Humber Industrial Cluster: Supply chain

FINAL REPORT

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Executive Summary

1. Executive Summary

Maximising the benefits from the push for Net Zero

Significant amounts of investment will be required in the Humber region in order to develop a Net Zero industrial cluster. This represents a major opportunity for the region to attain a sustainable, future-proof growth path for its industrial base. Timelines for the creation of a Net Zero cluster in the Humber are challenging, with the ambition of achieving carbon neutrality by 2040. The coming years will therefore be a period of intensive activity and high demand for the goods and services needed to drive decarbonisation.

The Humber Industrial Cluster Plan (HICP), set up in January 2021, aims to support the transition towards a Net Zero cluster by 2040. The cluster is based on a roadmap of multiple projects which are set to commence construction in 2024.

This report focuses on Lot 7 of the cluster plan – Supply Chain. In order to ensure that regional and national economies maximise the benefits from the anticipated investment, and that low-carbon projects can be completed on time and to budget, local supply chains should be able to meet a significant and growing proportion of the parts and materials requirements for decarbonisation projects in the Humber.

Purpose of this study

This study assesses the readiness of supply chains to meet the demands of the decarbonisation programme in the Humber cluster and identifies steps that need to be taken to ensure local supply chains play their full role in creating a Net Zero cluster. Specifically, it:

- Provides an indication of overall demand for parts and materials to develop the first phase of decarbonisation projects in the region (assumed to be the eligible projects for Phase 2 of the BEIS Cluster Sequencing Competition);
- Assesses the current readiness of local supply chains to meet demand;
- Identifies key risks which may prevent local supply chains playing a full role in the development of a Net Zero industrial cluster in the Humber; and
- Develops recommendations to overcome these risks and ensure that local benefits are maximised.

Key findings

Future supply chain requirements

- There will be a large increase in the parts and materials demand from the Humber cluster as Net Zero projects move into their development and construction phase. There is significant overlap in the equipment demands of different technologies e.g. CCS kit, hydrogen projects and low-carbon gas networks will all need turbines and compressors which will heighten demand and could highlight supply constraints.
- Wider UK low carbon projects (such as those in other clusters and Hinkley Point C) will increase pressure on supply chains (due to the increase in demand), at a time of adjustment to new global realities e.g. Ukraine war, COVID-19.
- It is hard at present to assemble an aggregated, quantified view of demand for parts and components, reflecting the fact that Net Zero projects in the region are early in their development and have not fully identified requirements. Other work is ongoing to understand the aggregate picture e.g. by Advanced Manufacturing Research Centre (AMRC): this should be used to inform decisions around supply chain areas to prioritise for support/strategic investment.

1. Executive Summary

Supply chain capabilities

- As with demand for parts and materials, it is hard to get a clear sense of supply chain capabilities at present. Although there have been a number of supplier days in the region, which have been good for raising awareness of upcoming projects among potential suppliers, this has not been the appropriate forum to collect granular, robust data on supplier capabilities. The full picture will likely become clearer when formal procurement processes for Net Zero projects commence.
- Based on stakeholder views and the findings of the literature review, it appears that, while there are some areas of strength in UK supply chains for key technologies such as CCS and hydrogen e.g. planning, technical engineering, there are areas where there is little UK manufacturing capability (these include large components such as compressors). The UK will therefore need to take strategic decisions around whether the benefits of a UK manufacturing capability in these areas outweigh the costs of the strategic Government intervention required to drive industry investment in new facilities.
- Stakeholders distinguished between supply chain *capability* and *capacity:* whereas the UK may have firms which can produce equipment for Net Zero projects, it is unclear whether they will be able to produce the volumes required within tight timeframes and remain cost competitive.

Key risks

Stakeholder engagement identified a number of risks which could affect supply chains' ability to deliver Net Zero projects in the Humber region. These are summarised below:

- **Uncertain demand makes it hard for suppliers to make the required investments:** stakeholders indicated that a lack of long-term certainty around Government support for Net Zero projects, and the early stage of Net Zero projects (such that technical requirements are not clear), results in suppliers not having the necessary comfort to make investments to scale up production.
- **Smaller suppliers and firms are often excluded from the current project contracts:** Small and medium enterprises (SMEs) can only deliver parts of the large Net Zero projects planned in the Humber and on an uncertain and short notice basis. Large emitters use Engineering, Procurement and Construction contractors (EPC) to act as the principal contractor and engage with subcontractors for certain work scopes.
- **Collaboration between suppliers is difficult:** Whereas collaboration could be an effective means of widening the supply pool and attracting entrants, stakeholders suggested that some larger EPCs may be reluctant to collaborate with SMEs since they view them as competitors.
- **There is a lack of understanding of the aggregate supply and demand picture for key parts and materials:** although there has been extensive engagement with suppliers on the part of emitters, for example through supplier days, emitters are not yet at the stage where they can provide suppliers with a detailed specification and supply chain requirements.
- **There is a lack of incentive to increase UK levels of content:** The government has incentivised clusters to achieve a minimum UK content target of 60%, however there are currently no binding UK content requirements for Net Zero projects, and EPCs may find it cheaper and more convenient to use their existing global supplier networks rather than familiarise themselves with local supply chains. This is particularly relevant given the urgency of the first wave of Net Zero projects (scheduled to commission by Q4 2026 / Q1 2027).

1. Executive summary

Recommendations

We have developed a series of recommendations aimed at addressing key risks we have identified. These can be summarised as follows:

Table 1: Summary of recommendations

Recommendation	High-level summary of actions
R1: Set clear guidelines for UK content There is a lack of tangible targets and a mature regulatory framework for UK content in government publications. As a result, there is minimal direction from project developers to prescribe local content targets in their supply chains.	National government: Establish transparent frameworks that set preferred percentage levels for UK content and associated funding schemes. Emitters/infrastructure developers: Provide more direction to EPCs and local contractors to prescribe local content into supply chain strategies (such as mandating ambitious UK content percentages in their EPC bids). Further, incorporate costs of developing UK content into contract fees. Industry (general): Collaborate and engage with government where possible to establish a feasible trajectory to higher UK content requirements.
R2: Promote development of modularisation facilities in the Humber. Given the benefits of adopting modular off-site construction techniques (improved efficiency and schedule certainty), there is a need to support the development, upscaling and efficiency of modularisation facilities in the Humber. This would put the UK in a good position to meet demand locally and become a future exporter.	Trade associations and industry bodies: Drive collaborations to promote investment. National government: Provide funding to de-risk associated capital investment. Emitters/infrastructure developers: Collaborate / share knowledge on innovative solutions and efficient approaches to modularisation. Also, invest in modern equipment to improve process efficiency. Local government and land owners: Collaborate to ease the burden of land purchase.
R3: Transparency on UK content and drive to promote opportunities There is a lack of transparency on exact supply chain pipelines, particularly on where parts are manufactured. This clouds visibility over UK content opportunities and over where the UK could realistically strengthen in time to deliver on Net Zero projects.	Industry: Publish information on supply chain content and UK capabilities. Collaborate to determine where the strengthening of UK content is achievable – sharing findings with government. National government: Make intentions to support low-carbon supply chains clearer through developing a framework for appraising and prioritising interventions. Develop business cases to provide support for investment in new manufacturing and modularisation facilities. Dialogue with potential investors where required.

1. Executive summary

Table 1: Summary of recommendations

Recommendation	Detail/Rationale
R4: Establish standardised supply chain demand mapping Aggregated supply chain requirements are not available for Net Zero projects in the region. The demand and supply side volumes and requirements need to be connected.	Emitters/infrastructure developers: Provide clarity over future project needs and communicate this to market. Suppliers: Provide clear appraisal of capabilities to deliver specific requirements once known. Third party (industry groups or LEP): Establish combined datasets combining demand and supply data to provide aggregate view of regional capabilities.
R5: Engagement with smaller suppliers and contractors Smaller suppliers and contractors have limited Net Zero know-how and capabilities, but are highly capable in core industrial skill sets required for Net Zero. Closer collaboration and engagement from operators / EPCs undertaking feed studies will ensure these suppliers and contractors are well-prepared and better utilised.	Emitters/infrastructure developers: Identify which areas of projects are suited to local suppliers and structure procurement so that smaller contractors do not face barriers to entry. Create a common database in which SMEs and smaller suppliers can register to various modules of projects. Smaller suppliers and contractors: Proactively engage with project developers through supplier days and other avenues available to ensure that capabilities to deliver Net Zero products are known.
R6: Establish a common cooperation framework between local companies. As demand requires strengthening of platforms for collaboration between suppliers (such as the existing Supply Chain Network), different parts of projects could be split so that capacities can be utilized more efficiently and smaller SMEs can be more involved in projects.	Third party (industry groups or LEP): Create more platforms for collaboration between suppliers e.g. supplier forum. Emitters/infrastructure providers: Structure procurement such that suppliers are able to form consortia to bid for different parts of projects.
R7: Standardisation of equipment and parts specifications If larger firms and engineering contractors agreed on the standardisation of equipment specifications required to deliver projects (and provide visibility to the supply chain), it would provide clarity and offer local supply chains a clearer view of requirements and routes for scaling up.	Trade associations and industry bodies: Develop collaborations with CCS developers and create forums to promote standardisation and transparency of equipment specifications across the UK supply chain. National Government: Integrate the vision of marketing a standardised UK CCS and Hydrogen Supply chain. Emitters/infrastructure providers: Share know-how and collaborate with the supply chain and wider stakeholders to agree standardised approaches.
R8: Provide end-use demand certainty to de-risk investment into the supply chain. There is a high level of uncertainty on the delivery and relative scale of some Net Zero projects. Firms are reluctant to invest in preparation prior to end-use clarity.	National government: Continue engagement with industry and establish clearer signalling on end-use demand for CCUS and hydrogen projects. Provide more regular updates to business models and incorporate feedback from industry where possible.

02

Introduction and methodology

2. Introduction & methodology

The purpose of this report

This study forms the output for Lot 7 of the overall Humber Industrial Cluster Plan – focusing on supply chain.

Significant amounts of investment will be required in the Humber region in order to develop a Net Zero industrial cluster. This represents a major opportunity for the region to attain a sustainable, future-proof growth path for its industrial base. Timelines for the creation of a Net Zero cluster in the Humber are challenging, with the ambition of achieving carbon neutrality by 2040. The coming years will therefore be a period of intensive activity and high demand for the goods and services needed to drive decarbonisation.

In order to ensure that regional and national economies maximise the benefits from the anticipated investment, and that low-carbon projects can be completed on time and to budget, local supply chains should be able to meet a significant and growing proportion of the parts and materials needs of decarbonisation projects in the Humber.

This study assesses the readiness of supply chains to meet the demands of the decarbonisation programme in the Humber cluster and identifies steps that need to be taken to ensure local supply chains play their full role in creating a Net Zero cluster. Specifically, it:

- Provides an indication of overall demand for parts and materials to develop the first phase of decarbonisation projects in the region (assumed to be the eligible projects for Phase 1 of the BEIS Cluster Sequencing Competition);
- Assesses the current readiness of local supply chains to meet demand;
- Identifies key risks which may prevent local supply chains playing a full role in the development of a Net Zero industrial cluster in the Humber; and
- Develops recommendations to overcome these risks and ensure that local benefits are maximised.

This study looks into the supply chain requirements and gaps of the low-carbon industry in the UK and in the Humber Region. It identifies supply chains through the different technologies planned for deployment in the Humber Cluster, and targets the different industries involved.

Methodology

The findings in this report have been developed in 3 stages:

- **Literature review:** publicly available sources regarding the capabilities of the relevant low-carbon supply chains in the Humber region, as well as the UK more widely, have been reviewed and insights identified. Where necessary, this has been supplemented by sources provided by Hull City Council and CATCH. Sources and their insights are summarised in Appendix 1. The findings of the literature review informed the topics which formed the basis for engagement with stakeholders (see below).

2. Introduction & methodology

- **Stakeholder engagement:** stakeholders with an interest/perspective on supply chain capability were identified based on the ownership of existing industrial assets and involvement in plans for the Net Zero industrial cluster. Structured interviews with stakeholders were held, focusing on parts and materials requirements, current supply chain capabilities and risks to local supply chains meeting demand for parts and materials. 31 interviews were held in total with stakeholders from various constituencies (infrastructure providers, national and local government, industrial and power emitters, EPCs, training providers, industry groups, consultancies). In addition, a stakeholder workshop was convened by CATCH with attendees drawn from supply chain organisations.
- **Quantitative analysis:** We have made a top down, indicative estimate of the volumes of parts and materials to deliver the first wave of Net Zero CCS investments in the cluster based on the available information. The basis for the estimate is a set of detailed assumptions made by VPI for its proposed CCS project at its Immingham plant in the Humber[1] and capex estimates provided by ECITB for CCS projects in the cluster. In terms of a bottom-up estimate for parts and materials requirements, this has not been possible to develop due to uncertainty from project developers and projects being in FEED design stage.

[1] Please note that the Immingham project has not been deemed eligible by BEIS as part of Phase 1 of the Cluster Sequencing Competition.

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Supply chain requirements to deliver Net Zero in the Humber cluster

3. Supply chain requirements to deliver Net Zero in the Humber cluster

Overview

To provide context for the assessment of supply chain capabilities in the Humber, a top-down estimate of the parts and materials capabilities in the Humber has been developed. The estimate uses published information and extrapolates from this for the anticipated Net Zero projects taking place in the cluster. An estimate for the supporting network infrastructure requirements (principally transportation networks for carbon dioxide (CO_2) and hydrogen) has also been included.

There is limited information regarding the parts and materials requirements for Net Zero projects in the Humber at this stage in the public domain. Stakeholders interviewed as part of the project were unable to supplement publicly available information, since projects have not completed FEED studies which would provide granular estimates.

The estimates here should therefore be treated as indicative at this stage. They cover only the initial stage of Net Zero deployment in the Humber (all projects are due to complete by 2027) and draws heavily on a single project's assessment of parts and materials requirements. Nevertheless it provides a useful indication of the scale of parts and material requirements which supply chains will have to meet within a very short space of time.

Approach to developing estimate of supply requirements

We have developed parts and materials estimates for:

- Carbon Capture Utilisation and Storage (CCS) equipment;
- Transportation infrastructure (CO_2 and hydrogen pipelines); and
- Energy production (power and hydrogen production).

Each is discussed in turn below.

1. CCS equipment

To create an indicative estimate of supply chain requirements, we have taken published data for the VPI project at Immingham in Humber. This project proposes to retrofit CCS equipment to an existing combined cycle gas turbine (CCGT) power station. The published data provides a granular breakdown of the required manufactured parts and materials volumes for civils/structural/architectural work. This is set out in Table 3 below.

The Engineering Construction Industry Training Board (ECITB) have provided a total capex estimate[2] for Net Zero CCS projects in the Humber region (£5bn). Of this total, around 40% is comprised of VPI Immingham costs. To give a total estimate of parts and material requirements for CCS projects in the region, we have scaled up the VPI Immingham requirement by (100/40)%.

[2] These are indicative early stage estimates and are not based on studies for the actual projects.

3. Supply Chain Requirements to deliver Net Zero in the Humber cluster

Table 2: Estimated parts and materials volumes for VPI Immingham[3]

Category	Part/ material	Volume (VPI)	Unit	Volume for VPI Immingham
Piping	Pipes	30	km	30km at 6 inch average width
Fabricated equipment	Air Cooled Heat Exchangers	200	piece	appr. 200 - Water, solvent and CO_2 coolers
	Plate Heat Exchangers (Stainless Steel)	9	piece	appr. 9
	Shell and Tube Exchangers (Stainless Steel)	5	piece	5x
	Direct Contact Cooler and Absorber (DCC)	2	piece	2x 18m Square slipform concrete built towers with 316 Stainless Steel lining, with internals and structured packing. DCC approx. 30m high & absorber approx. 60m high
	Pressure vessels and columns	23	piece	23x Up to 28m high x 8.8m Ø column; with structured packing 316L (low content of carbon) Stainless Steel or Carbon Steel +316L clad
	Storage tanks	3	piece	3x Carbon Steel + Stainless Steel lining, up to 2000 m^3
Rotating Equipment	Compressors	4	piece	4x Low Pressure & High pressure stage integrally geared centrifugal, 140 bar discharge, approx. 20MW Mechanical Vapour Recovery compressor approx. 6MW
	Steam Turbine Generator	60	MW	1 x 60MW
	Pumps	50	piece	50x Centrifugal ISO 5199 (International Organization for Standardization); Centrifugal API 610 (Application Programming Interface)
	Flue Gas Fans	4	piece	4x
Packaged / Misc Equipment	De-superheaters	4	piece	4x
Civils, Structural, Architectural	CFA Piles	3 800	Nr	approx. 25m long - 3,800 Nr.
	Concrete	17 000	m3	17,000 m^3
	Pipe racks	880	m	880 m length
	Duct support routes	600	m	600 m length
	Steelwork	3 400	t	3,400 tonnes

[3] Table Source: VPI Immingham - Post Combustion Carbon Capture Project

3. Supply Chain Requirements

This approach gives an aggregated parts and materials requirement for CCS as follows:

Table 3: Estimated parts and materials volumes for VPI Immingham extrapolated for all Humber projects

Category	Part/ material	Volume (VPI)	Unit	Humber total
Piping	Pipes (onsite)	30	km	75 km
Fabricated equipment	Air Cooled Heat Exchangers	200	piece	500
	Plate Heat Exchangers (SS)	9	piece	23
	Shell and Tube Exchangers (SS)	5	piece	13
	Direct Contact Cooler and Absorber	2	piece	5
	Pressure vessels and columns	23	piece	58
	Storage tanks	3	piece	7.5
Rotating Equipment	Compressors	4	piece	10
	Steam Turbine Generator	60	MW	150 MW
	Pumps	50	piece	125
	Flue Gas Fans	4	piece	10
Packaged / Misc Equipment	Desuperheaters	4	piece	10
Civils, Structural, Architectural	CFA Piles	3800	Nr	9500
	Concrete	17000	m3	42500
	Pipe racks	880	m	2200
	Duct support routes	600	m	1500
	Steelwork	3400	t	8500

2. CO_2 and Hydrogen pipelines

The Humber will also require networks to transport hydrogen from production facilities to offtakers as well as to take captured CO_2 out for storage under the North Sea.

Although the dimensions of the pipeline network are relatively well-understood, there remains uncertainty over the demands this will place on supply chains.

It is likely that a significant proportion of the network will be able to repurpose existing parts of the region's gas transportation infrastructure, rather than building new pipelines. This will reduce the demand for metal piping, although the requirement for valves and other regulating equipment e.g. compressors will remain. Table 6 below shows publically available information about the current assumptions for lengths and characteristics of the low-carbon pipeline infrastructure in the region.

3. Supply Chain Requirements

2. Gas transportation networks (ctd)

Table 4: Anticipated CO_2 and hydrogen pipeline projects in the Humber[4]

Project	length (km)	from	to	Onshore/ offshore	CO_2 / H2	Pipeline size
Humber Pipeline	103	Zero Carbon Humber	Endurance Store	offshore	carbon dioxide	The dehydrated and compressed CO_2 will be transported offshore via two new 28″, concrete-coated CO_2 export pipelines that will direct the dense phase fluid to the Endurance Store.
Humber Low Carbon Pipelines Scoping Route Corridor	25	Drax	Keadby AGI options	onshore	CO_2 / H2	CO_2 in an onshore pipeline up to 600 mm (24”) nominal diameter from industrial emitters to a secure offshore carbon dioxide storage facility with a capacity up to 17.8 million tonnes of carbon dioxide per annum (MTPA) and a Maximum Allowable Operating Pressure (MAOP) of 136 barg. Hydrogen in a pipeline up to 900 mm (36”) nominal diameter, with a capacity up to 10 Giga Watts (GW) and a Maximum Operating Pressure (MOP) between 50 to 75 barg.
	17	Keadby AGI options	British Steel AGI options	onshore	CO_2 / H2	
	38	British Steel AGI options	Killingholme AGI options	onshore	CO_2 / H2	
	10	Killingholme AGI options	Saltend AGI options (Humber Crossing)	onshore	CO_2 / H2	
	29	Saltend AGI options	Easington AGI options	onshore	CO_2 / H2	

3. Energy production projects

Achieving Net Zero in the Humber will also require new energy generation facilities e.g. Combined Cycle Gas Turbine (CCGT) and Steam Methane Reforming (SMR) hydrogen production units. In the table below, we indicate where there will be additional demand for parts and materials required for CCS kit in new CCGT and SMR facilities in the region.

This should not be considered an exhaustive list of equipment required to deliver Net Zero in the Humber, but it indicates components and materials where demand is likely to be particularly high across all projects.

[4] Table Source: Northern Endurance Partnership - Scoping Report for Offshore Environmental Impact Assessment. National Grid - Humber Low Carbon Pipelines. Scoping Route Corridor - the boundary within which the carbon dioxide and hydrogen pipelines would be developed. The information in this section is indicative and subject to further design refinement

3. Supply Chain Requirements

3. Energy production projects (ctd)

Category	Part/ material	Humber total	Required for CCGT?	Required for SMR?
Piping	Pipes (onsite)	75 km	YES	YES
Fabricated equipment	Air Cooled Heat Exchangers	500		
	Plate Heat Exchangers (SS)	22.5		
	Shell and Tube Exchangers (SS)	12.5		
	Direct Contact Cooler and Absorber	5		
	Pressure vessels and columns	57.5	YES	YES
	Storage tanks	7.5		
Rotating Equipment	Compressors	10	YES	YES
	Steam Turbine Generator	150 MW	YES	YES
	Pumps	125	YES	YES
	Flue Gas Fans	10		
Packaged / Misc Equipment	Desuperheaters	10		
Civils, Structural, Architectural	CFA Piles	9500		
	Concrete	42,500	YES	YES
	Pipe racks	2,200	YES	YES
	Duct support routes	1,500	YES	YES
	Steelwork	11,300	YES	YES

04

Supply chain capabilities

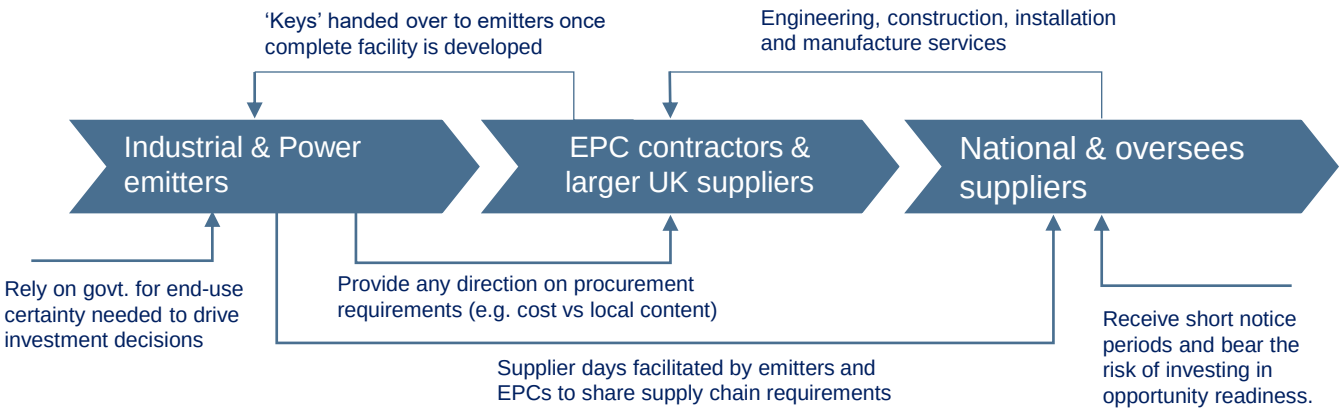
4. Supply chain capabilities

Overview

As outlined in Section 3, there are some parts and materials that will be in very high demand across all Net Zero projects in the Humber region e.g. pipes, turbines, and compressors. This demand is amplified when assessing requirements across other industrial clusters in the UK, as well as other major infrastructure projects with overlapping supply chains such as Hinkley Point C.

This section assesses the extent to which supply chains in the Humber region and in the UK more widely have the capacity and capability to meet these demands. It also assesses how 'joined up' different parts of the value chain are e.g. are buyers aware of local supply chain capabilities? Robust, responsive supply chains will be a key element in ensuring that the Humber and UK economies enjoy the full benefits from the low-carbon investment in the region.

Low-carbon supply chains in the Humber are complex and have several interdependent layers, the following structure is typically seen:



This complex structure creates significant limitations in analysing supply chain capability, particularly from a quantitative perspective. We have spoken to 11 emitters and EPC contractors but it has not been possible to undertake any bottom-up quantitative analysis of local supply chain capacity. This is mainly because projects are early in FEED stages, and the nature of competition for resources means that project-specific information is not being shared other than at a high-level in supplier engagement days. The main sources of information for this chapter are therefore mainly qualitative views from stakeholders and information obtained from the literature review.

Insights from the literature review

There is a significant body of literature in the public domain around UK supply chain capabilities to deliver Net Zero infrastructure. Literature on capabilities in the Humber region is more limited. Most analysis is qualitative in nature with limited attempts to measure or quantify.

We understand from our stakeholder engagement that there is ongoing work to provide a more granular understanding of supply chain capabilities, most notably by AMRC and the Carbon Capture & Storage Association (CCSA). As outputs from these studies emerge, they should be used to test the analysis and recommendations in this report and further refine the Cluster Plan.

4 .Supply chain capabilities

1. CCS capabilities in the UK

The literature suggests that the UK has capabilities in a number of products and services relevant to the CCS industry, including the **manufacture of pollution control equipment, machinery for filtering and purifying gases, pipes, chemical reactors and engineering, procurement, construction and project management services.**

The UK manufacture content of UK projects is relatively small however. Vivid Economics estimates that although UK content for project development, EPC, installation and operations exceed 90%**, the UK manufacture content of 'goods' bought is only 19.9% for new build power, 56.4% for industry and power retrofits, 24% for CO_2 transport and storage and 41.2% for hydrogen**. Based on this, about 60% of the total capex by 2035 (41bn) would be spent overseas – largely driven by the fact that the bulk of spend is associated with the manufacture and fabrication of parts.

There is limited accessible information on the supply chain readiness for CCS and Hydrogen. Some of our stakeholders engaged with have provided general insights and examples of where UK capabilities have been unable to supply industrial needs such that bids were sought from international suppliers – for example when sourcing pressure vessels or other large scale fabricated equipment. Furthermore, project developers emphasised long equipment lead times for orders (e.g. 12 months for vessels & 14 months for compressors) which UK suppliers are unable to commit to developing capability for without confirmed funding and project plans.

For CCS, some initial supply chain readiness analysis has been conducted by AMRC (who are undertaking a more detailed analysis to map supply with demand). The table below summarises their findings, with notes for areas where supply chain capability may be more limited:

Table 5: Summary of CCS supply chain readiness in the UK by component type[5]

Component	No. of manuf-actures	Capa-bility	Exper-ience	Supply chain readiness	Notes
CO_2 compressors					Few manufacturers produce equipment required, and companies with UK facilities have many operations based abroad.
Absorption columns					Estimated sizes of the largest absorption columns is too large to be produced by UK manufacturers.
Amine treatment					
CO_2 pipelines					
Flue gas blower					Whilst industrial fan manufacturers in the UK exist, there is uncertainty on whether large specifications can be met.
Direct contact coolers					As with absorption columns, estimated sized are too large.
CO_2 stripper columns					Existing manufacturers have relevant capabilities - however there is uncertainty on readiness of current manufacturers to adapt to Net Zero specifications.
Pumps					
Heat exchangers					
Gas-gas exchangers					
Crossover exchangers					

	Number of suitable manufacturers	*Capability*	*Experience*
	More than 5	*Sufficient knowledge*	*Fully experienced in this delivery*
	3 to 5	*Some but requires investment*	*Some experience*
	Fewer than 3	*Low with high investment required*	*Lack of experience*
	Insufficient information gathered during the analysis, due to lack of publicly available information. Direct contact with likely companies will be required in future for proper analysis to be performed.		

[5] Source: Nuclear AMRC - CCUS supply chain intervention strategy

4. Supply chain capabilities

Following on from their initial findings in the 'CCUS supply chain intervention strategy' report in March 2022, AMRC have been conducting extensive ongoing Humber-specific supply chain research to map the supply of key equipment and materials for CCS and Hydrogen projects (looking at over 750 supply chain components).

Supply chain market intelligence providers have produced some supply chain data to support emitters in the design and application phases of projects. For example, the Energy Industries Council (EIC) are equipped with a supply mapping database which identifies the CCS market in the UK, and have shared with us high level information to suggest there is a relatively small proven UK market accessible to the Humber, with only 28 companies with proven capabilities in the CCS capture space. More optimistically however, EIC's analysis suggests that there are 1,720 companies with the potential to move into the CCS space.

The Department for Energy Security and Net Zero (DESNZ) and the Carbon Capture & Storage Association CCSA are amongst other stakeholders who are conducting work internally (with a view of publishing findings) to better understand and map the supply and demand of CCS technology relevant to the Humber industrial cluster.

In summary, whilst previous work has shown that there is sufficient capability in the UK to deliver a proportion of CCS projects, there is currently a significant shortage of capacity when viewed in the context of the anticipated surge in demand once projects in the Humber, UK and Europe enter the construction phase and compete for the same resources. This issue is amplified further due the limited time for companies in the supply chain to invest in growth between now and the anticipated construction date for CCS projects in the Humber (~2024). In addition, there are significant issues for global supply chains at present which could affect the ability of Humber projects to source parts and materials e.g. COVID-19, the Ukraine war. These risks may not be fully reflected in existing literature.

2. Hydrogen capabilities in the UK

The UK Government has conducted extensive research into the UK's capabilities to take advantage of future growth in hydrogen demand both domestically and globally.

It notes significant existing strength in hydrogen supply chains, in particular:

- The UK hydrogen economy already contributes £4.5bn (sales) to the national economy through the activities of 8,100 companies. It is a net exporter (£1.74bn versus imports of £1.06bn) and has a forecast total growth rate of more than 50% over the next five years.
- The Pipeline Assets sub-sector has the second highest forecast growth rate for the UK of 53.1% over the next five years (after Professional Services – 55.2%). This sub-sector will benefit from activities to re-purpose or replace part of the current gas distribution system, which will be essential work to enable full deployment of hydrogen in the UK's energy systems.

4. Supply chain capabilities

2. Hydrogen capabilities in the UK (ctd)

- With regard to capabilities, the largest number of companies (55) identified in the region are from the Technical Services sub-sector, reflecting the very strong regional presence of project planning and technical engineering skills on the part of companies such as Arup, Jacobs, Ricardo and Wood plc. At the UK level, 12% of sales in this sub-sector are attributed to engineering services, representing £4.9m of sales and exports in excess of £1m[6].

However, it also identified a number of supply chain gaps where UK supply chain capability requires development to meet significantly increased future market demand, in particular:

- **Reformers**, as no UK suppliers of industrial scale reformers were identified.
- **Line pipe**, as UK manufacturers of line pipe are not, currently, qualified for production of the full range of higher grades of pipe for hydrogen service.
- **Electrolyser packages**, although there is one internationally recognised UK-based supplier of industrial-scale electrolyser packages for hydrogen services, future demand is expected to support several additional suppliers.
- **Hydrogen compressors**, as there is a shortage of suppliers able to support large-capacity, medium-pressure compression required for hydrogen transmission systems.
- **CO_2 compressors** as there are limited UK suppliers that can provide CO_2 compressor packages for transport of CO_2 away from blue hydrogen plants for permanent storage.
- **High integrity valves**, as the number of UK manufacturers is small.
- **Packaged dehydration units** because no UK manufacturers were identified.

There is limited/minimal work looking at the current capabilities of supply chains in the Humber to meet future demand for hydrogen parts and materials.

In summary, as with CCS, the review of existing literature around hydrogen supply chains suggests that, while there are some areas of strength, there are significant gaps in other areas.

Insights from stakeholder engagement

Stakeholder engagement largely corroborates the findings of the literature review, with parties highlighting areas of the supply chain with fewer UK firms. In addition, stakeholders highlighted the difficulty in forming a clear view of the strengths and weaknesses of supply chains at present, when the exact specifications of Net Zero projects (both in the Humber and nationally) have not been developed.

Key stakeholder insights are summarised in Table 6 overleaf.

[6] Source: BEIS (2022), 'Supply chains to support a UK hydrogen economy'

4. Supply chain capabilities

Table 6: Stakeholder views on supply chain capability

Insight	Detail	Implications
Specifications of equipment required are uncertain at present, creating a barrier for suppliers to prepare.	Due to projects being in the FEED design stage, equipment specifications are not yet confirmed for all projects. Most supplier engagement days conducted to date consist of high level information on requirements.	A lack of specific requirements leave suppliers unprepared and with less time to adapt their manufacturing operations. This uncertainty increases the risk of suppliers investing in growth.
UK manufacturing capabilities cannot cover the entire supply chain requirements.	Certain manufactured parts – especially large ones like turbines and compressors are generally produced by large international firms (such as Siemens and GE) and cannot be sourced locally or even in the UK.	The UK must identify the extent to which it wants to drive the levels of investment needed to create a base in large manufactured parts.
UK capability gaps are clear at this stage e.g. lack of foundries, but capacity gaps (can UK supply chains scale up to meet increased demand from Net Zero?) are less clear	On a high level, firms are generally aware what can be sourced locally (or in the UK) capability wise. However, supply chain capacities and volumes are not yet visible to most firms.	If firms consider local or UK capacities as a risk they may turn to foreign suppliers to ensure the delivery of projects.
There is high capability in the UK for fabrication	Whilst there is a lack of regional fabrication capacity in the Humber, there is a relatively mature UK fabrication sector from oil and gas operations.	There is the potential for fabrication plants to be developed in the Humber region for use by project developers.
Material prices are currently very unstable, with some reliance on material from Ukraine.	Raw materials that feed the supply chain of UK projects are commonly sourced from eastern Europe including Ukraine.	Unstable conditions and material prices will make it difficult for projects to plan and lock down prices.
The UK supply chain has a rich history of developing industrial solutions.	UK sectors such as the Oil & Gas sector (onshore and offshore) have a history of developing solutions for transportation, compression and refinement of gas.	There is potential to leverage supply chain capabilities from other sectors such as the Oil and Gas sector.

05

Key Risks to Supply Chains delivering Net Zero in the Humber

5. Key Risks

Overview

The previous sections have shown that while there are some areas of strength in low-carbon supply chains, there are also gaps, which will make it a challenge to ensure that the Humber and UK economies enjoy maximum benefits from Net Zero investment.

This section covers the underlying risks that may put the development of an adequate supply chain at risk. Recommended measures to mitigate the risks are set out in Section 6.

Key risks have been identified from stakeholder engagement. They have been grouped into themes as follows:

- UK & Local Content;
- Demand forecast;
- Phasing of Projects;
- Cooperation; and
- Uncertainties and Risks.

Stakeholder views

These are set out in the table below:

Table 7: Key risks identified by stakeholders

Ref	Insight	Detail	Implications
A. UK & Local Content			
A1	EPCs are not incentivised to use local content.	Larger EPCs which have international supply chains might use their established routes to fulfill project requirements. If they could procure more cost efficiently overseas, it would lead to a neglect of local supply chains.	There is a possibility EPCs will rely on their global supply chains after demands are mapped.
A2	There are no established guidelines or framework for local content from UK Government	The preference for UK content is implied in previous BEIS statements but more tangible targets to drive changes to firm behaviour are lacking.	If there is no tangible targets or incentives and funds, firms may place significantly less emphasis on driving higher UK or local content.
B. Demand forecast			
B1	Accurate demand figures can only be estimated after the projects complete FEED.	For future projects, equipment volumes can be assessed after the completion of the FEED stage. Currently, many project have not reached this.	Most of the projects have not completed FEED, resulting in the aggregated demand forecast being very challenging.

5. Key Risks

Ref	Insight	Detail	Implications
C. Phasing projects			
C1	The implementation of Net Zero projects will lead to significant bottlenecks.	The East Coast Cluster (Teesside and Humber) and Hynet are being developed simultaneously as Track 1 clusters. This could put pressure on supply chains. Construction phase for Track 1 projects is estimated to start in between 2023-24.	If similar projects are delivered simultaneously in different areas, there may be significant bottlenecks.
D. Cooperation			
D1	Projects are generally contracted via large EPCs.	In the region firms are reluctant to contract smaller EPCs. Larger EPCs often view smaller ones as competitors.	The potential of smaller EPCs may not be fully utilised on Net Zero projects.
D2	Smaller suppliers cannot scale up their capabilities prior to contracting.	Smaller suppliers cannot afford larger overheads, and as a result are not able to scale up capacities prior to contracting a project. However, they are often not contracted due to lacking capacity.	Smaller suppliers are not involved in the development of projects.
D3	Lack of standardized equipment requirements.	Firms generally prefer to use their own, customised equipment, even if the differences to that used by others are very slight.	Limited supply chain capacities and production streamlining.
D4	Historically projects are managed in a silo view.	Many suppliers are expressing a sense of ‘competition fatigue’ and not providing market intel to their clients around future capacities in order to stay focused on more immediate opportunities.	This ‘protectionist’ type of behaviour from firms limits cooperation and transparency on projects overall.
E. Uncertainties & Risks			
E1	Lack of clear signalling for low-carbon projects from the Government.	The Government does not provide a transparent, comprehensive framework for the low-carbon investments. High level expectations and targets are present, but detailed roadmaps and guidelines are not.	Without clear signalling about the funding model of the low-carbon projects in the Humber (and in general) investment in these types of projects are seen as a substantial risk.

06

Recommendations for Key Risks

6. Recommendations

Overview

The analysis in Section 5 identifies a range of barriers that affect the development of supply chains needed to deliver a Net Zero industrial cluster in the Humber and ensure that local economies and communities benefit from the high levels of investment that will be required.

In this section measures to mitigate these risks are described. The rationale for each recommendation is set out, together with immediate steps towards implementation, stakeholders involved, and which risks the recommendation addresses.

Table 8: List of Recommendations

Ref	Recomm-endation	Detail / Rationale	Actions to implement	Risk addressed
R1	***Set clear guidelines for UK content***	There is clear Government ambition for high UK content but a more tangible framework is needed to drive behaviour change.	National government: Establish transparent frameworks that set preferred percentage levels for UK content and associated funding schemes. This should include a trajectory to higher UK content levels so that projects are not put at risk as supply chains develop. Emitters/infrastructure developers: Provide more direction to EPCs and local contractors to prescribe local content into supply chain strategies. Incorporate costs of developing UK content into contract fees with contractors. Industry (general): Collaborate together and engage with government where possible to establish a feasible trajectory to higher UK content requirement. Be transparent on what is feasible and where UK content is an unlikely option.	A1, A2
R2	***Promote development of modularisat-ion facilities in the Humber***	Given the benefits of adopting modular off-site construction techniques (improved efficiency and schedule certainty), there is the need to support the development and upscaling of modularisation facilities in the Humber. This would put the UK in a good position to meet demand locally and become a future exporter.	Trade associations and industry bodies: Drive collaborations to promote investment into key modularisation facilities in the Humber. National government: Provide funding to de-risk capital investments in such facilities. Emitters/infrastructure developers: Collaborate to share knowledge on innovative solutions and efficient approaches to modularisation. Invest in modern equipment to improve process efficiency. Local government and land owners: Collaborate to ease the burden of land purchase for fabrication plant operators.	C1

6. Recommendations

Table 8: List of Recommendations

Ref	Recomm-endation	Detail / Rationale	Actions to implement	Risks addressed
R3	***Transparency on UK content and drive to promote opportunities***	There is a lack of transparency on exact supply chain pipelines, particularly on where parts are manufactured. This clouds visibility over UK content opportunities and over where the UK could realistically strengthen in time to deliver on Net Zero projects.	Industry: Publish information on supply chain content and UK capabilities. Collaborate to determine where the strengthening of UK content is achievable – sharing findings with government. National government: Make intentions to support low-carbon supply chains clearer through developing a framework for appraising and prioritising interventions. Develop business cases to provide support for investment in new manufacturing and modularisation facilities. Dialogue with potential investors where required.	A1, A2
R4	***Establish standardised supply chain demand mapping***	Aggregated supply chain demand requirements are not available for Net Zero projects in the region. The demand and supply side volumes and requirements need to be connected.	Emitters/infrastructure developers: Provide clarity over future project needs as soon as possible and communicate this to the market. Push suppliers to provide a clear assessment of their capabilities. Supply chain companies: Provide clear appraisal of capabilities to deliver specific requirements once known. Third party (industry groups or LEPs): establish combined dataset combining demand and supply data to provide aggregate view of regional capabilities.	C1
R5	***Engagement with smaller suppliers and contractors***	Smaller suppliers and contractors have limited Net Zero know-how and capabilities, however they are highly capable in the core skill sets required for industrial decarbonisation. Closer collaboration and engagement from operators and EPCs undertaking FEED studies will ensure these suppliers and contractors are well-prepared and better utilised.	Emitters/infrastructure developers: Identify which areas of a project are suited to the modular approach and structure procurement so that smaller contractors do not face barriers to entry. Engage supplier companies, and create a common database in which SMEs and other firms can register to various modules of the projects. Smaller suppliers and contractors: Proactively engage with project developers through supplier days and explore other avenues available to ensure that capabilities to deliver Net Zero products are known.	D1, D2

6. Recommendations

Table 8: List of Recommendations

Ref	Recomm-endation	Detail / Rationale	Actions to implement	Risks addressed
R6	***Establish a common cooperation framework between local companies***	As demand requires strengthening of platforms for collaboration between suppliers (such as the existing Supply Chain Network), different parts of projects could be split so that capacities can be utilized more efficiently and smaller SMEs can be more involved in projects.	Third party (industry group or LEP): - Create more platforms for collaboration and build on existing initiatives such as 'The Supply Chain Network' to facilitate additional networks as required. - Through a mapping exercise (see R3), identify where suppliers have complementary capabilities. Emitters/infrastructure providers: Structure procurement such that suppliers are able to form consortia to bid for different parts of projects.	D2
R7	***Standardisation of equipment and parts specifications***	If larger firms and engineering contractors agreed on the standardisation of various parts required to deliver projects (and provide visibility to the supply chain), it would offer local supply chains a clearer view of requirements and routes for scaling up.	Trade associations and industry bodies: Develop collaborations with CCS developers and create forums to promote standardisation and transparency of equipment specifications across the UK supply chain. National Government: Integrate the vision of marketing a standardised UK CCS and Hydrogen Supply chain Emitters/infrastructure providers: Share know-how and collaborate with the supply chain and wider stakeholders to agree standardised approaches.	D3
R8	***Provide end-use demand certainty to de-risk investment into the supply chain***	There is a high level of uncertainty about the delivery of some Net Zero projects and their relative scales. Firms are reluctant to invest in preparation prior to clarity on end-use demand.	National government: Continue engagement with industry and establish clearer signalling on end-use demand for Carbon and Hydrogen. Provide more regular updates to business models and incorporate feedback from industry where possible.	E1

A1

Appendix 1 - Literature review

A1 - Literature Review Summary

Document	Author	Summary
Hydrogen supply chain evidence base, Nov 2018	BEIS	Dataset of techno-economic assumptions around infrastructure requirements and associated costs of converting heating and industrial applications to hydrogen
CCUS supply chain mapping, May 2021	BEIS	Sets out how Government and industry can work together to harness the power of strong UK CCS supply chains
Analysis of the potential of bioenergy with carbon capture to 2050, Aug 2020	BEIS	As per title
Optimization of CCS supply chains in the UK: a strategic role for emissions reduction, Mar 2020	Leonzio et al	The study presents an innovative proposal to reduce CO_2 impact in the UK, a country rich in coal, which requires reduction of carbon dioxide emissions from flue gases as the easiest and best performing solution.
Design and optimization of a hydrogen supply chain using a centralized storage model, Mar 2020	Seo et al	This study involves the construction of a hydrogen supply chain optimization model using a centralized storage model that combines and consolidates flows of hydrogen from different production sites into integrated bulk storage
Carbon capture and storage from energy and industrial emission sources: A Europe-wide supply chain optimisation, Mar 2021	d'Amore et al	A Europe-wide carbon capture and storage supply chain is here optimised via a mixed integer linear programming framework
Hydrogen Supply Chain Opportunities, Feb 2019	Greater Manchester Business Growth Hub	GC Business Growth Hub (GC BGH) in Greater Manchester commissioned Gyron LLP (Gyron) to research and prepare a report about hydrogen supply chain opportunities, with a focus on Greater Manchester businesses. The national context for hydrogen is presented first, including economic data on current UK hydrogen activities.
Supply Chain Excellence for CCUS, Jul 2021	CCSA	This report demonstrates that not only will CCS be vital for achieving the UK's Net Zero goal, but also the significant role CCS will play in boosting the UK's prosperity and delivering the government's levelling-up agenda by supporting jobs and growth in the UK's industrial heartlands. It sets out recommendations to maximise this impact by developing supply chain strategies to deliver long-term benefit to the UK and its domestic projects, and to ramp up the export opportunities created though international deployment of CCS.
H2H supply chain event, Nov 2021	Supply Chain Network	Recording of supplier engagement event for H2H Saltend (hydrogen production project in Humber)
Capturing carbon at Drax-delivering jobs, clean growth and levelling up the Humber, Nov 2020	Vivid Economics	This report sets out the direct and wider economic benefits of the project, along with an analysis of skills and labour required to achieve the vision of the project.
Green Jobs Taskforce report, Jul 2021	BEIS	Findings and recommendations from green jobs taskforce
Supply Chains to Support a Hydrogen Economy, Jul 2022	BEIS	This report analyses supply chain requirements for hydrogen production, transmission, distribution and storage and the manufacture of fuel cells over the period to 2050 and identifies economic development opportunities for the UK.
Green Jobs and Skills Analysis report, Jan 2022	HEY LEP	The HEY LEP commissioned Energy & Utility Skills to produce an analysis of the "green" jobs and skills requirements likely to emerge across the HEY LEP region and the surrounding area over the coming years.

A2

Appendix 2 - Script for supply chain interviews

A2 - Script for supply chain interviews

Current operations

- What is your current approach to sourcing parts/materials/skills for projects in the Humber cluster?
- Who are your principal providers (max. 10) ?

Requirement	Provider	Location	Reliability/quality	Alternatives

- What are the major issues you are currently facing in sourcing parts and materials?
- If you outsource significant parts of your operations, do you have good visibility of supply chain resilience and capacity, or is this managed by your suppliers? If possible, can you provide any useful key contacts from the supply chain that we can speak to?

Future Net Zero projects

- How far advanced are you with procurement to deliver Net Zero projects?
- What will be your procurement model? (mainly inhouse or mainly outsourced)
- If you are planning a mainly outsourced model, do you have good visibility of future supply chain issues, or is there a supplier better placed to talk about this?
- Are you seeing any issues with procuring particular parts/materials/skills locally? How far afield are you having to look to source these? What impact does this have on project logistics/economics?
- What areas do you see as particular strengths for suppliers in the region/UK in terms of delivering Net Zero projects? What are the areas of greatest shortage/weakness?

Requirement	UK providers	Capacity	Overseas providers identified
		i.e. can UK providers meet all your needs?	

Addressing issues

- What do you see as the major causes of lack of coverage in local/UK supply chains- high cost base, overseas competition, lack of incentives for investment/innovation?
- What policy interventions (at local or national level) could help address these issues? Would the situation improve quickly enough to have a material impact on how Net Zero projects are delivered?
- What collaborative approaches between commercial organisations are possible (within the constraints of competition law)?