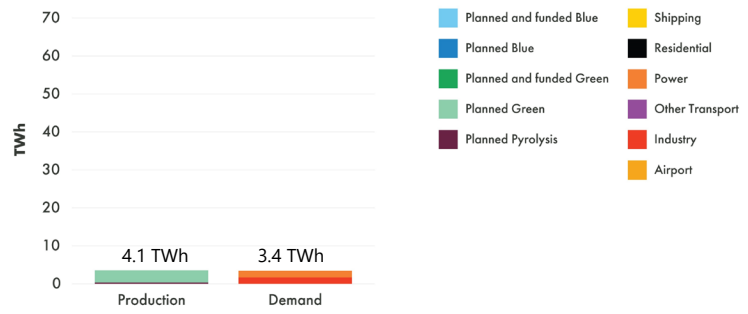
Construction has started on new build hydrogen pipelines such as Cadent's Immingham to Rotherham hydrogen pipeline. The pipeline will enable industry along the route to switch away from natural gas, contributing to the decarbonisation of UK steel, glass, chemicals, building materials and fuel production.



East Midlands

By 2030, electrolytic hydrogen production has started in at least three different sites in Nottinghamshire, totalling 500MW of hydrogen production capacity. Hydrogen will be used on or near production sites or will be transported to customer via tube trailer.

Subject to funding and consent, construction has started on Cadent's East Midlands Hydrogen Pipeline, that will connect production sites to East Midlands Airport, local industry and flexible power generators. Through the EMStor Project, a demonstrator has been developed for storage of hydrogen in depleted oil fields and plans are underway to roll-out localised storage to accelerate further development of the pipeline and connections to industry.



By 2035

Following completion of initial infrastructure, hydrogen production is connected to demand across the region.

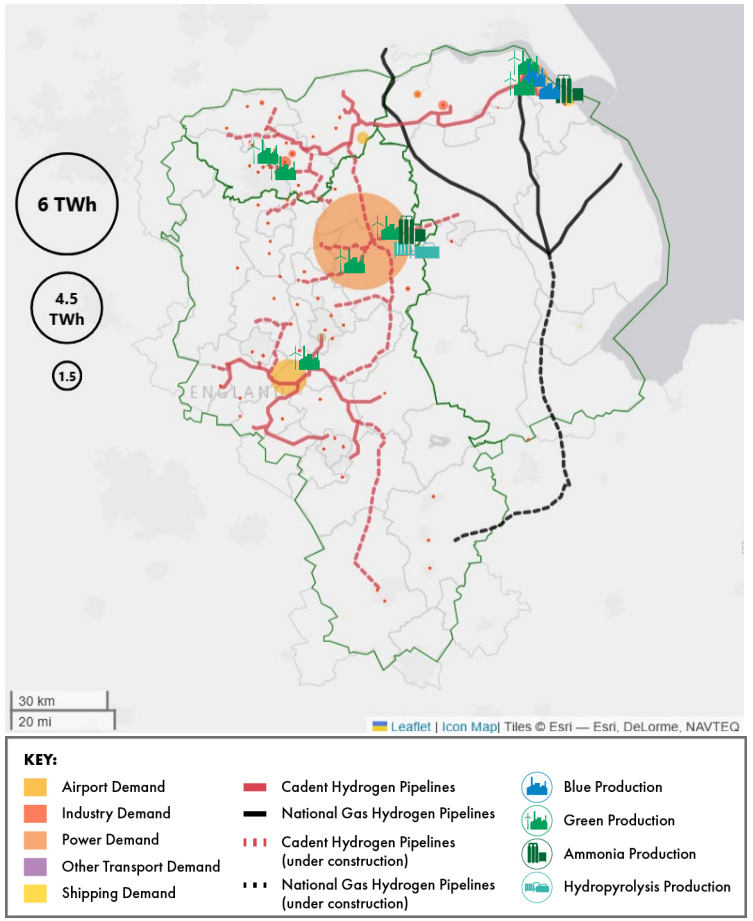
The hydrogen economy is taking shape with infrastructure now in place and production at scale.

Production: 19TWh of green hydrogen is produced annually in the region. Export of excess hydrogen production across the UK is supported by East Coast Hydrogen pipelines. The Megawatt Valley has been re-powered, re-invigorating the region to support green hydrogen production.

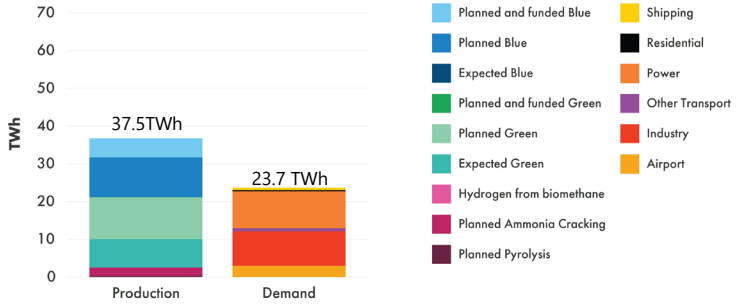
Demand: Regional hydrogen demand has reached 24TWh each year, predominantly utilised within the industry and power sectors. The UK has reached its target to decarbonise the electricity grid, hydrogen has supported that with 10TWh of hydrogen used annually to decarbonise power within the region. The East coast has become a hydrogen hub. As the shipping industry decarbonises, the East is using locally derived hydrogen to produce marine fuels. This attracts global business, enabling trade of low carbon goods and fuel.

Transport and storage: Cadent's new hydrogen pipelines now connect South Humber to South Yorkshire and has created a small network in the East Midlands. Design work is completing, and construction has started on parts of the North to South connection, as well as sections increasing the geographical reach of the South Yorkshire and East Midlands networks. Rough and Aldbrough hydrogen storage facilities connect to the East by new pipelines, creating additional security to hydrogen supply.

Figure 10: Infrastructure helps bring hydrogen to the East



Growth of hydrogen production and demand



Developments

- Additional biomethane producers start to produce hydrogen, further reducing carbon emissions
- Future phases of East Coast Hydrogen are under construction, expanding into Yorkshire and the East Midlands and creating a North to South connection between them
- 50% of industrial energy demand has now switched to hydrogen
- Growing demand in the hydrogen supply chain causes an increase in the number of jobs required to support manufacturing in areas such as South Yorkshire.

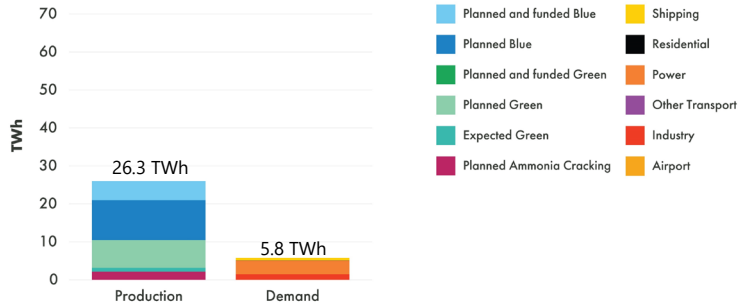
By 2035

Following completion of initial infrastructure, hydrogen production is connected to demand across the region.

South Humber and Lincolnshire

Across the region, new industries are shifting to hydrogen, accelerating the transition to Net Zero. 6TWh of hydrogen is being used in the sub-region to enable a transition away from natural gas for steel, chemicals, building materials, manufacturing and power. However, 26TWh of hydrogen is being produced annually, the majority of which is used outside of the sub-region, its transportation being enabled by East Coast Hydrogen pipelines to South Yorkshire, the East Midlands and further afield.

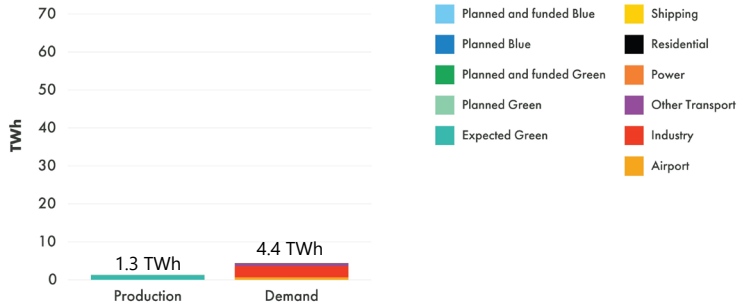
The Humber Industrial Cluster is on track to become Net Zero by 2040. Hydrogen and hydrogen derived fuels are produced locally for ports, such as Immingham. These become hydrogen hubs.



South Yorkshire

Collaboration in South Yorkshire means that industry are embracing hydrogen with 4TWh of hydrogen demand throughout the region. Additional low carbon hydrogen production facilities are under construction and more potential offtakers are encouraged to make the transition. As well as Rotherham's hydrogen refuelling stations, additional refuelling stations are being built to keep up with hydrogen demand from HGV's doing long haul journeys through South Yorkshire.

Cadent's East Coast Hydrogen connection from South Yorkshire to South Humber increases the rate of industrial decarbonisation with production facilities being used at scale.

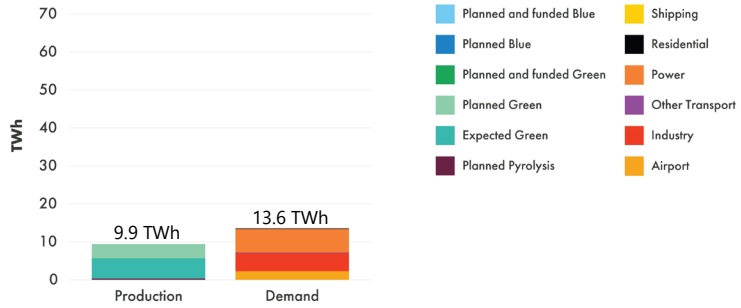


East Midlands

6TWh of hydrogen is used by the power sector in the East Midlands. A low carbon hydrogen economy has been created in what was the Megawatt Valley helping to decarbonise British power generation. Sites such as West Burton have accelerated the transition to Net Zero helping the UK achieve its decarbonisation target.

48% of industrial energy demand is catered for by hydrogen.

After commissioning a small hydrogen network in the East Midlands, work begins on extending the network as far south as Northampton and connecting the South to the Northern parts of the East Coast Hydrogen network, leading to further growth in the hydrogen economy across the sub-region.



By 2040

Hydrogen plays a key role in Net Zero targets being met

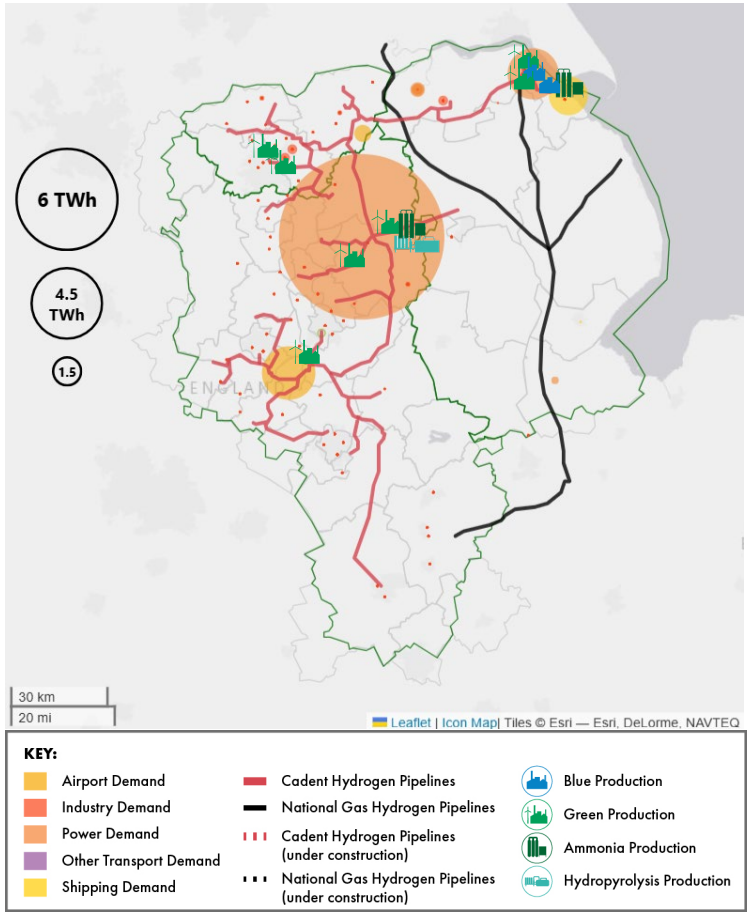
The East has supported the growth of the hydrogen economy through collaboration between local authorities, producers, industry, and infrastructure developers.

Production: 45TWh of low carbon hydrogen is produced per year in the region predominantly green and blue hydrogen. Following the reduction of Government subsidies, the commercial viability of biomethane injection into the gas grid could become more challenging, as a result some producers are switching to make biohydrogen providing an additional 4TWh of low carbon hydrogen.

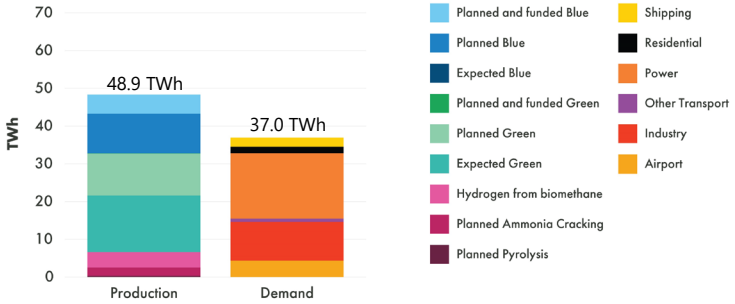
Demand: Hydrogen has supported the decarbonisation of hard to decarbonise sectors such as industry and long-haul HGV's. The railway between Nottingham and Skegness has switched to hydrogen[11]. East Midlands Airport leads in the aviation sector achieving its 2038 Net Zero target and by 2040 hydrogen-fuelled flights are starting. East Midlands and Humber's Freeports have attracted investment, boosting the local economy and helping industries innovate.

Transport and storage: Cadent have completed the East Coast Hydrogen pipeline allowing transportation of hydrogen across the East and are planning future connections to hydrogen transmission and distribution networks in the West Midlands, East Anglia and North London. Subject to a successful EMStor demonstrator, dis-used and end of life oil fields are being re-purposed to hydrogen storage in Lincolnshire and the East Midlands.

Figure 11: Decarbonisation at scale across the East



Growth of hydrogen production and demand



Developments

- Testing of mainstream hydrogen-fuelled flights has completed and East Midlands Airport start to run regular zero emissions flights using locally produced hydrogen and sustainable aviation fuels.
- The region is particularly well placed to produce electrolytic hydrogen and so supply outweighs demand. Connection through pipelines allows hydrogen to be transported across the UK, supporting national decarbonisation.
- The development of hydrogen sites, infrastructure and fuel switching has allowed the upskilling and creation of operational and maintenance jobs across the East.

By 2040

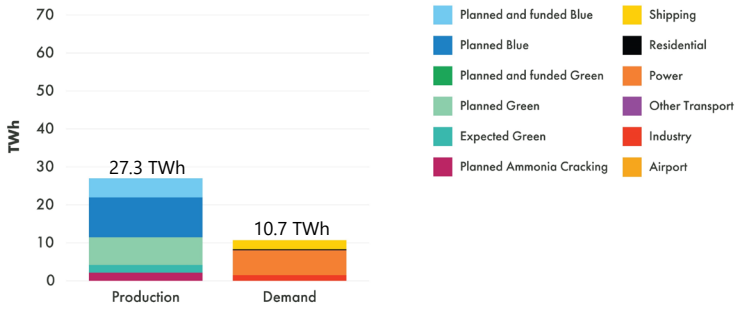
Hydrogen plays a key role in Net Zero targets being met

South Humber and Lincolnshire

The Humber Industrial Cluster has become the world's first Net Zero industrial cluster.

South Humber and Lincolnshire sees a growth in its export potential with 11TWh of annual hydrogen demand and 27TWh of annual production. The completion of the East Coast Hydrogen pipelines allows the region to become a net exporter of hydrogen by 2040.

Shipping accounts for 12% of the region's hydrogen demand with the global maritime community viewing the Humber as an example on how to decarbonise.

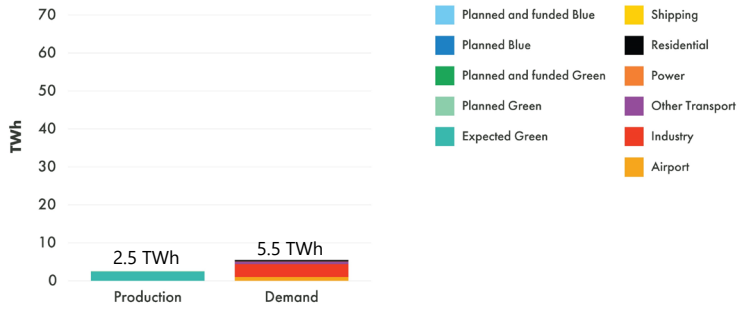


South Yorkshire

South Yorkshire has achieved its target of becoming Net Zero by 2040, with hydrogen playing an important role alongside other decarbonisation methods.

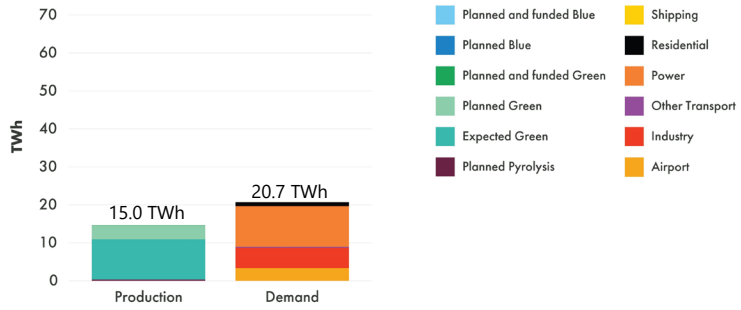
Long haul HGV's transiting along the M1 are supplied by the region's hydrogen refuelling stations.

The completion of Cadent's regional network connects South Yorkshire to the East Midlands enabling the regions to work together to ensure industrial hydrogen demand is met and offer security of supply.



East Midlands

Hydrogen demand from offtakers across the region has increased to 21TWh. Low carbon hydrogen production has reached 15TWh. 54% of the East Midlands industrial natural gas demand has switched to hydrogen and the region is thriving under the development of the hydrogen economy. East Midlands Airport leads the Net Zero aviation sector, with hydrogen-fuelled flights in operation , demonstrating to airports across the UK and globally that Net Zero aviation is achievable. Hydrogen demand in the transport sector has grown, refuelling stations are deployed across the Nottingham and Northampton area, helping the 'golden triangle' logistics centre to decarbonise.



*Modelled energy demand includes Oil and Gas derived energy in industry, power, commercial, transport and domestic sectors. This excludes low carbon sources, coal derived and off grid energy demand.

By 2050

The hydrogen economy has realised its full potential in the East

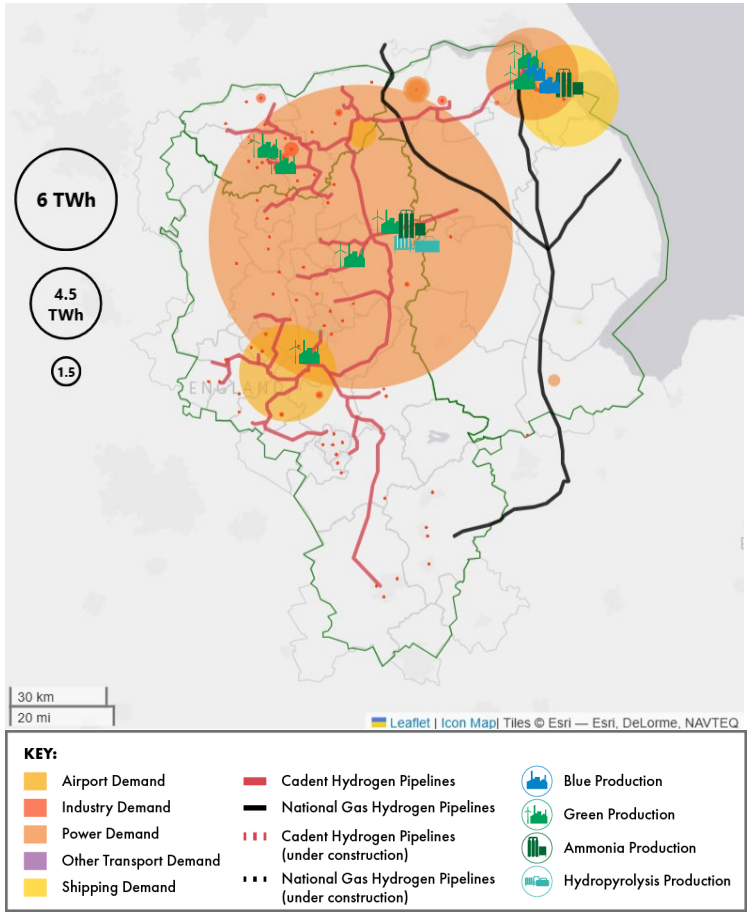
The East has achieved Net Zero, with hydrogen playing a pivotal role alongside other Net Zero technologies and interventions.

Production: Annual hydrogen production has increased to near 65TWh, dominated by green production.

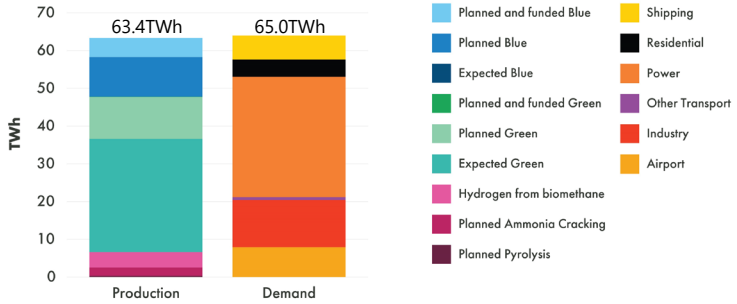
Demand: By 2050, 44% of the region's modelled current energy demand* is forecast to have fuel-switched to hydrogen supplementing electrification and other low carbon technologies such as carbon capture storage to help the East achieve Net Zero. Ports such as Immingham and Grimsby have transitioned to 100%, hydrogen derived, sustainable marine fuel utilising 6.5TWh of hydrogen each year. Industry has embraced the hydrogen opportunity and new industries are being established in the East, attracted by the hydrogen ecosystem and Freeports in East Midlands and the Humber.

Transport and storage: The UK has become a leading Net Zero country. Gas networks have played a vital role in the transition by ensuring that new and repurposed infrastructure connects hydrogen producers and end users. The extensive hydrogen pipeline brings competitive hydrogen pricing and encourages offtakers to switch to hydrogen. Storage in the region, created by projects such as EMStor, Rough and Aldbrough, provide energy security and resilience to hydrogen supply.

Figure 12: Net Zero East



Growth of hydrogen production and demand



Developments

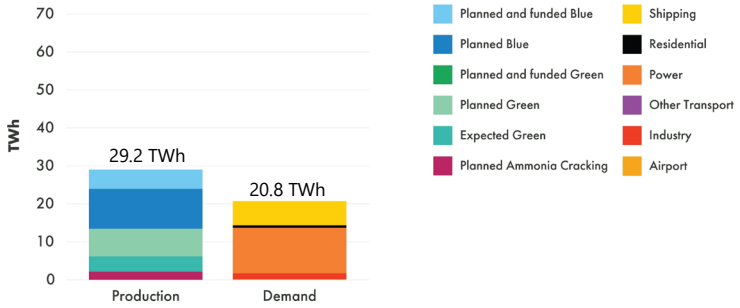
- The East requires almost 65TWh of hydrogen by 2050
- The 2050 target to achieve Net Zero is met
- Overall hydrogen is saving 9.6Mt of carbon dioxide emissions per year
- Collaboration in each of the three sub-regions and across the East has allowed the hydrogen economy to flourish
- The hydrogen economy has brought prosperity to the East creating and supporting local green jobs.

By 2050

The hydrogen economy has realised its full potential in the East

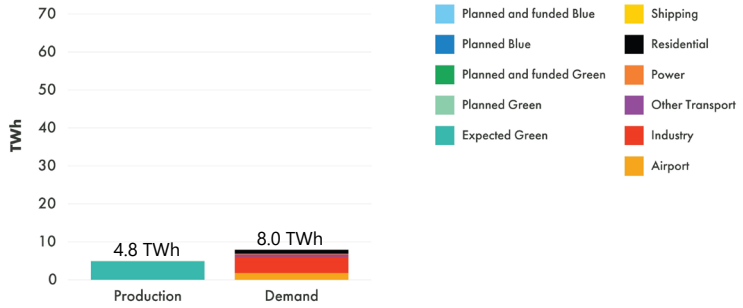
South Humber and Lincolnshire

Following on from The Humber Industrial Cluster achieving Net Zero, South Humber and Lincolnshire has met its target of becoming Net Zero. 21TWh of hydrogen is used annually in the region, saving 2.7Mt of carbon dioxide per year. The region produces 29TWh of hydrogen, exporting the excess across the UK to meet other regions' hydrogen requirements.



South Yorkshire

South Yorkshire has expanded its hydrogen economy with new industry coming to the region to support the hydrogen supply chain. 8TWh of hydrogen is needed per year to meet the demand of offtakers. This saves 1.4Mt of carbon dioxide per year, continuing to help the region maintain Net Zero.



East Midlands

The East Midlands has reached Net Zero, achieving the targets set out by its local authorities. 25.3TWh of low carbon hydrogen is now produced in the region. Over 50% of hydrogen demand is used to generate low carbon power and 67% of industry in the region is now supported by hydrogen. The transition to hydrogen saved 5.8Mt of carbon dioxide emissions per year

The Vision

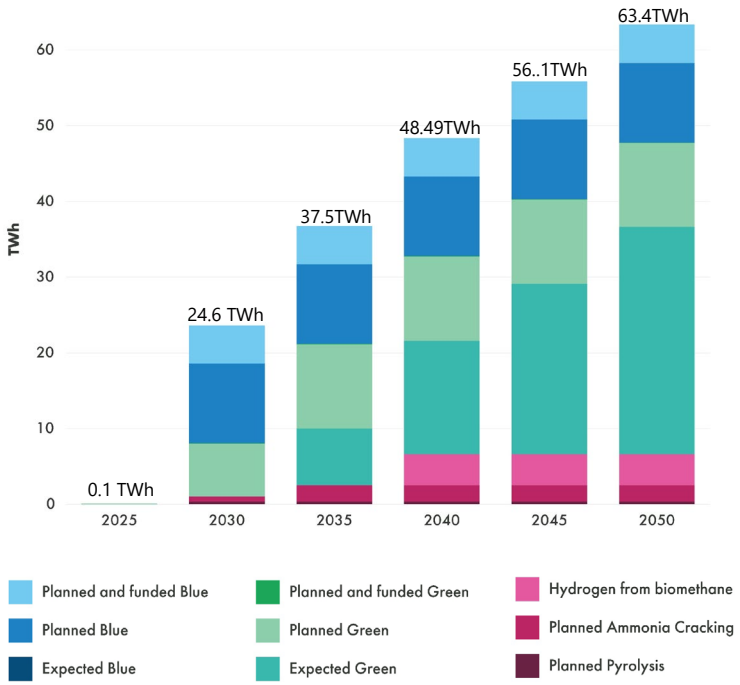
Summary

Our modelling has identified almost 65TWh of cross sector energy **demand** which is likely to require hydrogen to decarbonise by 2050. 50% of this demand comes from power generation maintaining the region as a net exporter of power.

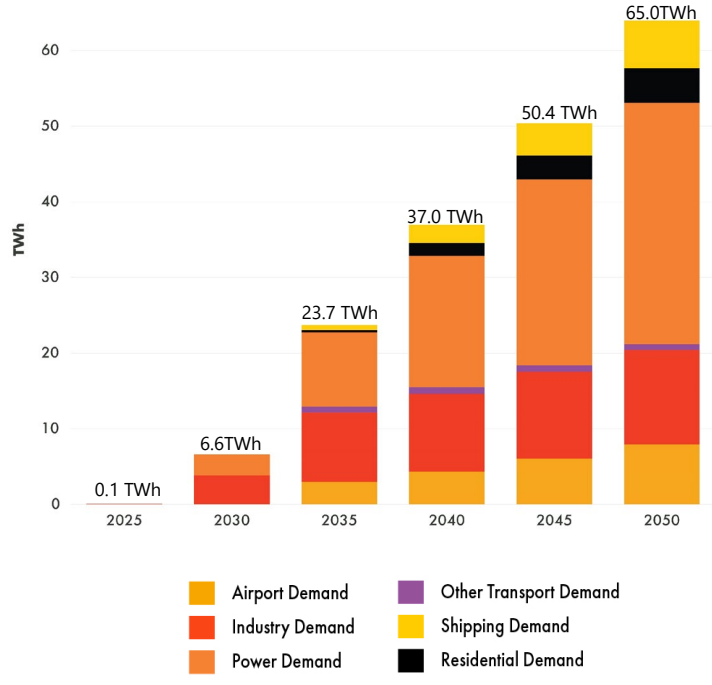
By 2050 a diverse range of hydrogen **producers** are based in the East with 8.7GW of hydrogen production capacity. Green and blue low carbon hydrogen production is supplemented by production from ammonia cracking, hydropyrolysis and production of hydrogen from biomethane. The skills, innovation and supply chains developed in the region to support the growth of the hydrogen economy can be exported globally.

Collaboration has been the foundation to the development of the hydrogen economy. Groups forming around a shared vision of the demand for hydrogen, building out the required production, transportation and storage infrastructure projects have capitalised on the opportunity. East Coast Hydrogen and East Midlands Hydrogen consortia have been at the forefront of progress demonstrating the benefits a hydrogen economy can bring when stakeholders work together.

Evolution of hydrogen production in the East



Evolution of hydrogen demand in the East



KEY MILESTONES

2025
The regions first low carbon hydrogen production facility goes into operation at HyMarnham.

2030
Carbon Capture and Storage facilities come online (Northern Endurance Partnership and Viking).

2035
Regional hydrogen demand has reached 24TWh each year.

2040
Construction of the East Coast Hydrogen pipeline has been completed.

2050
The East has achieved Net Zero, utilising 65TWh of hydrogen a year.

The Vision South Humber and Lincolnshire

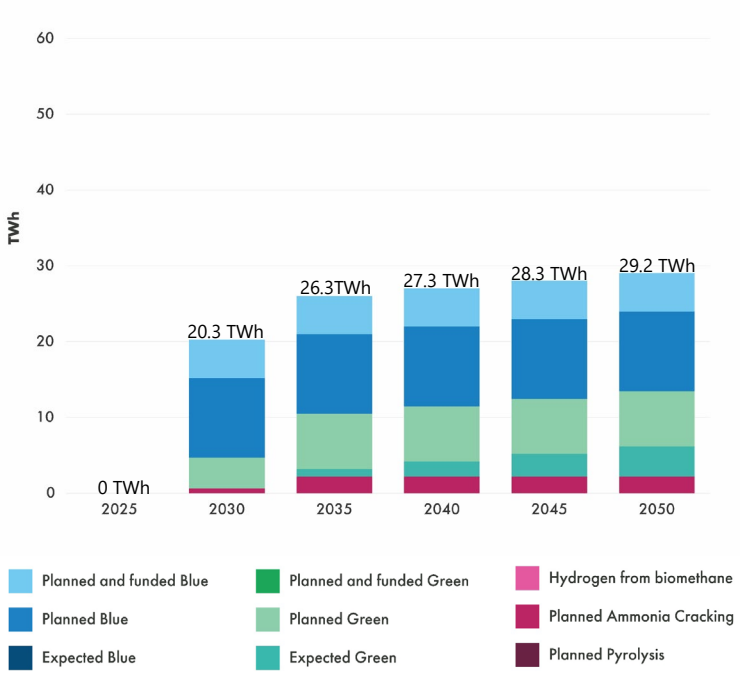
Summary

Our modelling demonstrates how South Humber and Lincolnshire can capitalise on its coastal location, taking renewable energy from offshore wind farms and converting it to 25TWh of hydrogen per year by 2050. This hydrogen is used both within and outside of the region. Exporting to the rest of the UK is made possible through the development of transport and storage infrastructure throughout the East region.

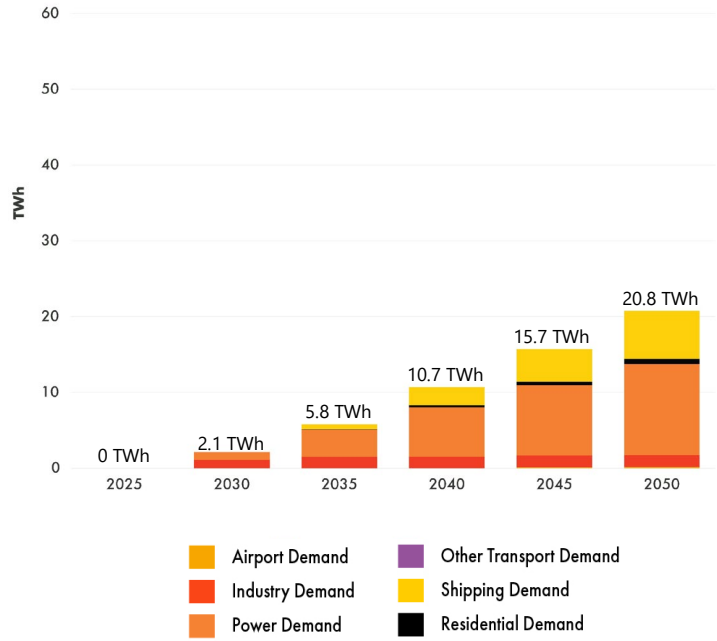
The rural landscape and resulting availability of biomass feedstock has also enabled biogas producers to ramp up production in the region, helping to decarbonise the gas network. When parts of the gas network are converted to hydrogen, following the decision to utilise hydrogen for heating in 2026, biomass producers pivot to produce hydrogen, which is fed into the network.

East Coast Hydrogen is already leading the way in identifying hydrogen demand and bringing together the necessary stakeholders to advance the hydrogen economy.

Evolution of hydrogen production in South Humber and Lincolnshire



Evolution of hydrogen demand in South Humber and Lincolnshire



KEY MILESTONES

2025
Hydrogen production facilities at Immingham Green Energy Terminal and Humber H2ub are under development.

2030
Carbon Capture and Storage facilities come online (Northern Endurance Partnership and Viking).

2035
Cadent's East Coast Hydrogen network connects South Humber and Lincolnshire to South Yorkshire.

2040
Humber Industrial Cluster has become the world's first net zero industrial cluster.

2050
21TWh of hydrogen is used annually in the region, saving 2.7Mt of carbon dioxide per year.

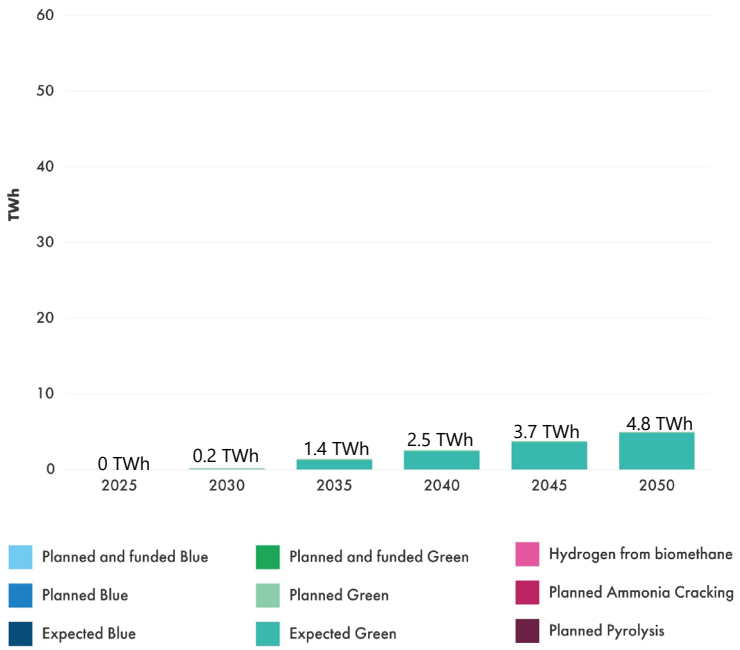
The Vision South Yorkshire

Summary

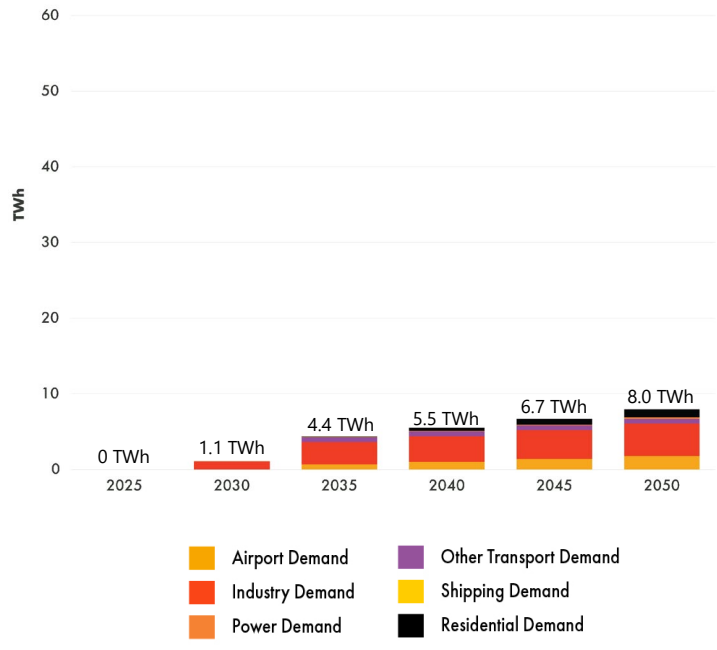
Our modelling shows that South Yorkshire will be a net importer of hydrogen by 2050. However, it is a net exporter of equipment which supports the hydrogen economy, e.g. electrolysers, gas cylinders, specialist valves etc. Facilitating the wider hydrogen supply chain through parts and expertise and supporting local jobs.

Additionally, projects such as HyDESS help demonstrate the business case for bringing hydrogen to difficult to decarbonise sectors, such as the steel manufacturing. Projects have been developed by willing stakeholders who recognised the hydrogen opportunity and have brought hydrogen use at scale to the region.

Evolution of hydrogen production in South Yorkshire



Evolution of hydrogen demand in South Yorkshire



KEY MILESTONES

2025
Hydrogen production at Blackburn Meadows is under development.

2030
Blackburn Meadows provides 24.2MW of hydrogen production capacity, creating a hydrogen hub in South Yorkshire.

2035
Cadent's East Coast Hydrogen network connects South Humber and Lincolnshire to South Yorkshire.

2040
South Yorkshire achieves Net Zero Targets.

2050
8TWh of hydrogen is needed per year to meet demand of offtakers, saving 1.4Mt of carbon dioxide per year.

The Vision East Midlands

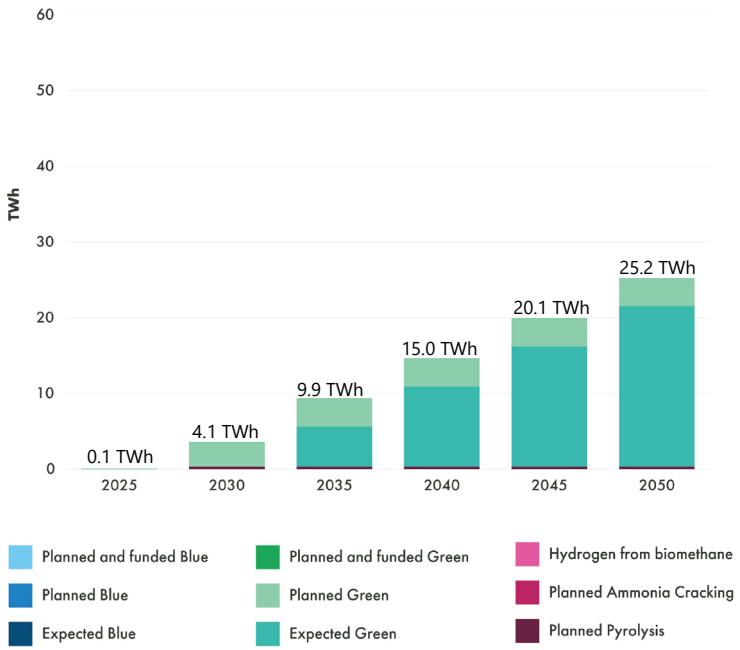
Summary

Our modelling shows that the East Midlands can play a significant role in the development of a hydrogen economy. Although the region is inland, its access to water from the River Trent, good power connectivity, and the development of depleted oil fields for hydrogen storage can support green hydrogen production. This will enable the East Midlands to develop as one of the largest inland hydrogen clusters and accelerate its industrial decarbonisation.

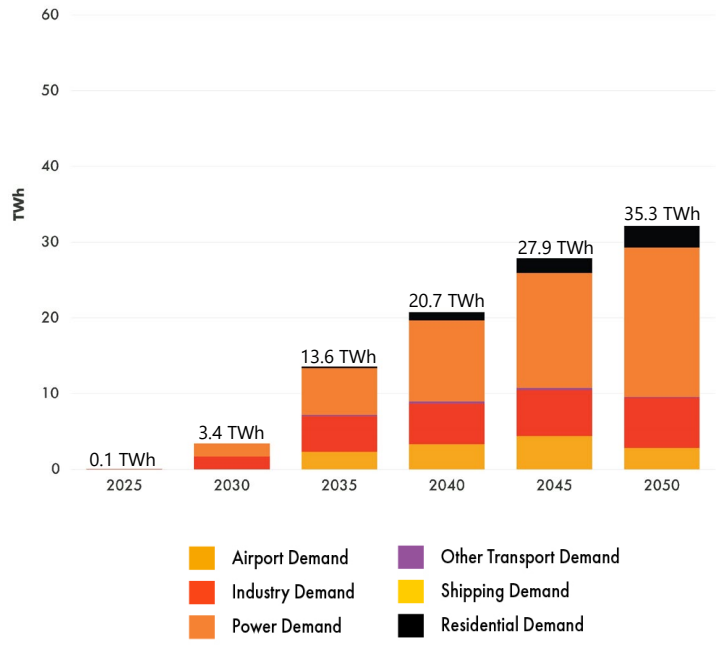
Collaboration through East Midlands Hydrogen is driving the hydrogen agenda in 7 key theme areas: production, distribution, industrial fuel switching, skills development, innovation, transport decarbonisation and local area energy planning.

The region has also been strengthened by its Freeport status which attracts investment.

Evolution of hydrogen production in East Midlands



Evolution of hydrogen demand in East Midlands



KEY MILESTONES

2025
Operation commences at HyMarnham.

2030
Ratcliffe-On-Soar hydrogen production has started.

2035
6TWh of hydrogen is used for the power sector in the East Midlands. Low carbon hydrogen produced in the former 'Megawatt Valley' is helping decarbonise British power.

2040
East Midlands Airport leads the Net Zero aviation sector and hydrogen-fuelled flight takes off from 2040.

2050
35.3TWh of low carbon hydrogen is utilised in the region per year, saving 5.8Mt of carbon dioxide emissions annually.

Hydrogen Production Growth

Areas of hydrogen production deployment opportunity

Our modelling identified areas of opportunity in terms of hydrogen production deployment.

The modelling highlighted demand of significant size which is close to planned infrastructure. The model indicates that an additional 4.8GW of hydrogen production capacity is required in the East to meet hydrogen demand not currently being served by planned hydrogen infrastructure projects.

This section highlights where there is potential to develop these additional projects and how that capacity has been distributed in our model.

The heat map opposite shows the areas of opportunity for new hydrogen production. The analysis highlights south of the Humber, eastern South Yorkshire, and several parts of East Midlands as desirable areas to support new projects based on:

- There being currently unserved hydrogen demand
- Them being close to planned hydrogen pipelines
- Them being close to what was the 'MegaWatt Valley' and therefore close to ample water supply provided by the river Trent and legacy high voltage transmission lines providing power connectivity.

The model also identifies clusters of industry led hydrogen demand which are not yet served by current planned projects and are separated from them. These demand centres are highlighted in the map on the right, including Derbyshire Dales, Lincolnshire and North Northamptonshire.

In the Derbyshire Dales, the model has identified industry-led hydrogen demand located to the west of current proposed infrastructure that would benefit from a hydrogen production site in the area.

North Northamptonshire is a significant distance from the initial phase of Cadent's hydrogen pipelines in the region. A hydrogen production plant in the area would allow the area to switch from natural gas, aiding a transition to Net Zero that might otherwise be difficult.

Lincolnshire's coastline and connections to offshore wind farms and carbon capture storage lines from Viking presents the prospect of additional low carbon hydrogen production. This provides decarbonisation opportunities along the coast, including exporting hydrogen regionally, nationally and internationally.

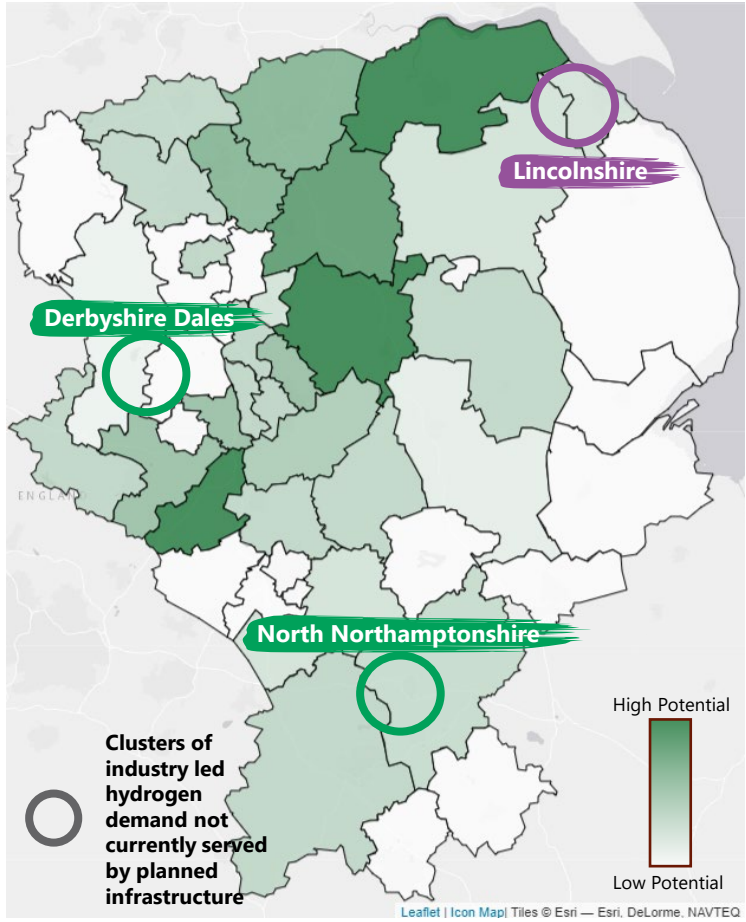


Figure 13: Additional hydrogen production heat map

4.0
Making the Economic Case

Economic Benefits

Development of hydrogen production capacity can generate thousands of jobs, during both the construction and operational phases

The growth of hydrogen will create a variety of new high-quality jobs in the East across the hydrogen ecosystem, and across the project lifecycles.

Hydrogen is expected to have a significant impact on the construction industry and its associated supply chains as hydrogen production, storage and distribution infrastructure is built. It is estimated that hydrogen production at the scale calculated by our modelling could create over **8,000 construction jobs** between 2025 and 2050, with the peak of activity between 2025 and 2035.

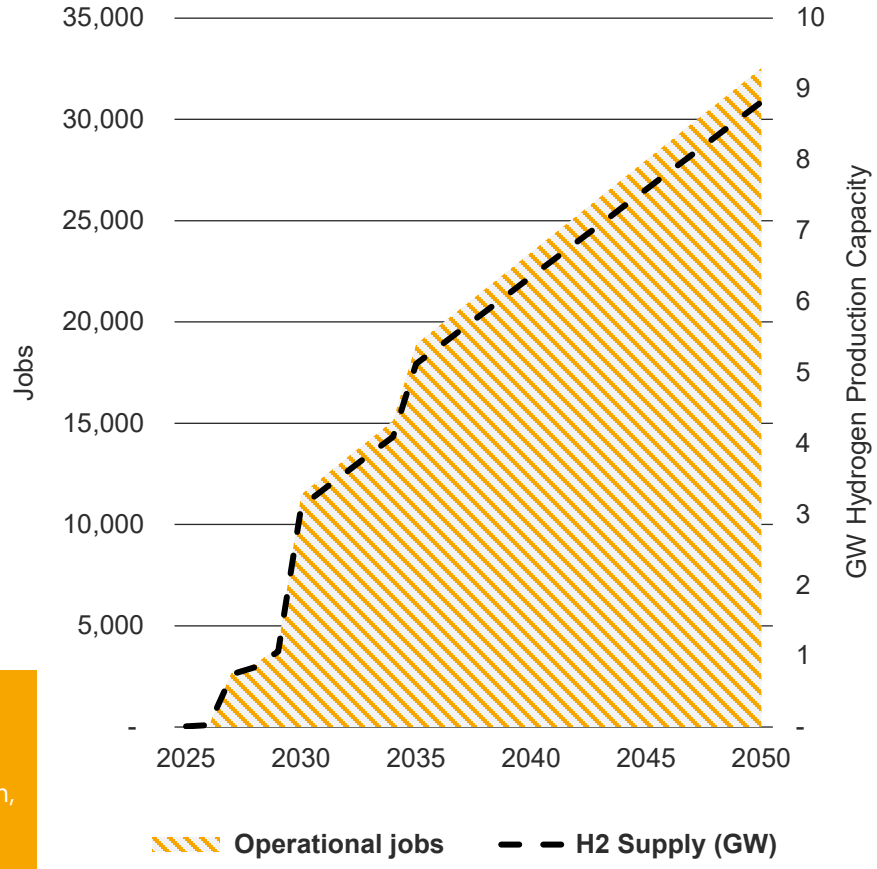
By 2050, with production capacity reaching approximately 8.7GW, **32,500 net additional operational jobs** could be created. These numbers indicate the significant impact the hydrogen opportunity could have on employment.

Construction and operation jobs can be broken down into direct, and indirect, these are explored further overleaf. In all three sub-regions, jobs could be created across the hydrogen ecosystem, with each sub-region taking on its own particular focus.

By 2050, it is estimated that there could be a **net additional GVA of £3.44bn per annum** (in today's prices) through the production and consumption of hydrogen in the East. This represents the additional GVA resulting from the displacement of hydrocarbon fuel for hydrogen.

Construction Jobs
Created through increased investment to deploy hydrogen, relating to capital expenditure (CAPEX), including both components and services as well as consultancy and technical services.

Operational Jobs
Created through increased activity of suppliers as goods and services are purchased across all levels of the value chain, from companies who then increase their hydrogen demand with their own suppliers.



South Humber and Lincolnshire

- ✓ Significant employment opportunities in the "day to day" management and operation of hydrogen production facilities.

South Yorkshire

- ✓ Significant supply chain opportunities for the local manufacturing industry to provide major components and parts.

East Midlands

- ✓ A large contingent of direct operational roles and the chance to use hydrogen to support major industries in their decarbonisation.

Economic Benefits

A hydrogen network could have a deep, broad economic impact, creating thousands of direct and indirect jobs

The hydrogen industry is highly dependent on other industries, and has strong supply chain links, meaning investment leads to significant economic impacts beyond direct employment.

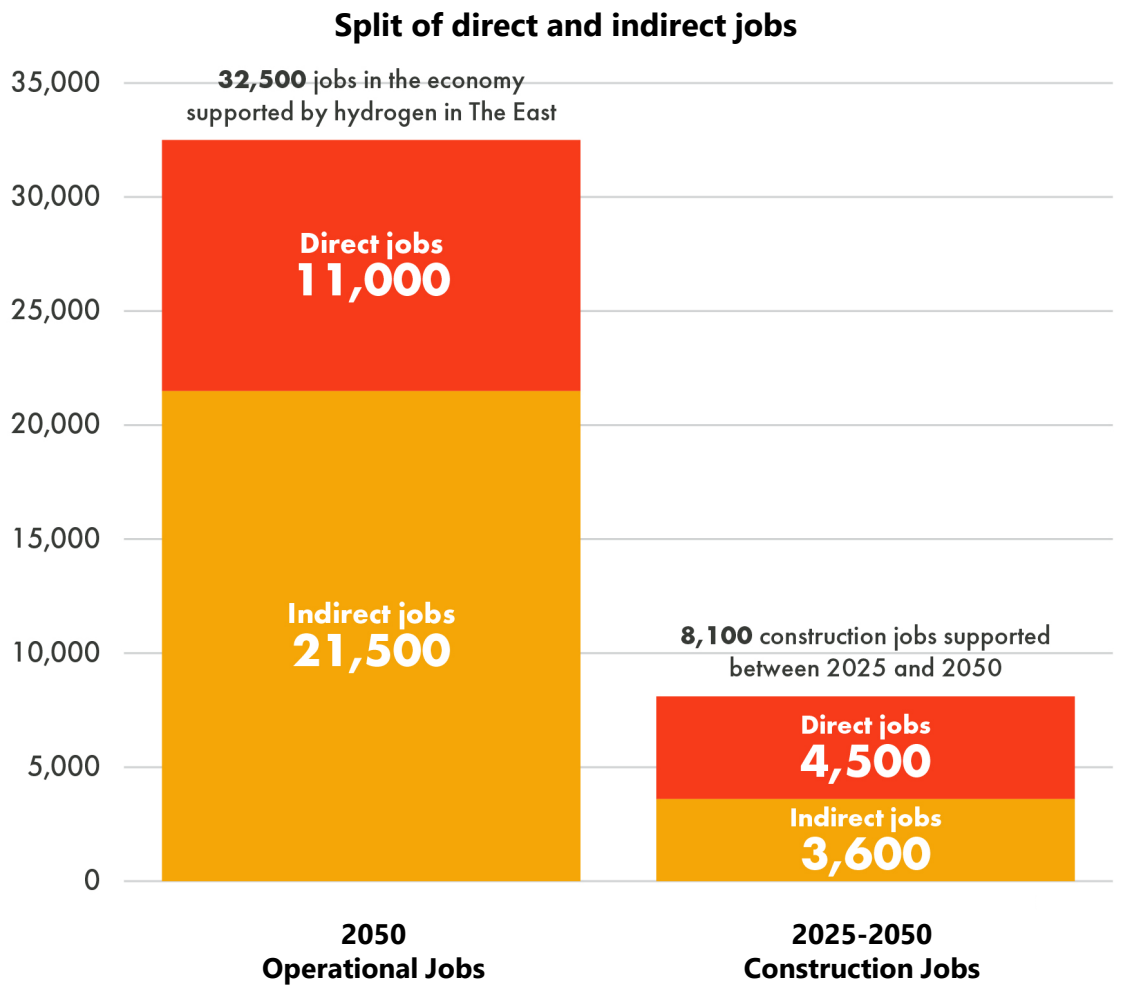
Over **11,000 direct jobs** could be supported by the hydrogen industry in the East. These jobs will include roles related to operating and maintaining production, transport and distribution assets. They also include jobs in sectors that are directly providing goods and services to the industry such as the water industry, power industry or ancillary services such as accounting, legal, IT and management.

These industries spend money with their suppliers, on component parts, products and services, driving a multiplier economic impact effect. It is estimated that hydrogen in the East could support **21,500 indirect roles**, ranging from turbine blade manufacturing for wind power generation to pipe manufacturing.

Of the **32,500 jobs** supported by the Easts hydrogen economy, many will be created locally, including jobs in the water and power industries and jobs in the day-to-day operation and maintenance of production facilities. The remaining ancillary support services (from accounting, IT, etc.) could be based locally, or elsewhere.

Direct Jobs
Created through impacts that occur in sector that supply goods and services directly to the hydrogen industry, including water, feedstock energy and ancillary services such as legal and IT.

Indirect Jobs
Upstream multiplier effects on industry sectors that supply goods and services for intermediate consumption i.e., that supply goods and services to sectors directly involved in operating the hydrogen network.



Supporting Industry

Hydrogen will support high-value industries in the East to decarbonise their operations

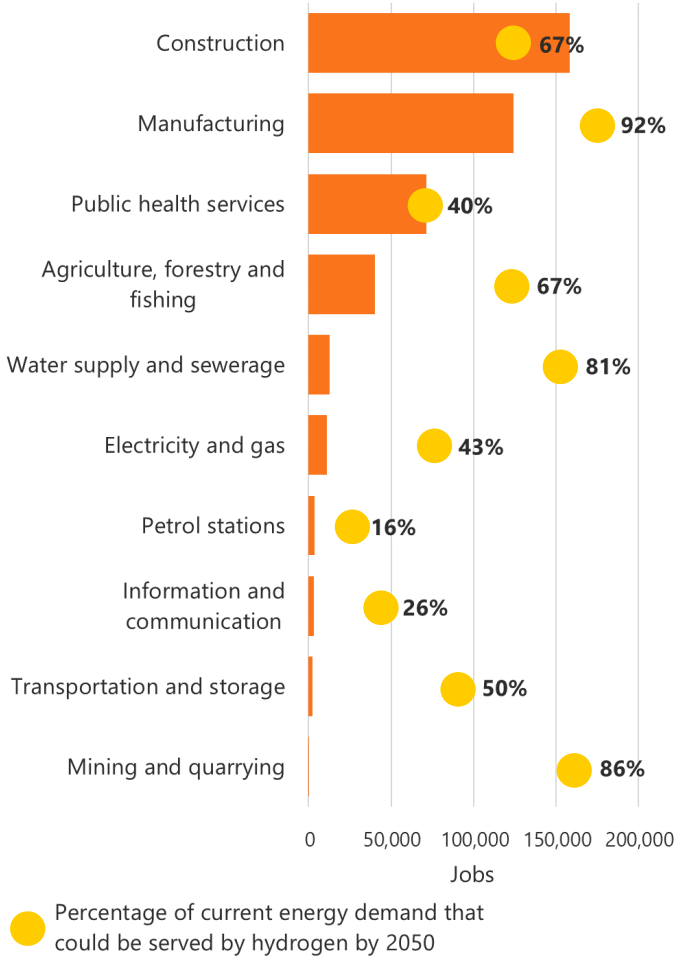
Natural gas supports industry, power and commerce in the East today, providing heat for industrial processes and aiding sectors such as transportation and manufacturing. These sectors are now seeking to deliver economic value sustainably. It is essential to consider how a just transition can be achieved to ensure workers in carbon-intensive industries can move into low-carbon jobs.

As carbon pricing becomes prevalent and low-carbon products are mandated through public procurement and product standards, the importance of sustainable fuels will grow. Ensuring the availability of hydrogen will enable value-adding employers in the East to continue driving economic activity.

There is strong support from the private sector. Prominent companies like Toyota and Mercia are among those exploring their potential to switch to hydrogen to decarbonise.

The chart (right) provides a breakdown of the regional industries where hydrogen can play a role to decarbonise their processes. It shows the current number of jobs in the East that are involved in activities (within each industry) which could be decarbonised using hydrogen, and the potential percentage of energy demand that hydrogen will meet in the East by 2050.

Currently, these gas-dependent industries **employ 500,000 people** in the region and contribute **over £39bn to the regional GVA.**



South Humber and Lincolnshire

The South bank of the Humber is critical to the East Coast Hydrogen project. It is home to the Phillips 66 refinery which plans to use hydrogen. Further inland, Keadby could be the world's first power station to use hydrogen to balance peaking loads. In the sub-region, chemicals, building products and steel will be decarbonised using hydrogen.

South Yorkshire

South Yorkshire's remaining steel and glass industries are exploring hydrogen, and there is potential production at Blackburn Meadows. Sheffield's Universities, the Advanced Manufacturing Research Centre and industry are working in tandem to advance manufacturing sectors. This includes the development equipment for the hydrogen supply chain such as electrolysers from ITM Power and CPH2.

East Midlands

The site that previously accommodated Ratcliffe-on-Soar coal-fired power station will be redeveloped for large scale hydrogen production.

Hydrogen will have a role in decarbonising bricks and building materials, as well as key automotive and advanced transport manufacturing; hydrogen is being considered by household names such as Rolls Royce and Toyota.

Supporting Industry

Careful planning is required to transition jobs and skills in the current gas sector to hydrogen

Jobs within the gas industry face significant risk if the energy transition is not handled carefully.

Currently the gas sector employs specialised and skilled workers throughout the value chain, from exploration and extraction to processing, distribution, and trading via the pipeline network.

Outlined below is a summary of the economic impact of the existing gas network in the East, emphasising the importance of its direct operation and maintenance for both residential and commercial purposes:

- 1,200 individuals are currently employed in gas distribution through the mains network;
- 1,500 individuals are currently engaged in gas trading through the mains network; and
- Approximately 17,260 registered Gas Safe Engineers in the East regularly install and maintain gas boilers.

Collectively, **nearly 20,000 gas industry-specific jobs in the East contribute over £1.9 billion in GVA to the regional economy**. It is crucial that these workers are retained, and their skills are transitioned to cleaner energy sources. A well-managed transition to hydrogen will be key to protect employment.

5.0
Want to know more?

Want to know more?

Please get in touch to further your journey towards decarbonisation

The opportunity presented by hydrogen in the East is clear. The industrial nature of the East both within and outside of the industrial cluster requires energy intensive fuels; hydrogen provides a means to both decarbonise and grow the economy.

Hydrogen and biomethane are primed to decarbonise these sectors with clear benefits:

- Creating almost 11,000 direct jobs
- Creating an additional £3.4bn in GVA
- Saving 9.6Mt of carbon dioxide per year

65TWh per year of demand could switch to hydrogen by 2050. 45% of the required hydrogen production can be sourced from planned and announced projects in the East; further projects are needed.

We appreciate the different needs of industry across the East. Additional information can be found on our website here:

https://cadentgas.com/future-of-gas/hydrogen

https://cadentgas.com/future-of-gas/biomethane

https://cadentgas.com/insights

We hold bespoke workshops and participate in events across the region, particularly through East Coast Hydrogen and East Midlands Hydrogen.

We are already supporting industry leaders and other key regional stakeholders, including regulators, policymakers, transport operators, and planners, to develop the hydrogen opportunity in the East together.

Our team can work with you to determine the timing and availability of low carbon hydrogen to your site.

If you want to know more about how hydrogen can support your journey toward decarbonisation please get in touch.

Contact us

Sally Brewis
T 07816109424
E sally.brewis@cadentgas.com

Cadent
future
Your Gas Network

Further info

Cadent
future
Your Gas Network

Further Info

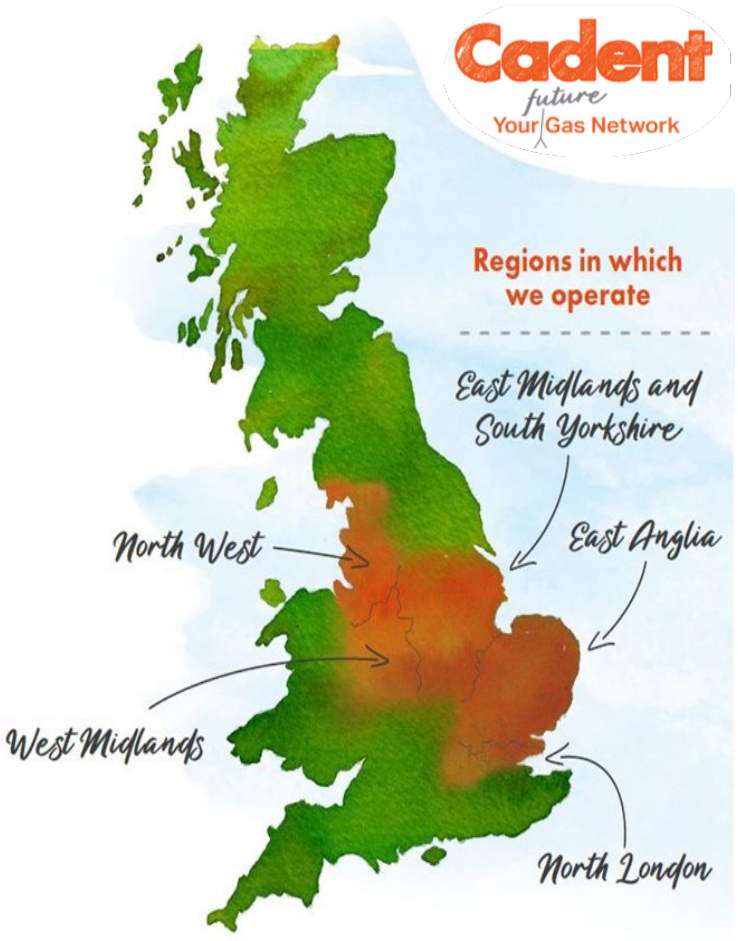
Cadent- Who we are

Cadent is the UK's largest gas distribution network, bringing gas to 11million industries, homes and businesses. Cadent manage a network of more than 82,000 miles of pipes, most of them underground, which transport gas throughout the North West, West Midlands, East Midlands, South Yorkshire, East of England and North London.

In summary Cadent are responsible for:

- 12m supply points across the UK
- Nearly 50% of the UK gas distribution market
- Over 6,100 employees
- 132,000 km's of pipeline
- Developing five primary Hydrogen schemes

To learn more about Cadent visit our website.



Hydrogen production routes

There are several ways to produce hydrogen. It can be produced from different feedstocks, using different energy sources and resulting in different levels of emissions. The UK Government defined low carbon hydrogen to have emission intensity lower than 20g CO_2e/ MJ LHV. The main two types of low hydrogen production are:

- Green hydrogen, produced by splitting water using electricity from renewable energy sources, e.g. solar.
- Blue hydrogen, produced from natural gas, using Steam Methane reforming process with the carbon dioxide produced captured and stored.

Low carbon hydrogen can be produced from biomass and using other low carbon energy sources such as nuclear.

The UK Low Carbon Hydrogen Standard can be found here.

Further Info

Biomethane

Biomethane is upgraded biogas produced from animal and plant waste as opposed to the extracted fossil methane (natural gas).

Currently 6.5TWh/year of biomethane is produced in the UK. This is expected to grow significantly over the next decade with Government subsidies such as the Green Gas Support Scheme offering subsidy for 15 years due to the reduced associated emissions in comparison with natural gas.

Today, biomethane is injected with natural gas into the gas network. As the gas network evolves to support Net Zero, the gas network could switch to hydrogen. At that point, biomethane sites have a range of different options, including:

- Upgrade to produce bio-hydrogen with carbon capture and storage and continue injecting into gas network.
- Continue to produce biomethane supplying fuel directly to demand sites.
- Divert supply to support the production of low carbon fuels for sectors such as heavy-duty, long distance vehicles, aviation and marine.

Detail of the Green Gas Support Scheme can be found here.

Units

GW (Gigawatt) is a power unit used to describe hydrogen production capacity of a plant in terms of maximum hydrogen output based on the hydrogen HHV equal to 39.4kWh/ kgH2 (High Heating Value).

TWh (Terawatt-hours) is an energy unit used to describe the energy content of hydrogen produced by a site, typically used to define the annual production capacity of the site taking into consideration plant operation profile.

East Coast Hydrogen

Resilient and home-grown energy across the East region

Aimed at advancing hydrogen infrastructure and development, East Coast Hydrogen is a **collaboration between National Gas, Northern Gas Networks and Cadent** to connect planned hydrogen production and storage with industrial users across the majority of the East of England.

Building on the East Coast Hydrogen Feasibility Report (2021), the East Coast Hydrogen Delivery Plan outlines the strategic approach of the programme and the opportunities and benefits of hydrogen infrastructure in the region through:

- Connecting supply and demand
- Decarbonising multiple sectors
- Providing UK energy system resilience and flexibility
- Supporting delivery of UK Government targets
- Catalysing wider system benefits

Over **120 stakeholders** across the hydrogen industry value-chain have become consortium members pledging their support to the programme. **83TWh of annual hydrogen production** and over 63TWh of annual industry and commercial, power and transport hydrogen demand have been identified over the next 15 years.

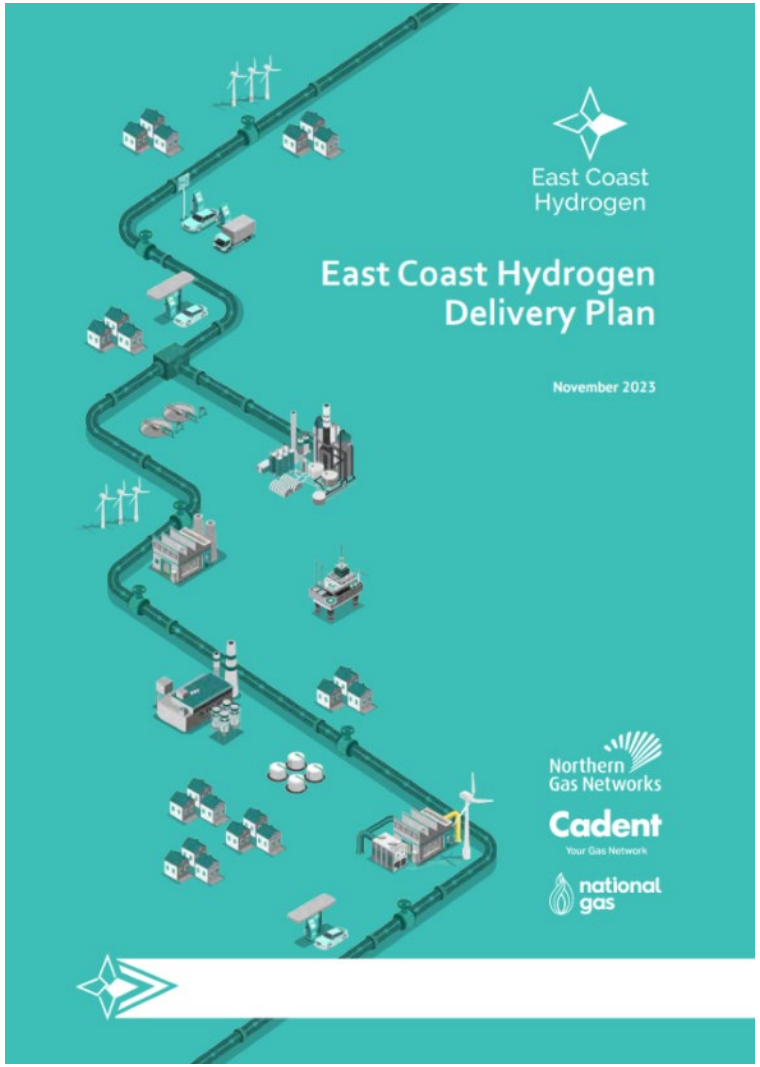
East Coast Hydrogen project aims to **enable the Government's 10GW hydrogen production target** by connecting 4 TWh of hydrogen storage with potential to **abate up to 12Mt of carbon emissions per year by 2037**.

Through this programme, hydrogen will play a crucial role in achieving net-zero in heavy transport applications and residential heat.

Following on from entering FEED stage in 2024. By 2031, construction of the northern phase connects the Humber and South Yorkshire clusters, expanding to the East Midlands in 2032 creating a **world-leading hydrogen hub** within the region.

More information on East Coast Hydrogen and the East Coast Hydrogen Delivery Plan can be found here.

The Cadent East Hydrogen Vision builds on from the findings of the East Coast Delivery Plan, covering the southern half of the region, looking into the hydrogen opportunity past 2037 all the way to 2050. The report also looks to expand on the opportunity locally for each of the 3 subregions, highlighting hydrogen locations and the hydrogen potential in transport. Both the East Hydrogen Vision and East Coast Hydrogen Delivery Plan highlight the potential of the hydrogen economy in the east.



East Coast Hydrogen Delivery Plan

East Midlands Hydrogen

The potential for large scale hydrogen production within the region

East Midlands Hydrogen is a new **industry-led initiative** consisting of **75+ consortium members** within the hydrogen value chain including hydrogen demand, production and distribution infrastructure. The members are committed to accelerating the development of the **UK's largest inland hydrogen cluster** in the East Midlands with plans supporting decarbonisation of industry, mobility and power generation.

East Midlands Hydrogen covers Nottinghamshire, Derbyshire and the northern half of Leicestershire which contains a cluster of prospective industrial hydrogen customers. This region presents significant potential **for large-scale hydrogen production**, connected through a section of Cadent's proposed East Coast Hydrogen pipeline.

Through this pipeline, the East Midlands can connect production and demand to the growing cluster of offtakers, to develop the UK's largest inland hydrogen cluster and bring economic benefits to the region.

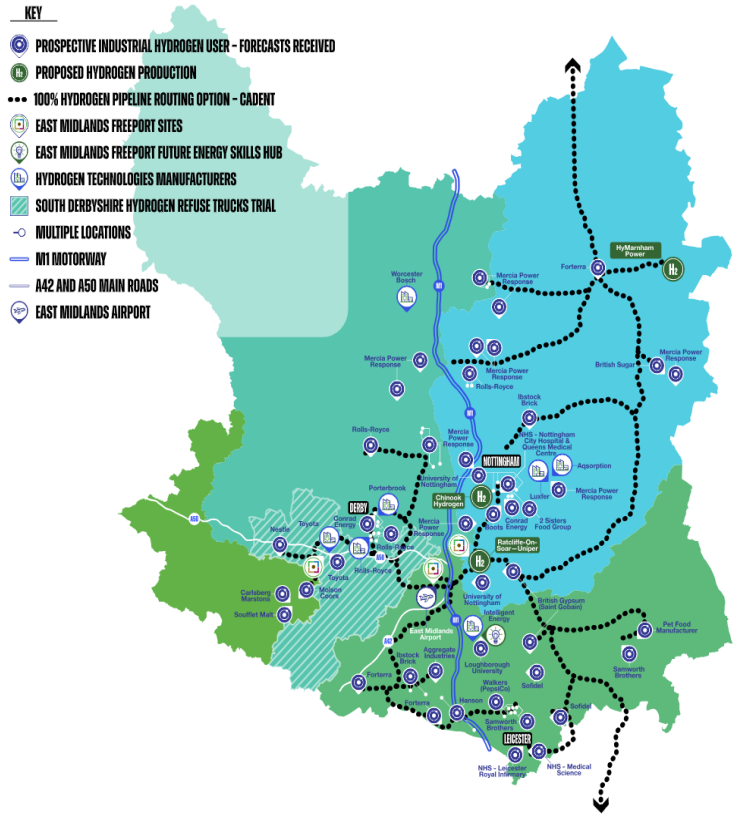
Using former coal-fired power stations and electricity infrastructure within the 'Megawatt Valley", the region has forecasted **650 MW of low-carbon hydrogen production capacity** with potential for GW-scale production by 2050.

By 2030, over 20 companies across 70 sites are forecasted to require a total hydrogen demand of 10 TWh per year with fuel switching **abating 1.9 Mt of carbon emissions per year**, equivalent to natural gas consumed by 860,000 homes.

Economic impact of the development of a full hydrogen supply chain is expected to **contribute £10bn** to regional GVA and **employ 110,000 people** in the region.

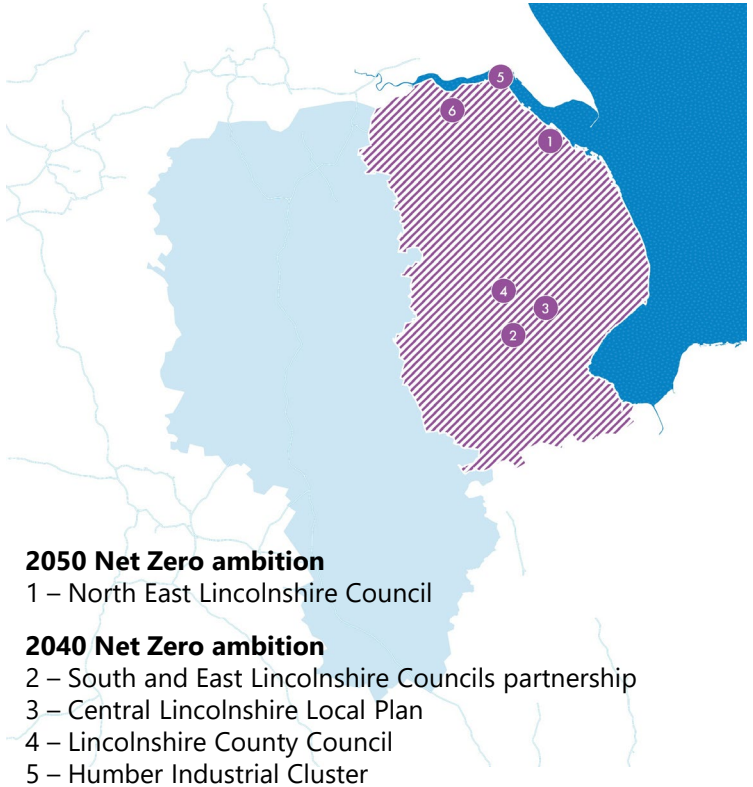
East Midlands Hydrogen is also part of a **wider Midlands Hydrogen** ecosystem with their involvement in the Midlands Engine partnership. The partnership involves other initiatives and regions like Tyseley Energy Park (Birmingham) and the Humber Region (Northern Lincolnshire), with a shared vision to link hydrogen production with offtakers, **adopting hydrogen technologies at scale** with support from academia and supply chains. Through this network, collaboration with partners across all sectors will ensure **knowledge-sharing** to adopt the best in-class practice essential for achieving net-zero goals .

More information on East Midlands Hydrogen can be found here.



East Midlands Hydrogen Network

The East Net Zero Commitments

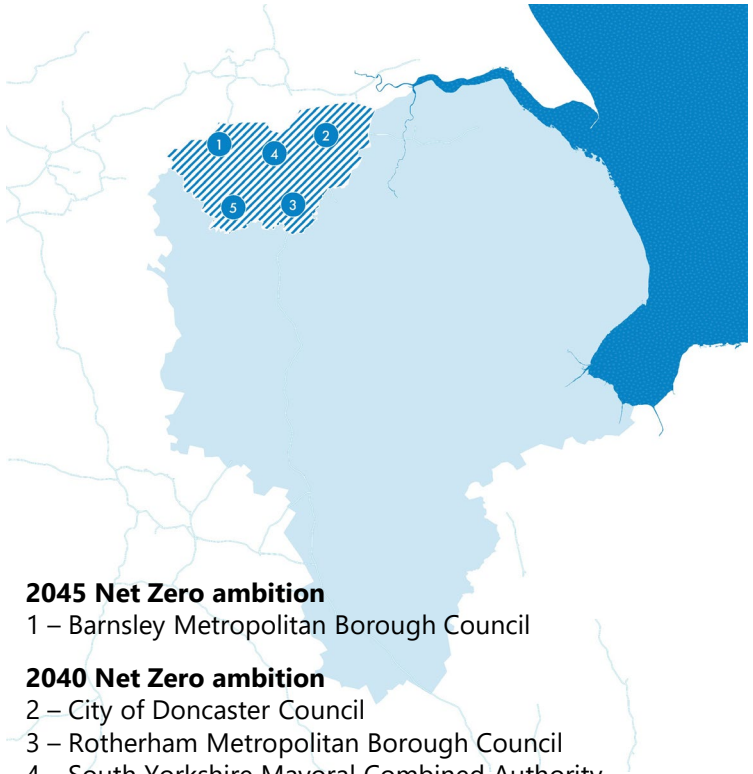


2050 Net Zero ambition
1 – North East Lincolnshire Council

2040 Net Zero ambition
2 – South and East Lincolnshire Councils partnership
3 – Central Lincolnshire Local Plan
4 – Lincolnshire County Council
5 – Humber Industrial Cluster

2030 Net Zero ambition
6 – North Lincolnshire Council

Net Zero commitments within the South Humber and Lincolnshire region

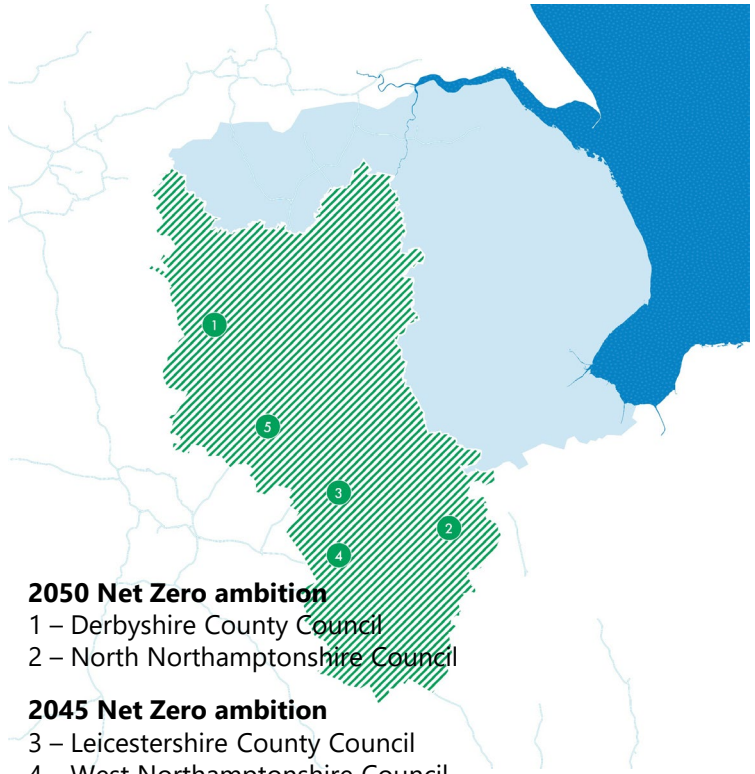


2045 Net Zero ambition
1 – Barnsley Metropolitan Borough Council

2040 Net Zero ambition
2 – City of Doncaster Council
3 – Rotherham Metropolitan Borough Council
4 – South Yorkshire Mayoral Combined Authority

2030 Net Zero ambition
5 – Sheffield City Council

Net Zero commitments within the South Yorkshire region



2050 Net Zero ambition
1 – Derbyshire County Council
2 – North Northamptonshire Council

2045 Net Zero ambition
3 – Leicestershire County Council
4 – West Northamptonshire Council

2030 Net Zero ambition
5 – Nottinghamshire County Council

Net Zero commitments within the East Midlands region

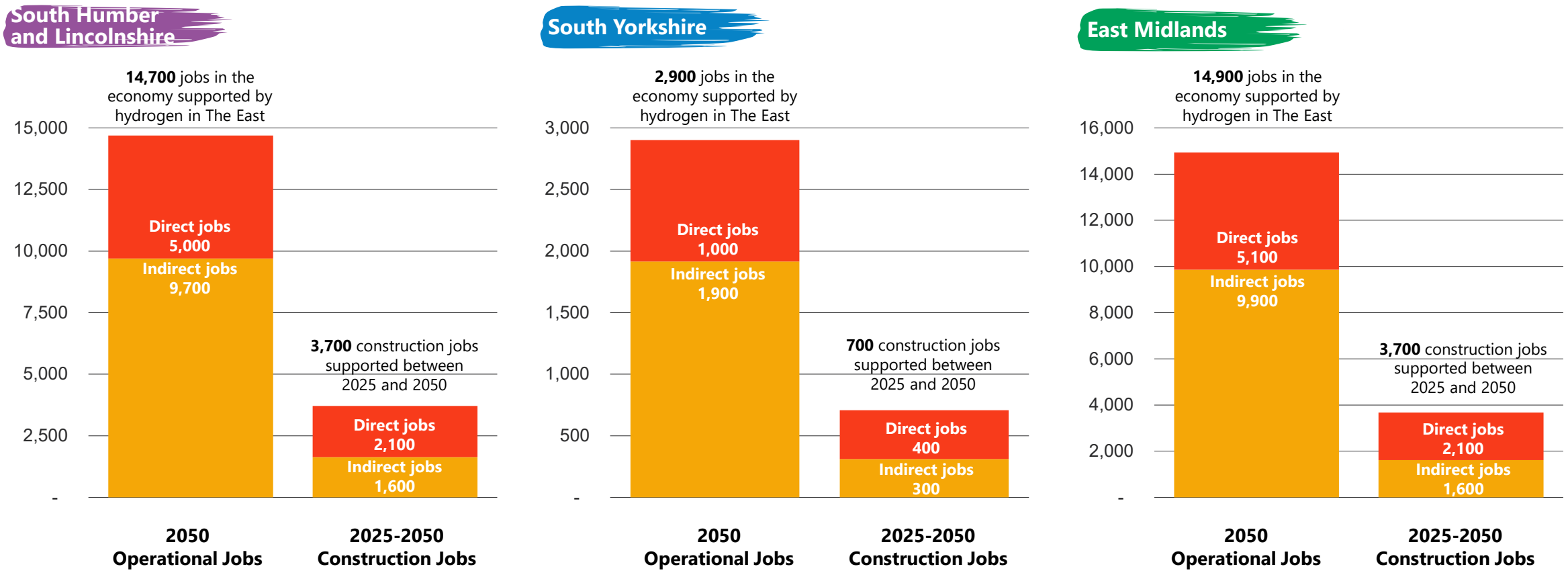
Economic benefit per local authority

Local Authority	Annual additional GVA by 2050/£	Total Jobs	Direct Jobs	Indirect Jobs
Amber Valley	-	-	-	-
Ashfield	49,500,000	469	159	309
Barnsley	49,500,000	469	159	309
Bassetlaw	171,100,000	1,619	550	1068
Blaby	-	-	-	-
Boston	-	-	-	-
Broxtowe	49,500,000	469	159	309
Charnwood	49,500,000	469	159	309
Chesterfield	49,500,000	469	159	309
Derby	-	-	-	-
Derbyshire Dales	10,200,000	96	33	63
Doncaster	99,100,000	937	319	619
East Staffordshire	49,500,000	469	159	309
Erewash	82,600,000	781	266	515
Gedling	82,600,000	781	266	515
Harborough	33,000,000	312	106	206
Hinckley	33,000,000	312	106	206
Leicester	-	-	-	-
Mansfield	33,000,000	312	106	206

Local Authority	Annual additional GVA by 2050/£	Total Jobs	Direct Jobs	Indirect Jobs
Melton	49,500,000	469	159	309
Newark and Sherwood	165,600,000	1,567	533	1034
North East Derbyshire	-	-	-	-
North East Lincolnshire	960,100,000	9,081	3088	5994
North Kesteven	49,500,000	469	159	309
North Lincolnshire	492,800,000	4,662	1585	3077
North Northamptonshire	43,800,000	415	141	274
North West Leicestershire	165,100,000	1,562	531	1031
Nottingham	69,000,000	653	222	431
Oadby and Wigston	-	-	-	-
Rotherham	99,100,000	938	319	619
Rushcliffe	261,100,000	2,470	840	1630
Sheffield	59,000,000	558	190	368
South Derbyshire	82,600,000	781	266	515
South Holland	-	-	-	-
South Kesteven	18,100,000	171	58	113
West Lindsey	33,000,000	312	106	206
West Northamptonshire	49,500,000	469	159	309

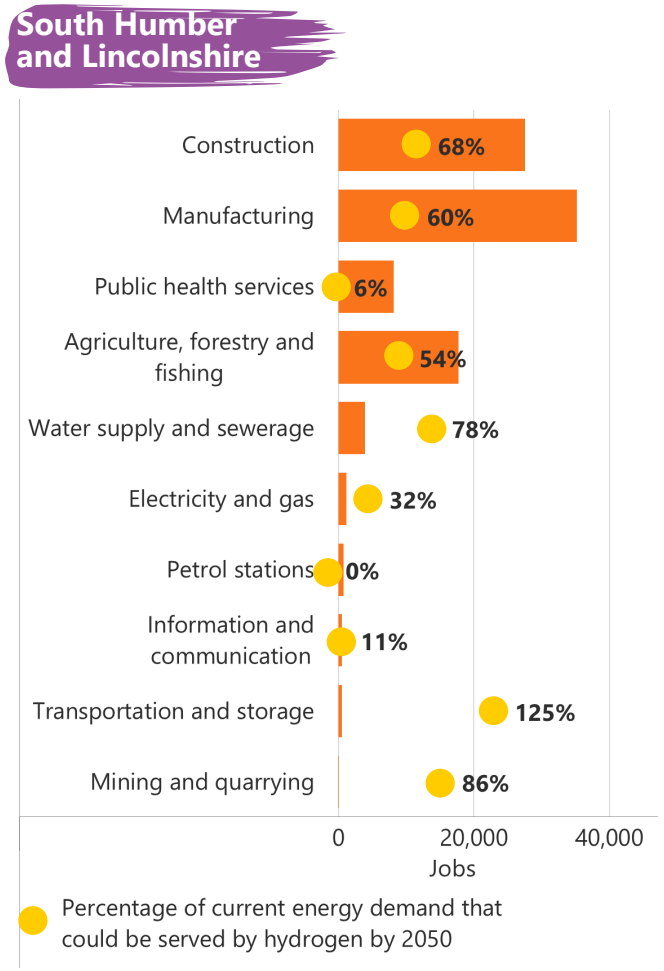
Economic Benefit – Further info

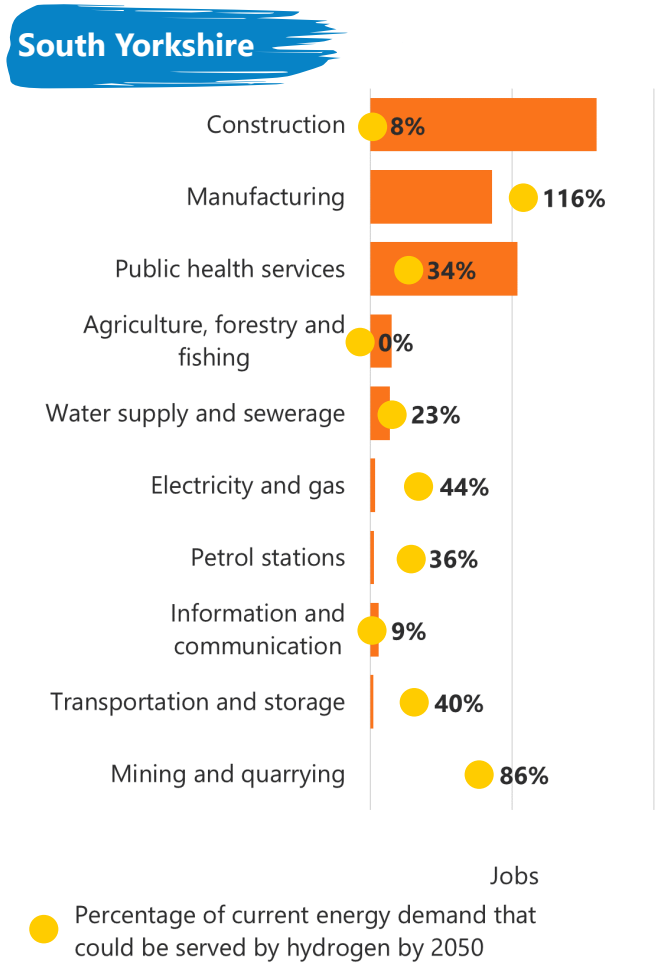
The make up of direct and indirect jobs, through construction and operation, by region

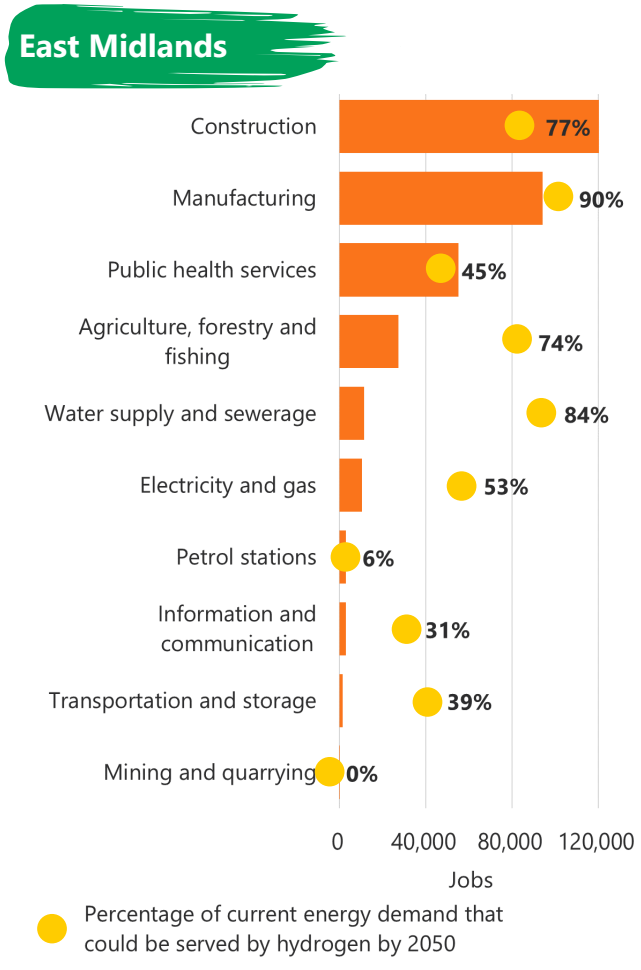


Supporting Industry – Further Info

The size and scale of existing industry activity that could take hydrogen in the future, by region







Abbreviations

AMRC	Advanced Manufacturing Research Centre
bn	Billion
CAPEX	Capital Expenditure
CBAM	Carbon Border Adjustment System
CCS	Carbon Capture and Storage
EfW	Energy from Waste
EMH	East Midlands Hydrogen
ETS	Emission Trading System
FES	Future Energy Scenario
GVA	Gross Value Added
GW	Gigawatt
GWh	Gigawatt Hour
HAR	Hydrogen Allocation Round
HGV	Heavy Goods Vehicle
HPP	Hydrogen Production Plant
HyDESS	Hydrogen for Decarbonisation of Sheffield Steel
Mt	Megatonne
MW	Megawatt
SAF	Sustainable Aviation Fuel
TRL	Technology Readiness Level
TWh	Terawatt Hour

References

1 https://assets.publishing.service.gov.uk/media/5ad9be7fe5274a76c13dffad/england-port-connectivity-the-current-picture.pdf

2 https://www.caa.co.uk/Documents/Download/9116/47a460b2-0592-4ef7-b24b-aa5e27ccfce4/5636

3 https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/articles/theriseoftheukwarehouseandthegoldenlogisticstriangle/2022-04-11

4 https://humberindustrialclusterplan.co.uk/the-humber-a-2030-vision-for-industrial-decarbonisation.html

5 https://www.gov.uk/Government/news/major-blueprint-to-create-green-jobs-and-slash-emissions-from-industry-schools-and-hospitals

6 https://www.lincolnshire.gov.uk/devolution/proposal/2#:~:text=Energy%2C%20decarbonisation%20and%20net%20zero%3A%20Greater%20Lincolnshire%20is,to%20become%20a%20net%20energy%20exporter%20by%202040.

7 https://www.gov.uk/Government/publications/renewable-energy-planning-database-monthly-extract

8 https://www.southyorkshire-ca.gov.uk/getmedia/66c30a9c-a301-44c8-a9ad-18c9f867363c/SYMCA_Energy-Strategy_v2_Jan22.pdf

9 https://www.arup.com/-/media/arup/files/publications/h/hydrogen-sheffield.pdf

10 https://data.nationalgas.com/find-gas-data

11 https://midlandsengine.org/wp-content/uploads/2024/03/Hydrogen-Rail-report-for-web.pdf