EASTSUFFOLK COUNCIL

East Suffolk Clean Hydrogen Strategy 2023 - 2028

HM Government

December 2022

CONTENTS

VISION

The Council's vision is to establish East Suffolk as a nationally significant, hub for the generation, distribution, innovation, and adoption of clean hydrogen as part of the collective ambition of the private and public sector to achieve net zero by 2030. [1]

The East Suffolk Hydrogen Strategy will set out how East Suffolk Council can enable the emergence of the local hydrogen economy between 2023 and 2028 to achieve our vision. The strategy examines the current hydrogen landscape from a national, regional perspective, and details localised opportunities and projects in planning, to determine how the local authority can provide integral support that advances the hydrogen economy for the benefit of its people, businesses, visitors, and environment.

[1] Clean Hydrogen – has been used by East Suffolk Council to refer to all hydrogen projects in East Suffolk that are planned to produce electrolytic hydrogen via renewable or nuclear sources. The official terms for hydrogen are set by the Low Carbon Hydrogen Standard.

AIM

To identify the local hydrogen priorities that will stimulate the development of a co-ordinated hydrogen economy over the next five years (2023-2028) and set out how the council can enable these. This strategy will establish, in broad terms, how East Suffolk Council; enacts its role to support and enable the long-term goals associated with clean hydrogen rollout and considers direct intervention where possible. Overall, this strategy looks to secure investment and stimulate private sector collaboration for Clean Hydrogen production, consumption, and infrastructure to progress the opportunity of East Suffolk's Hydrogen Economy.

The vision and aims for this strategy align with several important themes and key priorities that are specified in East Suffolk Strategic Plan 2020-2024:

Growing our Economy – we want our district to achieve its maximum potential, for the good of everyone in the area.

1. Maximise and grow the unique selling points of East Suffolk
2. Attract and stimulate inward investment
3. Develop business partnerships
4. Support and deliver infrastructure

Caring for our Environment – We will put the environment at the heart of everything we do

1. Lead by example
2. Explore renewable energy
3. Protect, educate and influence

OBJECTIVES

To deliver the 2028 vision, there are several objectives that can be enacted within the five-year period. The following key objectives represent areas where ESC and partners can have a tangible and positive impact in enabling a high value local clean hydrogen economy. Given the nascent state of the hydrogen industry, flexibility needs to be accommodated within the strategy. Therefore, the Working Group referred to in objective 1, will determine how best to achieve these objectives in the context of a rapidly evolving industry.

Objective 1 – Establish a hydrogen working group comprised of internal departments and external stakeholders to proactively support appropriate hydrogen production and its supporting infrastructure.

Objective 2 – Raise awareness, in collaboration with local and regional stakeholders, of East Suffolk's important position as an early clean hydrogen adopter, and the epicentre for clean hydrogen in the East of England.

Objective 3 – Establish and enhance working relationships with regional and national stakeholders to improve communication between local, regional, and national hydrogen activity.

Objective 4 – Proactively facilitate the case development for each planned hydrogen project and any future projects looking to invest in clean hydrogen in East Suffolk.

Objective 5 – Lobby for greater regional and national activity to remove known economic barriers such water supply, grid infrastructure, distribution networks, and capital investment.

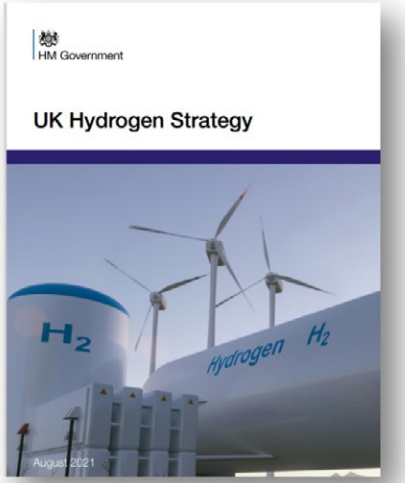
Objective 6 – Explore and bring forward East Suffolk Councils adoption of hydrogen products, demonstrating proof of use to the market.

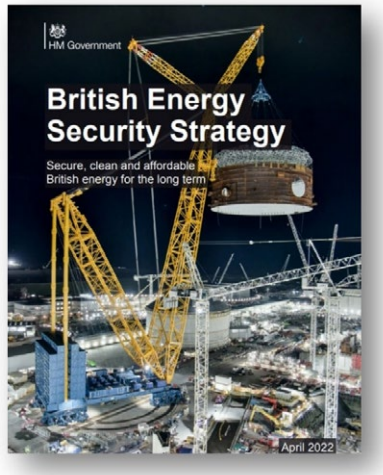
The objectives set out above were determined via consultation with stakeholders, formalised analysis, and in response to existing preparatory work undertaken by the Council's Economic Development and Regeneration Team.

UK HYDROGEN CONTEXT

The UK's hydrogen supply chain presents a significant economic and environmental opportunity for the UK, though the industry is embryonic, complex, and uncertain. Low carbon hydrogen is expected to be a key enabler for the UK to meet its net zero targets. The UK's ambition is for 10 Gigawatts (GW) of low carbon hydrogen production capacity by 2030, subject to affordability and value for money, with at least half of this coming from electrolytic hydrogen. This doubled the previous ambition set out in the governments' 10-Point Plan for a Green Industrial Revolution [2] and the Hydrogen Strategy. More recently, low carbon hydrogen could also play a critical role in our energy system, supporting UK energy security and independence, in addition to its carbon reduction targets. [3]

See Appendix 1 for further details.





[2] The Ten Point Plan for a Green Industrial Revolution (BEIS, Nov 2020)

[3] UK Hydrogen Strategy (BEIS, July 2022)

REGIONAL HYDROGEN CONTEXT

The Norfolk and Suffolk Economic Strategy, published in January 2022, signals the strategic importance of hydrogen development to the regional economy.

> *"Norfolk and Suffolk is the UK's epicentre for energy generation with its unique mix of onshore and offshore renewables, gas and nuclear generation and emerging opportunities for hydrogen."* [4]

The New Anglia region can also make a significant contribution to realising low-carbon hydrogen's potential and support delivery of the Government's Hydrogen Strategy, statutory carbon budgets and the Net Zero target. Hydrogen East, the region's hydrogen research organisation, has built a robust evidence base around the deployment of electrolysers in a predominantly non-urban area with specific local characteristics, and in which transport decarbonisation is a key priority, but a major challenge.

The suggested proposals centre on a "core" electrolyser project, or projects, at key sites in Norfolk and Suffolk that would be close to facilitated demand cases based primarily around different large vehicle classes. Under this approach, several geographically approximate small electrolysers could be developed, and the supporting infrastructure added as regional demand grows.

See Appendix 2 for further details.

[4] Norfolk and Suffolk Economic Strategy, Jan 2022


EVERGREEN
Port of Felixstowe

EAST SUFFOLK HYDROGEN CONTEXT

The clean energy sector is and has been crucial for East Suffolk and will continue to provide significant opportunities for its people and businesses. It has the potential to create a positive legacy that will support future generations and could lead to yet unexplored opportunities through the aggregated potential of the sector. The energy industry in East Suffolk already delivers economic benefits that relate to jobs, investment and supply chain opportunities in offshore wind energy and nuclear power generation, but these benefits will also be enhanced by rapidly emerging energy sources such as hydrogen.

Based on current hydrogen planning and developments in East Suffolk and the effective implementation of this strategy, by 2028 the nascent East Suffolk hydrogen economy could include;

1. Three operational demonstrator electrolysers of varying scale with local end-user agreements with the intent to expand.
2. Three different vehicle trials successfully delivered with the intent to expand.
3. Local supply chain companies have begun to take on hydrogen contracts.
4. A formalised Hydrogen Forum focusing on alleviating local and regional barriers.
5. East Suffolk Council has planned for, or taken ownership of, hydrogen powered vehicles and assets to meet its environmental ambitions.

These five opportunities are realistic and valuable targets that will each contribute to East Suffolk's vision of establishing a regional and potentially national clean hydrogen hub. The purpose of this strategy is therefore to ensure such opportunities become a reality and are maximised for the benefit of everyone in East Suffolk.

EASTSUFFOLK COUNCIL

East Suffolk H2 Locations

Why Hydrogen?

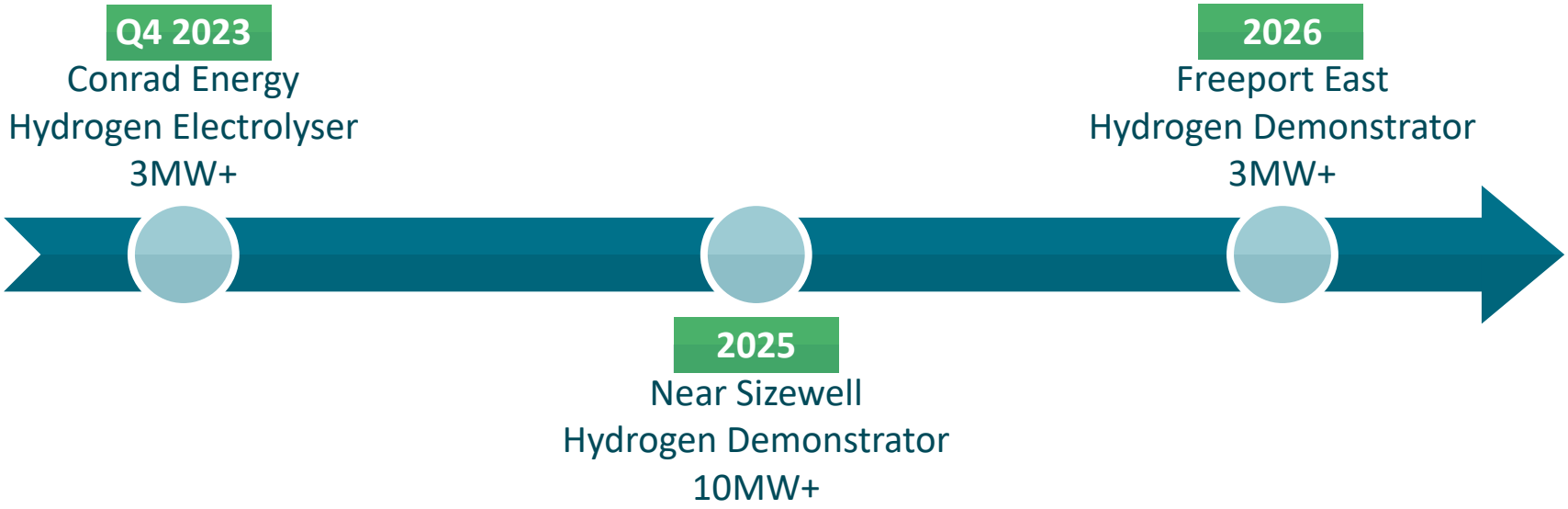
The creation of hydrogen via a method such as electrolysis, the splitting of purified water (H2O) into its constituent parts of hydrogen (H2) and oxygen (O2), produces no harmful emissions or residues. The process of electrolysis requires a source of power, which can be acquired by renewable or offsetting non-renewable energy sources. Hydrogen therefore represents a potentially clean product and fuel that has the potential to support the decarbonisation of many industries such as construction, transport, and agriculture. This is particularly impactful for rural parts of the UK such as East Suffolk where electrification of industries is unviable.

Hydrogen is already a vital input to produce various industrial chemicals such as ammonia, used in large quantities to produce fertilizer. However, the significant potential of hydrogen as a fuel source is being proven more and more across multiple industries and by various leaders such as JCB, Hyundai, and Airbus. Within East Suffolk, demonstrator projects are already in planning that could see trial vehicles powered by hydrogen combustion engines or fuel cells within the lifetime of this strategy. Furthermore, the high concentration of construction projects in Norfolk and Suffolk creates an aggregated demand and strong business case for hydrogen, if supported to transition to hydrogen and use local hydrogen sources, many construction projects could be significantly decarbonised. This includes but may not be limited to buses, vessels, construction equipment and operational port equipment.

See Appendix 3 for further details.

Across the UK, various hydrogen projects are in planning, areas such as Teesside, Derby and Aberdeen are embracing clean hydrogen and are leading from the front by establishing their own strategic priorities and plans to embed clean hydrogen as an integral part of their local economies. Regional and national research and planning has highlighted that coastal areas with a well-established blend of energy sources are strongly positioned to welcome hydrogen and its associated benefits. It must therefore be acknowledged that a significant opportunity exists for East Suffolk to also become a UK leader in the early development of a clean hydrogen economy. The vision for an embedded clean hydrogen economy could encompass all parts of the process from production though to consumption, and the required infrastructure for transportation, storage, and refuelling.

It is one of the latest emerging industries in the clean energy mix that is gathering rapid momentum and private sector investment in East Suffolk and regionally. With several key hydrogen developments planned and progressing in the district, East Suffolk's importance regionally, and potentially nationally as a significant clean energy leader, could be strengthened further. In the northern part of the district, Conrad Energy are constructing a 3MW hydrogen production site on the Lowestoft Power Park. Sizewell C are tendering for the development of an independent hydrogen facility during construction, which could then be powered by Sizewell C once operational. At the Port of Felixstowe, Scottish Power Renewables are progressing plans for an initial 100MW electrolyser. In total Freeport East has ambitions to deliver 1GW of hydrogen production across its sites.



Economic benefit

The economic benefit of hydrogen is potentially significant at a local level. The addition of hydrogen assets will further diversify the growing energy industry in East Suffolk, expanding supply chain opportunities and providing greater stability for local organisations. The clean gas also has the potential to support East Suffolk Council in meeting its own net zero ambitions through the possible use in refuse fleets, the Council's housing stock and leisure centres. Hydrogen refuelling and storage is also expected to increase energy security and flexibility for businesses and communities in the event of any future energy shocks. The use case for clean hydrogen also supports the further expansion of the Southern North Sea's renewable energy capacity which continues to support local business and jobs.

Demand for hydrogen

To date, East Suffolk and the wider region is experiencing slower progress on demand side developments of hydrogen. This mirrors the national picture but is exacerbated by the absence of diverse potential end-users such as, chemical production, and significant industrial power & heating requirement. However, East Suffolk has great potential in transport, construction, port operation equipment, and agriculture. Already two confirmed plans for vehicle trials are progressing at Freeport East and Sizewell respectively, with further discussions under way for new trials elsewhere, and opportunities for aggregated demand across various construction projects. These critical and nascent developments must be nurtured to deliver proof of concept which can then be the catalyst for further expansion and investment of hydrogen production and consumption in East Suffolk.

As the owner and operator of a refuse fleet and buildings across East Suffolk, the Council could lead the way for end-users to prove viability and potentially derisk investment decisions.

Progress Overview

Prior to the development of this strategy and in response to the identified hydrogen developments, the Economic Development and Regeneration team has undertaken early work to informally engage private and public stakeholders. This led to the development of the Hydrogen Development Forum, a quarterly meeting to share development insights, better understand constraints and opportunities and bring together key demand and supply side stakeholders such as Sizewell C, Scottish Power Renewables, Hutchinson Ports, Associated British Ports, Conrad Energy, Hynamics, and Windcat Workboats.

Building on the success of the hydrogen developers forum, East Suffolk Council is leading the development of the East Suffolk Hydrogen Conference. This is in response to strong support from developers and stakeholders, and an identified gap regionally that should bring hydrogen developers, end-users, innovators, and wider stakeholders together to raise the profile of clean, local hydrogen developments and address any barriers that are likely to be inhibiting the pace and scale of growth.

EAST SUFFOLK PROJECTS

The strategic priorities and clean hydrogen ambitions for East Suffolk are closely aligned with progressing local hydrogen developments. These include Freeport East, which will involve the development of a Green Energy Hub, the proposed Sizewell C development, and ABP's significant outer harbour development which is supported by the development of the Powerpark. If realised, these projects might span between 30 MW to 100 MW from 2030 as they scale, and electrolyser costs fall.

See Appendix 4 for further details.

The Powerpark and the Port of Lowestoft

Hydrogen East assessed that the Powerpark in Lowestoft has existing, refurbished, planned and potential energy assets in the area which could be integrated to create a local flexibility hub, including a hydrogen electrolyser in conjunction with renewable electricity generation to provide alternative low carbon fuel, initially for local transport fleets but also for other potential local use cases. The hydrogen industry will provide the Port of Lowestoft with a pipeline of operations, maintenance, and construction support over coming decades, and create new energy sources that allow the decarbonisation of the Port's own networks and activities including the energy and marine supply chain. This would need to be based mainly on grid imports in the short-term but could be supplemented by Gulliver turbine and development of local PV solar.

Planning consent was received from East Suffolk Council in February 2022 for Conrad Energy's 3MW project comprised of up to three hydrogen electrolysers and associated storage, located within the Lowestoft PowerPark. Powered by clean electricity, the project has the potential to produce up to 470 tonnes of hydrogen per year – enough clean gas to heat the equivalent of 1500 average homes or fuel the equivalent of 60 hydrogen fuelled HGVs travelling 50,000 miles per year. Conrad has already started construction on the 7MW flexible generation site which forms part of the proposals and will bring grid stability to the wider Lowestoft area at times of high demand and grid system stress.

Local end-users such as bus operators, HGV logistics and vessel operators have the potential to explore initial trials that could consume hydrogen produced by Conrad Energy. Though not currently in planning, there's the possibility to support the expansion of hydrogen production within Lowestoft, subject to local demand.

Production: 3MW+

Operational by: Q4 2023

Stage: Under Construction

In March 2021, Associated British Ports, owners of the Port of Lowestoft, announced a five-year plan to develop the Lowestoft Eastern Energy Facility (LEEF), involving an initial £30 million investment in state-of-the-art infrastructure to support the offshore energy industry. LEEF East – phase 1– is ideally positioned to support Lowestoft's existing customers and future offshore wind projects with Operations & Maintenance (O&M) and construction support activities. In late 2022 ABP announced McLaughlin & Harvey as the successful design and build contractor for LEEF East, with the construction of the facility due to start in mid-2023.

LEEF West – phase 2 – involves creating up to 200m of additional quayside and a further five acres of developable land.

Given the level of investment to support a thriving clean-energy industry at and around the Port of Lowestoft, hydrogen could become an exciting and important strand that, if explored further, could complement and enhance the strength of the industry in and around Lowestoft.

Sizewell C

Powering up to 186 hydrogen buses for our construction workforce

Refuelling and maintenance hubs

Vehicles and machinery

Sustainable Aviation Fuel (SAF)

Consumption: 10MW+

Operational by: 2025

Stage: Tendering

The Sizewell C Project aspires to decarbonise the construction of the power plant as much as possible. Using clean hydrogen buses and construction equipment will be vital to achieving this aim. The hydrogen needed for such buses or construction equipment at Sizewell C could be powered by a circa 10MW (or more) electrolyser that uses Sizewell B, photovoltaic arrays, and/or other zero/ low-carbon electricity sources for generation. The hydrogen produced from the electrolyser (which can be sized accordingly) could also be potentially used to serve other markets, such as shipping and port activities. The Sizewell C project will be a consumer of low carbon hydrogen during the construction phase – the project will be procuring hydrogen buses / equipment and refuelling facilities and looking to use low-carbon hydrogen produced locally – and hopes that these plans can kickstart a hydrogen ecosystem in the region.

When operational, the Sizewell C Project is exploring extraction of low-carbon heat from the power station before it is converted into electricity – such heat can be used (alongside electricity) to make hydrogen production more efficient and reduce cost per kg. As part of its energy hub proposal, the Sizewell C project is also exploring other innovative technologies such as Direct Air Capture (DAC) – carbon dioxide captured via DAC can be combined with hydrogen produced, to form synthetic fuels.

Freeport East

Comprising of three Tax Sites at Felixstowe, Harwich and Gateway 14, Freeport East is centred on the UK's largest intermodal ports cluster, with excellent road, rail, and sea infrastructure. The port links UK businesses with over 190 countries worldwide, handles 40% of all the UK's trade with Asia, and serves EU markets through regular container and roll/on-roll-off services, making it a major UK gateway port for global trade.

Freeport East's vision for a Green Energy Hub will contribute significantly to the projected 10GW of low carbon hydrogen production capacity, by 2030, 1GW of green hydrogen could be produced. Given the significant volume and variety of machinery and vehicles that operate in the Port or pass through it, it is an ideal location for substantial hydrogen developments. As a key connection point for global trade, it has excellent routes to future expansion of green hydrogen production, through the development of export infrastructure serving national and international markets. The project is likely to be one of the world's first green hydrogen hubs satisfying a wide range of demands demonstrated at the UK's largest port facility.

To date, ScottishPower and Hutchison Ports have identified the Port of Felixstowe as a highly strategic location for a large-scale green hydrogen hub. Deploying 100MW of electrolytic hydrogen production by 2026. The production of green hydrogen at Felixstowe will help Hutchison Ports and Freeport East realise their ambition of reducing their greenhouse gas emissions whilst facilitating trade and economic development. Hutchison Ports will benefit from the carbon free fuel which will provide the means to fuel-switch machinery, including terminal tractors, cranes, rail shunters and for use in on-site vehicles.

Consumption: 100MW+

Operational by: 2026

Stage: Ideation

The development also opens new opportunities for locally important industries such as; clean energy, construction & manufacturing, agriculture, and transportation to decarbonise their operations, with local demand for hydrogen liquefaction and ammonia production. The project provides an optimal location for future refuelling facilities for road hauliers and rail freight operators, providing response to additional demand.

- In collaboration with Cranfield University, a demonstrator of hydrogen power port tractor trailer units will be delivered on site. With 350 items of mobile equipment, the Port of Felixstowe is the best location in the UK for off-highway trials of hydrogen vehicles. This can then be deployed into significant HGV activity at the Freeport for road trials.

- The Freeport will also explore the possibility of deploying a hydrogen demonstrator Clean Maritime project with SZC, EDF, Hutchinson Ports and Cranfield university, subject to a funded study to map hydrogen demand at Ports.

- Scottish Power Renewables have also submitted plans to the Net Zero Hydrogen Fund for a £150 million green hydrogen hub at the Port of Felixstowe.

EXTERNAL HYDROGEN PROJECTS

Project Union

National Grid Gas Transmission will convert key sections of the existing gas network, with some new build, to deliver a UK hydrogen backbone by the early 2030s. Project Union will connect hydrogen production, storage and end-use, providing resilience to London and the wider UK energy system.

Project Union will deliver a “first of a kind” hydrogen transmission backbone for the UK. Through the phased repurposing of existing assets alongside new ones, a hydrogen backbone of around 2,000km will be created, representing around 25% of the UK’s current natural gas transmission pipelines.

Capital Hydrogen

Capital Hydrogen is a partnership between Cadent, SGN and National Grid Gas Transmission, which are responsible for the safe and reliable supply of gas to millions of customers. The programme plans to deliver a transition to hydrogen for gas networks in the East of England, South East and London through a series of projects over the next 15-20 years.

Current planning includes the laying of new transmission piping from London to Bacton, with the possibility that a connection could be made at Lowestoft.

Bacton Energy Hub

There is a significant market opportunity at Bacton given the access to a range of low-carbon energy technologies and assets, the need to decarbonise gas supply.

The core components of development of a Bacton Energy Hub include the re-use of North Sea assets for carbon storage, blue and green hydrogen production and strong collaboration with offshore wind and potentially nuclear sectors. This could be supplemented by other asset types, including battery storage, solar, wave or tidal generation, and could see innovative offshore hybrid solutions as well as land-based developments.

The implications of hydrogen developments in the gas network for local electrolyser developments are not fully known and predictable, a collaborative model of knowledge sharing must be pursued.

SWOT ANALYSIS

The SWOT analysis below examines the development of a local hydrogen economy to help shape priorities and specifically where East Suffolk Council and other public sector partners can enable the industry to develop.

SUPPLY - STRENGTHS AND OPPORTUNITIES

1. Established and growing low carbon energy developments and supply chain.
2. Geographical proximity of potential hydrogen consumption and production.
3. Political support for the progression of the local hydrogen industry.
4. Clear support and supporting hydrogen investment from local energy developers.
5. Proximity to zero / low carbon energy sources to support clean hydrogen developments.

SUPPLY - WEAKNESSES AND THREATS

1. Community, environmental and political sensitivity for additional energy infrastructure.
2. Limited supply chain awareness of local opportunities.
3. Lack of national stakeholder awareness and engagement with East Suffolk developments.
4. Constrained fresh water supply, scaling hydrogen may require significant CAPEX subject to displacement from existing fossil fossils to hydrogen.
5. Constrained National Grid and UKPN capacity and connections, scaling hydrogen may require significant CAPEX.
6. Electricity and water upgrades subject to external planning decisions.
7. Large scale investment in hydrogen production must secure demand.
8. Constrained land availability and suitability.
9. Refuelling & storage research and mapping required at a regional level.

DEMAND - STRENGTHS AND OPPORTUNITIES

1. Significant infrastructure projects rolling out associated vehicle trials.
2. Reliable and clustered transport demand – HGV, Vessel, Bus, Train.
3. Existing co-ordination between hydrogen developments.
4. Anchor end-user agreements are and can be progressed.
5. Lessons can be learnt from the planning of transport hub models around the UK.

DEMAND - WEAKNESSES AND THREATS

1. Limited supply chain awareness and engagement of local hydrogen opportunities.
2. Nascent demand side developments pose investment risks with high CAPEX.
3. Timing of clean hydrogen production to meet need of local need.
4. Limited career information and guidance.
5. Wider rollout of hydrogen powered vehicles and assets is dependent on the life span of existing vehicles.

SWOT RECOMMENDATIONS

Using the SWOT analysis above, we can conclude that there is the potential for East Suffolk Council to support the early development of the local hydrogen economy. Below is a framework that sets out objectives as a journey by time and level of influence. Given the pace of progress and variety of unknown variables the objectives of this strategy should be subject to an on-going annual review to ensure their efficacy and relevance.

East Suffolk Council will engage with private and public sector partners whose priorities align with the ESC Hydrogen Strategy. Through their work, we shape mutually beneficial outcomes and deliver the ambition of the hydrogen strategy. This could be resourced through existing staff, but consideration should be given for the creation of a new role and/or an appropriate funding pot could be ring fenced to contribute to regional hydrogen work, if a strong case and outputs can be demonstrated.

The East Suffolk Hydrogen Strategy will set out how East Suffolk Council can directly and indirectly support the emergence of the local hydrogen economy between 2023 and 2028 to achieve our vision.

Objective 1 *– Establish a hydrogen working group comprised of internal departments and external stakeholders to proactively support appropriate hydrogen production and its supporting infrastructure.*

An East Suffolk Hydrogen Working Group could provide the central governance needed to deliver the East Suffolk Hydrogen Strategy and improve cross-departmental working on the fledgling hydrogen industry. This group would also provide a space for external enabling stakeholders to attend, providing information and guidance. It will require flexibility to scale in accordance with the developmental work required by East Suffolk Council to provide an appropriate level of support and resources.

The reporting generated by the Working Group would further support the integration of developments in East Suffolk into any regional hydrogen activity. As an example, EEEGR (the East of England Energy Group) are launching the Hydrogen Sector Council in early 2023, a special interest group to represent and action activity at a regional level.

It is expected that the workload required to support and facilitate hydrogen developments will incrementally increase and become more complex over the lifetime of the Clean Hydrogen Strategy. In anticipation of this increasing and evolving workload, the Hydrogen Working Group should periodically review the merits of appointing an internal officer as the ESC hydrogen lead, and making a formal recommendation of this appointment if and when it becomes a necessity to continue the implementation of the Hydrogen strategy. The role and responsibilities of the lead should be developed in accordance with the work required for the implementation of the strategy at the time of determination. Broadly, an appointed ESC hydrogen lead could be responsible for the successful delivery of the East Suffolk Hydrogen Strategy and future work associated with hydrogen.

***Objective 2** – Raise awareness, in collaboration with local and regional stakeholders, of East Suffolk's important position as an early clean hydrogen adopter, and the epicentre for clean hydrogen in the East of England.*

The existence of well-established and developing clean energy sources both onshore and offshore means that East Suffolk is well positioned to see advancing development in the production of clean hydrogen. Clean hydrogen is defined as any form of hydrogen production that uses a renewable energy source.

The East Suffolk based hydrogen developments are in mixed stages of planning and construction. Conrad Energy Flexgen site will likely be the first operational hydrogen development in East Suffolk and the wider region.

Given its embryonic stage, the opportunities of planned hydrogen production within East Suffolk are not yet fully understood by all parties, this includes public sector authorities, infrastructure and utilities, the hydrogen market, and the supporting supply chain. This creates a knowledge deficit that could limit the pace of potential growth and create avoidable barriers. East Suffolk Council can play a pivotal role in ensuring that the opportunities and progress associated with each development are widely and systematically shared and accessible for various local and regional audiences.

For example, Generate, the publicly funded organisation responsible for marketing the energy industry in Norfolk and Suffolk. "Hydrogen opportunities in East Suffolk and the wider region" could become an integral and valued message of Generate further strengthening the energy industry offer to a national and international audience of supply chain organisations. Generate, with supporting stakeholders, could lead on the co-ordination of supply chain engagement.

Objective 3 *- Establish and enhance working relationships with regional and national stakeholders to improve communication between local, regional, and national hydrogen activity.*

East Suffolk Council should consider how to engage appropriate regional stakeholders who can lead and contribute to the strategic planning required to successfully support the initial hydrogen developments and their subsequent scaling.

By establishing working relationships and consulting hydrogen stakeholders, this should enable East Suffolk Council and the Hydrogen Working Group to better understand and articulate the role of a local authority in enabling hydrogen production and consumption.

For example, Hydrogen East, as the leading hydrogen research organisation for the region are well placed to provide information and guidance to all stakeholders. This includes providing insights into projects outside of East Suffolk such as the Bacton Energy Hub and Capital Hydrogen which may provide value and have implications for hydrogen developments in East Suffolk.

East Suffolk Council, with partners, should also pursue closer relationships with leading hydrogen authorities and arrange on-going knowledge sharing processes. This will be of particular importance if local authorities show similar characteristics in terms of geography, industry, and demographics. Planning for refuelling infrastructure has been identified as critical step that must be addressed through a multi-organisational approach.

***Objective 4** - Proactively facilitate the case development for each planned hydrogen project and any future projects looking to invest in clean hydrogen in East Suffolk.*

Lowestoft, Sizewell and the Port of Felixstowe are the current locations for each planned development. The size, type and location of the hydrogen production and consumption will vary in each case, therefore important considerations and any barriers associated with each development will be unique. Understanding the variations between each site will be imperative to ensure East Suffolk Council can provide effective facilitatory support across internal departments.

In broad terms, the hydrogen developments at Sizewell and the Port of Felixstowe are expected to produce larger volumes of hydrogen than the Conrad development, and are to be delivered with proposals put forward for end-use consumption i.e. a bus fleet at Sizewell and HGVs/ port equipment at Felixstowe.

This means that both developments may already have a relatively defined business case that could limit or delay short-term considerations for any additional end-use cases. In comparison, Conrad Energy's Lowestoft site, currently has no pre-determined local end-use case, and will be a smaller producer of hydrogen comparatively. Though this presents a challenge to the developer, it also means there is a degree of flexibility in how off-taker agreements are acquired and how quickly arrangements can be made with local end-users, subject to external factors.

Objective 5 *- Lobby for greater regional and national activity to remove known economic barriers such water supply, grid infrastructure, distribution networks, storage solutions and capital investment for demonstrator uses.*

The production and consumption of hydrogen has still yet to be proven at a commercial scale within the UK. This is primarily due to a number of barriers that inhibit the feasibility of hydrogen at scale in the short and mid-term. Regional and national economic agents will be required to provide solutions to many of these barriers, however it should be the responsibility of East Suffolk Council to lobby for greater activity and attention on such barriers that have a particularly limiting impact on hydrogen developments in East Suffolk.

Examples of pronounced hydrogen production barriers in East Suffolk include, a scalable supply of purified water, and reinforced grid infrastructure around proposed locations for hydrogen production sites. For hydrogen consumption the most significant barrier that is not unique to East Suffolk is the lack of demand side innovation, where present, innovations for end-use cases requires financial intervention to de-risk investment decisions.

Objective 6 *– Explore and bring forward East Suffolk Councils adoption of hydrogen products, demonstrating proof of use to the market.*

As the owner and operator of a refuse fleet, East Suffolk Council can explore its direct stake as a potential hydrogen consumer in the mid to long term. The existing fleet currently operates on HVO (hydrotreated vegetable oil) which could be transitioned to hydrogen. In doing so, we could lead the way for end-users to prove viability and potentially derisk the investment decision for external organisations.

Furthermore, assets owned and/or operated by East Suffolk Council could also be considered for innovative trials. For example, leisure centres typically consume large quantities of heat and power, resulting in large utility costs, hydrogen could present a suitable solution for power or heat generation that not only address the environmental impact but also the financial impact as the cost of hydrogen continues to fall. It is stated in this strategy that the opportunity for East Suffolk Council to directly embrace hydrogen must be explored further.

KEY STAKEHOLDERS

This table provides an initial assessment of important stakeholders who could contribute the successful development of East Suffolk's hydrogen economy. The appropriate stakeholders should be engaged with by the Hydrogen Working Group according to the progression the objectives set out within this strategy.

Hydrogen Producers

- EDF
- Scottish Power
- RWE
- Scottish Southern Energy
- Vattenfall
- Hynamics
- Ryze Energy
- Octopus Energy
- Conrad Energy

Notable Potential Hydrogen Consumers

- **Heat**
  Hydrogen Boilers (Domestic/Industrial)
  Gas Distribution Operators
  E.g. Conrad , Cadent , SGN , National Grid
- **Power**
  Turbines, Generators, Compressors, H2 Storage
  E.g. Prior Power
- **Transport**
  Road, Rail, Maritime, Aviation
  E.g. National Rail, CMB.TECH, Windcat Workboats, Wright Bus, First Bus, JCB, East Suffolk Council, Suffolk County Council, Vessel Operators, Sizewell C & Supply Chain.
- **Storage and Distribution**
  Refuelling and storage infrastructure
  E.g. Ryze, ULEMco

Local Education, Training and Skills

- University of East Anglia
- University of Suffolk
- East Coast College
- City College, Norwich
- College of West Anglia
- West Suffolk College
- Suffolk New College
- University Technical College Norfolk

Hydrogen Research, Development & Innovation

- An glia Ruskin University
- University of Cambridge
- University of Essex
- University of Birmingham and Aston University
- Cranfield University
- Brunel University London
- Colchester Institute
- Cambridge Norwich Tech Hub
- Thrive Renewables
- AFC Energy
- JCB

Key Supporting Organisations

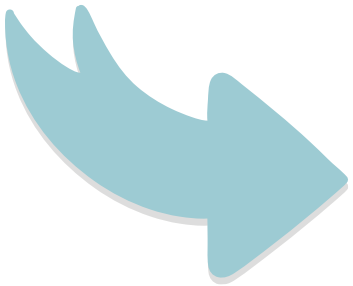
National - BEIS, Hydrogen UK, ORE Catapult, Energy Systems Catapult
Regional - New Anglia Local Enterprise Partnership, Suffolk County Council, Suffolk Growth Partnership, Generate, Hydrogen East, EEEGR Hydrogen Council, Hutchinson's Port UK, Associated British Ports.

GOVERNANCE

The governance set out below will serve as a basis to provide transparency and confidence to all stakeholders that the delivery of the hydrogen strategy will be maximised against its objectives and to ensure that East Suffolk Council is well placed to adapt and enhance the hydrogen strategy to a rapidly changing external environment.

To provide this governance the Economic Development & Regeneration Department will establish a multi-departmental & organisational “Hydrogen Working Group”.

The responsibilities of the Hydrogen Working group will be to:



- Ensure the objectives of this strategy are achieved and annually reviewed for efficacy and relevance.
- Develop and monitor the implementation of an annual delivery plan.
- Monitor and mitigate risks that may impede strategy delivery.
- Optimise the performance of the strategy by developing and procuring the required resources.
- To review the capacity of the working group to deliver the objectives of the strategy.

PERFORMANCE MONITORING

This section will set out key qualitative (and quantitative measures where possible) measures to appraise the performance the East Suffolk Hydrogen Strategy against its objectives.

Measure 1 – Mega Watts of hydrogen production

By measuring hydrogen production by megawatts, we will be able to track the progress of multiple projects as they scale.

Measure 2 – Local supply chain contract value

As production capacity is developed, it is important that the value of hydrogen supports the East Suffolk economy through supply chain contracts.

Measure 3 – No. and type of hydrogen end use products locally used and developed.

This measure should indicate the level of and pace of demand uptake overtime. It should also provide a reliable picture of where hydrogen adoption emerges and in which sectors.

CONCLUSION

East Suffolk Council is in the position to enable, support (and possibly directly influence) the nascent hydrogen projects in planning and any future developments. Collectively the hydrogen economy has the high potential to create skilled jobs, support local businesses, decarbonise significant operations across multiple industries, and further develop the clean energy USP of East Suffolk. East Suffolk can become a nationally significant leader for the clean hydrogen industry and economy.

Through this strategy, East Suffolk Council, and supportive stakeholders, over the next five years can stimulate private sector investment and collaboration for Clean Hydrogen production, consumption, and infrastructure to progress the opportunity of East Suffolk's clean hydrogen economy.

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East Suffolk Clean Hydrogen Strategy - Appendices

EUROPEAN UNION
European Regional Development Fund

HM Government

December 2022

APPENDIX 1 – NATIONAL HYDROGEN PERSPECTIVE

The total economic impact to deliver the hydrogen capacity defined in 2030 is estimated as follows (See Appendix 1):

Investment - The estimated supply chain investments to establish UK hydrogen economies in 2030, are between £7.9 billion and £9.3 billion (and between £34 billion and £124 billion in 2050).

Employment - The average annual employment from 2023 to 2029 to establish the 2030 hydrogen supply capacity is estimated at between 6,100 and 7,100 full time equivalent staff.

Gross Value Added - The average annual direct GVA over the period from 2023 to 2029 to establish the 2030 hydrogen supply capacity is estimated at between £575 million and £665 million.

To meet the UK's renewed 10GW target the government and industry are making commitments to develop first-of-a-kind projects and commercial projects at scale. However, on the demand side, further support is needed for the widespread conversion of equipment and infrastructure to run on hydrogen, and the feasible scaling of commercial electrolyser capacity to meet demand. It is documented that nationally; a lack of clarity and widespread awareness of supply chain opportunities, and a shortage of UK manufacturers and suppliers, are recognised as current weaknesses in the UK hydrogen economy. Therefore, the government and industry must address the lack of confidence for supply chain investment, which represents a substantial threat to the pace and scale of growth of hydrogen developments to meet the 2030 target, alongside other potential challenges including the lack of high-quality water, and competition for renewable energy capacity.

Delivering a supportive environment across the UK is critical to overcoming the complexity and immaturity of the hydrogen supply chain and optimising supply chain development and growth. To address this, strong public and private sector leadership is required to enable the development of the UK hydrogen supply chain, and the prioritisation of areas for growth and investment. Supporting organisations such as Hydrogen UK and the Hydrogen Council is paramount to successfully implement the UK's hydrogen strategy.

One step towards implementation is the UK governments Hydrogen Sector Development Action Plan (SDAP), which has been published alongside a short brochure setting out different sources of government funding for hydrogen R&I. The purpose of this Sector Development Action Plan is to highlight the nature and scale of opportunities across the hydrogen economy in the UK. The plan focusses on deliverable targets across four key areas: investment; supply chains; jobs and skills [1].

[1] Hydrogen Sector Development Action Plan (BEIS, July 2022)

Supply Chain Framework for the UK Hydrogen Economy
Hydrogen Sector Development Action Plan (Pg 16, BEIS, June 2022)

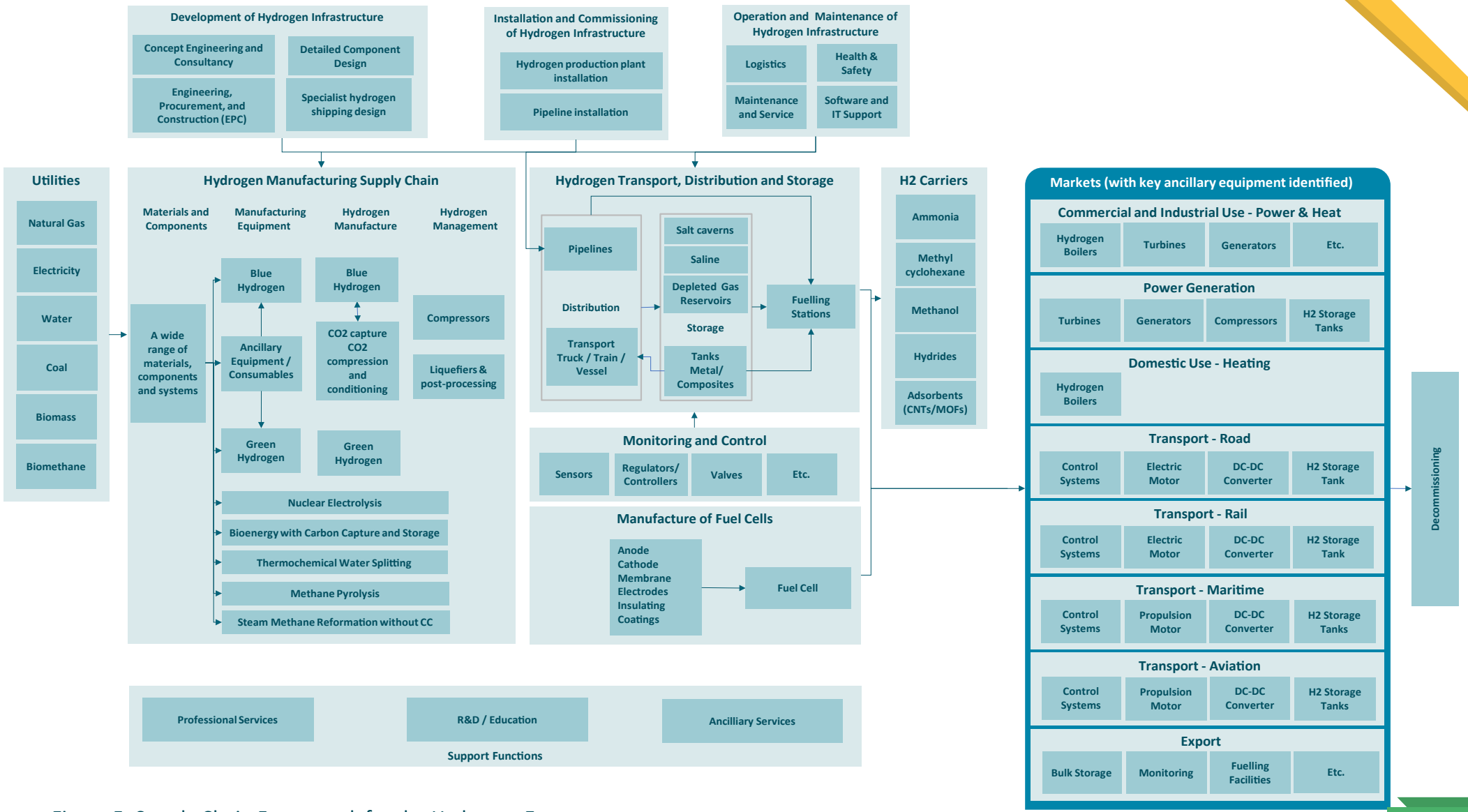

Figure 5: Supply Chain Framework for the Hydrogen Economy

SWOT Analysis of the UK hydrogen supply chain.
Supply Chains to Support a Hydrogen Economy (Pg 4, BEIS, June 2022)

STRENGTHS

- UK hydrogen, energy security and decarbonisation strategies
- Government commitment to commercial development projects
- Credible plans for development of commercial scale production
- Access to suitable permanent CO2 stores
- Significant availability of offshore wind energy
- Significant cavern capacity for hydrogen storage
- Industrial commitment to develop capacity
- Broad range of suppliers of equipment, materials and services
- Internationally recognised UK capability in electrolysis technologies
- UK-based technology providers for blue hydrogen production
- Commitment to develop fuel cell technologies for automotive applications

WEAKNESSES

- Lack of clarity on supply chain development priorities
- Lack of widespead awareness of the opportunities arising
- Shortage of qualified producers of line pipe steel
- Shortage of UK manufacturers of specialist high-integrity valves and packaged equipment
- Shortage of suppliers able to support large-capacity, medium-pressure compression required for hydrogen transmission systems
- Limited UK suppliers that can provide CO2 compressor packages for transport of CO2 away from blue hydrogen plants for permanent storage

OPPORTUNITIES

- Widespread conversion of equipment and infrastructure to run on hydrogen
- Expand commercial-scale electrolyser capacity
- Exploit globally-recognised institutions for qualification of materials for hydrogen-service
- Develop UK compressor capability
- Develop capabilities in the conceptual design and engineering of salt caverns

THREATS

- European competition for green hydrogen manufacturing
- Lack of confidence for supply chain investment
- Competition from alternative net zero solutions
- International supply chains dominate UK supply opportunities
- Lack of high quality water availability
- Competiton for renewable energy capacity

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Identification and Analysis of Supply Chain Constraints
Supply Chains to Support a Hydrogen Economy (Pg 76, BEIS, June 2022)

CONSTRAINT	IMPACT ON SUPPLY CHAIN POTENTIAL	POTENTIAL MITIGATION
The extensive and disparate nature of the supply chain makes it difficult to identify how it will develop, limiting the potential to pursue business opportunities with confidence	Supply chain investment is inhibited due to difficulties in identifying and making the case for attractive opportunities	Separately address different elements of the supply chain (under wider framework)
Lack of confidence in the availability and capability of the required constuction resources to build hydrogen economy infrastructure	Supply chain investment inhibited as it is not clear that manufacturing plant and infrstructure will be available when needed	Mapping of construction capability Investment in skills development
Lack of CO2 shipping infrastructure to support blue hydrogen manufacturing	Blue hydrogen manufacturing investment inhibited as there is no readily available solution for carbon dioxide emissions	Prepare holistic sector development programme and investment plan
Lack of hydrogen shipping infrastructure to support international trade	Supply chain opportunities related to exporting inhibited	Prepare holistic sector development programme and investment plan
Lack of hydrogen infrastructure to support end user market developments	Supply chain investment is inhibited due to difficulties in identifying and making the case for attractive opportunities	Prepare holistic sector development programme and investment plan
Limited focus on developing hydrogen application supply chains, affecting business cases for hydrogen supply chain development	Supply chain investment is inhibited due to difficulties in identifying and making the case for attractive opportunities	Prepare holistic sector development programme and investment plan
Unproven supply chain capability inhibiting the ability of companies to pursue technology development	Slow development and introduction of technology	Demonstration projects

These all reflect the embryonic nature, complexity and wide scope of the hydrogen supply chain and highlight a lack of clarity and confidence in how the supply chain will develop. This, in turn affects how individual companies, which have proven approaches to business development will pursue opportunities and how UK industry can win a significant share. How can investment decisions be made regarding specific products or services when it is not clear how relevant supply chains and markets will develop? Leadership in the development of the UK hydrogen supply chain and prioritisation of areas for growth and investment is, therefore, required.

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Identification and Analysis of Constraints in the Business Environment Supply Chains to Support a Hydrogen Economy (Pg 77, BEIS, June 2022)

FACTOR	CONSTRAINT	IMPACT ON SUPPLY CHAIN
Demand Conditions	Lack of established market infrastructure, activity and demand	Limited supply chain drivers
	Lack of clarity on priorities for domestic market demand	Supply chain development inhibited
	Overseas market attitude to UK hydrogen that may have come from non-renewable sources	No export market
	Global competition for supply chain investment	Lack of UK supply chain development
	Lack of demand in transport - linked to technology readiness of vehicles	Supply chain development inhibited
	Major challenge to certify automotive (fuel cell) hydrogen specification fully	Supply chain development inhibited
	Lack of regulations and standards for hydrogen combustion in transport	Hydrogen clarity on market need
	Hydrogen transport options for international trading unclear	Lack of rationale for sector / supply chain development
	Hydrogen fired gas turbines not commercially available	Delay in power generation market development
Factor Conditions	Lack of confidence that the required infrastructure will be established	Lack of rationale for sector / supply chain development
	Lack of UK rail testing facilities for hydrogen traction	Product demonstration and supply chain development inhibited
	Decision on conversion of NTS to hydrogen vs new-build hydrogen backbone needed	Supply chain development inhibited
	Access to hydrogen based on clusters	Need to have a geographical approach to end use
	Regulations, codes, and standards either not in place or not appropriate	Supply chain development inhibited
	There are no UK certification facilities for hydrogen components	Cost of entry and certification for new components is prohibitive for UK manufs
	Actual or perceived safety risks re ammonia and/or hydrogen storage and combustion	Limiting development and commercialisation
Firm Strategy	Lack of global hydrogen supply chain companies	Lack of focal points / drivers for supply chain development
	Lack of investment in UK manufacturing sector	Supply chain development inhibited
	Limited exploitation/commercialisation of strong R&D portfolio	Supply chain development inhibited
	Lack of insurance and certification for new supply chain players	No confidence in capabilities
Related Industries	Need engagement and buy-in across related key sectors - e.g. finance, insurance, etc.	Development and operation of the supply chain affected

The identification and analysis of constraints and barriers in the business environment, was structured using the four factors in Porter's Diamond Model37, a diamond-shaped framework that focuses on explaining why certain national industries are competitive internationally, while others might not. These factors are:

- Strategy, structure, and rivalry of companies in the sector
- Factor conditions - the natural, capital and human resources available
- Demand conditions – domestic and export demand and the complexity of demand
- Related and supporting industries - industries that supply, distribute, or are otherwise related to the industry being examined.

APPENDIX 2 – REGIONAL HYDROGEN CONTEXT

Hydrogen East state that, the Government needs to give due weight to early deployment of clean hydrogen, as well as blue, and not be over-focussed on industrial clusters using the existing gas network in places such as Humberside, Teesside, and the North-West. They recommend that the Government should create opportunity and growth across a variety of unique and disparate regions of the UK such as the East of England, allowing low-carbon hydrogen to be a significant and important contributor to a Net Zero Britain in the short to medium term.

The Government also needs to address the options within a framework that supports a whole-systems approach. In this regard, deployment of electrolysers could also provide a valuable source of local flexibility to the electricity system while playing an important role in supporting decarbonisation of larger transport in the region, in dispersed, often largely rural areas.

Hydrogen East believes low-carbon hydrogen development will be strongly influenced by local conditions, and lead to the formation of clusters with strong regional characteristics. This will reflect place-based opportunities (site availability, existing infrastructure, renewable surpluses and local use cases) and other decarbonisation measures being adopted locally to achieve Net Zero. These opportunities include developments that will arise from the need to decarbonise transport, especially larger vehicles and shipping, as well as local flexibility markets (and in which electrolysers could play a key role when local electricity supply is in surplus), delivering value to local networks by relieving energy supply bottlenecks and constraints. Most industry analysis also fails to consider the wide range of potential use cases that differ from region to region and which require urgent consideration if carbon budgets are to be achieved. [2]

[2] Developing a clean hydrogen cluster in the East of England, Hydrogen East 2022

Regional Hydrogen Production Conditions

There are many factors that could give rise to opportunities in the East of England, and Hydrogen East have already identified potential electrolyser opportunities across the region. These include:

- Multiple opportunities for hydrogen production from renewable and low-carbon resources.
- Nuclear development could open opportunities both as a user of hydrogen during construction and through the use of waste heat to produce hydrogen in the long term.
- Projects at Bacton and Felixstowe could catalyse wider adoption in the region.
- Early scaling of wind generation off the East Anglian coast, is also likely to increase renewable generation surpluses that could be used for electrolytic hydrogen production.
- Renewable technologies could be paired with electrolysers to provide an important “sink” to deal with excess power in a relatively constrained local electricity system.
- The capture of local flexibility values enabled by the “flexibility first” approach being adopted by the local distribution network operator, UKPN.
- Regional fossil-fuel generators, including “flexgen” operators, decarbonising fuel supplies.
- Hydrogen could potentially be used in parts of the existing gas supply system, which could see early development of “hydrogen neighbourhoods”.
- Additionally, as the whole region has relatively low dual-fuel penetration and large areas off the gas grid, electrolysers could provide a valuable supporting role, enabling a more coordinated approach to addressing mass electrification of heat and the removal of old polluting legacy oil-based heating systems.

Regional Hydrogen Consumption Conditions

On the demand-side, the region does not have significant industrial load like other hydrogen clusters. However, typical distances travelled and journey times are above average, and consequently there are real challenges facing transport electrification in many areas.

- Larger land-based transport in various forms (including trucks, gritters, municipal refuse wagons, rail) that present real decarbonisation challenges in a region that has high transport emissions.
- Norfolk and Suffolk is the focus for a number of large-scale projects and Nationally Strategic Infrastructure Projects (NSIPs). Appendix 4 shows the top 20 most valuable infrastructure projects planned for the counties of Norfolk and Suffolk in the period between 2020 and 2035.
- Rail is also relevant as Network Rail already has plans to convert three regional lines to hydrogen use.
- Shipping, starting with offshore Crew Transfer Vessels and port-side vehicles but extending over time to larger freight carriers and offshore Service Operations Vehicles combined with dock-side vehicles (including forklifts, cranes, haulage).
- Use in conjunction with gas generation sites in the region (Kings Lynn, Great Yarmouth) as well as at “flexgen” sites using fossil fuels (Stowmarket, Ipswich, Lowestoft), and operators are known to be considering decarbonisation pathways that could see early hydrogen blending possibly in combination with introduction of new hydrogen turbines
- Agriculture, with large numbers of large off-road working vehicles, and food processing.

All these use cases could offer early security of demand for low-carbon hydrogen from electrolysers and support the pull through of additional renewable generation and provide the basic elements of a regional low-carbon hydrogen market.

APPENDIX 3 – TECHNICAL SKILLS LEGACY FOR NORFOLK AND SUFFOLK JANUARY 2020 PYE TAIT

Norfolk and Suffolk is the focus for a number of large-scale projects and Nationally Strategic Infrastructure Projects (NSIPs). In sum, there are some 1,600 approved and planned infrastructure projects in the pipeline for 2020-2035. The projects fall into the following 7 project categories:

- Heavy Civils Construction
- Industrial Building
- Oil and Gas
- Power Distribution
- Residential Building
- Transport
- Water and Sewerage

The table below shows the top 20 most valuable infrastructure projects planned for the counties of Norfolk and Suffolk in the period between 2020 and 2035. All of these projects have been identified through the Glenigan database and supplemented through desk research into Nationally Significant Infrastructure Projects.

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PROJECT NAME	VALUE (£)
Sizewell C	10,000,000,000
East Anglian Hub (GRANTED)	6,500,000,000
Anglia Route Strategy CP6	2,164,000,000
Norfolk Vanguard	1,800,000,000
Norfolk Council Highway Services 2014-2021 (contract awarded)	780,000,000
UK Power Networks - East (EPN) RIIO	750,000,000
UK Power Networks - East (EPN) RIIO	750,000,000
Suffolk Council East of England Construction Framework 2019-2023	750,000,000
Highways Maintenance Block Funding (SR10 allocation) East of England	325,000,000
Highways Maintenance Block Funding (SR10 allocation) East of England	325,000,000
Kings Lynn B (GRANTED)	600,000,000
Suffolk Council Construction Framework 2016-2020 (Contract awarded)	500,000,000
Suffolk Council Highways Contract 2013-2022 (Contract awarded)	500,000,000
Clarion Honingham Largest Residential Development	485,100,000
Norfolk Boreas	400,000,000
Ipswich Northern Route Road	400,000,000
North Rackheath Eco Town Masterlead	375,000,000
Peel Ports Great Yarmouth Expansion	317,020,000
Local Enterprise Partnerships Allocation for Transport in Strategic Economic Plans - East of England	165,000,000
Local Enterprise Partnerships Allocation for Transport in Strategic Economic Plans - East of England	165,000,000

APPENDIX 4 – EAST SUFFOLK SUPPLY SIDE DEVELOPMENT OVERVIEW

PROJECT	LOCATION	LEAD	DESCRIPTION	CONSTRUCTION DATES (EST)
Conrad Energy Flexgen	Lowestoft	Conrad Energy	7MW Flexgen lead by Conrad Energy, permission granted in Dec 2020, installation commenced Q1 2022. Onsite hydrogen electrolyser, planning application submitted. Battery storage alongside the flexgen assets, planning application submitted.	Start: Q1 2022 Completion: Q4 2023
Hydrogen Electrolyser Demonstrator	Sizewell	TBC	SZC are working through a tender process to award the development of a small-scale electrolyser (less than 2MW initially). This project needs to scale to 10MW to meet peak requirements of SZC construction.	Start:TBC Estimated Completion: 2025
Freeport East Hydrogen Demonstrator	Freeport East	Hutchinson Ports (HPUK)	Working with UKPN an initial 1-3 MW electrolyser will be constructed for use within the port for HGVs or injection in the network. This will be built with the capabilities to scale up to a 5 - 25 MW electrolyser.	Start Date: TBC Estimated Completion: 2026

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